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Radiation Protection and Cancer Awareness Among Medical Students, Faculty Members, and Health Workers in Western Libya

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Abstract

Background: Radiation plays a critical role in cancer diagnosis and treatment. However, inadequate knowledge of radiation protection among healthcare workers and students can lead to unnecessary exposure and associated health risks. This study aimed to assess the knowledge and awareness of cancer risks and radiation protection among medical students, faculty members, and healthcare workers in Western Libya.

Materials and Method: A cross-sectional study was conducted among university medical students and faculty members/ healthcare workers in western Libya from December 2024 till March 2025. A structured questionnaire was used to evaluate participants' knowledge, attitudes, and perceptions of cancer and radiation protection. Data were analyzed using SPSS, Chi-square tests used to assess associations between demographic characteristics and knowledge levels.

Results: The study included 98 participants, most were students (58.2%) and female (76.5%). While (94.9%) agreed that radiation exposure can cause cancer, only (16.3%) had received formal training in radiation protection. Skin cancer (66.3%) and thyroid cancer (30.6%) were the most commonly recognized radiation-associated cancers. Significant gender differences were found in recognizing thyroid cancer as radiation-related ($p = 0.041$), and in knowledge of radiation sources such as X-rays ($p < 0.001$) and nuclear plants ($p = 0.006$). Gender was also significantly associated with knowledge of ALARA principles ($p = 0.039$) and protective equipment like lead aprons ($p < 0.001$). In terms of occupation, staff and employees were significantly more likely than students to identify genetic factors ($p = 0.024$) and environmental pollution ($p = 0.006$) as cancer risks. They also reported significantly more frequent cancer screening ($p < 0.001$). Occupation was further associated with better knowledge of X-rays ($p = 0.034$) and nuclear plants ($p = 0.004$) as radiation sources, and greater agreement on the necessity of protection during diagnostic imaging ($p = 0.036$).

Conclusion: There is a significant gap in knowledge regarding radiation protection among Libyan medical students, faculty and health sciences workers. Targeted educational interventions and structured training programs are necessary to improve awareness and ensure adherence to radiation safety protocols.

Keywords

Radiation Protection, Awareness, Knowledge, Medical Students, Healthcare Workers.

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INTRODUCTION

Cancer remains one of the most significant public health challenges worldwide, with increasing reliance on radiation-based technologies in medical diagnostics and treatment.[1] Radiation exposure is a significant concern in medical applications, particularly in diagnostic imaging and radiotherapy. Ionizing radiation has been widely used for decades, providing critical benefits in cancer treatment and disease diagnosis.[2] However, its potential risks including increased likelihood of developing cancer, necessitate strict radiation protection measures.[3] Effective radiation protection protocols are essential to ensure the safety of healthcare workers, patients, and the general public.[4] The International Commission on

Radiological Protection (ICRP) has established guidelines to limit radiation exposure, emphasizing the principles of justification, optimization, and dose limitation.[4] Despite these guidelines, studies have shown that healthcare professionals often lack sufficient knowledge about radiation protection, which can lead to unnecessary exposure for both patients and staff.[5]

Medical students and health sciences workers are particularly vulnerable to radiation exposure due to their frequent involvement in diagnostic and therapeutic procedures. Radiographer professionals and interns might lack the knowledge of radiation protection and the understanding of dose levels for various procedures.[4] Similarly, Kavak Yürük[5] reported that healthcare students, including nursing and medical students, had inadequate knowledge of ionizing radiation and radiation protection. However, this issue is evident in diagnostic radiology, where professionals are frequently exposed to low-dose ionizing radiation.[6]

The lack of knowledge about radiation protection among healthcare workers is concerning. Radiation exposure can have both short-term and long-term health effects. Another crucial aspect is the impact of cumulative radiation exposure on long-term health outcomes.[3] Recent research indicates a growing concern over cancer risks associated with low-dose ionizing radiation, especially among individuals undergoing repeated imaging procedures.[7] Acute effects include skin burns and radiation sickness, while long-term effects may include an increased risk of cancer.[3] The risk of cancer from low-dose radiation exposure is particularly significant for healthcare workers who are exposed repeatedly over their careers. Studies have shown that even low doses of ionizing radiation can increase the risk of cancer, especially when accumulated over time.[8] Therefore, it is essential that healthcare professionals are well-informed about the risks and take appropriate measures to protect themselves and their patients.

Education and training play a critical role in improving knowledge and awareness of radiation protection. The International Atomic Energy Agency (IAEA) and the European Commission have emphasized the importance of comprehensive training programs for healthcare professionals.[5] These programs should cover the fundamental principles of radiation protection, including the use of protective equipment and the application of theoretical knowledge in clinical settings. However, many healthcare students and workers do not receive adequate training in radiation safety, leading to gaps in knowledge and unsafe practices.[4,9]

This study seeks to address these gaps by assessing the knowledge and awareness of cancer risks and radiation protection among medical students, faculty members, and health sciences workers in western Libya. By identifying areas of weakness, this research aims to inform the development of targeted educational interventions to improve radiation safety practices in healthcare settings. The findings of this study will contribute to the growing body of literature on radiation protection and provide valuable insights for policymakers and educators in the healthcare sector in Libya.

MATERIALS AND METHODS

Study Design and Participants

The study used a cross-sectional design from December 2024 to March 2025. It focused on knowledge and awareness of radiation protection and cancer risks. The participants were from academic institutions and healthcare centers in Western Libya.

The study included participants from three public universities in western Libya, University of Tripoli, University of Zawia, and University of Gharyan as well as the Radiotherapy Department of Tripoli Medical Center. Participants were grouped into students and faculty/healthcare workers. The student group comprised individuals from Radiologic Technology, Dental Technology, and Physical Therapy programs. The faculty/ healthcare workers group included academic staff from the mentioned universities, and healthcare professionals working at the Tripoli Medical Center.

Questionnaire Design and Validation

The questionnaire used in this study was designed to assess participants' knowledge and perceptions related to cancer and radiation protection. It consisted of five main sections: The first section collected demographic information such as gender, age, occupation, educational level, and region. The second section assessed knowledge about causes of cancer, cancers related to radiation exposure, and the frequency of medical check-ups. The third section evaluated participants' understanding of radiation protection, identifying radiation sources, training received, safety practices, and attitudes towards protection measures. The fourth section explored concerns regarding radiation exposure, perceptions of public awareness, and sources of information. Lastly, the fifth section requested suggestions to enhance public awareness and provided space for general feedback. The questionnaire was sent to experts in the field for content validity, clarity, and reliability before being sent to the participants.

Sample Size and Data Collection

The study involved 98 participants. All students, medical staff, and healthcare workers in western Libya were invited to participate. An online questionnaire method was used to collect the data. Informed consent was obtained from all participants after providing detailed explanations of the study objectives.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 26 and Excel 365. Descriptive statistics were reported as N(%). Chi-square tests evaluated associations between demographics and participants' knowledge and attitudes. A p value of < 0.05 was considered significant.

RESULTS

Demographics

The study included 98 participants, with the majority being female 75 (76.5%) and aged between 20 to 29 years 56 (57.1%). All participants were from the Western region of Libya, and the majority were students 57 (58.2%) or university staff/employees 41 (41.8%). Most participants held a Bachelor's degree 55 (56.1%), and all were involved in medical or health sciences fields Table 1.

Knowledge of Cancer

Participants identified lifestyle choices 70 (71.4%) as the most common cause of cancer, followed by radiation exposure 53 (54.1%) and genetic factors 49 (50%). Environmental pollution was recognized by 46 (46.9%) of participants, while 2 (2%) reported not knowing the causes. A significant majority 93 (94.9%) agreed that radiation exposure can cause cancer, while 3 (3.1%) were unsure. Skin cancer 65 (66.3%) was the most commonly associated cancer with radiation exposure, followed by thyroid cancer 30 (30.6%).

Table 1. Demographics data of the participants.

		N (%)
Gender	Female	75 (76.5%)
	Male	23 (23.5%)
Age Group	Under 20	3 (3.1%)
	20 to 29	56 (57.1%)
	30 to 39	8 (8.2%)
	40 to 49	19 (19.4%)
	Over 50	12 (12.2%)
Occupation	Student	57 (58.2%)
	University Staff / Employee	41 (41.8%)
Education Level	High School	6 (6.1%)
	Bachelor's Degree	55 (56.1%)
	Master's Degree	27 (27.6%)
	PhD	10 (10.2%)

Only 11 (11.2%) associated lung cancer with radiation, and none associated leukemia. The majority of participants 64 (65.3%) reported never undergoing regular medical check-ups for cancer screening, while 6 (6.1%) reported doing so annually Table 2. Mobile phones 69 (70.4%) and X-rays 45 (45.9%) were identified as common sources of radiation in daily life. Only 22 (22.4%) recognized nuclear plants as a source, and none identified sunlight. Only 16 (16.3%) of participants reported receiving formal education or training on radiation protection Table 3.

Half of the participants 50 (51%) correctly identified ALARA as "As Low As Reasonably Achievable," while 46 (46.9%) did not know its meaning. Lead aprons 61 (62.2%) and time management to reduce exposure 71 (72.4%) were the most recognized protective measures. Dosimeters were not recognized by any participant. The majority 84 (85.7%) believed that radiation protection measures are necessary during medical procedures like X-rays or CT scans Table 4.

Attitudes and knowledge

While 16 (16.3%) of participants were very concerned about radiation exposure in daily life, 50 (51%) were somewhat concerned, and 32 (32.7%) were not concerned. The majority 81 (82.7%) believed that the public in Libya is not well-informed about cancer and radiation protection. Most participants obtained information about radiation and cancer from media 73 (74.5%) and school/university/workplace 66 (67.3%). Only 24 (24.5%) reported getting information from health professionals.

Feedback on Improving Public Knowledge

Participants suggested several measures to improve public knowledge of cancer and radiation protection. Public awareness campaigns were supported by 78 (79.6%) of participants, while 65 (66.3%) recommended more education programs in schools and universities. Increased media coverage was suggested by 65 (66.3%), and 48 (49%) of participants supported the idea of training workshops Table 5.

The impact of gender and occupation

Figure 1 A and B summarizes Participants knowledge cancer causes and the radiation as cancer risk factor to among the participants based on their gender and occupation. Lifestyle choices were recognized as a primary cause of cancer across all groups, with students reporting the highest awareness at 42 (73.7%) and university staff/employees at 28 (68.3%). Radiation exposure was identified as a common cause by university staff/employees 24 (58.5%) and females 41 (54.7%). Skin cancer was most frequently associated with radiation exposure among males 18 (78.3%) and students 39 (68.4%). Awareness that radiation can cause cancer was consistently high: females 71 (94.7%), males 22 (95.7%), students 52 (91.2%), and staff/employees 41 (100%). However, regular medical check-ups for cancer screening were infrequent, particularly among students, with 48 (84.2%) reporting never undergoing screening.

Figure 2 A and B presents data on radiation protection awareness among participants based on gender and occupation. Mobile phones 69 (70.4%) and X-rays 45 (45.9%) were frequently identified as radiation sources. Nuclear plants were less recognized as radiation sources, especially by students 7 (12.3%)

Table 2. Knowledge of cancer among the participants.

			N (%)
What do you think are the common causes of cancer?	Radiation exposure	Yes	53 (54.1%)
		No	45 (45.9%)
	Genetic factors	Yes	49 (50%)
		No	49 (50%)
	Lifestyle choices	Yes	70 (71.4%)
		No	28 (28.6%)
	Environmental pollution	Yes	46 (46.9%)
		No	52 (53.1%)
	Don't know	Yes	2 (2%)
		No	96 (98%)
Can radiation exposure cause cancer?		Yes	93 (94.9%)
		No	2 (2%)
		Don't Know	3 (3.1%)
Which of the following types of cancer do you associate with radiation exposure?	Leukemia	Yes	0 (0%)
		No	98 (100%)
	Thyroid cancer	Yes	30 (30.6%)
		No	68 (69.4%)
	Skin cancer	Yes	65 (66.3%)
		No	33 (33.7%)
	Lung cancer	Yes	11 (11.2%)
		No	87 (88.8%)
	Don't know	Yes	13 (13.3%)
		No	85 (86.7%)
How often do you undergo medical check-ups for cancer screening?		Regularly	6 (6.1%)
		Occasionally	9 (9.2%)
		Rarely	19 (19.4%)
		Never	64 (65.3%)

Table 3. Knowledge of radiation protection among the participants.

			N (%)
What are common sources of radiation in daily life?	X-rays	Yes	45 (45.9%)
		No	53 (54.1%)
	Mobile phones	Yes	69 (70.4%)
		No	29 (29.6%)
	Nuclear plants	Yes	22 (22.4%)
		No	76 (77.6%)
	Sunlight	Yes	0 (0%)
		No	98 (100%)
	Don't know	Yes	6 (6.1%)
		No	92 (93.9%)
Have you received any formal education or training on radiation protection?		Yes	16 (16.3%)
		No	82 (83.7%)
What does ALARA stand for in radiation protection?		As Low as Reasonably Achievable	50 (51%)
		As Long as Radiation Acts	2 (2%)
		Don't know	46 (46.9%)
What measures can help protect against harmful radiation exposure?	Lead aprons	Yes	61 (62.2%)
		No	37 (37.8%)
	Dosimeters	Yes	0 (0%)
		No	98 (100%)
	Increasing distance from the radiation source	Yes	44 (44.9%)
		No	54 (55.1%)
	Time management to reduce exposure	Yes	71 (72.4%)
		No	27 (27.6%)
	Don't know	Yes	7 (7.1%)
		No	91 (92.9%)
Do you believe radiation protection measures are necessary during medical procedures like X-rays or CT scans?		Yes	84 (85.7%)
		No	6 (6.1%)
		Not Sure	8 (8.2%)

Table 4. Attitudes and Perceptions of the Medical students and Health Sciences workers.

			N (%)
How concerned are you about radiation exposure in your daily life?		Very concerned	16 (16.3%)
		Somewhat concerned	50 (51%)
		Not concerned	32 (32.7%)
Do you think the public in Libya is well-informed about cancer and radiation protection?		Yes	3 (3.1%)
		No	81 (82.7%)
Where do you get most of your information about radiation and cancer?	School / University / Workplace	Yes	66 (67.3%)
		No	32 (32.7%)
	Media	Yes	73 (74.5%)
		No	25 (25.5%)
	Health professionals	Yes	24 (24.5%)
		No	74 (75.5%)
	Friends and family	Yes	12 (12.2%)
		No	86 (87.8%)
	Others	Yes	0 (0%)
		No	98 (100%)

and females 12 (16.0%). Formal training on radiation protection was notably low: males 6 (26.1%) and females 10 (13.3%). The ALARA principle was recognized more by males 17 (73.9%) and staff/ employees 22 (53.7%) compared to females 33 (44.0%) and students 28 (49.1%). Protective measures, including lead aprons 61 (62.2%) and exposure time management 71 (72.4%), were widely acknowledged, whereas no participant recognized dosimeters as protective equipment.

Table 5. Participants' Feedback toward improving the public knowledge of cancer and radiation protection.

Feedback and Recommendations		N (%)
More education programs in schools and universities	Yes	65 (66.3%)
	No	33 (33.7%)
Public awareness campaigns	Yes	78 (79.6%)
	No	20 (20.4%)
Training workshops	Yes	48 (49%)
	No	50 (51%)
Increased media coverage	Yes	65 (66.3%)
	No	33 (33.7%)
Others	Yes	0 (0%)
	No	98 (100%)

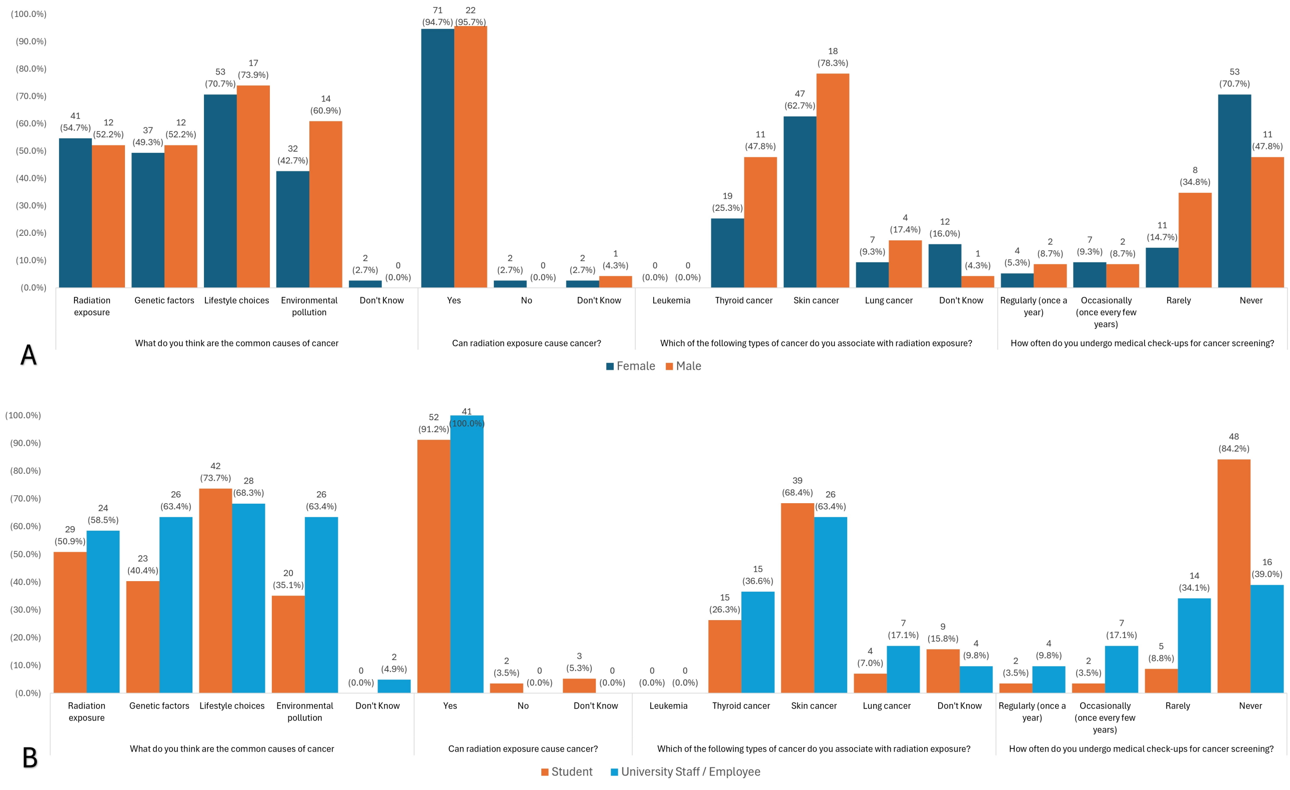

Fig 1. Participants knowledge cancer causes and the radiation as cancer risk factor to among the participants based on A: gender and B: occupation.

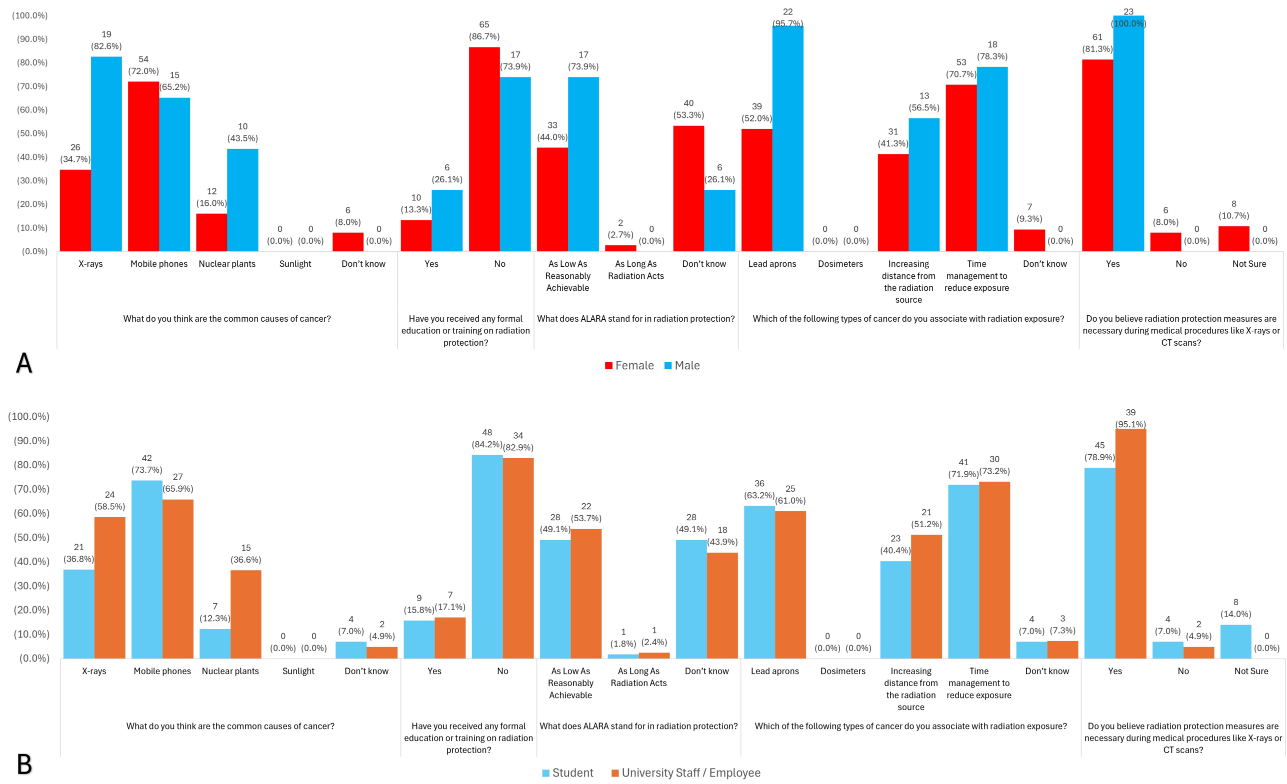

Fig 2. Radiation protection awareness and knowledge among the participants based on A: gender and B: occupation.

Association between cancer and radiation protection knowledge with gender and occupation

The analysis revealed several statistically significant associations between cancer and radiation protection knowledge with both gender and occupation. While most cancer-related items showed no gender differences, a significant association was found between gender and awareness of thyroid cancer as a radiation-related disease ($\chi^2 = 4.192$, = 0.041). This suggests that males and females differ in recognizing this specific cancer risk. Additionally, gender was significantly associated with several aspects of radiation protection knowledge. Females and males differed in identifying X-rays ($\chi^2 = 16.290$, $p < 0.001$) and nuclear plants ($\chi^2 = 7.628$, $p = 0.006$) as sources of radiation. They also showed significant differences in correctly defining the ALARA principle ($\chi^2 = 6.480$, $p = 0.039$) and in recognizing the importance of lead aprons as protective equipment ($\chi^2 = 14.272$, $p < 0.001$). These findings indicate a gender gap in specific areas of radiation protection awareness (Table 6).

In contrast, occupation was associated with broader differences in both cancer knowledge and health behavior. Staff and employees were significantly more likely than students to identify genetic factors ($\chi^2 = 5.074$, $p = 0.024$) and environmental pollution ($\chi^2 = 7.683$, $p = 0.006$) as causes of cancer. Moreover, a strong association was observed between occupation and the frequency of cancer screening, with staff and employees undergoing screening more frequently than students ($\chi^2 = 21.673$, $p < 0.001$). In terms of radiation protection knowledge, occupation was significantly associated with identifying X-rays ($\chi^2 = 4.520$, $p = 0.034$) and nuclear plants ($\chi^2 = 8.092$, $p = 0.004$) as radiation sources. Furthermore, staff and employees were more likely to acknowledge the need for protection during diagnostic imaging procedures such as X-rays and CT scans ($\chi^2 = 6.660$, $p = 0.036$) (Table 6).

Taken together, these results highlight the influence of both gender and occupational status on awareness and behavior related to cancer and radiation protection. While gender differences were more apparent in technical knowledge of radiation safety, occupational differences extended to both knowledge and preventive practices. This underscores the need for targeted educational initiatives to address these gaps, especially among students and specific gender groups (Table 6).

DISCUSSION

The findings of the study highlight the importance of radiation protection for healthcare professionals and patients. It shows a significant gap in knowledge of radiation protection among medical students, faculty members, and healthcare workers in western Libya. The literature pointed out the insufficient awareness of radiation exposure risks and safety measures among

Table 6. Person Chi-square association of cancer knowledge and radiation protection knowledge with gender and occupation.

		Gender		Occupation	
		Chi-square	Sig.	Chi-square	Sig.
Cancer knowledge					
What do you think are the common causes of cancer?	Radiation exposure	0.04	0.833	0.56	.453
	Genetic factors	0.06	0.811	5.07	.024*
	Lifestyle choices	0.09	0.763	0.34	.560
	Environmental pollution	2.34	0.125	7.68	.006*
	Don't know	0.63	0.429	2.84	0.092
Can radiation exposure cause cancer?		0.78	0.78	0.678	3.79
Which of the following types of cancer do you associate with radiation exposure?	Leukemia	0	0	0	0
	Thyroid cancer	4.19	.041*	1.18	.277
	Skin cancer	1.92	0.166	0.27	.605
	Lung cancer	1.157	.284	2.42	.120
	Don't know	2.08	.150	0.75	.385
How often do you undergo medical check-ups for cancer screening?		5.41	.144	21.67	.000*
Radiation protection knowledge					
What do you think are the common causes of cancer?	X-rays	16.29	.000*	4.52	.034*
	Mobile phones	0.39	0.53	0.7	.402b
	Nuclear plants	7.63	.006*	8.09	.004*
	Sunlight	0	0	0	0
	Don't know	1.96	.162b	0.19	.663
Have you received any formal education or training on radiation protection?		2.1	.148b	0.029	.865
What does ALARA stand for in radiation protection?		6.48	.039*	0.29	.865
Which of the following types of cancer do you associate with radiation exposure?	Lead aprons	14.27	.000*	0.05	.826
	Dosimeters	0	0	0	0
	Increasing distance from the radiation source	1.64	0.2	1.14	.286
	Time management to reduce exposure	0.51	0.48	0.018	.892
	I don't know	2.31	.128	0.003	.955
Do you believe radiation protection measures are necessary during medical procedures like X-rays or CT scans?		5.01	.082	6.66	.036

healthcare professionals.[10] The study found that while most participants acknowledged the link between radiation exposure and cancer, only a minority had received formal training in radiation protection. This is concerning given that education plays a key role in safe practices and that the lack of knowledge may result in unnecessary radiation exposure for both patients and staff.[11]

Previous research has shown that radiography students and radiology residents generally have a better understanding of radiation protection compared to medical students.[12] The International Commission on Radiological Protection (ICRP) recommends structured educational initiatives to address knowledge gaps.[4] However, studies indicate that such training is often inadequate or inconsistently implemented.[13]

Another key concern is the cumulative radiation exposure faced by healthcare workers. Long-term exposure, even at low doses, increases the risk of developing cancer.[3] Repeated exposure during medical imaging procedures, particularly among radiographers and interventional radiologists, poses a significant occupational hazard.[7] Despite these risks, the use of personal protective equipment such as lead aprons and dosimeters remains suboptimal.[14] The lack of adherence to safety measures is often linked to insufficient training and awareness.[5]

Despite existing guidelines, many medical curricula fail to provide sufficient education on radiation dose levels and safety measures.[13] A Delphi study established core competencies that medical students should achieve by graduation, yet these competencies are not consistently incorporated into training programmes.[13] Studies indicate that structured educational interventions improve knowledge levels among healthcare professionals and enhance compliance with radiation protection protocols.[9,11] Training programmes have been shown to enhance awareness and improve clinical decision-making when requesting imaging tests, potentially reducing unnecessary radiation exposure.[11] Studies have demonstrated that interactive training sessions, and mobile applications rather than traditional lectures, are more effective and indispensable tools in radiology education that could increase the understanding, retention, confidence, skills, and learning experience of radiation safety principles.[15,16] In addition to formal education, workplace-based learning and continuous professional development programs should be implemented to reinforce best practices.[4]

CONCLUSION

This study reinforces the urgent need for improved radiation protection education among medical students and healthcare workers in Libya. Given the potential long-term health risks associated with radiation exposure, it is crucial to implement standardized training programs to enhance awareness and ensure adherence to safety protocols. Future initiatives should focus on integrating radiation protection education into undergraduate and postgraduate curricula, as well as offering regular courses for practicing professionals. By addressing these knowledge gaps, healthcare institutions can minimize unnecessary radiation exposure and improve overall safety for both medical personnel and patients.

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