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Evaluation of radiographers knowledge about radiation safety and cancer risks of ionizing radiation exposure

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Abstract: Ionizing Radiation (IR) crucial to both therapeutic and diagnostic methods. However, it has hazardous exposure effects on patients and workers in radiation environment personnel. This study aimed to assess the level of knowledge among radiographers working in the private and public hospitals in Palestine about radiation safety and cancer risks of radiation exposure. Online questionnaires were distributed to 74 radiographers at seven private and public hospitals in Palestine. Four demographic characteristics and 17 several options questions about radiation protection were included in the survey. This study revealed that the mean of correct scores was (7.20) out of 17 enquiries from Palestinian radiographers on radiation safety. The current investigation revealed a inadequate knowledge of radiation protection and safety. (40.5%) of the radiographers admitted seldom received any training about radiation protection. While only (2.7%) of them reported that they regularly attended such training. and (27.0%) they never attended it. The knowledge score according to work experience, hospital type, and gender did not have statistical significance. In terms of academic level showed significant differences (P< 0.05), postgraduates' level of knowledge score was (10.2±2.13), higher than undergraduates (6.88±1.51). The results show that the radiographers involved in this study lacked sufficient understanding on radiation protection and safety. Therefore, the most crucial topic is the administrations of the foundations using radiation have to exercise prudence by supplying staff or the essential infrastructure in the form of equipment and training.

Keywords: Ionizing Radiation, Radiation Dose, Cancer Risks, Radiation Safety, Radiography.

INTRODUCTION:

Ionizing Radiation (IR) is frequently used in routine medical procedures. It is crucial to both therapeutic and diagnostic methods. However, IR has hazardous exposure effects on patients as well as radiographers and other workers in radiation environment personnel Alyousef [1].

According to various research, exposure to medical radiation raises the possibility of infertility, blindness, birth defects, and stem cell inhibition [2-4]. According to several claims, there is a connection between the development of lifelong cancer and an increase in radiation from artificial IR sources [5-8]. By this rises, radiation protection has become more significant to protect welfare and the health of healthcare workers, patients and community [8]. Because of this rise radiation safety, it is now more crucial than it was in the past to safeguard the health and welfare of patients, healthcare workers, and society.

The three main ideas of radiation safety against ionising radiation risk are justification, optimising, and dose limit. Because medicinal radiation exposure has particular consequences, the diagnosis guideline value is usually used as an indicator instead of dosage limits. In addition to As Low As Reasonably Achievable (ALARA) principles are believed to be the primary concepts supporting radiation dose reduction. Following these recommendations, a reliable diagnostic image can be obtained at the lowest possible dose [9]. The science of shielding people and the environment from the harmful effects of ionising radiation is known as radiation protection. It can also refer to any measures implemented to limit the radiation exposure of patients and employees during x-ray procedures [10]. The most important objective of radiological protection is to supply the public, employees, and patients detailed instructions for using IR safely [11].

Survey of the released scientific literature reveals that the growing use of medical radiation can be partially attributed to professionals, doctors, medical students, trainees, and family caregivers. They have inaccurate and frequently insufficient knowledge about radiation safety, risks, and doses associated with regular imaging procedures [12-16]. Surprisingly, there are few studies among radiographers. When high dose investigations are performed without optimizing, this kind of knowledge about radiation risk can be quite dangerous and keep patients at risk for a considerable biological life. Overall, these and other studies show that medical personnel have a limited awareness of the radiation risks that patients face during routine imaging investigations and are unable to accurately respond to the questions that patients frequently ask [15-18].

Their level of radiation safety understanding influences the reactions of employees. Insufficient knowledge of the subject matter will make their activities unsafe and may have unfavorable effects. It is critical that the medical community learns the terms, common tools, and accepted procedures used in radiation safety and monitoring in order to protect patients, providers, and employees [19]. According these facts, the purpose of this study was to find out how well versed radiographers who work in radiation-exposed environments are in applications related to radiation protection.

METHODOLOGY

1. Population and sample

This prospective, cross-sectional and descriptive approach study was performed to assess the knowledge level of radiation preventive and cancer risks of exposure between radiographers working in the radiology departments of seven hospitals in north governments of West Bank in Palestine. From which three private and four public hospitals in Nablus, Jenin, Tubas and Tulkarm (Figure 1). The participants aware that the findings would be used for a scientific research only.

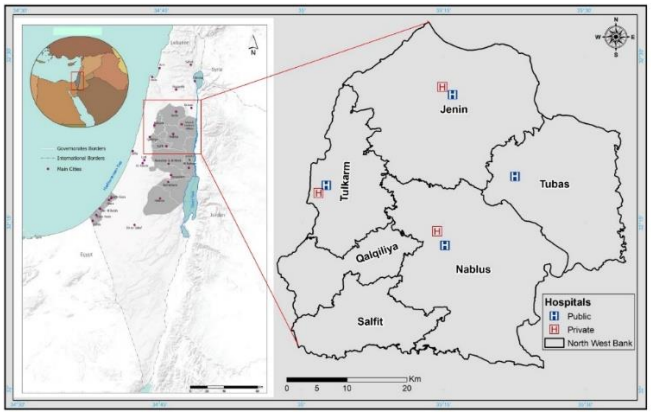


Figure 1. The geographical distribution of hospitals in northern governorates of West Bank in Palestine.

2. Study tool

Following a comprehensive evaluation of the literature and an extensive investigation of web resources [1, 4, 20], an online item-based questionnaire was developed. Three parts made up the validated questionnaire. Among the socio-demographic traits covered in the first part are sex, formal education, type of hospitals, and work experience. The 16 multiple-choice questions in the remaining two parts asked about general knowledge, awareness, and experience with medicinal radiation imaging. The degree of knowledge and perception of radiation safety and protection principles was assessed using ten questions (Section 2). Specific topics include: (1) radiation safety standards; (2) radiation exposure risks; (3) regulations; (4) dosimeter information; (5) IR sensitivity; (6) lead aprons and the level lead diameter in aprons and goggles; and (7) which organ is more vulnerable to radiation damage. The remaining six questions assessed respondents' understanding of the dangers of radiation exposure for cancer (Section 3).

Google Forms was used to build an online version of the questionnaire, which makes it easier for participants to complete and enables researchers to automatically and instantly collect data without introducing bias into the process. The link to complete the questionnaire was emailed to prospective participants between April 1, 2024, and May 30, 2024. The participants were given explicit instructions to finish the questionnaire within 30 minutes. An additional email was sent to participants two weeks following the initial one in an effort to entice more of them to reply to the survey. The participants were strongly advised not to reply to the questionnaire again if they had already finished it in order to avoid duplications.

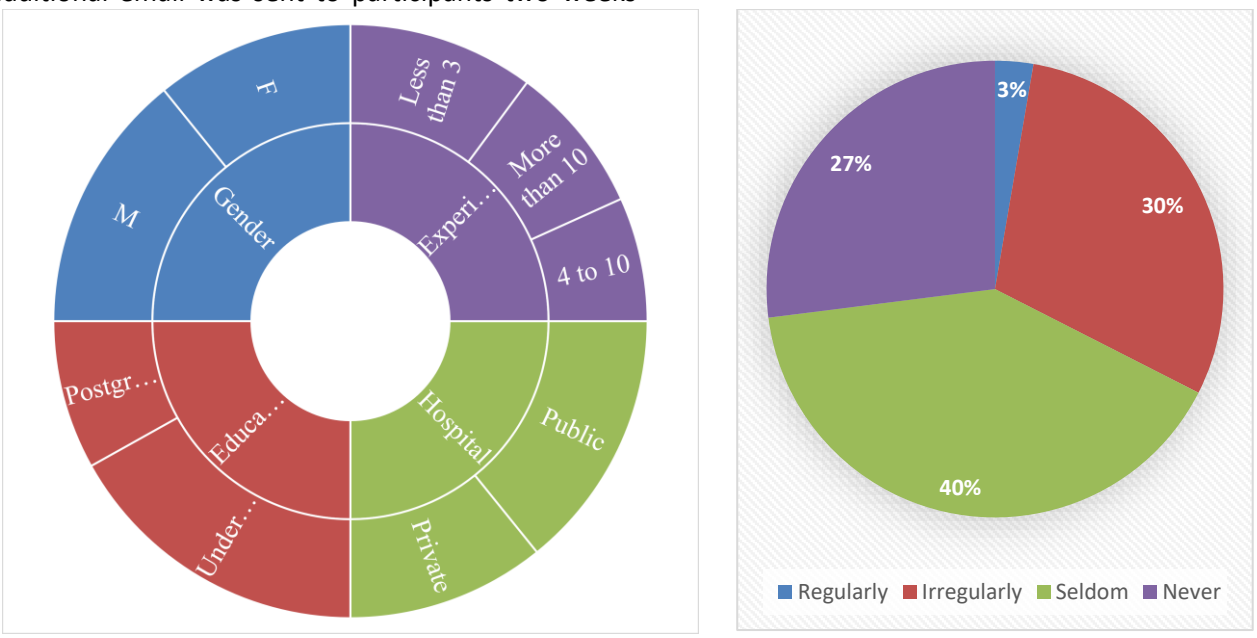
3. Data analysis

The SPSS, 22.0 software was applied to analyse the obtained data; for the analysis of demographic data, frequency and percentage was calculated and the average and SD were studied. There was just one correct answer for each of the five multiple-choice questions in Sections 2 and 3. The maximum achievable score in these two sections were 17. ANOVA was used to study the variations in the categories' grades of radiation safety knowledge by gender, formal education, expertise, and medical institution type, in addition to the chi-square test was performed.

RESULTS

1. Analysis of radiographers' knowledge about radiation protection and safety

A total of 74 potential radiographers participated and completed the questionnaire for a reply rate of (67.3%). Most of the participants were males (56.8%) and had undergraduate formal education (67.6%). Only (43.2%) of participants were employed in a private hospital and (56.8%) in a public hospital. Regarding to their work experience, The majority of the respondents (40.5%) had previous expertise which was less than 3 years. (32.4%) more than 10 years, while (27.0%) between 3 to 10 years of experience (Figure 2A).



A B

Figure 2. Distribution of the respondent community according to the demographic data and Percent of participants attending training programs about IR protection

When participants were asked about attending training programs in IR protection, only (2.7%) of the respondents answered that they regularly attended training courses and (27.0%) they never attended training. While (40.5%) of them admitted that they seldom had any training about IR protection (Fig. 2B).

With a result of one for every right response and zero for wrong or unclear responses, the overall average of the correct answers was 7.20 out of 17. The lowest and highest scores were 2 and 12, respectively. As shown in Figure (3), the average of right responses for the second section on knowledge level of IR protection and safety (6.58 out of 11) were better than the average of the third section on radiographers knowledge of cancer risks of radiation exposure (0.62 out of 6).

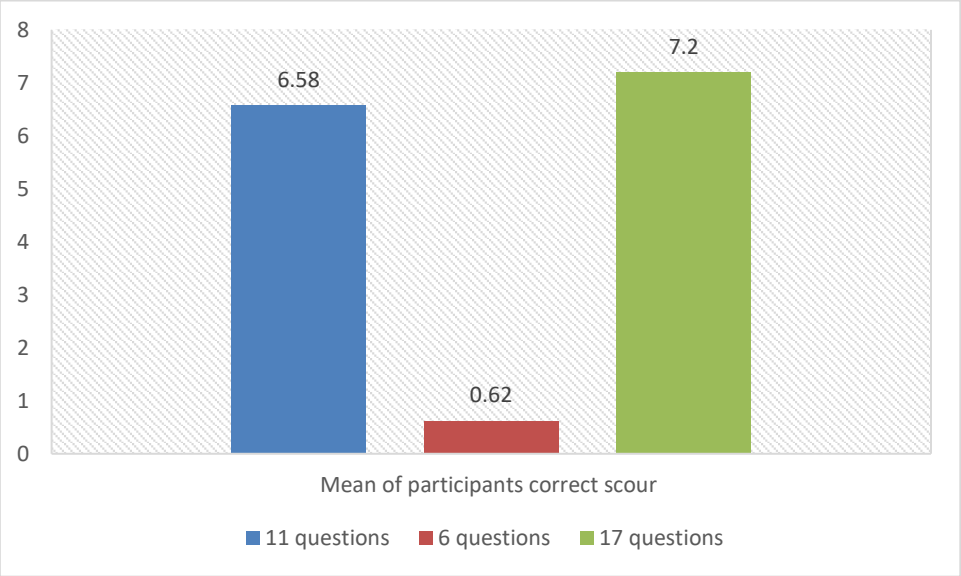


Fig. 3. Mean of participants correct score for the knowledge level of ionizing radiation protection and safety (11 questions), cancer risks of radiation exposure (6 questions), and the total mean of correct score (17 questions)

2. Analysis of radiographers' knowledge about cancer risks of radiation exposure

Most of the questions (59.83 %) related to the knowledge of radiation safety were answered correctly, (31.45%) were incorrect and (8.72%) were with no idea (Table 1). (94.59 %) of the radiographers knew the meaning of ALARA principle of radiation safety and (89.19%) of them knew that MRI has no radiation risks. Only (18.92%) of participants knew that the average natural background radiation is in the range 2–3 mSv annually. The radiographers' knowledge about dosimeters and lead goggle questions was low, only (35.14%) answered correct for both questions. More than (55%) of participants answered correctly the two questions about lead apron and (75.68%) of participants knew that IR could be hazardous to the eyes, thyroid gland, and ovary organs (Table 1).

Table 1. Analysis of respondents' knowledge about radiation protection, safety and cancer risks of radiation exposure (N = 74)

Section 2: Radiographers' knowledge about radiation protection and safety							
No.	Question	Correct answer		Incorrect answer		No Idea answer	
		Freq.	%	Freq.	%	Freq.	%
1	Meaning of ALARA principle of radiation protection	70	94.59	0	0	4	5.41
2	Which of these poses no risk of radiation?	66	89.19	4	5.41	4	5.41
3	Average natural background radiation	14	18.92	50	67.57	10	13.51
4	Most sensitive age group to radiation	50	67.57	20	27.03	4	5.41
5	Most sensitive organ to radiation	56	75.68	14	18.92	4	5.41
6	The main source of radiation exposure for employees in the intervention room	24	32.43	46	62.16	4	5.41
7	Thickness of lead in the lead apron	58	78.38	8	10.81	8	10.81
8	What is the safe separation between the employee	54	72.97	8	10.81	12	16.22

	and the X-ray machine?						
9	Regarding dosimeters, which of the following claims is accurate?	26	35.14	46	62.16	2	2.70
10	Regarding lead goggle, which of the following claims is accurate?	26	35.14	32	43.24	16	21.62
11	Regarding lead apron, which of the following claims is accurate?	43	58.11	28	37.84	3	4.05
Average		**44.27**	**59.83**	**23.27**	**31.45**	**6.45**	**8.72**
Section 3: Respondents' knowledge about imaging techniques and the lethal cancer risks they pose							
1	Chest CT	18	24.32	16	21.62	40	54.05
2	Abdomen CT	4	5.41	32	43.24	38	51.35
3	Coronary CT angiography	6	8.11	24	32.43	44	59.46
4	Brain CT	6	8.11	25	33.78	43	58.11
5	Whole-body Positron Emission Tomography (PET)	3	4.05	27	36.49	44	59.46
6	Chest CT	10	13.51	20	27.03	44	59.46
Average		**7.83**	**10.59**	**24**	**32.43**	**42.17**	**56.98**

Analysis of radiographers' knowledge about cancer risks of radiation exposure

By analyzing the data of this third section about radiographers' awareness of the risks of IR on the development of fatal cancer, it was found that most of the participants in this study answered the six questions incorrectly or no idea, with an average of (32.43%) and (56.98%), respectively. Only (10.59%) of them answered correctly the same questions of this section (Table 1).

3. Analysis of radiographers' knowledge according to the demographical parameters

The study participants' responses were examined in light of individual characteristics including the radiographers' gender, experience, hospital type, and level of education. The findings are shown in Table (2). The maximum possible score of sections two and three, and the total correct score (out of 17) were for postgraduate radiographers with mean scores of (8.21±2.09), (1.96±1.96), and (10.2±2.13) respectively (Table 2). As for the gender of the participants, the average correct responses for males and females were adjacent, with a slight advantage for females regarding knowledge of radiation safety (section2) with a mean score of (7.31± 0.95) for females and (6.02± 1.55) for males. Regarding to the type of hospital in which the participants worked, the mean score of correct answers of radiographers in public hospitals were slightly better than those in private hospitals for the two sections and for total (Table 2).

It is evident from Table (2) that the results supported the hypothesis that there are no notable variation ($P > 0.05$) between the means of participants' correct responses concerning gender, experience and type of hospital in terms of their awareness of IR safety (section 2) and their knowledge level of cancer risks of radiation exposure (section 3).

Table (2) clearly shows a notable distinction ($P < 0.05$) in the averages of radiographers' responses based on the educational level variable. This disparity is observed both in terms of radiographers' knowledge of sections two and three. Specifically, postgraduates exhibit the highest mean level of knowledge score toward radiation safety for all questions (10.2±2.13) compared to undergraduates' radiographers (6.88±1.51) (Table 2).

Table 2. Mean score of participants' correct answers for each of studied section and total with statistical significance.

Variables	Category	Frequency (%)	Mean correct scour ± SD			P- Value
			Section 1 out of 11	Section 2 out of 6	Total out of 17	
Gender	Male	32 (43.2)	6.02± 1.55	0.71± 0.98	6.74± 1.80	0.122
	Female	42 (56.8)	7.31± 0.95	0.50± 1.20	7.81± 1.05	
Education	Undergraduate	50 (67.6)	6.24±1.49	0.64±1.72	6.88±1.51	**0.041**
	Postgraduate	24 (32.4)	8.21±2.09	1.96±1.96	10.2±2.13	

Type of hospital	Private hospital	32 (43.2)	6.19± 2.10	0.44± 1.95	6.63± 2.05	0.075
	Public hospital	42 (56.8)	6.88± 1.90	0.76± 2.15	7.64± 2.03	
Experience/year	Less than 3	30 (40.5)	6.53±1.23	0.57±1.55	7.1±1.05	0.082
	4 to 10	20 (27.0)	6.6±1.98	0.85±2.13	7.45±2.09	
	More than 10	24 (32.4)	6.63±1.62	0.50±1.93	7.13±1.39	

DISCUSSION

Since radiographers are essential to the structure of radiation safety. The radiographer may be held accountable for excessively raising the IR dosage given to the patient during a particular imaging trial if he/she lacks sufficient knowledge of radiation risks. As far as we are aware, this study was the 1st survey accomplished in the West Bank in Palestine to examine stage of knowledge about radiation protection and cancer risks of exposure among Palestinian radiographers.

The main findings of this survey show that most radiographers had insufficient knowledge about IR protection; mainly their level of knowledge about cancer risks of IR exposure. The total mean of correct score of radiation safety knowledge was (7.20) out of (17) questions. Several scientific articles have emphasized the requirement for radiographers to enhance their knowledge in radiation safety cases [8, 21-22].

This study was conducted in occupied Palestine, which has limited resources regarding radiation protection. The outcome revealed insufficient knowledge in radiation safety, in spite of the existence of specialized undergraduate and postgraduate educational programs in radiology in Palestinian universities. However, there is a clear weakness in the quality of radiology education compared to developed countries. Palestine's government and the authorized bodies have not improved the current situation of IR safety; Palestine is still not a member of the International Atomic Energy Agency (IAEA). It is tragic that Palestine still lacks laws protecting patients and radiation workers from radiation exposure. In addition to the lack of legislation that obliges medical institutions to train medical workers regarding radiation safety, especially training in modern knowledge and technology in this field. Al-Jamal et al. (2021) stated in their study that there is no radiation safety officer responsible for radiation protection in all hospitals and health centers in Palestine [23]. There are no regulations in Palestine to appoint a person responsible for supervising radiation protection practices in medical imaging departments, and therefore there are no regulations regarding monitoring violations that occur in medical imaging centers and there is no fear of potential penalties among radiographers who do not take into account radiation safety standards during X-ray examination.

Responses of radiographers in this present study, revealed a lack knowledge among them about radiation doses associated with imaging techniques and the lethal cancer threats they pose. To our surprise, near (90%) of participants answered all questions about that incorrectly or no idea with a total mean of scores was (32.43%) and (56.98%), respectively. Paolicchi et al., (2016), have also conducted similarly research, which has led to a lack of awareness among urology residents from twenty different European countries, and almost 50% of respondents were unaware that widely used imaging methods carry a lethal cancer risk [24].

Upon careful analysis of this present study, it is surprising that a significant proportion of radiographers had either seldom or never attended specific radiation protection training courses during their working time in the hospitals. This is inconsistent with the European Union's 97/43/Euratom of June 30, 1997 transposition, which confirms that all member states provide continuing education and training following qualification. In the unique situation of the clinical use of new methods, training related to these techniques is scheduled and related radiation protection requirements are taken into consideration [25]. Regular training programs should be developed on a health care institutions and national level at scheduled times [26]. Many research studies have also determined that radiographers need to become more knowledgeable about radiation risks [22, 24, 27], with a focus on increasing awareness during the study time [28-30].

This important research focus on the knowledge of IR safety in public and private hospitals in Palestine. Previously, Hamarsheh and Amro (2017), who found that radio-technologists lacked sufficient knowledge, with a mean percentage of correct responses to knowledge and awareness questions being 26.4%, conducted another study in Palestine [31]. Awadghanem et al. (2020) also concluded not enough knowledge of radiation protection of IR exposure and its hazards between medical undergraduates from Palestine. The participants' average level of knowledge was 11% [21].

From the results of this research, there is a knowledge

shortage through radiographers concerning the use of individual safety tools such as lead gloves or protective eyeglasses. These results are consistent with previous study conducted by Sharma et al., (2016) [32]. To fulfil the identified gap, the concerned department must initiate Information Education Communication (IEC) campaigns through training courses, workshops, and the distribution of IR sensitization materials.

The knowledge about IR protection did not vary notably among radiographers groups regarding to the type of hospitals and between groups that differ in gender and experience. In a similar study, Paolicchi, et al., (2016) reported that IR danger is independent of sex [24]. Although there was not a significant distinction between knowledge in the current research and the period of time employed in the sector. No correlation was found between the length of time spent in the field and the knowledge pertaining to radiation safety in the similar studies [33-35].

However, there was a slight but notable difference in knowledge between the groups based on their academic qualification. Postgraduate radiologists scored slightly higher level of knowledge than undergraduates. These findings are in line with a prior study by Maharjan et al., (2020), who found that students' knowledge levels were inadequate compared with that who graduated with higher education degrees [30].

Study limitations

This research focused solely on radiographers from seven hospitals in the Northern governorates of West Bank, with sample size (n = 74) is insufficient to represent the entirety of Palestine. Unlike the study conducted by Paolicchi et al. (2016) (24), with 780 Italian radiographers completed the questionnaire, and other study by Erkan et al., (2019) [35], which included a broader spectrum of participants. A more extensive sample drawn from other institutions would have improved the outcomes.

CONCLUSIONS

This study's findings indicate that Palestinian radiographers lack adequate knowledge of radiation safety. This emphasizes the necessity for specific education in radiation protection in order to improve the standard of nursing for all radiological methods. It is essential that workers in IR environments take annual recertification courses in order to stay up to date on the latest developments and to be reminded of occasionally ignored safety measures. To ensure patient safety, specific measures need to be put in place to raise attention of ray's dangers and to support learning of radiation protection. By incorporating sufficient radiation protection modules into the study curriculum, the author anticipates that graduates in medical imaging will have a better understanding of radiation protection. It is crucial to have regular conferences, workshops, and seminars on radiation protection and to extend invitations to all radiographers in the community. It is vital to receive formal training in radiation safety and protection, particularly in relation to the training in radiation doses associated with imaging methods and the serious cancer threats they pose. The author anticipate that the adoption of regulations governing the proper use of radiation would mark a significant turning point in starting this difficult process.

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