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Awareness and Attitude Towards Radiation Protection and Safety among Dental Community in Ajilat, Sabratha, and Surman

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Abstract:

Dental radiography is an essential diagnostic and therapeutic tool in dental practice, requiring practitioners to have accurate knowledge of radiation protection principles and to implement safety protocols to ensure the safety of patients and the healthcare team. This study aims to assess the level of knowledge and compliance with radiation protection standards among dental practitioners in the western region of Libya (cities of Sabratha, Surman, and Al Ajilat), focusing on gaps in understanding and practical application of safety measures.

A descriptive cross-sectional study was conducted involving 108 practitioners from public and private clinics in the cities of Sabratha, Surman, and Al Ajilat. Data were collected using a structured questionnaire consisting of 41 items covering demographic characteristics, professional experience, technical knowledge, and protective practices related to radiation exposure. The questionnaire was distributed both in paper form during field visits and electronically via online platforms. Data were analyzed using **Excel** for descriptive analysis and testing relationships among variables.

Findings revealed that a significant proportion of participants (72%) were aware of the radiation hazard symbol and the importance of protecting the thyroid gland during imaging, yet 75% lacked knowledge of recommended radiation dose limits, and 84% were unfamiliar with the ALARA principle. A substantial deficiency was noted in the implementation of personal protective measures, with 75% not using protective barriers and 87% not employing personal dose monitoring devices. These indicators highlight a clear gap between theoretical knowledge and practical application.

The study underscores an urgent need to strengthen training and awareness programs in radiation protection, improve infrastructure, and support regulatory frameworks to ensure effective implementation of radiation safety standards. Focus should be placed on closing knowledge and practice gaps to better protect both patients and healthcare workers.

It is recommended to incorporate mandatory continuous training programs into educational curricula and professional development, enhance institutional oversight on the application of protective measures, and ensure the availability of personal protective equipment and dose monitoring devices across all dental facilities to guarantee a technically and environmentally safe working environment.

Keywords: Dentistry, Radiation Protection, Radiation Safety, Professional Knowledge, Protective Practices, Radiography.

الوعي والمعرفة اتجاه الحماية من الإشعاع والسلامة بين مجتمع طب الأسنان في العجيلات، صبراتة، وصرمان

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الملخص

تُعد الأشعة السينية السنية أداةً أساسية للتشخيص والعلاج في طب الأسنان، الأمر الذي يتطلب من الممارسين امتلاك معرفة دقيقة بمبادئ الحماية من الإشعاع وتطبيق بروتوكولات السلامة لضمان حماية المرضى وفريق الرعاية الصحية. تهدف هذه الدراسة إلى تقييم مستوى المعرفة والالتزام بمعايير الحماية من الإشعاع لدى ممارسي طب الأسنان في المنطقة الغربية من ليبيا مدن (العجيلات وصبراتة وصرمان)، مع التركيز على الثغرات في الفهم والتطبيق العملي لإجراءات السلامة.

تم إجراء دراسة وصفية مقطعية شملت (108) ممارسًا من العيادات العامة والخاصة في مدن صبراتة وصورمان والعجيلات. جُمعت البيانات باستخدام استبيان مُنظم مكون من (41) بندًا شملت الخصائص الديموغرافية، الخبرة المهنية، المعرفة التقنية، والممارسات الوقائية المتعلقة بالتعرض للإشعاع. وُزّع الاستبيان ورقيًا خلال الزيارات الميدانية وإلكترونيًا عبر المنصات الإلكترونية. وتم تحليل البيانات باستخدام **excel** للتحليل الوصفي واختبار العلاقات بين المتغيرات

أظهرت النتائج أن نسبة كبيرة من المشاركين (72%) كانوا على دراية برمز الخطر الإشعاعي وبأهمية حماية الغدة الدرقية أثناء التصوير، ومع ذلك فإن (75%) منهم يفتقرون إلى المعرفة بحدود الجرعة الإشعاعية الموصى بها، و(84%) غير ملمّين بمبدأ **ALARA**. كما لوحظ قصور واضح في تطبيق التدابير الوقائية الشخصية، حيث إن (75%) لا يستخدمون الحواجز الواقية، و(87%) لا يستخدمون أجهزة مراقبة الجرعة الشخصية. هذه المؤشرات تُبرز فجوة واضحة بين المعرفة النظرية والتطبيق العملي.

وتؤكد الدراسة على الحاجة المُلِحّة لتعزيز برامج التدريب والتوعية بالحماية من الإشعاع، وتحسين البنية التحتية، ودعم الأطر التنظيمية لضمان التطبيق الفعّال لمعايير السلامة الإشعاعية. ويجب التركيز على سد فجوات المعرفة والممارسة لحماية المرضى والعاملين في الرعاية الصحية بشكل أفضل.

وتوصي الدراسة بضرورة دمج برامج تدريبية مستمرة وإلزامية ضمن المناهج التعليمية والتطوير المهني، وتعزيز الرقابة المؤسسية على تطبيق التدابير الوقائية، وضمان توافر معدات الحماية الشخصية وأجهزة مراقبة الجرعة في جميع مرافق طب الأسنان، لضمان بيئة عمل آمنة تقنيًا وبيئيًا.

الكلمات المفتاحية :طب الأسنان، الحماية من الإشعاع، سلامة الإشعاع، المعرفة المهنية، الممارسات الوقائية، الأشعة السينية

Introduction

Since Wilhelm Roentgen's groundbreaking discovery of X-rays in Germany in 1895, radiology has evolved into an essential discipline within both medicine and dentistry, driving significant advancements in dental radiographic technology. With each year that passes, the application of ionizing radiation for diagnostic purposes, treatment planning, and patient follow-up has shown remarkable growth.

Given the well-documented adverse effects associated with radiation exposure, it is crucial to weigh the potential benefits against the harmful impacts it poses to both professionals conducting radiographic examinations and their patients. Numerous organizations globally have established protective guidelines, and clinical training is provided to dental students as part of their academic programs to inform them about radiation risks and methods for reducing exposure. Studies are continuously undertaken worldwide to assess the risk-benefit ratio associated with these ionizing radiations.

Although the exposure to ionizing radiation in dental practices is generally low, it still carries potential health risks for both patients and dental professionals. Understanding radiation protection protocols is essential for minimizing these risks. This research assesses the knowledge and attitudes of dental practitioners in Ajilat, Sabratha, and Surman towards radiation safety, with the aim of identifying areas that need improvement and suggesting strategies to enhance safety practices. To tackle this issue, a survey was conducted to gauge the awareness of dental health professionals in these regions regarding various radiation dose reduction methods, the upkeep of radiographic equipment, safety precautions for both patients and radiographers, and their overall knowledge of dental X-ray exposure levels

Methods

Study design and setting

This study was conducted as a descriptive cross-sectional survey aimed at assessing the level of knowledge and awareness regarding radiation protection practices among dental practitioners in the cities of Sabratha, Al Ajilat, and Surman. Data collection was carried out in July 2024 and included 108 practitioners working in both public and private clinics in these cities. Participants were selected based on inclusion criteria that targeted qualified healthcare providers specialized in dental radiology.

Data collection procedure

Data were collected using a structured questionnaire consisting of 41 items, developed following a comprehensive review of relevant literature. The questionnaire covered several domains including demographic information, educational background and professional experience, fundamental concepts of radiation safety, dose reduction strategies, protective practices for patients and staff, as well as technical aspects related to radiographic equipment

usage such as the type of image receptor (digital or analogue), exposure settings, presence of shielding walls, use of personal protective equipment, and the distance maintained from the radiation source during operation.
The questionnaire was distributed through two approaches: a paper-based survey conducted via field visits to clinics, yielding 70 completed responses, and an electronic survey disseminated via online platforms, with 38 responses collected. After data collection, responses were coded and analyzed using Excel for descriptive analysis and to examine relationships among study variables. Results were presented in tables and graphs to illustrate participants' awareness and practices concerning radiation protection standards.

Results
The result thus obtained was divided into the following categories:
Demographic Data

Table 1. Classification of the participants based on grouping**.**

Gender	Group										Total
	Undergraduate		At the graduation stage		After graduation		doctor		Assistant doctor		
	Count	%	Count	%	Count	%	Count	%	Count	%	
Male	2	1.85%	3	2.78%	4	3.70%	25	23.15 %	0	0%	33
Female	4	3.70%	6	5.56%	16	14.81%	39	36.11 %	9	8.33 %	75
Total	5.56%		8.33%		18.52%		59.25%		8.33 %		108

The classification of participants by educational and professional status, as shown in Table 1, reveals several notable trends. Among 108 participants, females represented the majority with 75 individuals (69.4%), while males numbered 33 (30.6%). Female predominance was observed across most groups, particularly among doctors (39 females vs. 25 males), assistant doctors (9 females vs. 0 males), and postgraduates (16 females vs. 4 males).
Regarding distribution by academic and professional stage, the largest group consisted of doctors (59.25%, n=64), followed by postgraduates (18.52%, n=22), participants at the graduation stage (8.33%, n=9), assistant doctors (8.33%, n=9), and undergraduates (5.56%, n=6). This distribution indicates that the sample primarily includes individuals with advanced educational or professional experience. The high female representation may reflect the growing role of women in medical and healthcare fields. Additionally, the predominance of doctors and postgraduates could influence the overall knowledge, attitudes, and practices reported in the study. Therefore, the composition of the study population should be carefully considered when interpreting and generalizing the findings.

Radiation Protection
The table presents the results of a set of questions related to radiation safety in dental imaging, reflecting varying levels of knowledge and awareness among participants.

Table 2. Participants' attitudes and practices in Radiation Protection

No.	Question	Response	Count	Percentage (%)
2	Are you aware of the radiation hazard symbol?	Yes	78	72.22
		No	30	27.77
3	In your knowledge, what is the most important organ to protect from radiation in dental imaging?	Thyroid gland	78	72.22
		Bone marrow	13	12.03
		Skin	9	8.33
		Gonads	8	7.40
5	The radiation dose from simple dental X-rays is completely safe and has no health effects?	True	51	47.22
		False	57	52.77
8	Should a patient have a prescription before a dentist performs an X-ray?	Yes	86	79.62
		No	22	20.37
9	Does every radiation exposure carry the possibility of harmful effects?	Yes	91	84.25
		No	17	15.74

A total of 72.22% of respondents reported being familiar with the radiation hazard symbol, while 27.77% were not, indicating a relatively good level of awareness that still requires further reinforcement. Regarding the most important organ to protect during dental X-ray procedures, the majority (72.22%) correctly identified the thyroid gland, while smaller proportions selected bone marrow (12.03%), skin (8.33%), or gonads (7.40%), suggesting accurate awareness among most participants, with some variation in responses.

In terms of the safety of radiation doses from dental imaging, 47.22% believed such doses are completely safe and have no health effects, whereas 52.77% disagreed, reflecting differing understandings of the effects of low-dose radiation. Concerning the need for a medical prescription before performing dental X-rays, 79.62% supported this requirement, while 20.37% did not, indicating an understanding of the importance of medical oversight.

Finally, 84.25% acknowledged that every radiation exposure carries the possibility of harmful effects, compared to 15.74% who disagreed, demonstrating a relatively high awareness of the principle that no radiation dose is entirely risk-free. Overall, the table indicates that participants possess good awareness in certain aspects, while highlighting the need to further improve understanding of low-dose risks and the importance of radiation protection.

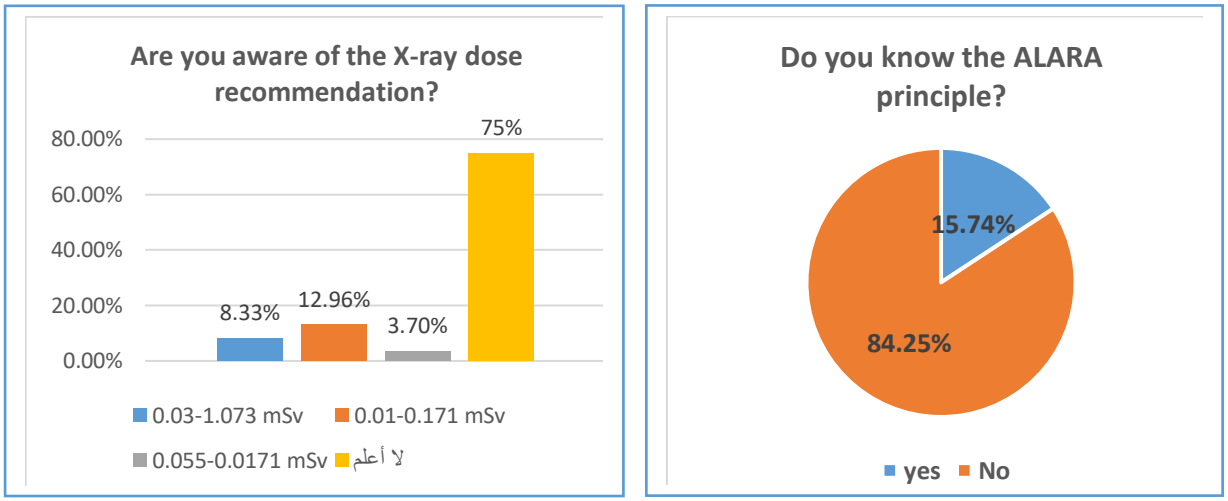

Figure 1: The column chart shows that 75% of participants were unaware of the recommended X-ray dose. Among the remaining, 8.33% selected a dose between 0.03–1.073 mSv, 12.96% selected a dose between 0.01–0.171 mSv, and 3.70% selected a dose between 0.055–0.0171 mSv, indicating limited awareness of the standard exposure limits. The pie chart shows that 84.25% of participants were not aware of the ALARA principle, while only 15.74% were familiar with it, reflecting a significant gap in radiation protection knowledge.

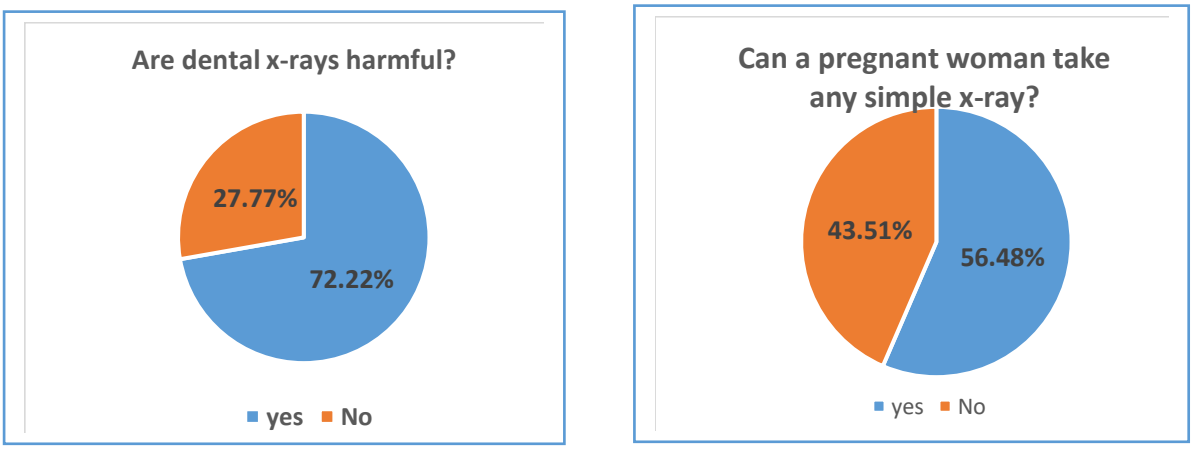

Figure 2: The pie chart shows that 72.22% of participants believe that dental X-rays are harmful, while 27.77% consider them harmless, reflecting an overestimation of the risk associated with the low radiation doses used in dental imaging. The pie chart shows that 56.48% of participants believe that a pregnant woman can undergo any simple X-ray, while 43.51% think it is not possible, indicating the presence of inaccurate perceptions regarding the safety of radiation exposure during pregnancy.

The Level of Awareness and Practices Related to Radiation Protection:

Table 3: The Level of Awareness and Practices Related to Radiation Protection

Sr.No.	Question	Answer Option	Count	Percentage (%)
1	What type of imaging do you prescribe for a new adult patient?	None	18	16.66%
		Periapical	14	12.96%
		Panoramic	14	12.96%
		Both	62	57.40%
2	What type of imaging do you prescribe for a new child patient?	None	23	21.29%
		Periapical	45	41.66%
		Panoramic	13	12.03%
		Both	27	25.00%
3	What is the kilovolt (kVp) of your X-ray imaging device?	Don't know	88	81.48%
		45-55 kVp	7	6.48%
		56-64 kVp	4	3.70%
		65-70 kVp	8	7.40%
		More than 81 kVp	1	0.92%
4	What is the tube current (mA) in your intraoral imaging device?	Don't know	79	73.14%
		10 mA	6	5.55%
		10-12 mA	8	7.40%
		More than 12 mA	0	0.00%
		I don't have this device	15	13.88%
5	Do you think collimation affects radiation dose reduction?	Yes	60	55.55%
		No	3	2.77%
		I don't know	45	41.66%
6	Which type of collimator reduces radiation exposure or provides less radiation?	Triangular	38	35.18%
		Circular	51	47.22%
		Rectangular	19	17.59%
7	Does exposure time vary?	Yes	86	79.62%
		No	12	11.11%
		I don't know	10	9.25%
8	Do you think film speed affects the radiation dose?	Yes	66	61.11%
		No	13	12.03%
		I don't know	29	26.85%
9	If yes, which film speed gives less radiation to the patient?	Slow speed	15	13.88%
		Fast speed	61	56.48%
		I don't know	32	29.62%
10	Where do you stand during intraoral exposure?	Change position according to tube angle	80	74.07%
		Fixed position	28	25.92%
11	Is there a lead apron or thyroid collar at your workplace?	Yes	57	52.77%
		No	51	47.22%
12	Are the walls of the X-ray room covered with lead?	Yes	38	35.18%
		No	70	64.81%
13	In your opinion, which radiographic technique exposes the patient to more radiation?	Panoramic imaging (Pantomograph)	68	62.96%
		Full mouth periapical imaging	13	12.03%
		I don't know	27	25.00%
14	Which of the following do you use to measure radiation exposure dose?	TLD badges	6	5.55%
		LED goggles	4	3.70%
		Gonad shield	6	5.55%
		Lead apron	8	7.40%
		I use nothing	84	77.77%
15	What is the safe distance for the radiology technician from the X-ray tube?	I don't know	35	32.40%
		1 meter	16	14.81%
		2 meters	7	6.48%

		3 meters	7	6.48%
		4 meters	14	12.96%
		5 meters	2	1.85%
		6 meters	27	25.00%
16	Do you think the length of the cone in the X-ray tube affects radiation dose reduction?	Yes	74	68.51%
		No	7	6.48%
		I don't know	27	25.00%
17	If yes, which gives less radiation to the patient?	Short cone tube	10	9.25%
		Long cone tube	71	65.74%
		I don't know	27	25.00%
18	Should the patient have a medical prescription for the dentist to perform an X-ray?	Yes	86	79.62%
		No	22	20.37%
19	Does every radiation exposure carry the possibility of harmful effects?	Yes	91	84.25%
		No	17	15.74%

Assessing the level of awareness and practices related to radiation protection is crucial for ensuring the safety of both patients and healthcare workers, particularly in radiographic imaging environments. The survey results revealed clear variations in knowledge and practices among participants, highlighting both strengths and weaknesses that warrant further attention.

Regarding the type of imaging prescribed for new patients, the data showed that more than half of the participants (57.4%) prescribe both panoramic and periapical images for adult patients, which is a positive indicator of relative awareness in selecting appropriate imaging based on clinical need. However, 16.66% reported not prescribing any imaging for new adult patients, which may indicate a lack of practice or failure to follow established diagnostic protocols. Similarly, for pediatric patients, 41.66% prescribed periapical images only, and 25% prescribed both types, reflecting an approach to minimize radiation exposure in children by opting for less irradiating imaging techniques. Nonetheless, 21.29% did not prescribe any imaging for children, which could represent either excessive caution or a lack of clear guidelines.

Concerning basic technical knowledge of X-ray devices, the results revealed significant deficiencies; over 80% of participants were unaware of the kilovolt peak (kVp) setting used in their machines, while approximately 73% were unaware of the tube current (mA) in their intraoral imaging devices. This lack of technical knowledge can negatively impact the ability to optimize device settings to reduce radiation dose while maintaining image quality.

In terms of understanding dose-reduction factors, only 55.55% of participants believed that collimation reduces radiation dose, whereas 41.66% did not know its effect, reflecting a substantial knowledge gap. Furthermore, opinions varied on the type of collimator that provides the greatest dose reduction; nearly half of the participants identified the circular collimator as the least irradiating, while scientific literature confirms that rectangular collimators are more effective in reducing dose. This indicates the presence of misconceptions that should be addressed through targeted training.

The findings also show good awareness among most participants (about 80%) that exposure time varies depending on the situation, and over 60% recognized the effect of film speed on radiation dose, with a majority knowing that faster films reduce patient exposure compared to slower films. This reflects a reasonable understanding of practical factors affecting dose.

Regarding personal and environmental safety practices, the data revealed that 74% of participants adjusted their position during intraoral exposures according to tube angle, demonstrating awareness of self-protection measures. However, environmental safety was found lacking, as nearly half of the participants did not have lead aprons or thyroid collars at their workplace, and more than 64% reported that their X-ray rooms were not lined with lead, posing a potential hazard to staff and patients and indicating the need for improved protective infrastructure.

With respect to radiation dose monitoring, 77.77% of participants reported not using any devices to measure exposure, which is a serious concern reflecting the absence of dose monitoring protocols and potentially exposing patients and staff to unnecessary risks. Additionally, knowledge of the safe distance for the operator from the X-ray tube was inconsistent, with 32.4% not knowing the safe distance, highlighting insufficient awareness of protective measures.

On other technical factors, the majority (68.51%) acknowledged that the length of the X-ray tube cone affects dose reduction, and most correctly identified that a long cone reduces exposure more effectively. Moreover, 79.62% adhered to the necessity of having a medical prescription before performing X-rays, which reflects compliance with medical and legal requirements.

Finally, 84.25% of participants recognized that every radiation exposure carries a potential harmful effect, indicating general awareness of the health risks associated with radiation.

Overall, the results indicate a relative awareness in some aspects of radiation protection; however, significant knowledge and technical gaps remain regarding device specifications, use of protective equipment, dose

monitoring, and environmental safety. Hence, there is a pressing need to enhance continuous education and training programs for all personnel involved in radiographic imaging to improve knowledge and practices, thereby reducing radiation risks and ensuring health safety.

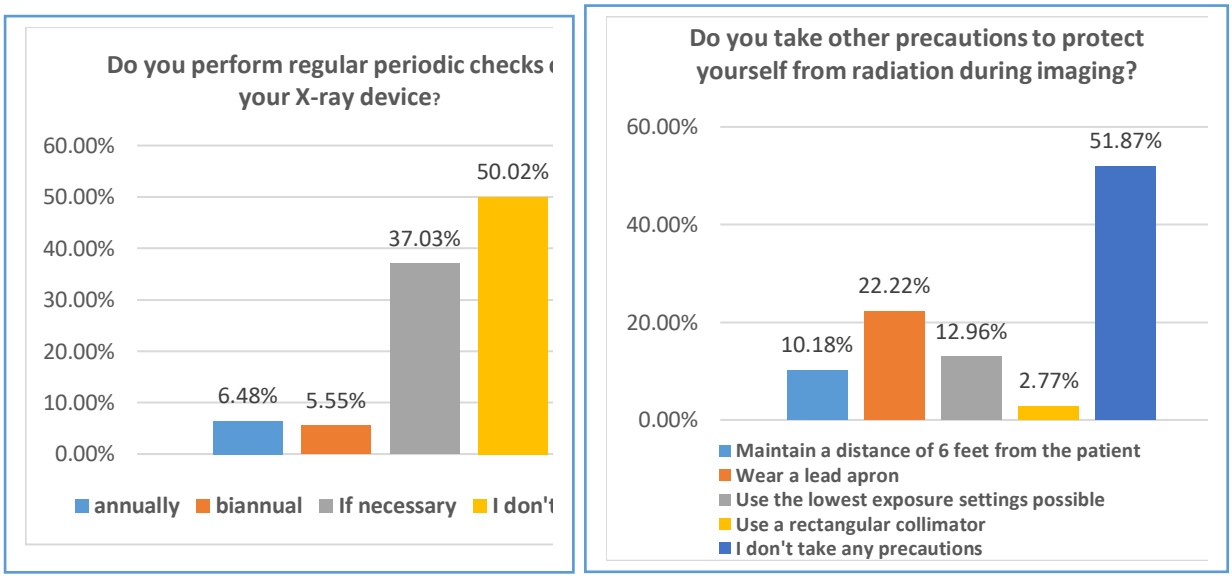

Figure 3: The chart indicates that 50.02% of participants are not employed in the field, while 37.03% check X-ray devices only when necessary. In contrast, 6.48% perform annual checks and 5.55% conduct biannual checks, highlighting a limited commitment to regular inspections. It also reveals that 51.87% take no additional protective measures during imaging, whereas 22.22% wear a lead apron, 12.96% apply the lowest possible exposure settings, and 10.18% maintain a safe distance. The rectangular collimator is used by only 2.77% of participants, reflecting gaps in the application of radiation protection practices.

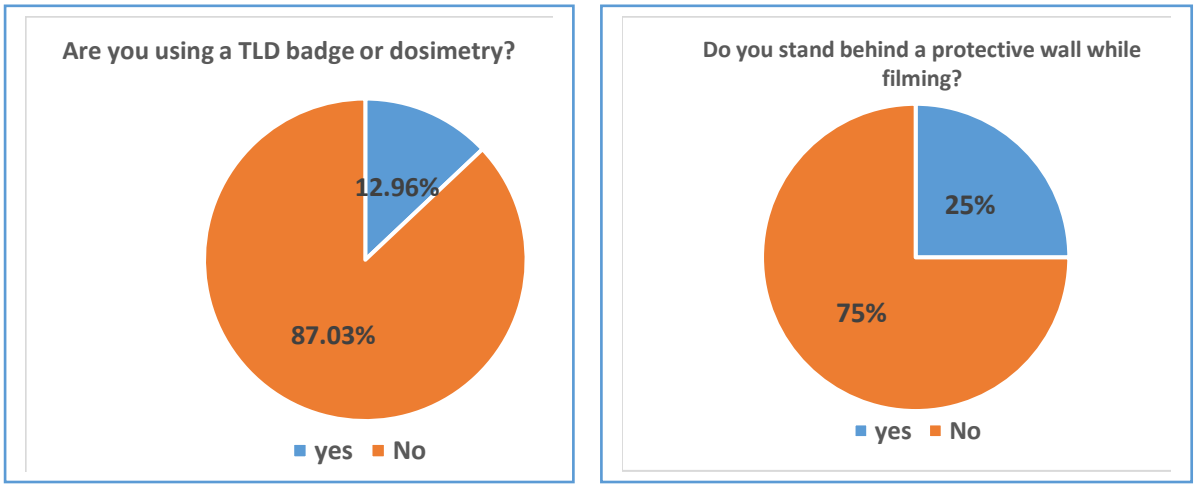

Figure 4: The pie charts show that only 12.96% of participants reported using a TLD badge or dosimetry, while the majority (87.03%) did not, indicating limited implementation of personal dose monitoring. Regarding protective measures during X-ray procedures, 25% of participants reported standing behind a protective wall, whereas 75% did not, reflecting insufficient adherence to basic radiation protection practices. Together, these findings highlight a significant gap in the practical application of radiation safety measures among the participants

Discussion

The findings of this study revealed that the majority of participants (69.4%) were female, with a high representation of doctors (59.25%), followed by postgraduate students (18.52%). This distribution can be attributed to the nature of the targeted sample, which leans toward medically trained individuals with an advanced academic background. Such representation may suggest an expected higher level of knowledge and practices related to radiation protection; however, the results highlighted significant gaps in this regard.

Although more than two-thirds of participants (72.22%) demonstrated awareness of the radiation hazard symbol and identified the thyroid gland as the most important organ to protect during dental radiographic procedures, 75% admitted to not knowing the recommended radiation dose levels. Moreover, 84.25% reported being unfamiliar with the ALARA principle, indicating a clear deficiency in understanding the fundamental concepts of radiation protection.

In terms of clinical practices, the results showed variability in radiographic prescription patterns for new patients. Specifically, 57.4% reported prescribing both periapical and panoramic radiographs for adult patients, while 16.66% stated they do not prescribe any form of imaging. Regarding pediatric patients, 41.66% preferred to prescribe periapical images only, while 23.14% avoided radiographic imaging altogether. This trend may reflect a cautious approach to minimizing radiation exposure in younger age groups.

The data also revealed a significant lack of technical knowledge. A total of 81.48% of respondents were unaware of the kilovoltage (kVp) used in their equipment, and 73.14% did not know the milliampere (mA) settings, despite the direct impact these parameters have on the absorbed radiation dose. Furthermore, there was insufficient understanding of dose-reduction techniques, with approximately half of the participants believing that circular collimators are more effective than rectangular ones contrary to scientific recommendations, which favor rectangular collimators for minimizing scatter radiation.

From a safety practice perspective, the findings showed notable shortcomings. Approximately 75% of participants did not stand behind protective barriers during imaging procedures, 52.31% did not adopt any personal protective measures, and 87.03% did not use any form of dose-monitoring devices such as TLD badges. These results raise concerns about adherence to professional radiation safety standards and the implementation of proper protocols. On the other hand, 84.25% of participants expressed awareness that every radiation exposure carries potential risks, and 79.62% affirmed the necessity of a medical referral before imaging indicating a partial understanding of the justification principle in radiation protection. Additionally, 61.11% recognized the importance of film speed in determining the absorbed dose, representing one of the few positive indicators observed in the data.

Conclusion

This study revealed a clear discrepancy between the theoretical knowledge and practical application of radiation protection measures among dental practitioners and students in western Libya. While participants demonstrated partial awareness of basic safety principles such as the need to protect the thyroid gland and recognition of radiation hazard symbols there were substantial deficiencies in technical knowledge, particularly regarding exposure parameters (kVp, mA), awareness of the ALARA principle, and the implementation of protective measures in clinical practice. The lack of personal dosimetry usage, inadequate shielding infrastructure, and insufficient adoption of lead aprons or thyroid collars underscore critical gaps in adherence to international radiation protection standards.

These findings emphasize the urgent need for comprehensive and mandatory training programs in radiation protection to be integrated into both undergraduate curricula and continuing professional education. Furthermore, institutional and governmental oversight should be strengthened to ensure the availability of protective infrastructure, enforcement of safety protocols, and provision of personal monitoring devices across dental facilities.

In light of these outcomes, the study highlights the importance of bridging the gap between knowledge and practice to achieve a safe radiographic environment for both patients and healthcare workers. Future research should expand to include larger and more diverse populations across different regions of Libya, enabling a broader assessment of national compliance with radiation safety standards and facilitating evidence-based policy development.

Limitations

This study has certain limitations that should be acknowledged. First, the sample was limited to dental practitioners from only three cities in western Libya, which may restrict the generalizability of the findings to other regions. Second, the data were collected using a self-administered questionnaire, which may have introduced recall or response bias. Additionally, the study relied primarily on descriptive analysis without advanced statistical testing, which limits the ability to establish stronger associations between variables. Future research with larger, more diverse samples and broader geographic coverage is recommended to validate and expand upon these findings.

Disclaimer

The authors affirm that this article has not been previously presented or published in any journal or scientific conference, and it does not constitute part of an academic thesis project.

Conflict of Interest

The authors declare that there are no conflicts of interest, whether financial, personal, or professional, related to this research work.

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