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Research Article

**AWARENESS AMONG DENTAL PRACTITIONERS TOWARDS
RADIATION HAZARDS AND PROTECTION IN ABHA CITY,
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Yara Alshehri⁵, and Lujain Alsahman⁶,**^{1,2,5,6} General Dentist, ministry of health, Saudi Arabia³Teaching Assistant, King Khalid University, Faculty of Dentistry, Saudi Arabia⁴Assistant Professor, Teaching assistant, King Khalid University, Faculty of Dentistry, Saudi Arabia**Abstract:****Background:** Dental X-ray is a fundamental part of dentistry. It contributes to the establishment of a definitive diagnosis and the proposed treatment plan.

Several modalities are used, ranging from conventional to cone-beam computed tomography with varieties of doses absorbed by the living tissue.

Methods: Self-structured questionnaire was established and distributed among 119 dental practitioners working in private and government hospitals through Google® forms. Final-year graduate students of King Khalid University in Abha, Aseer region, Saudi Arabia, were involved as well.**Results:** A total of 119 participants were included in this prospective survey with a mean \pm S.D.age of 33.30 ± 3.6 . There is a significant difference ($P < 0.05$) among the participants in their responses to the most sensitive organ to X-ray, whether the handheld portable X-ray unit was safer than the traditional one, and their knowledge about handheld portable X-ray units. Additionally, there is a significant difference in the responses to whether they used a monitoring device, the distance kept while taking X-rays, and whether they have the patients wear a thyroid collar.**Conclusions:** The overall extent of awareness of the participants of the dental X-ray hazards, protection measures being followed, and the modes of updating knowledge were found to be satisfactory. The study results will help practitioners to improve their knowledge and to consider protective measures strictly.**Keywords:** Dental radiology; Radiation hazards; Radiation protection; Dental X-ray; Radiation biology.**Corresponding author:****Rakan Al Thobaiti,**

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INTRODUCTION:

Background

Dental X-rays are one of the most beneficial tools in modern dental health care. They play a critical role in the process of treatment planning, disease progress management, and treatment outcome assessment in the maxillofacial region [1].

In recent decades, the field of dentistry has witnessed the introduction of cone-beam computed tomography (CBCT), which involves a higher exposure dose than conventional radiography [2, 3]. The use of dental radiography including conventional radiography and CBCT in daily dental practice is common practice.

It is well known that X-rays are a type of electromagnetic radiation, which emits energy. Accordingly, they can ionize tissues that they pass through and form free radicals [4,5]. These free radicals exert a biological effect on the tissue involved and lead to molecular changes [6]. The effect of radiation exposure can be divided into deterministic and stochastic effects. The stochastic effect is considered a direct function of dose. The potential occurrence of the effect is proportional to the increase in dose. It is different from the deterministic effect in that it does not have a dose threshold. An example is a cancer. On the other hand, the deterministic effect (non-stochastic) is a threshold in which the severity of the disease increases with an increase in the absorbed dose above a threshold [6, 7]. Although the radiation received by a person involved with dental X-rays is relatively low, the exposure over time accumulates and possibly creates a potential risk. A radiation safety protocol has been implemented in the practice, recommending dental practitioners to follow the ALARA concept: "as low as reasonably achievable" [4, 8]. To our knowledge, no previous studies have been conducted in the southern region of Saudi Arabia to assess the knowledge and attitudes of different dental practitioners. In this regard, we intended to conduct this cross-sectional study among dental practitioners at King Khalid University including undergraduates, interns, general practitioners, postgraduates, and postdoctoral staff working in the private sector and other government sectors to address their knowledge about radiation hazards from dental X-rays, the protection measures being followed, and knowledge updates.

METHODS:

Data collection

In this cross-sectional study, we gathered data from different groups of dental professionals. A

self-formatted

questionnaire was designed and submitted to the research committee at King Khalid University, College of Dentistry, Abha, Saudi Arabia, for approval. The study was approved by the ethics committee for research under the ethics number SRC/ETH/2018-19/005. Informed consent was included as well in the questionnaire form. The questionnaire was composed of four sections including demographic, radiation hazards, protection measures, and knowledge items. Section 1 reflected the demographic and educational background. Categories such as age, qualifications, and years of experience were addressed. Section 2 contained questions related to the knowledge of radiation hazards. We intended to assess the perception of the participants concerning whether they know if X-rays are harmful, the most sensitive organ, and the times they deliver X-rays to patients. (Table 2) illustrates the rest of the questions. Section 3 involved the questions regarding the protection measures against radiation risks. The inquiries regarding the protection measures such as lead aprons and thyroid collars are included in (Table 3). Section 4 was composed of one question addressing how the practitioners update their knowledge about radiation hazards, as shown in (Table 4). The survey was distributed among students of the dental school and the clinicians working in the private sectors and government hospitals using Google® forms.

Data analysis

The resultant data was entered into SPSS® software ver.22 software for analysis. Descriptive statistics (mean, S.D., frequency, and percentages) were computed; for inferential statistics, the chi-squared test was used to measure the degree of association (significant differences) among the variables of interest. A P value of less than 0.05 was considered significant.

RESULTS:

Among 119 respondents, the mean \pm S.D. age was 33.30 ± 3.6 years, and 76.5% were male, while 23.5% were female (Table 1). Among UGs (undergraduates)-level respondents, 100% had a government job; among interns, 97.78% had a government job. Concerning GPs (general practitioners), 75.00% were engaged in government jobs. Meanwhile, 100% and 85.71% of the postgraduate and postdoctoral participants, respectively, reported having worked in the government sector. Most of the UGs respondents (81.82%) had less than 10 years of experience. All of

the intern-level respondents and GPs-level respondents (100.0%) had Less than 10 years of experience. In the postgraduate category, 55.0% of the respondents had less than 10 years of experience,

while in the postdoctoral category, most of the respondents had between 10 and 30 years of experience (Table 1).

Table 1: Shows the different participants in relation to gender, working sector, and experience.

Group						
Variables	Category	Undergraduates	Interns	GP	Postgraduate	Postdoctoral
Gender	Male	81.82%	55.56%	91.67%	90.00%	85.71%
	Female	18.18%	44.44%	8.33%	10.00%	14.29%
Working sector	Private	0.00%	2.22%	25.00%	0.00%	14.29%
	Government	100.00%	97.78%	75.00%	100.00%	85.71%
Experience in years	<10	81.82%	100.00%	100.00%	55.00%	0.00%
	30-Oct	18.18%	0.00%	0.00%	45.00%	71.43%
	>30	0.00%	0.00%	0.00%	0.00%	28.57%

Our results show that approximately 57.1% of the respondents consider dental X-rays to be harmful, and 71.4% believe that children are more sensitive to radiation. In addition, 84% consider dental X-rays to be harmful to pregnant women, and 77.3% selected the thyroid as the most sensitive organ to dental X-ray radiation. Additionally, 35.3% believed that cone beam computed tomography (CBCT) produces more radiation, 24.4% thought that full-mouth intra-oral radiography produces more radiation, and 26.9% thought that panoramic radiography emits more radiation. The results show that 84.9% agreed that imaging is very important in the field of dentistry. Regarding the frequent exposure per week, 39.5%

reported that they consume dental X-rays many times per week. Currently, digital X-rays are popular in dental practice, and approximately 82.4% of our participants reported using digitally based over film-based X-rays. When asked about yearly maintenance and calibration, approximately 52.1% reported they do not follow the yearly maintenance and calibration of the X-ray machine. To the use of portable X-rays, 44.5% reported having the ability to handle the portable X-ray unit. Only 28.6% suggested that the handheld portable X-ray unit was safer than the traditional one regarding the radiation emitted (Table 2).

Table 2: Radiation hazards questions.

Dental X-ray is harmful to patients		
	Frequency	Percent
No	49	41.2
No idea	2	1.7
Yes	68	57.1
Children are more sensitive to radiation		
FALSE	20	16.8
No idea	14	11.8
TRUE	85	71.4
Total	119	100
Dental x-ray is harmful to pregnant women		
FALSE	15	12.6
No idea	4	3.4

TRUE	100	84
The most sensitive organ to dental X-ray radiation is		
Bone marrow	12	10.1
Brain	4	3.4
No idea	11	9.2
Thyroid	92	77.3
Total	119	100
Which one delivers more radiation		
Cone-beam computed tomography (CBCT)	42	35.3
Full mouth intraoral radiography	29	24.4
No idea	16	13.4
Panoramic radiography	32	26.9
How important imaging in the field of Dentistry		
Not important	2	1.7
Sometimes important	16	13.4
Very important	101	84.9
How many times do you carry out X-ray exposures for patients?		
Many times per day	50	42
Many times per week	47	39.5
Not at all	22	18.5
Do you usually use digital or film-based radiography?		
Digital-based	98	82.4

Film-based	21	17.6
Do you carry out yearly maintenance & calibration of the X-ray machine?		
No	62	52.1
Yes	57	47.9
Do you know about the handheld portable X-ray unit?		
No	28	23.5
No idea	38	31.9
Yes	53	44.5
Is the handheld portable X-ray unit safer than the traditional one regarding radiation emitted?		
No	23	19.3
No idea	62	52.1
Yes	34	28.6

Our study illustrates that only 42.0% of respondents know and follow the ALARA concept. Additionally, only 22.7% use radiation monitoring devices such as film badges and thermoluminescent dosimeters (Table 3).

Table 3: Protection measures questions.

I keep a distance of greater than 1.8 meters from the patient while taking x-ray:		
	Frequency	Percent
No	27	22.7
No idea	19	16
Yes	73	61.3
Total	119	100
Do I make my patients wear a lead apron		
No	35	29.4
No idea	5	4.2
Yes	79	66.4
Do I wear a lead apron		
No	73	61.3
No idea	4	3.4
Yes	42	35.3
Do I make my patients wear thyroid collar:		
No	57	47.9
No idea	6	5
Yes	56	47.1
I use the possible lowest settings of the parameters (exposure time, KvP, ma):		
No	29	24.4
No idea	37	31.1
Yes	53	44.5
I know and follow the ALARA concept (As low as reasonably achievable):		
No	25	21
No idea	44	37
Yes	50	42
Do you use radiation monitoring devices like film badges and thermoluminescent dosimeter:		
No	53	44.5
No idea	39	32.8
Yes	27	22.7

Becoming updated with the latest knowledge is important for remaining on track. Approximately 84.9% of the respondents agreed that continuing education courses that include a workshop and lectures is the best approach to having updated knowledge about radiation protection (Table 4).

Table 4: Opinions about updating knowledge.

In your opinion, the best approach to have updated knowledge about radiation protection		
	Frequency	Percent
Continuous education courses	101	84.9
self-study through internet	18	15.1

Concerning the comparison of radiation hazards among different categories of respondents, significant differences ($P < 0.05$) were observed for the following items: “The most sensitive organ to X-ray is”, “Is the handheld portable X-ray unit safer than the traditional one regarding radiation emitted?” and “Do you know about handheld portable X-ray units?” (0.000, 0.000, and 0.018, respectively, (Table 5).

Table 5: Comparison of Radiation hazards.

Group							
	Undergraduate	Interns	GP	Postgraduate	Postdoctoral	Chi Square vale	p- value
1. Dental X-ray is harmful to patients?							
Yes	54.55%	55.56%	55.56%	60.00%	71.43%	11.36	0.182
No	45.45%	44.44%	44.44%	30.00%	28.57%		
No idea	0.00%	0.00%	0.00%	10.00%	0%		
2. Children are more sensitive to radiation?							
Yes	90.91%	75.56%	61.11%	70.00%	71.43%	6.8	0.55
No	9.09%	11.11%	22.22%	20.00%	28.57%		
No idea	0.00%	13.33%	16.67%	10.00%	0.00%		
3. Dental X-ray might be harmful to pregnant women?							
True	100.00%	82.96%	83.33%	80.00%	85.71%	10.2	0.251
False	0.00%	9.63%	16.67%	20.00%	14.29%		
No idea	0.00%	7.41%	0.00%	0.00%	0.00%		
4. The most sensitive organ to X-ray is?							
Brain	0.00%	4.44%	2.78%	5.00%	0.00%	31.78	0.0001*
Thyroid	81.82%	73.33%	97.22%	55.00%	57.14%		
Bone	9.09%	4.44%	0.00%	35.00%	28.57%		

marrow							
No Idea	9.09%	17.78%	0.00%	5.00%	14.29%		
5. Which one delivers more radiation?							
Cone-beam computed tomography (CBCT)	27.27%	40.00%	30.56%	35.00%	42.86%	7.05	0.85
No idea	18.18%	15.56%	11.11%	10.00%	14.29%		
Panoramic radiography	27.27%	26.67%	36.11%	15.00%	14.29%		
6. How important the imaging in the field of dentistry?							
Not important	0.00%	2.22%	0.00%	0.00%	14.29%	11.9	0.152
Sometimes important	9.09%	20.00%	13.89%	5.00%	0.00%		
Very important	90.91%	77.78%	86.11%	95.00%	85.71%		
7. How many times do you carry out X- ray exposures for patients?							
Many times, per day	36.36%	46.67%	50.00%	30.00%	14.29%	9.4	0.303
Many times, per week	36.36%	31.11%	44.44%	45.00%	57.14%		
Not at all	27.27%	22.22%	5.56%	25.00%	28.57%		
8. Do you usually use digital or film-based radiography?							
Digital based	81.82%	91.11%	63.89%	95.00%	85.71%	13.7	0.1011
Film based	18.18%	8.89%	36.11%	5.00%	14.29%		
9. Do you carry out yearly maintenance & calibration of the X-ray machine?							
Yes	54.55%	35.56%	52.78%	55.00%	71.43%	5.2	0.263
No	45.45%	64.44%	47.22%	45.00%	28.57%		
10. Do you know about handheld portable X-ray unit?							
Yes	45.45%	26.67%	44.44%	70.00%	85.71%	18.5	0.018*
No	9.09%	35.56%	25.00%	10.00%	0.00%		
No idea	45.45%	37.78%	30.56%	20.00%	14.29%		
11. Is the handheld portable X-ray unit safer than the traditional one regarding radiation emitted?							
Yes	45.45%	31.11%	22.22%	20.00%	42.86%	30.4	0.0001*
No	9.09%	4.44%	16.67%	55.00%	42.86%		
No idea	45.45%	64.44%	61.11%	25.00%	14.29%		
*Significantly different							

Regarding the comparison of protection among different categories of respondents, we observed significant differences ($P < 0.05$) in the following items: “Do you use radiation monitoring devices such as film badges and a thermo-luminescent dosimeter?”, “I keep a distance of greater than 1.8 meters from the patient while taking X-rays”, and “Do I make my patients wear a thyroid collar?” (0.049, 0.009, and 0.0106, respectively, (Table 6).

Table 6: Comparison of Protection.

Group							
	Undergraduate	Interns	GP	Postgraduate	Postdoctoral	Chi-Square value	p-value
1. I keep a distance of greater than 1.8 meters from the patient while taking the x-ray							
Yes	72.73%	68.89%	38.89%	75.00%	71.43%	20.38	0.009*
No	0.00%	13.33%	47.22%	15.00%	14.29%		
No idea	27.27%	17.78%	13.89%	10.00%	14.29%		
2. Do I make my patients wear a lead apron?							
Yes	81.82%	68.89%	55.56%	70.00%	71.43%	11.698	0.165
No	9.09%	24.44%	44.44%	30.00%	14.29%		
No idea	9.09%	6.67%	0.00%	0.00%	14.29%		
3. Do I wear a lead apron?							
Yes	54.55%	33.33%	19.44%	50.00%	57.14%	13.36	0.1
No	45.45%	64.44%	77.78%	45.00%	28.57%		
No idea	0.00%	2.22%	2.78%	5.00%	14.29%		
4. Do I make my patients wear thyroid collar							
Yes	45.45%	57.78%	38.89%	30.00%	71.43%	18.84	0.0106*
No	9.09%	2.22%	2.78%	5.00%	28.57%		
No idea	45.45%	40.00%	58.33%	65.00%	0.00%		
5. I use the possible lowest settings of the parameters (exposure time, KvP, ma)							
Yes	45.45%	31.11%	47.22%	60.00%	71.43%	14.02	0.081
No	18.18%	24.44%	36.11%	10.00%	14.29%		
No idea	36.36%	44.44%	16.67%	30.00%	14.29%		
6. I know and follow the ALARA concept (As low as reasonably achievable):							
Yes	45.45%	40.00%	30.56%	55.00%	71.43%	7.83	0.45
No	9.09%	22.22%	27.78%	20.00%	0.00%		
No idea	45.45%	37.78%	41.67%	25.00%	28.57%		
7. Do you use radiation monitoring devices like film badges and thermoluminescent dosimeter							
Yes	18.18%	20.00%	13.89%	30.00%	71.43%	15.42	0.049*
No	54.55%	42.22%	58.33%	35.00%	0.00%		
No idea	27.27%	37.78%	27.78%	35.00%	28.57%		
*Significantly different							

DISCUSSION:

Although the impact of dental X-rays on the patients and the practitioners are considered minimal, it must not be ignored. Generally, dental clinicians need adequate training and updates in relation to the radiation hazards and the protection guidelines that they must follow. A prospective questionnaire study could provide in-depth information about this aspect.

Radiation hazards

Through the literature review, we found three studies assessing the knowledge and attitudes of dental practitioners towards radiation hazards and protection in Saudi Arabia [9-11]. Approximately 11 questions related to this section were directed to the assessment of the participants about their knowledge of radiation hazards. In our study, all dental practitioners generally agreed that dental X-rays are harmful to patients. The postgraduate students and postdoctoral staff represent 60% and 71.43% of the respondents, respectively. The percentage of undergraduate students, interns, and GPs were 54.55%, 55.56%, and 55.56%, respectively. Our results are in agreement with the previously published studies by Arnout and Jafar *et al.* [9], Arnout *et al.* [12], and Shah *et al.* [13], who reported that 67%, 88%, and 75% of their participants stated that dental X-rays are harmful, respectively. Also, our data agreed with the published results by Bahija *et al.* [10], who reported that 63.5% of dental students, 67.1% of dental staff, and 59.8% of dentists claimed that dental X-rays are harmful. Children may be more susceptible to the harmful effects of radiation than elderly people [14]. Our participants were questioned whether children are more sensitive to radiation. All of the dental practitioners agreed that children are more sensitive to radiation. Our result is also in agreement with the study published by Bahiaj *et al.* [10]. However, disagreements were found with the study conducted by Aravind *et al.* [15], who claimed that a low percentage of 22% of participants are aware that pregnant women and children are susceptible to radiation. About pregnant women, dental X-rays have potentially adverse effects, especially in the first and third trimesters. Our sample of dental practitioners was asked if dental X-rays, in general, posed harm to pregnant women. Our data show that all participants agreed that dental X-rays might harm pregnant women. Our results are in agreement with the data reported by Rani *et al.* [11]. However, Srivastava *et al.* [16] contradicted our results by stating that approximately 59% of their study sample claimed that dental X-rays are not contra-indicated in pregnant women. As radiation exerts some biological effects

on the human body, it is not unusual for different organs to be affected adversely such as the thyroid, brain, bone marrow, and gonads. We questioned our participants on the most sensitive organ to X-rays. All of our participants agreed that the thyroid is the most sensitive organ. Studies reported by Bahija *et al.* [10] and Rania *et al.* [11] stated that their participants agreed that the organ that should be protected most during dental X-rays is the thyroid. Accordingly, our results were consistent with theirs. Intra-oral and panoramic radiographs are routinely used in daily dental practice. CBCT is also used based on an individual basis. As all modalities are used, we decided to ask the dental practitioners which among the previously mentioned techniques can deliver more radiation. Only the interns and postdoctoral staff declared that CBCT delivers more radiation than the other modalities (40% and 42.86%, respectively). Also, 14.29% of the staff in our study stated that full-mouth intra-oral radiography delivers more radiation than panoramic radiography, contradicting the study reported by Bahija *et al.* [10] in which the majority of dental staff thought that panoramic radiography delivers more radiation. It is well known that dental X-rays provide more confidence in diagnosis in combination with clinical findings. We wanted to know the perception of the different practitioners about the importance of dental X-rays in their regular practice. All of them agreed that it is very important in their sequence of delivering treatment to their patients. Dental X-rays are considered supplemental in terms of diagnosis and the treatment plan. They could be used daily for different cases. The most frequent use was reported by interns and the GPs with 64.67% and 50%, respectively. This could reflect that the postgraduate students and postdoctoral staff are more cautious and judge the use of X-ray based on the case needs. Although film-based radiography is still used, digitally based radiography is becoming popular. The participants were asked whether they used conventional or digital techniques. All participants reported using digital techniques, with the highest percentage seen among the postgraduate students (95%). Our data are in agreement with the report by Bahija *et al.* [10]. They reported that all of the participants were in favor of using digital radiography over film-based radiography. Maintenance and calibration of the dental X-ray machine are important for obtaining reliable and accurate results. Because this has an impact on the reliability of the X-ray image, we tried to gather insight into the practitioner's perception of this issue. All of our participants reported that they follow yearly maintenance and calibration except for the interns. The interns scored poorly in this item

possibly because the period of internship is limited and not permanent. The use of handheld dental X-ray machines for intraoral radiography has been increasing over time. However, the application of the ALARA principle while using this modality might be violated [17]. We asked our participants if they knew about it. Approximately 45.45% of the undergraduate students and 37.78% of the interns reported not knowing about the portable X-ray. Education can improve their knowledge of this technique. After the participants were asked whether they know about the portable dental X-ray, we tried to reach them and detect whether they thought that the handheld X-ray is safer than the traditional modalities in terms of the radiation emitted. Understandably, the majority of the undergraduates and interns did not know about safety as they were not aware of the machine at all according to the previous question. Interestingly, the majority of GPs reported knowing this handheld technique, but they did not know about its safety compared with the traditional modalities. In addition, the staff was divided equally, as 42.86% scored “yes” and 42.86% scored “no” in terms of the radiation emitted compared with the traditional modalities.

Protection measures

Seven questions were designed to gauge the commitment of different dental practitioners to protection precautions. We found that most of the UG, interns, postgraduates, and postdoctoral staff (72.73%, 68.89%, 75%, and 71.43%, respectively) keep a distance of greater than 1.8 m from the patient while taking the X-ray. In contrast, the majority of 47% of GPs do not follow this rule. When the participants were asked about whether they have their patients wear a lead apron, it was obvious from the percentage that most of them were committed to using the lead apron for their patients. The participants were asked if they wear a lead apron while taking X-rays of patients, and we found that the majority of GPs and interns do not utilize this protective measure (64.44% and 77.87%, respectively). However, our results regarding the intern’s awareness of the lead apron contradict the results of a study in which the majority of interns were aware of the usage of lead aprons [18]. Our results are in agreement with the previous study published by Bahija *et al.* [10] concerning dental students and dental staff. They demonstrated that the majority of dental students and dental staff use a lead apron. However, our results disagreed with the study concerning dentists who we describe in our study as general practitioners. The majority of the general practitioner participants as well as the interns in our study reported not using lead aprons during X-ray

procedures (64.44% and 77.78%, respectively). Due to its proximity, the thyroid has potential sensitivity to dental X-rays [19], especially with the use of cone-beam computed tomography and computed tomography in the maxillofacial region. Although thyroid shielding might not be necessary regularly, when using some modalities or techniques, it seems needed. An interesting finding from our study is that the majority of undergraduate students, general practitioners, and postgraduate students demonstrated a lack of knowledge about the usefulness of the thyroid collar for their patients. Generally, the exposure time, mill amperage (mA), and kilovoltage are settings that control the amount of radiation delivered during X-ray examination. The kilo voltage should not exceed 90 kVp [18]. The participants were asked if they use the lowest possible settings of the parameters (exposure time, Kvp, and MA) during X-ray procedures. Only the majority of interns illustrated a lack of awareness about the usefulness of the lowest settings of the aforementioned parameters. On the other hand, the vast majority of the undergraduates, GPs, postgraduates, and postdoctoral staff follow the use of the lowest settings. The ALARA principle (as low as reasonably achievable) is crucial in terms of radiation protection [20]. It has been reviewed frequently as a result of the increase in knowledge of radiation and its effect on people. This concept emphasizes the optimization of radiation in practice [4]. In our survey study, we asked the participants whether they know and follow this concept. Interestingly, the majority of GPs 41.67% was not aware of it. In addition, 45.45% of the undergraduate respondents were not aware of it, while 45.45% of them mentioned they know and follow the concept. On the other hand, the other participants, including interns, postgraduates, and postdoctoral staff, demonstrated a high percentage of 40%, 55%, and 71.43% in terms of ALARA concept awareness. Regarding the GP results concerning ALARA, our results agreed with other reported studies that revealed an overall low percentage of awareness of the ALARA principle [9, 12, 16, 21]. Film badges and thermo-luminescent dosimeters are used to monitor the radiation exposure for the workers involved in radiation source places. We aimed to ask the participants if they use such monitoring devices in their workplace where dental X-rays are given to patients.

Interestingly, only postdoctoral staff reported using these devices 71.43%. In contrast, the majority of undergraduate students, interns, and GPs stated that they do not use them. Meanwhile, 35% of the

postgraduates reported that they either do not use the devices or lack awareness about them. We can conclude from these results on the use of dosimeters that education on how to utilize such monitoring devices is fundamental. The literature has reported that the use of dosimeters is low [22]. Dental students and some practitioners appear to be unaware of the cumulative radiation doses that could be explored and calculated upon using those monitoring devices [22].

Knowledge updates

The last part of our survey addressed the best approach to receiving updated knowledge about radiation hazards and protection. We noticed that most participants prefer continuous education courses to self-study through the Internet. Our data are in agreement with the results reported by Motwani et al. [23].

CONCLUSION:

The awareness of the participants included in the survey study was satisfactory to some extent. Postgraduate students and staff reported better awareness about radiation hazards and protective measures than the other participants. Continuous education in terms of knowledge improvement and protection implications can increase the level of awareness in the future.

Abbreviations

CBCT (Cone beam computed tomography)
GPs (General practitioners)UGs (Undergraduates)
MA (Milli
amperage)
kVp
(Kilovolt
ge peak)
ALARA (As low as reasonably
achievable)SD (Standard
deviation)
SPSS (Statistical Package for the Social
Sciences)

Declaration

Ethics approval & consent of the participants: The study was approved by the research committee at King Khalid University, College of Dentistry, under the number SRC/ETH/2018-19/005. The consent of the participants was obtained before study commencement and was included in the questionnaire's Google® forms.

Availability of data materials

The datasets used and/or analyzed during the current study are available from the corresponding author

upon reasonable request.

Competing interest

The authors declare that they have no competing interests.

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Author's contribution

HA: manuscript writing and results analysis. AAD: Abstract preparation and discussion writing. RS: Background writing and results writing contribution. YA: questionnaire distribution and conclusion writing. LA: questionnaire distribution and methods of writing. AM: questionnaire distribution.

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