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Original Article

Knowledge, Attitude and Practice of Radiation Safety among Dentists in Ismailia City, Egypt

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Abstract

Background: Ionizing radiation is extensively used for diagnostic and therapeutic purposes, particularly in dental procedures. Dentists, therefore, belong to occupational groups chronically exposed to ionizing radiation.
Objective(s): This study aims to assess dentists' knowledge, attitudes, and practices regarding radiation safety.
Methods: A cross-sectional, questionnaire-based study was conducted among 271 dentists working at the Medical Complex Hospital, Faculty of Dentistry at Suez Canal University, and various private clinics and centers in Ismailia City, Egypt. Participants were selected through convenience sampling, and data were collected using a self-administered structured questionnaire.
Results: Among the participants, 53% were female, and 44.3% were aged between 25 and 34 years. In terms of knowledge, 73.1% demonstrated good understanding of radiation safety. Regarding attitudes, 57.9% disagreed that radiation safety policies and procedures were clear and understandable. Concerning practices, 43.9% reported conducting periodic maintenance of X-ray equipment, 53.5% confirmed performing annual maintenance on X-ray machines, and 33.2% had a radiation safety manual in their practice. Additionally, 49.1% reported usually standing behind a lead barrier during X-ray exposure, 38% frequently used lead aprons, and about half maintained a distance of 6 feet from the X-ray beam during exposure.
Conclusion: Approximately 75% of the dentists surveyed had good knowledge of radiation hazards and safety. However, the findings indicate gaps in certain areas of knowledge and practice, with many dentists expressing concerns about the clarity of safety measures at their workplaces. Given the continuous exposure to radiation in their profession, it is recommended to implement a mandatory, ongoing education program for dentists focusing on radiation hazards and the latest safety protocols.

Keywords: Radiation safety, awareness, KAP, Egyptian dentists

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INTRODUCTION

Ionizing radiation is widely used for diagnostic and therapeutic purposes [(1)]. Therefore, the knowledge of the radiation safety and biological effects of radiation should be evaluated and eventually improved upon to ensure the prevention of potential harmful effects among healthcare workers [(2)].

Dentists are among the occupational groups chronically exposed to ionizing radiation. Dentists use radiographs more often than any other health care profession [(3)]. The practicing dentist exposes, processes, and interprets the radiographs for diagnosis, and monitoring treatment or lesion development [(4)]. So, radiographic machines and cone-beam computed tomography (CBCT) are more frequently being installed in dental clinics [(5)]. The dose of radiation received by the operating dentist or the patient from dental radiography depends on several exposure parameters such as collimation, digital or film-based imaging, the film speed, technique, and protecting barriers used [(6)]. Health effects from ionizing radiation can be grouped into deterministic and stochastic effects. The deterministic effect is dose-dependent and happens when a specific exposure threshold has been exceeded. Stochastic effect, such as heritable effect and cancer is a dose-dependent probability and results due to damage to DNA, with no-threshold dose [(7)].

While the radiation dose received from the dental radiographs is low, both patient and dentist are at high risk of stochastic effects. So, it is crucial to decrease the occupational exposure to ionizing radiation with avoidance of the accumulated dose to patient and dentist in their lifetime [(8)]. Generally, radiation protection is described as all activities directed towards minimizing radiation exposure of patients and personnel with a goal to minimize its harmful effects [(6)].

Occupational radiation protection necessitates both appropriate education and training for dental practitioners and the availability of suitable protective tools and equipment. Besides, occupational radiation protection is achieved by implementation of the International Commission on Radiological Protection (ICRP) principles including justification, optimization of protection and dose limitation. This demands the dentist to have a detailed knowledge towards ionizing radiation hazard and its protection measure [7,9]. Furthermore, an Egyptian survey conducted on dentists, interns, and dental students to evaluate knowledge, attitude, and perception (KAP) about Radiologic Protection and biological Hazards. Its results showed that the overall correct responses of general KAP towards radiation biological hazards ranged from 19.3% to 69.9%. Whereas the overall correct responses of KAP about radiographic protection ranged from 25% to 93.9% [10]. Additionally, Ahmed et al. (2019) stated that 97.4% of Saudi dentists possess good knowledge of radiation hazards, but their practice and attitude towards protection from radiation were rated as poor (75%) [11] . Meanwhile, Panwar et al. (2022) showed in their research that most Indian dentists tend to neglect proper implementation of radiation protection procedures [12].

These findings indicate that there are significant gaps in knowledge, attitudes, and practices concerning radiologic safety. highlighting a necessity for enhanced educational initiatives, training, and awareness campaigns centered on radiologic safety and biological risks in dental environments. Thus, a need arises to assess the knowledge, attitudes, and practices (KAP) of Egyptian dentists toward radiation safety in order to help dentists involved in the radiation field to protect themselves and the patients efficiently. It is to be noted that there have been few published data about the KAP of dental professionals in Egypt regarding radiation safety. Therefore, the present study aimed to assess dentists' knowledge, attitudes, and practices regarding radiation safety in Ismailia city, Egypt.

METHODS

Study Design

A cross-sectional study was conducted. Data collection was carried out from March to August 2023.

Study Setting and Population

The study was carried out on dentists working in the Medical Complex Hospital, Faculty of Dentistry Suez Canal University, and private clinics and centers in Ismailia city, Egypt.

Inclusion criteria:

- Both male and female dentists were included in the study.
- Egyptian dental general practitioners, postgraduate students, and specialists were included in the study.

Sample Size and Sampling Technique

The sample size was calculated using Epi Info Stat Calc software, version 7.2.4.0, prevalence of awareness of radiation safety among Egyptian dentists = 21.6% [10], a 5 % margin of error, and a 95% confidence level. The calculated sample size was 254 dentists. After adding 10% non-response rate, the total sample size increased to 280 participants. The obtained sample size was 271 dentists representing 97% response rate. Dentists were recruited in this study using a convenience sampling technique.

Tool of Data Collection

Data were collected by a structured self-administrated questionnaire. The questions of the questionnaire were gathered from previous studies [6, 10–16]. The questionnaire was in English and anonymous and voluntarily to apply. The main parts of the questionnaire included sociodemographic data such as sex, age, marital status, residence, current job, and years of experience. Knowledge about radiation safety including 16 questions about awareness of health effects of radiation, and protective procedures during exposure. Each correct response received a score of one, while a wrong or unsure response received a score of zero. Based on a cut-off point = 60%, dentists' knowledge was classified as poor level if the score was below 60% and good level if the score was above 60% [16].

Attitude toward radiation safety: It included questions about their opinion and feelings about workplace radiation safety measures and monitoring. Questions on safe working procedures were evaluated using a three-point Likert scale ranging from 3 (agree) to 1 (disagree), with a higher score indicating a good attitude and a lower score indicating a negative attitude. Practice of radiation safety: Items included in this section were related to the application of radiation safety during their practice.

The questionnaire was formed in English language; to assess face and content validity, the questions were revised by two experts, one in occupational health and the other is dentist radiology who revised the questionnaire to ensure that questions covered study objectives. A pilot study was carried out on 10 dentists to test the questionnaire to ensure language clearness and feasibility. Therefore, we changed two questions, and two questions were removed. Data derived from the pilot study was excluded from the final analysis.

Cronbach's alpha coefficient to assess reliability was calculated = 0.80 which indicated reliability of the questionnaire.

Data Management

Data was entered and analyzed by SPSS software program version 22. Qualitative variables as gender, job, questions of knowledge, attitude and practice

were displayed as numbers and percentages. Quantitative variables as years of experience and knowledge score were described as mean ± standard deviation, median and range. All numerical data were not normally distributed, therefore, Mann Whitney U test was used for bivariate analysis of numerical variables. For qualitative data differences Chi-square test was performed. Statistical significance was set as $p<0.05$.

Ethical Considerations

The study was conducted according to guidelines of Helsinki declarations. The study received approval from the Research Ethics Committee of Faculty of Medicine, Suez Canal University approval No. 5185# on 17/1/2023. The participants agreed on the ethical consent before starting to fill out the survey. The ethical consent agreement was a required section before the questions. The informed consent described the aim of the study, purpose of research, researchers' information, ensured confidentiality and voluntary participation. Questionnaires were anonymous. All administrative approvals were taken.

RESULTS

This study included dentists in the current study were 271 participants. Nearly half of responders (52.8%) were females. One hundred and twenty of the studied participants (44.3%) were aged 25 to less than 35 years. More than half of the included dentists (56.1%) were married. Regarding occupational data, 79 dentists 29.2%) reported that they work in Ismailia medical complex only, 141 dentists (52%) were working as general practitioner. The year of working experience ranged from 1 to 39 years with mean of 11.40 ± 7.05 years **(Table 1)**.

Regarding knowledge of included participants about X-ray hazards, 87.5% of dentists recounted that dental X-ray is harmful, 54.2% stated that X-ray has hazardous effects. Less than half (42.1%) of participants were aware that X-ray has detrimental and stochastic effects and 55% were aware that X-ray can be reflected from walls of the room. With regards to awareness of radiation safety measures; 45.8% of participants were aware of the radiation hazard symbol. In addition, 60.5% of participants answered that they are aware of the protection measures during using X‑ray machine. Moreover, 62.4% mentioned that they are aware of the ALARA (as low as reasonably achievable) principle. However, 195 participants (72%) correctly identified the full form of ALARA. In contrast to ALARA awareness, 74.2% of included dentists were not aware of NCRP (National Council on Radiation Protection and Measurement) /ICRP (International Commission on Radiological Protection) recommendations. Furthermore, more than half of participants (54.6%) correctly identified that 6 feet and 90°-135° is the ideal distance that operator should stand during dental radiographic exposure. 64.9% as well as 63.5% of participants correctly reported that high speed films reduce exposure, and the operator should wear personal monitoring badge; respectively. By asking if the operator should wear personal monitoring badges; 63.5% of participants answered yes. Ninety percent of dentists correctly responded that lead aprons with shields and time of exposure all together reduce radiation exposure. Additionally, 38% of studied dentists correctly selected 3 months as the minimum exposure duration for using personnel monitoring devices and 55% correctly chose 5.0 rems/year as the maximum permissible dose for occupationally exposure **(Table 2)**.

The mean of radiation hazards and safety knowledge score was 11.05 ± 2.56 with median of 11 ranging from 3 to 16. Furthermore; 198 dentists (73.1%) had good knowledge, and 73 dentists (26.3%) had poor knowledge **(Figure 1)**.

Table 1. Sociodemographic data of studied dentists

Sociodemographic variables	Dentists (n=271) No. (%)
Sex	
Male	128 (47.2)
Female	143 (52.8)
Age Category	
25-	120 (44.3)
35-	85 (31.4)
45-	51 (18.8)
55-65	15 (5.5)
Marital status	
Unmarried	119 (43.9)
Married	152 (56.1)
Residence	
Urban	169 (62.4)
Rural	102 (37.6)
Place of work	
University hospital	74 (27.3)
Ismailia medical complex	79 (29.2)
Both	34 (12.5)
Private clinics and centres	84 (31.0)
Current job	
General practitioner	141 (52.0)
Postgraduate student	54 (19.9)
Specialist	76 (28.0)
Years of experience	
mean ± SD	11.40 ± 7.05
Median (Range)	10 (1-39)

SD: Standard Deviation

Regarding the attitude of studied dentists about workplace radiation safety, 157 dentists (57.9%) disagreed that policies and procedures of radiation precautions are clear and understandable, as same as 57.9% disagreed that workplace policies and procedures related to radiation protection are established on current regulations. Moreover, 55.7% of studied dentists reported that they disagreed about feeling safe while caring for patients requiring radiation precautions versus

22.9% who agreed. Besides, the percentage of participants who did not feel confident regarding their radiation exposure monitoring was higher than who felt confident (53.9%, and 12.9%; respectively). However, 43.5% agreed that using collimators and filters in dental radiography is important **(Table 3)**.

Table 2. Knowledge of studied dentists regarding radiation safety

Knowledge variables	Dentists' correct answers (n=271) No. (%)
If dental X-ray is harmful	273 (87.5)
Awareness of hazardous effect of X-ray	147 (54.2)
Awareness of detrimental and stochastic effects of X-ray	114 (42.1)
If X-ray can be reflected from the walls of the room	149 (55.0)
Awareness of the radiation hazard symbol	124 (45.8)
Awareness of the protection measures during using X‑ray machine	164 (60.5)
Awareness of ALARA (as low as reasonably achievable) principle	169 (62.4)
Awareness of full form of ALARA	195 (72.0)
Awareness of NCRP (National Council on Radiation Protection and Measurement) /ICRP (International Commission on Radiological Protection) recommendations	70 (25.8)
Ideal distance that operator should stand during dental radiographic exposure	148 (54.6)
If high speed films reduce exposure	176 (64.9)
If the operator should wear personal monitoring badges	172 (63.5)
Awareness of options that reduce radiation exposure	245 (90.4)
If digital radiography differs than conventional radiography in the harmful effects	164 (60.5)
Minimum exposure duration for using personnel monitoring devices	103 (38.0)
Maximum permissible dose for occupationally exposure	149 (55.0)

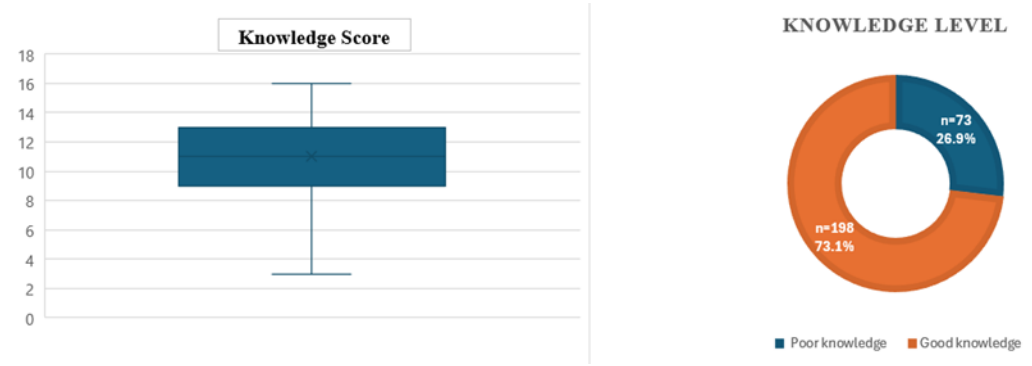

Figure 1. Radiation knowledge status among studied dentists (n=271)

Table 3. Attitude of studied dentists about radiation safety (n=271)

Attitude questions	Disagree No. (%)	Neutral No. (%)	Agree No. (%)
The Policies and procedures of radiation precautions are easy to understand and clear.	157 (57.9)	75 (27.7)	39 (14.4)
I feel in the workplace that policies and procedures related to radiation protection are established on current regulations.	157 (57.9)	75 (27.7)	39 (14.4)
I feel confident about steps that need to be taken when caring for patients requiring radiation precautions.	151 (55.7)	58 (21.4)	62 (22.9)
I feel safe while caring for patients requiring radiation precautions.	155 (57.2)	56 (20.7)	60 (22.1)
I feel confident regarding my radiation exposure monitoring.	146 (53.9)	90 (33.2)	35 (12.9)
Using collimators and filters in dental radiography is important.	103 (38.0)	50 (18.5)	118 (43.5)

With regards to practice, one hundred and seventy-three dentists (63.8%) reported that they attended basic lecture about radiation exposure. In addition, 43.9% revealed that they conduct maintenance of X-ray equipment, 53.5% informed that do maintenance for the X‑ray machine yearly, and 33.2% answered that they have radiation safety manual in place of dental practice. However, 60.5% mentioned that they are exposed to radiation several times a day. One hundred and fort five participants (53.5%) stated that they always use the dentist's hands while adjusting X‑ray tube. Moreover, 47.2% of the studied dentists mentioned that they use D film speed for periapical radiography and 58.3% confirmed that they use both walls constructed of gypsum wallboard and lead aprons to make the room of X-ray exposure safe. However, 53.5% of participants revealed that they do not measure radiation exposure (**Table 4)**.

Regarding adherence of dentists to radiation safety measures during practicing, 49.1%, 41.3%, 49.4%, 38.4%, and 45.8% of studied dentists reported that they frequently/very frequently stand behind a lead barrier while X-ray exposure, use lead aprons during X-ray exposure, stand 6 feet far away from primary X-ray beam while X-ray exposure, hold or display warning signs during X-ray exposure, and allow people to enter the room during X-ray exposure; respectively **(Table 5)**.

Table 4. Practice of radiation safety among studied dentists

Practice questions	Dentists (n=271) No. (%)
Ever attending a basic lecture about radiation exposure	
Yes	173 (63.8)
Conducting maintenance of X-ray equipment	
Yes	119 (43.9)
Frequency of maintenance X‑ray machine	
Yearly	145 (53.5)
Monthly	21 (7.7)
Weekly	30 (11.1)
Daily	75 (27.7)
Having radiation safety manual in place of dental practice	
No	79 (29.2
Yes	90 (33.2)
Do not know	102 (37.6)
Frequency of getting exposed to radiation	
Several times a day	164 (60.5)
Several times a week	59 (21.8)
Several times a month	12 (4.4)
None of the above	36 (13.3)
Using the dentist's hands while adjusting X‑ray tube	
Yes, always	145 (53.5)
Yes, occasionally	112 (41.3)
No	14 (5.2)
Film speed used for periapical radiography	
D	128 (47.2)
E	48 (17.7)
F	95 (35.1)
Measures taken to make the room of X-ray exposure safe	
Lead walls	40 (14.8)
Walls constructed of gypsum wallboard	47 (17.3)
Both	158 (58.3)
None of the above	26 (9.6)
Measuring radiation exposure	
Yes, always	33 (12.2)
Yes, occasionally	93 (34.3)
No	145 (53.5)

Table 5. Adherence of dentists to radiation safety measures during practice (n=271)

Practice measures	Never/ Rarely No. (%)	Occasionally No. (%)	Frequently/ very frequently No. (%)
Standing behind a lead barrier while X-ray exposure.	99 (36.5)	39 (14.4)	133 (49.1)
The dentist uses lead aprons during X-ray exposure.	131 (48.3)	28 (10.3)	112 (41.3)
If the participant within the same area, standing 6 feet far away from primary X-ray beam while X-ray exposure.	88 (32.5)	49 (18.1)	134 (49.4)
Holding or displaying caution of a warning sign during X-ray exposure.	95 (35.1)	72 (26.6)	104 (38.4)
Allowing of people to enter the room during X-ray exposure.	107 (39.5)	40 (14.8)	124 (45.8)

Among personal and job-related characteristics that may affect the level of knowledge, the dentists' current job was the statistically significant risk factor affecting level of knowledge. Although years of experience were higher among the good knowledge group (mean ± SD = 11.90 ± 7.20, median = 11) than the poor knowledge group (mean ± SD = 10.04 ± 6.51, median = 9). This difference was not statistically significant **(Table 6)**.

Table 6. Distribution of dentists' level of knowledge by personal and job-related factors

Risk factors	Level of Radiation knowledge (n=271)		p-value
	Poor knowledge (n=73) No. (%)	Good knowledge (n=198) No. (%)	
Sex			
Males	32 (25.0)	96 (75.0)	0.496
Females	41 (28.7)	102 (71.3)	
Age category			
25-	35 (29.2)	85 (70.8)	
35-	24 (28.2)	61 (71.8)	
45-	11 (21.6)	40 (78.4)	0.685
55-65	3 (20.0)	12 (80.0)	
Marital status			
Unmarried	31 (26.1)	88 (73.9)	0.771
Married	42 (27.6)	110 (72.4)	
Residence			
Urban	40 (23.7)	129 (76.3)	
Rural	33 (32.4)	69 (67.6)	0.118
Current job			
General practitioner	48 (34.0)	93 (66.0)	
Postgraduate studies	12 (22.2)	42 (77.8)	0.019*
Specialist	13 (17.1)	63 (82.9)	
Years of experience			
Mean ± SD	10.04 ± 6.51	11.90 ± 7.20	0.060[a]
Median (Range)	9.00 (1-29)	11.00 (1-39)	

SD: Standard Deviation, [a]: Independent-Samples Mann-Whitney U Test, * Statistically significant at *p* value < 0.05

DISCUSSION

The assessment of knowledge, attitude, and practices of dentists regarding radiation hazards and safety is crucial in ensuring the appropriate use of dental X-rays and minimizing potential risks to both patients and dental professionals. So, the present study was conducted to provide an insight into the dentists' knowledge, attitude and practices about radiation hazards and radiation safety in Ismailia city, Egypt. The findings of this study indicate that nearly three quarter of the studied group of dentists (73.1%) had good knowledge in this area. This demonstrates that a significant proportion of dentists have a well-rounded understanding of radiation safety protocols, which is essential for the protection of both patients and healthcare professionals. It is important to note that while our study reports a relatively high rate of knowledge, there is still room for improvement. This finding indicates that around one-quarter of the dentists surveyed may require further education or training in radiation hazards and safety. This finding was in line with studies conducted in Nigeria, and Saudi Arabia, which revealed that dentists had a high level of awareness regarding radiation hazards and safety, with reported percentages of 77.6% and 75.7%, respectively [17,18]. Nevertheless, this result was lower compared to a study conducted at various government and private dental clinics in Taif City, Kingdom of Saudi Arabia, where good knowledge toward radiation hazards and safety among dentists was reported to be 97.4% [11]. The variation in reported rates may be attributed to several factors, including differences in the study samples, methodologies, and criteria used to assess knowledge, training standards, and cultural and healthcare system differences.

Regarding the knowledge about the harmful nature of dental X-rays, an encouraging 87.5% of the surveyed dentists knew that X-ray exposure is harmful. This indicates a relatively high level of awareness among the dental community regarding the potential hazards of radiation. This finding is similar to an Egyptian study by Arnout (2014), and a Saudi study by Ahmed et al. (2023) where 87.5%, and 86% of dental practitioners generally were aware of the harmful nature of dental X-rays, respectively [10,18]. Additionally, this study reveals a noteworthy finding that approximately half of the participants (54.2%) recognized that the potential risks posed by X-rays are associated with both direct and indirect effects on somatic or genetic cells which was lower than that of a study conducted in Egypt, which accounted for 69.9 % [10]. Whereas it is concerning to note that less than half of the dentists (42.1%) displayed an understanding of the detrimental and stochastic effects of X-ray radiation. In contrast to this finding, previous studies conducted in India and Saudi Arabia revealed that 98.4% and 78.2% of dentists, respectively demonstrated awareness of these effects, [11,12]. Additionally, the participants reported a lower awareness of the radiation hazard symbol (45.8%), which acts as a visual warning for potential radiation hazard, compared to recent Saudi study among dentists (73.8%) [18]. This lack of awareness may result in unintentional exposure or insufficient protective measures.

The ALARA principle is a fundamental concept in radiation safety. Our findings indicate that 62.4% of dentists were familiar with this principle, which is

slightly lower than the previous study by Lawani et al. (2023) reporting a higher rate of familiarity among dentists in Nigeria (76.8%) [17]. Although this proportion is relatively encouraging, it is important to make further efforts to ensure that all dentists are familiar with and adhere to this principle in order to optimize radiation protection practices. Conversely, Ahmed et al., (2023), Yurt et al., (2022), and Arnout, (2014) reported that only 37.1% of Saudi dentists, 53% of Turkish dentists, and 33.3% of Egyptian dentists were aware of the ALARA principle, respectively [18,19,10]. Whereas, nearly one quarter (25.8%) of the surveyed dentists were found to be aware of the guidelines and standards for radiation protection provided by the NCRP or ICRP recommendations. The results of this study are consistent with the findings reported in a Nigerian study [18] , and an Egyptian study [10] where only 19.5% and 25% of dentists had sufficient knowledge of the NCRP and ICRP recommendations, respectively. This finding indicates a significant knowledge gap among dentists when it comes to established guidelines and best practices for radiation safety.

Also, our study revealed that more than half of the participants (54.6%) were aware of the ideal distance that an operator should maintain during dental radiographic exposure which is 6 feet distance from the x-ray source and at a position greater than a right angle (90-135° angle) to the primary beam. In contrast, the current study's finding was inferior to that of a study carried out in India, where 95.2% of participants exhibited similar knowledge [12] and higher than that of a recent Nigerian study (22 %) [18].

Mirroring previous studies in Nigeria, Saudi Arabia, and Turkey [17–19], our study shows that over half of the surveyed dentists could distinguish between digital and conventional radiography in terms of harmful effects. This finding indicates a reasonable level of awareness among the dental staff regarding the advantages of digital radiography, which generally results in lower radiation doses compared to conventional film-based techniques. Furthermore, approximately half of dentists reported that they are familiar with the maximum permissible dose for occupational exposure (5.0 rems/year). This implies that a significant number of dentists understand the importance of setting dose limits to protect individuals occupationally exposed to radiation.

In order to avoid being exposed to x-rays at work, it is necessary for individuals operating radiology equipment to employ simple protective measures [20]. One interesting finding from our research is that the majority of studied dentists indicated that they are knowledgeable about the various methods available to minimize radiation exposure, such as using lead aprons, lead shields, and managing the duration of exposure.

The findings of this study also shed light on the current status of radiation safety practices among dental practitioners. The present study demonstrated that nearly two thirds of the participants had attended a basic lecture about radiation exposure at some point. This result indicates that a significant proportion of dentists have received formal education or training regarding radiation safety. However, the study indicates that only 33% of dental practitioners have a radiation safety plan in place, suggesting a potential gap in implementing comprehensive safety measures. Regarding the use of hands while adjusting the X-ray tube, the study found that a majority of participants reported using their hands for this task. This closely aligns with the finding of Panwar et al. (2022) [12] where 86.5% of the dentists were negligent to this protocol and used hands when adjusting the tube. Our study also noticed that approximately 53% of participants reported using E or F film speed for radiography. Likewise, prior studies in India and Turkey revealed that E-films were used in clinics by 35.7% and 56.3% of dentists, respectively [12,19]. This finding indicates that a considerable number of dentists still opt for slower film speeds, which can lead to higher radiation doses for patients.

It is highly recommended that the person operating radiology equipment either remains outside the room or stands behind a suitable barrier or wall when exposed to radiation [20]. It is worth noting that approximately half of the participants frequently choose to stand behind a lead barrier during X-ray exposure, which demonstrates a positive approach to radiation protection. This finding is consistent with earlier studies conducted in Saudi Arabia and India ([11,12] but higher compared to the result obtained in Nigerian study (24.4%) [17].

On the other hand, only 41% frequently use lead aprons if they decided to stay within the same clinic during exposure which is higher than that reported in the Nigerian study [18]. While, Ahmed et al. (2023) and Panwar et al. (2022) [18,12] highlighted that majority of participants use lead aprons. If leaving the room is not possible or if there is no barrier present, the radiology operator will need to depend on the principles of distance and position [20]. This study underscores that around half of examined dentists often stand 6 feet away from the primary X-ray beam while within the same area. This result is in line with recommended safety guidelines and shows a good understanding of maintaining a safe distance during X-ray procedures. This finding corporates with previous research in North India [21]. However, another study conducted in in teaching dental hospitals of Peshawar, found that only 24.1% of dentists follow the distance and position

rule when taking radiographs [22]. The findings of this study also demonstrated a statistically significant association between the dentists' current job and the level of knowledge regarding radiation safety ($p<0.05$) with more general practitioner exhibited poor knowledge compared to postgraduates and specialists. This could be attributed to the comprehensive education on radiation safety included in postgraduate and specialist training programs, whereas general practitioners may lack focused training in this area. Furthermore, specialists who frequently utilize radiographic techniques in their practice may have more opportunities to stay informed about the latest practices and advancements in radiation safety. This result aligns with prior study on Turkish dentists that have also emphasized a significant association between current job and knowledge levels in the field of radiation safety [19].

It should be emphasized that there are priority recommendations every dentist should recognize it thoroughly as follows: Dentists should order radiographs based on the needs of treatment planning and diagnosis, and they should try their best to get radiographs from prior clinical dental examinations. When performing intraoral, panoramic, and cephalometric imaging, digital receptors rather than film should be used. For intraoral imaging, whenever feasible, rectangular collimation is highly advocated. Cone-beam computed tomography should only be used when lower-exposure methods are unable to provide the necessary diagnostic data [23].

Limitations

While the findings provide valuable insights, several limitations should be considered. First, the study relies on self-reported data, which is subject to recall bias and social desirability bias. Dentists might provide responses they perceive as more socially acceptable, leading to potential overestimation of positive attitudes, and good practices related to radiation safety. Second, findings may lack generalizability beyond Ismailia City and may not be universally applicable to all dental settings or regions, as variations in education, practice settings, and cultural factors could impact the knowledge, attitudes, and practices of dentists.

CONCLUSION AND RECOMMENDATIONS

In conclusion, about three quarters of studied dentists had overall good knowledge about radiation hazards and safety measures. However, the study findings highlight deficiencies in certain areas of knowledge and practices of dentists regarding radiation hazards and safety. Regarding the attitude of dentists, most dentists disagreed about safety measures in their workplace. So, it is recommended to establish a mandatory ongoing education program for dentists focused on radiation safety and the latest protocols and guidelines for radiation protection provided by NCRP or ICRP. In addition to periodic monitoring of radiation safety practices in workplaces.

In light of the study's findings, it is advisable to incorporate radiation safety into the dental curriculum emphasizing on understanding of the detrimental and stochastic effects of X-ray radiation, and the ALARA principle. The ministry of health should collaborate with radiation safety experts and conduct regular audits of all radiation departments in dental clinics to identify and rectify any deficiencies in safety protocols. In addition, periodic assessments or competency exams on radiation safety should be implemented to evaluate and reinforce dentists' comprehension and application of best practices. Moreover, it is suggested to carry out further research to assess the effectiveness of different educational interventions in improving dentists' understanding, attitudes, and practices related to radiation safety.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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