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Assessment of Radiation Protection Adherence and Support Services among Healthcare Professionals Working in Radiation Environment in Palestine

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Abstract: Radiation protection (RP) is crucial for safeguarding healthcare professionals in radiation circumstances. This survey aimed to evaluate RP adherence and the availability of support services among healthcare professionals working in Palestinian hospitals, distinguishing gaps and domains for improvement. A descriptive cross-sectional survey was conducted in six Palestinian hospitals, comprising (112) healthcare workers from diverse departments. A well-designed questionnaire assessed adherence to RP practices, availability of support services, and demographic characteristics. Data were analyzed using XLSTAT 2021, employing ANOVA and descriptive statistics. The results present that the response rate was (84.8%), overall adherence to RP guidelines was (75.6%), and with high level, usage of lead aprons (92%) and dosimeters (88.4%), but weak adherence to lead goggle usage (34.8%). However (95.5%) expressed willingness to attend radiation risk training, only (52.9%) reported enough RP support services, highlighting gaps in institutional resources and training. Occupation, gender, and department significantly affected levels of adherence, with males and radiologic technologists showing higher compliance ($p< 0.05$). Healthcare workers in Palestinian hospitals exhibit good adherence to RP guidelines, but significant gaps in training and support services persist. Addressing these shortages through boosting institutional support, implementing regular training programs. In addition to developing comprehensive RP policies and regulatory framework is critical to improving RP practices and ensure healthcare worker safety.

Keywords: Healthcare Workers, Cancer, Nurse, Physicians, Radiation Protection, Radiology.

Research Paper

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INTRODUCTION

Ionizing radiation has become an indispensable tool in recent medicine, playing a critical function in both therapeutic and diagnostic procedures (Buls, 2016; Thierry-Chef *et al*., 2020). Recent universal statistics indicate that medicinal radiation procedures have raised by approximately 40% in the latest decade, with over than 3600 million for diagnostic radiology (X-ray), 7.5 million radiotherapy cases and 37 million nuclear imaging operations performed per year (WHO, 2016).

Healthcare workers in radiation environments face different levels of exposure during routine procedures such as X-ray imaging, nuclear medicine, radiotherapy, and fluoroscopy (Boice *et al.*, 2020). They receive an average occupational dose of 1.8 mSv yearly; employees in nuclear imaging operations, radiation treatment, and diagnostic radiology were reported to have yearly average effective doses of 1.56, 0.28, and 0.66 mSv respectively (Nassef, and Kinsara, 2017; Aamry, *et al*., 2022). The interventional radiologists having increased doses between 2-4 mSv annually even though these technologies greatly improve patient care, they also pose health concerns to medical personnel who work in radiation environments on a daily basis (Miller, 2010). The International Commission on Radiological Protection (ICRP) has founded inclusive guidelines for Radiation Protection (RP), confirming the basic principles of optimization, dose limitation, and justification with an occupational exposure limit of 20 mSv annually averaged over five years (ICRP, 2019).

The achievement of RP measures faces particular difficulties for the Palestinian healthcare system. It works across fragmented districts, with approximately 93 hospitals (58 in West Bank, and 35 in Gaza Strip) serving an estimated population of (5.3) million (MoH, 2023). According to new studies, Khalilia *et al*., (2024a) reported that while 85% of radiological departments in Palestine possess basic RP equipment,

only 57% of staff members received comprehensive radiation safety training. In the year 2015, the total number of diagnostic medical images delivered through medical imaging departments in thirteen (13) Palestinian governmental hospitals in the West Bank was 572,404 medical images; in which 461,953 plain x-rays, 50,864 ultra sound, 53,130 CT scan, and 6,457 MRI images (MoH, 2016; Hassan, 2018; Aljamal, 2021). The healthcare system's infrastructure has been influenced by economic constraints, limited access to resources, and political instability, with an estimated 45% of major RP equipment being ancient or in need of change (Hassan, 2018; Lekhnath and Edward, 2025; Khalilia, 2025b).

Previous studies has revealed significant difference in RP practices globally. Through a systematic review, out of the 1,848 studies examined found that most studies had average practice concerning RP (Behzadmehr, 2021). In adjacent Middle Eastern countries, study has demonstrated insufficient adherence regarding RP practicing (Allam *et al.*, 2024).

Only nine governmental hospitals in Gaza were inclusive in the local study by Zer *et al*. (2016), which found a serious lack of infrastructure and practice. According to 182 diagnostic imaging workers, the diagnostic imaging departments at the hospitals have 35.2% of personal RP equipment available. Recent researches have showed that healthcare workers' adherence to RP may be influenced by many factors, including knowledge levels, availability of institutional policies, protective tools, and individual attitudes toward safety protocols (Abdelrahman, *et al.*, 2018; Abuzaid, *et al.*, 2019a; Allam, *et al.*, 2024).

This survey aimed to assess the adherence to RP practices and the availability of support services among healthcare professionals working in radiation environments across Palestinian hospitals. By understanding healthcare workers' perspectives, examining current practices, and identifying potential barriers to compliance this study seeks to provide invaluable insights for protecting the health of medical professionals and improving RP protocols in Palestine.

EXPERIMENTAL SECTION

Study Sample

This descriptive cross-sectional survey was performed in six Palestinian hospitals (four governmental and two private hospitals), which covering treatment and diagnostic radiography applications in north West Bank. The population was consisted of healthcare workers who elaborate in irradiation conditions. The Occupations of the participants included in this research were Physicians (24), Radiologic Technologist (32), Nurse (46), and other healthcare workers (10). In the six hospitals where the study is being conducted, (112) medical staff members (Emergency (15), ICU (16), Radiology (28), Neonatal and Pediatric (10), General surgery (21), and (22) from other sections) work in radiation-prone zones. Participants were informed that their responses were only to be utilized for research purposes.

Survey Questionnaire

A self-administrated questionnaire was prepared after reviewing the previous online resources and research on comparable topics (Abuzaid, *et al*., 2019b; Erkan, 2019; Zekioğlu, and Parlar, 2021; Alomairy, 2024; El Fahssi, *et al.*, 2024; Saida, *et al.*, 2024). Four of experts in occupational healthcare and four of radiology academic staff, reviewed the draft questionnaire to make sure it was reliable and valid.

The final form of the questionnaire involved three components with 15 questions. The 1st one consists of socio-demographic characteristics of the participants (gender, academic qualifications, occupations and departments).The 2nd section assess RP practices and adherence among Palestinian healthcare workers, which composed of items testing the adherence of the participants to RP during pursuit. 7 questions in this section concentrate on trainings about radiation, tools used for the purpose of RP while performing radiation protocols (lead aprons, thyroid shield, dosimeter, and lead goggle), and adherent to radiation safety guidelines. The last section evaluate health care workers RP support services in their departments. This section composed of 8 questions about the employer provides what is necessary for RP, which concentrate on radiation hazard warning information and guidelines, Radiation Safety Committee, sufficient trainings, operating room, and protective equipment. Closed questions with yes, no, or unsure answers were used for all of the items in sections two-three. To find and fix any possible problems that might come up during the survey period, a pilot survey with 15 healthcare workers was carried out before the questionnaire was distributed to the participants. Crucial form of the questionnaire was distributed to 132 healthcare workers by email. The survey launched in June 2024 for one month. Subsequent one reminder, 112 achieved questionnaires were gathered.

Statistical Analysis

Using the XLSTAT version 2021 for Excel, the data gathered from the Palestinian healthcare workers (n = 112) was analyzed (Addinsoft, 2021). ANOVA variance analysis were used, along with distribution of frequencies and average reports. Furthermore, a preliminary analysis of internal consistency and measurement reliability was performed.

RESULTS AND DISCUSSION

This study aimed to assess the adherence to RP practices and the availability of support services among healthcare professionals working in radiation environments across six Palestinian hospitals in the West Bank. Out of the 232 surveys, 112 healthcare workers were filled out the questionnaire. The high response rate of (84.8%) provides a strong foundation for evaluating the situation of RP in Palestinian healthcare departments, strengthens the reliability of this study finding, and proposes intense engagement from the healthcare society on this serious issue, like response rates in similar regional studies (Elsafadi *et al.*, 2020). The results of this study reveal important insights into the adherence to RP standards, and the availability of support services in Palestinian healthcare sectors for improvement. Although this survey provide significant insights into the demographic structure and distribution of healthcare professionals working in radiation environments across hospitals in the West Bank.

Figure 1 describes the sociodemographic data gathered from a survey of medical professionals who work in radiation environments in Palestinian hospitals. Most of them were males and holding bachelor educational qualifications with percentage of (64.3%) and (66.96%) respectively. Only (6.25%) of the participants were holding a two years diploma and (35.7%) were females. Concerning the educational level, qualifications of the contributors demonstrate a strong foundation, with two-thirds of contributors holding bachelor's degrees. This finding parallels the observations of Hussein *et al*., (2018) in Jordan, where they identified significant gaps in RP education among healthcare professionals. However, the relatively low percentage of professionals with diploma degrees (6.25%) suggests an opportunity for expanding continuing education and sophisticated training programs. It has been reported that RP awareness is influenced by educational background, with greater educational attainment frequently being associated with greater awareness and adherence to safety procedures (Khalilia, 2025a).

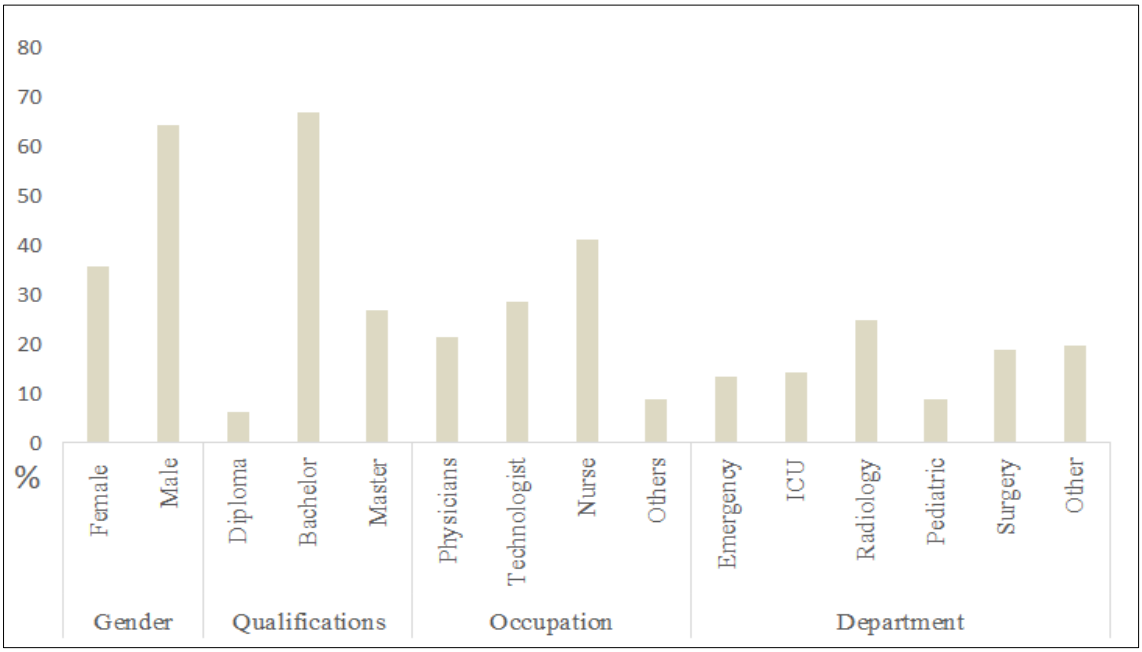

Figure 1: Percentage (%) of the healthcare workers according to the socio-demographic characteristics

Concerning the occupation of the participants in this study, percentage of nurses (41.1%), radiologic technologists (28.7%), physicians (21.4%), and others (8.9%). This distribution reflects the multidisciplinary nature of radiation safety in healthcare settings, consistent with findings from other Middle Eastern healthcare systems (Abuzaid, 2019a). Of all participants, (25%) were medical professionals working in radiology, 8.9% in neonatal and pediatric, (13.4%) in emergency, (14.3%) in ICU, (18.8%) in general surgery, and (19.6%) in other departments (Figure 1 and Table 1).

Table 1: Comparisons of the healthcare workers' adherence and RP support services according to socio-demographic characteristics

Characteristics		**Frequencies**	**%**
Gender	Female	40	35.71

	Male	72	64.29
Academic qualifications	Diploma	7	6.25
	Bachelor	75	66.96
	Master	30	26.79
Occupation	Physicians	24	21.43
	Radiologic Technologist	32	28.57
	Nurse	46	41.07
	Others	10	8.93
Department	Emergency	15	13.39
	ICU	16	14.29
	Radiology	28	25.00
	Neonatal and Pediatric	10	8.93
	General surgery	21	18.75
	Other	22	19.64

Of the total 112 respondents who answered seven questions about the level of adherence to RP standards, the average responses were "yes" (75.6%) and "no" (21.3%), while only (3.1%) answered "unsure" (Table 2). Most participants using protecting equipment such as lead aprons (92%) and dosimeters (88.4%). However, (65.2%) not wearing lead goggle while performing radiation protocols, showing a general awareness of radiation safety measures. Which is in line with similar findings in other regions, where a substantial proportion of healthcare workers in Turkey reported adherence to safety practices, though gaps in certain protective measures remained (Erkan *et al.*, 2019). In contrast, this survey revealed that a notable percentage of respondents did not wear lead goggles while implementing radiation protocols, which is a concerning, gap in commitment. This suggests that while there is recognition of key safety measures, there is room for improvement in consistent practice across all protective equipment. The non-adherence to goggles may be affected by perceived lower risk or discomfort, as noticed in similar studies in Morocco and Saudi Arabia (El Fahssi *et al.*, 2024; Alomairy, 2024). A substantial percentage of the respondents (95.5%) notify that they willing to join the training about radiation hazard. Which highlights an opportunity for healthcare hospitals in Palestine to address knowledge gaps and progress adherence to safety standards (Zekioğlu & Parlar, 2021). It is fundamental that this interest be capitalized on by offering organized, comprehensive training programs that confirm all aspects of RP, including the appropriate use of protective equipment like goggles and gloves.

On the other hand, the average results of participants answers to 8 question about evaluation of RP support services of the healthcare professionals in their workplace were as follows: (52.90%) yes, (34.4%) no, and (12.7%) unsure, indicating a moderate level of institutional support for RP. A substantial percentage of them (95.5%) notify that they have protective equipment and they have radiation hazard warning signs with a percentage of (97.3%) and (92.9%) respectively. On the other hand, (74.1%) reported they do not have periodic trainings on radiation safety (Table 2). However, findings revealed significant gaps in the availability of essential support services, including radiation safety officers, personal dosimeters, and comprehensive safety protocols. The lack of such services is a major concern, as healthcare workers are left without the proper tools to monitor and mitigate their radiation exposure. These findings align with similar researches in other regions, where inadequate institutional support was identified as a key challenge in RP (Abuzaid *et al.*, 2019a; Sulieman *et al.*, 2017). However, the lack of periodic training and the insufficient presence of dedicated radiation safety officers are critical gaps that need to be addressed (Nassef & Kinsara, 2017). This study also revealed that although RP equipment was available, its consistent use and comprehensive integration into daily practices were not guaranteed. This underscores the need for better resource management and structured support to ensure that healthcare workers are fully supported in their efforts to maintain radiation safety standards (Saida *et al.*, 2024).

Table 2: Assessment of RP adherence and support services among healthcare workers in Palestine

Healthcare workers' adherence to RP measurements N=112							
No.	**Question**	**Yes**		**No**		**Unsure**	
		Freq.	%	**Freq.**	%	**Freq.**	%
1	Adherent to radiation safety guidelines and protocols	74	66.1	33	29.5	5	4.46
2	Ensure a lowest level of 1- 2m range from radiation origin during process	86	76.8	11	9.82	15	13.39
3	Willing to join the training about radiation hazard	107	95.5	5	4.46	0	0

4	Using a dosimeter while performing radiation protocols	99	88.4	9	8.04	4	3.57
5	Using a lead apron while performing radiation protocols	103	92	9	8.04	0	0
6	Wearing lead goggle while performing radiation protocols	39	34.8	73	65.2	0	0
7	Wearing thyroid shield while performing radiation protocols	85	75.9	27	24.1	0	0
Average		**84.7**	**75.6**	**23.9**	**21.3**	**3.43**	**3.06**
Evaluation of RP support services of the healthcare workers							
8	Is there a Radiation Safety Committee (Safety Officer)?	45	40.2	58	51.8	9	8.04
9	Are you adequately informed concerning the responsibilities of radiation safety committees?	35	31.3	52	46.4	25	22.32
10	Are there regular trainings on RP?	20	17.9	83	74.1	9	8.04
11	Is the knowledge provided through the trainings effective to raise awareness on RP?	67	59.8	32	28.6	13	11.61
12	Is there a particular instruction on RP?	48	42.9	45	40.2	19	16.96
13	Do you have radiation hazard warning signs?	109	97.3	0	0	3	2.68
14	Are there any protective equipment to be used during fluoroscopy?	104	92.9	2	1.79	6	5.36
15	Do you have an operating room which is radiation safe?	46	41.1	36	32.1	30	26.79
Average		**59.25**	**52.90**	**38.5**	**34.4**	**14.75**	**12.72**

Table 3 shows the assessment of RP adherence among healthcare workers from Palestine according to gender and educational characteristics. Males had higher adherent (yes answers) to RP than females for the questions in this section (1-7), except question number 5 about wearing lead apron while performing radiation protocols, females answered (100%) yes compared with (87.5%) for males. Which showed a significant difference in adherence according to gender (p=0.025) with a yes score of (87.5%) and (35%) for males and females, respectively. These results aligns with findings from similar studies, where males tend to report higher adherence, possibly due to differences in roles, responsibilities, or perceptions of radiation safety (Zekioğlu & Parlar, 2021). The high adherence to lead apron use among females may indicate a raise awareness or more strict safety measures in place for female healthcare workers, as observed in prior studies in Morocco (El Fahssi *et al.*, 2024).

For adherence level of RP among healthcare workers regarding educational qualifications, the majority of respondents to question six, which asked about wearing lead goggle while performing radiation protocols, for diploma, master's, and bachelor's degrees, gave "no" response, with percentages of (100%), (70%), and (60%), respectively. Wile, the participants willing to join the training about radiation hazard, with a high percentage for diploma, bachelor, and master degrees, which reached (100%), (98.7%), and (86.7%), respectively with a significant difference (p=0.025) in assessment of RP adherence according to educational qualifications in their hospitals (Table 3). The readiness to undergo additional training was also higher among healthcare workers with higher educational qualifications, with (100%) of intermediate diploma and (98.7%) of bachelor degree holders expressing interest in joining radiation hazard training. This finding highlights the importance of education in enhancing a proactive approach to RP (Hassan, 2018).

Furthermore, Table 3 shows the evaluation of RP support services among healthcare workers from Palestine according to gender and educational characteristics. Most participants of both genders at different levels of education reported that they having warning signs of radiation hazards in their workplaces. Responses to the question 12 about the existence of specific guidelines on radiation safety were similar for "yes" and "no" answers in general. However, there were significant differences between the responses of males and females (p = 0.029) with a yes score of (47.2%) and (35%) for males and females, respectively. While for assessments of support services section (questions 8-15), results shows that there are significant differences in the participants' answers regarding the level of education to (9, 11, and 12) questions, with p value equal (0.021, 0.029, and 0.029), respectively (Table 3).

Table 3: Assessment of RP adherence and support services among healthcare workers from Palestine according to gender and educational qualification characteristics

Healthcare workers' adherence to RP measurements N=112									
	Question	**Answers**	**Gender: Frequency (%)**			**Education: Frequency (%)**			
			Female 40(35.7)	**Male 72(64.3)**	***P****	**Diploma 7(6.2)**	**Bachelor 75(67)**	**Master 30(26.8)**	***P****
1		Yes	24(60)	50(69.4)	0.066	5(71.4)	46(61.3)	23(76.7)	0.382

	Adherent to radiation safety guidelines and protocols	No	16(40)	17(23.6)		2(28.6)	26(34.7)	5(16.7)	
		Unsure	0	5(6.9)		0	3(4)	2(6.6)	
2	Ensure a lowest level of 1- 2m range from radiation origin during process	Yes	27(67.5)	59(81.9)	0.287	7(100)	55(73.3)	24(80)	0.545
		No	5(12.5)	6(8.3)		0	7(9.3)	4(13.3)	
		Unsure	8(20)	7(9.7)		0	13(17.4)	2(6.7)	
3	Willing to join the training about radiation hazard	Yes	40(100)	67(93.1)	0.158	7(100)	74(98.7)	26(86.7)	**0.048**
		No	0	5(6.9)		0	1(1.3)	4(13.3)	
		Unsure	0	0		0	0	0	
4	Using a dosimeter while performing radiation protocols	Yes	35(87.5)	64(88.9)	0.892	5(71.4)	66(88)	28(93.3)	0.082
		No	3(7.5)	6(8.3)		2(28.6)	7(9.3)	0	
		Unsure	2(5)	2(2.8)		0	2(2.7)	2(6.7)	
5	Wearing lead apron while performing radiation protocols	Yes	40(100)	63(87.5)	**0.025**	7(100)	68(90.7)	28(93.3)	1.000
		No	0	9(12.5)		0	7(9.3)	2(6.7)	
		Unsure	0	0		0	0	0	
6	Wearing lead goggle while performing radiation protocols	Yes	17(42.5)	22(30.6)	0.220	0	30(40)	9(30)	0.075
		No	23(57.5)	50(69.4)		7(100)	45(60)	21(70)	
		Unsure	0	0		0	0	0	
7	Wearing thyroid shield while performing radiation protocols	Yes	30(75)	55(76.4)	1.000	7(100)	54(72)	24(80)	0.256
		No	10(25)	17(23.6)		0	21(28)	6(20)	
		Unsure	0	0		0	0	0	
Evaluation of RP support services of the healthcare workers									
8	Is there a Radiation Safety Committee (Safety Officer)?	Yes	15(37.5)	30(41.7)	0.831	5(71.4)	28(37.3)	12(40)	0.368
		No	21(52.5)	37(51.4)		2(28.6)	42(56)	14(46.7)	
		Unsure	4(10)	5(6.9)		0	5(6.7)	4(13.3)	
9	Are you adequately informed concerning the responsibilities of radiation safety committees?	Yes	14(35)	21(29.2)	0.195	4(57.1)	21(28)	10(33.3)	**0.021**
		No	21(52.5)	31(43.1)		0	41(54.7)	11(36.3)	
		Unsure	5(12.5)	20(27.8)		3(42.9)	13(17.3)	9(30)	
10	Are there regular trainings on RP?	Yes	5(12.5)	15(20.8)	0.496	0	12(16)	8(26.7)	0.119
		No	31(77.5)	52(72.2)		7(100)	54(72)	22(73.3)	
		Unsure	4(10)	5(6.9)		0	9(12)	0	
11	Is the knowledge provided through the trainings effective to raise awareness on RP?	Yes	22(55)	45(62.5)	0.741	3(42.9)	40(53.3)	24(80)	**0.029**
		No	13(32.5)	19(26.4)		4(57.1)	25(33.3)	3(10)	
		Unsure	5(12.5)	8(11.1)		0	10(13.3)	3(10)	
12	Is there a particular instruction on RP?	Yes	14(35)	34(47.2)	**0.029**	2(28.6)	29(38.7)	17(56.7)	**0.029**
		No	14(35)	31(43.1)		5(71.4)	28(37.3)	12(40)	
		Unsure	12(30)	7(9.72)		0	18(24)	1(3.3)	
13	Do you have radiation hazard warning signs?	Yes	40(100)	69(95.8)	0.551	7(100)	73(97.3)	29(96.7)	1.000
		No	0	0		0	0	0	
		Unsure	0	3(4.17)		0	2(2.7)	1(3.3)	
14	Are there any protective equipment to be used during fluoroscopy?	Yes	38(95)	66(91.7)	0.844	7(100)	68(90.7)	29(96.7)	0.395
		No	0	2(2.8)		0	1(1.3)	1(3.3)	
		Unsure	2(5)	4(5.5)		0	6(8)	0	
15	Do you have an operating room which is radiation safe?	Yes	20(50)	26(36.1)	0.310	5(71.4)	27(36)	14(46.7)	0.337
		No	12(30)	24(33.3)		2(28.6)	26(34.7)	8(26.7)	
		Unsure	8(20)	22(30.6)		0	22(29.3)	8(26.7)	

* Statistically significant at $p < 0.05$

Table 4 shows the assessment of RP adherence among healthcare workers from Palestine according to their occupation (nurses, radiologic technologists, physicians, and other occupations). Regarding the assessment of adherence (1-7 questions) with RP standards, healthcare workers were asked about the tools used for the purpose of RP while performing radiation protocols (lead aprons, thyroid shield, dosimeter, and lead goggle), about training, and adherent to radiation safety guidelines. The results for question one shows a significant difference (p=0.042) in adherence according to occupation. With "yes" score of (50 %), (63%), (71.9%), and (100%) for physicians, nurses, radiologic technologists, and other occupations respectively.

Healthcare workers' commitment to RP standards also varied based on their professional occupations. Radiologic technologists and physicians had higher adherence rates to radiation safety guidelines and protocols compared to nurses, which was statistically

significant (p=0.042). This significance suggests that radiologic technologists, who are often directly involved with radiation procedures, may be more familiar with and inclined to follow safety protocols. Physicians, while showing relatively high adherence, could benefit from more focused radiation safety training, as they are frequently exposed to radiation in diagnostic and therapeutic settings (Miller *et al.*, 2010; Khalilia, 2025a).

For the evaluation of RP support services among healthcare workers from Palestine according to their occupation. Most participants reported that they having warning signs of radiation hazards and protective equipment in their workplaces for questions 13 and 14. Responses to the questions 13 shows significant differences between the responses (p = 0.158), with (91.7%), (100%), (96.9%) and (100%) for physicians, nurses, radiologic technologists, and other occupations respectively (Table 4). Most participants from all studied occupations admitted that there is no periodic training on radiation safety provided to them in their workplaces (question 10). With a percentage of (66.7%), (84.8%), 62.5%), and (80%) for physicians, nurses, radiologic technologists, and other occupations respectively (Table 4).

Table 4: Assessment of RP adherence and support services among healthcare workers from Palestine, according to occupation variable

	Healthcare workers' adherence to RP measurements N=112							
#	**Question**	**Occupation: Frequency (%)**						
		Answers	**Physician N=24**	**Nurse N=46**	**RT N=32**	**Other N=10**	**Total**	***P****
1	Adherent to radiation safety guidelines and protocols	Yes	12(50)	29(63)	23(71.9)	10(100)	74	**0.042**
		No	12(50)	13(28.3)	8(25)	0	33	
		Unsure	0	4(8.7)	1(3.1)	0	5	
2	Ensure a lowest level of 1- 2m range from radiation origin during process	Yes	20(83.3)	37(80.4)	21(65.6)	8(80)	86	0.099
		No	0	2(4.35)	7(21.9)	2(20)	11	
		Unsure	4(16.7)	7(15.2)	4(12.5)	0	15	
3	Willing to join the training about radiation hazard	Yes	24(100)	44(95.7)	31(96.6)	8(80)	107	0.127
		No	0	2(4.35)	1(3.1)	2(20)	5	
		Unsure	0	0	0	0	0	
4	Using a dosimeter while performing radiation protocols	Yes	18(75)	43 (93.5)	28(87.5)	10(100)	99	0.208
		No	4(16.7)	3(6.5)	2(6.25)	0	9	
		Unsure	2(8.3)	0	2(6.25)	0	4	
5	Wearing lead apron while performing radiation protocols	Yes	20(83.3)	42(91.3)	31(96.6)	10(100)	103	0.300
		No	4(16.7)	4(8.7)	1(3.1)	0	9	
		Unsure	0	0	0	0	0	
6	Wearing lead goggle while performing radiation protocols	Yes	4(16.7)	16(34.8)	15(46.9)	4(40)	39	
		No	20(83.3)	30(65.2)	17(53.1)	6(60)	73	
		Unsure	0	0	0	0	0	
7	Wearing thyroid shield while performing radiation protocols	Yes	14(58.3)	38(82.6)	25(78.1)	8(80)	85	0.117
		No	10(41.7)	8(17.4)	7(21.9)	2(20)	27	
		Unsure	0	0	0	0	0	
	Evaluation of RP support services of the healthcare workers							
8	Is there a Radiation Safety Committee (Safety Officer)?	Yes	4(16.7)	18(39.1)	21(65.6)	2(20)	45	0.000
		No	20(83.3)	22(47.8)	10(31.3)	6(60)	58	
		Unsure	0	6(13.1)	1(3.13)	2(20)	9	
9	Are you adequately informed concerning the responsibilities of radiation safety committees?	Yes	8(33.3)	11(23.9)	12(37.5)	4(40)	35	0.111
		No	14(58.3)	21(45.7)	11(34.4)	6(60)	52	
		Unsure	2(8.33)	14(30.4)	9(28.1)	0	25	
10	Are there regular trainings on RP?	Yes	4(16.7)	4(8.7)	10(31.3)	2(20)	20	0.121
		No	16(66.7)	39(84.8)	20(62.5)	8(80)	83	
		Unsure	4(16.7)	3(6.5)	2(6.3)	0	9	
11		Yes	10(41.7)	28(60.9)	21(65.6)	8(80)	67	0.231
		No	12(50)	11(23.9)	7(21.9)	2(20)	32	

	Is the knowledge provided through the trainings effective to raise awareness on RP?	Unsure	2(8.33)	7(15.2)	4(12.5)	0	13	
12	Is there a particular instruction on RP?	Yes	4(16.7)	20(43.5)	18(56.3)	6(60)	48	0.035
		No	12(50)	18(39.1)	11(34.4)	4(40)	45	
		Unsure	8(33.3)	8(17.4)	3(9.4)	0	19	
13	Do you have radiation hazard warning signs?	Yes	22(91,7)	46(100)	31(96.9)	10(100)	109	**0.158**
		No	0	0	0	0	0	
		Unsure	2(8.3)	0	1(3.13)	0	3	
14	Are there any protective equipment to be used during fluoroscopy?	Yes	20(83.3)	45(97.8)	29(90.6)	10(100)	104	0.067
		No	0	0	2(6.25)	0	2	
		Unsure	4(16.7)	1(2.2)	1(3.13)	0	6	
15	Do you have an operating room which is radiation safe?	Yes	12(50)	12(26.1)	18(56.3)	4(40)	46	0.088
		No	4(16.7)	20(43.5)	8(25)	4(40)	36	
		Unsure	8(33.3)	14(30.4)	6(18.7)	2(20)	30	

* Statistically significant at $p < 0.05$

The data in table 5 shows the assessment of RP adherence among healthcare workers from Palestine according to their departments (emergency, ICU, radiology, neonatal and pediatric, general surgery, and other departments). Regarding the assessment of adherence (1-7 questions) with RP standards, the results of most participants from all departments had higher adherence scores for questions number 2, 4, and 7 with a significant ($p = 0.001$, 0.013, and 0.039) respectively. Most healthcare workers from all studied departments answered question 3 with "yes", so they were willing to join the training about radiation hazard. While the majority of them from all departments, answered question six (wearing lead goggle while performing radiation protocols), with "no" response. The distribution of contributors in this study according to their departments provides worthy insight into radiation exposure types across hospital departments. While the concentration in radiology sections (25%) was expected, the representation from general surgery were (18.8%), ICU (14.3%), and emergency departments (13.4%) that aligns with new studies on radiation exposure in modern healthcare institutions (Al-Haj *et al.*, 2020), who documented the widespread nature of radiation exposure among several hospital sections in their survey. This finding supports the need for hospital-wide RP protocols rather than limiting such measures to traditional radiology field.

Table 5: Assessment of RP adherence and support services among healthcare workers from Palestine, according to department variable

Healthcare workers' adherence to RP measurements N=112								
	Question	**Ans.****	**Frequency (%)**					
			Emergency 15	**ICU 17**	**Radiology 27**	**Pediatric 8**	**Surgery 23**	**Other 22**	***P****
1	Adherent to radiation safety guidelines and protocols	Yes	11(73.3)	8(47)	20(74.1)	4(50)	13(56.5)	18(81.8)	0.072
		No	4(26.7)	9(53)	6(22.2)	4(50)	7(30.4)	3(13.6)	
		Unsure	0	0	1(3.7)	0	3(13.1)	1(4.6)	
2	Ensure a lowest level of 1- 2m range from radiation origin during process	Yes	15(100)	16(94.1)	16(59.3)	8(100)	14(60.9)	17(77.3)	**0.001**
		No	0	0	7(25.9)	0	2(8.7)	2(9.1)	
		Unsure	0	1(5.9)	4(14.8)	0	7(30.4)	3(13.6)	
3	Willing to join the training about radiation hazard	Yes	15(100)	17(100)	26(96.3)	8(100)	21(91.3)	20(90.9)	0.247
		No	0	0	1(3.7)	0	2(8.7)	2(9.1)	
		Unsure	0	0	0	0	0	0	
4	Using a dosimeter while performing radiation protocols	Yes	13(86.7)	13(76.5)	23(85.2)	6(75)	22(95.7)	22(100)	**0.013**
		No	0	4(23.5)	2(7.4)	2(25)	1(4.3)	0	
		Unsure	2(13.3)	0	2(7.4)	0	0	0	
5	Wearing lead apron while performing radiation protocols	Yes	11(73.3)	15(88.2)	26(96.3)	8(100)	22(95.7)	21(95.5)	0.205
		No	4(26.7)	2(11.8)	1(3.7)	0	1(4.3)	1(4.5)	
		Unsure	0	0	0	0	0	0	

6	Wearing lead goggle while performing radiation protocols	Yes	4(26.7)	2(11.8)	14(51.9)	2(25)	8(34.8)	9(40.9)	0.149
		No	11(73.3)	15(88.2)	13(48.1)	6(75)	15(65.2)	13(59.1)	
		Unsure	0	0	0	0	0	0	
7	Wearing thyroid shield while performing radiation protocols	Yes	13(86.7)	14(82.4)	20(74.1)	6(75)	13(56.5)	19(86.4)	**0.039**
		No	2(13.3)	3(17.6)	7(25.9)	2(25)	10(43.5)	3(13.6)	
		Unsure	0	0	0	0	0	0	
Evaluation of RP support services of the healthcare workers									
8	Is there a Radiation Safety Committee (Safety Officer)?	Yes	6(40)	4(23.5)	18(66.7)	4(50)	8(34.8)	5(22.7)	**0.024**
		No	9(60)	11(64.7)	8(29.6)	4(50)	11(47.8)	15(68.2)	
		Unsure	0	2(11.8)	1(3.7)	0	4(17.4)	2(9.1)	
9	Are you adequately informed concerning the responsibilities of radiation safety committees?	Yes	7(46.7)	4(23.5)	12(44.4)	0	4(17.4)	8(36.4)	0.287
		No	4(26.7)	11(64.7)	9(33.3)	4(50)	14(60.9)	10(45.5)	
		Unsure	4(26.7)	2(11.8)	6(22.2)	4(50)	5(21.7)	4(18.2)	
10	Are there regular trainings on RP?	Yes	4(26.7)	0	9(33.3)	2(25)	2(8.7)	3(13.6)	**0.008**
		No	11(73.3)	15(88.2)	16(59.3)	4(50)	20(87)	17(77.3)	
		Unsure	0	2(11.8)	2(7.4)	2(25)	1(4.3)	2(9.1)	
11	Is the knowledge provided through the trainings effective to raise awareness on RP?	Yes	7(46.7)	5(29.4)	18(66.7)	4(50)	17(73.9)	16(72.7)	0.126
		No	6(40)	8(47.1)	7(25.9)	2(25)	4(17.4)	5(22.7)	
		Unsure	2(13.3)	4(23.5)	2(7.4)	2(25)	2(8.7)	1(4.55)	
12	Is there a particular instruction on RP?	Yes	5(33.3)	6(35.3)	15(55.6)	4(50)	10(43.5)	8(36.4)	**0.029**
		No	10(66.7)	6(35.3)	9(33.3)	2(25)	6(26.1)	12(54.5)	
		Unsure	0	5(29.4)	3(11.1)	2(25)	7(30.4)	2(9.1)	
13	Do you have radiation hazard warning signs?	Yes	13(86.7)	17(100)	26(96.3)	8(100)	23(100)	22(100)	0.300
		No	0	0	0	0	0	0	
		Unsure	2(13.3)	0	1(3.7)	0	0	0	
14	Are there any protective equipment to be used during fluoroscopy?	Yes	15(100)	15(88.2)	24(88.9)	6(75)	22(95.7)	22(100)	**0.039**
		No	0	0	2(7.4)	0	0	0	
		Unsure	0	2(11.8)	1(3.7)	2(25)	1(4.3)	0	
15	Do you have an operating room which is radiation safe?	Yes	11(73.3)	3(17.6)	15(55.6)	2(25)	8(34.8)	7(31.8)	**0.000**
		No	2(13.3)	6(35.3)	8(29.6)	0	8(34.8)	12(54.5)	
		Unsure	2(13.3)	8(47.1)	4(14.8)	6(75)	7(30.4)	3(13.6)	

* Statistically significant at $p < 0.05$, ** Healthcare workers answers (Yes: Y; No: N; Unsure: Un)

On the other hand, assessment of support services (questions 8-15), the results of most participants from all departments had higher scores ("yes" answers) for questions 13 and 14 with a significant ($p = 0.039$) for question 14. While for questions 8 and 10 they had high scores ("no" answers) for most of departments with a significant ($p = 0.024, 0.008$) respectively. Most participants from all studied departments admitted that there is no periodic training on radiation safety provided to them in their workplaces (question 10). With percentage of (73.3%), (88 .2%), (59.3%), (50%), (87%), and (77.3%) for emergency, ICU, radiology, neonatal and pediatric, general surgery, and other departments respectively (Table 5).

The demographic variables have significant implications for RP practice. They propose the requirement for varied training programs that account for professional roles and varying educational backgrounds, as recommended by the International Commission on Radiological Protection (ICRP, 2019). Furthermore, the wide departmental distribution indicates that RP measures should be incorporated into major hospital safety protocols. Rather than treated as a specialty-specific concern.

A significant result from this research was the loss of regular RP training and the lack of a clear national institutional regulatory framework for ensuring compliance with standardized RP guidelines. The Ministry of Health (MoH) in Palestine has the opportunity to solve this gap by improving and performing a more organized national RP policy. Internationally, countries with strong regulatory frameworks, such as those in the U.S. and Europe, have seen improved radiation safety effect (Thierry-Chef *et al.,* 2022). International communities like the International Atomic Energy Agency (IAEA) have confirmed the importance of applying national RP guidelines (WHO, 2016), yet in Palestine, there is an obvious necessity for formal legislation and better control to ensure healthcare facilities adhere to RP standards. By aligning Palestinian healthcare policies with international best practices, institutions can ensure a safer working environment for healthcare workers and improve overall adherence to RP protocols. Other studies in Morocco and Pakistan also reveal that lack regulatory frameworks often lead to inconsistent radiation safety practices (Jafri *et al.,* 2022; El Fahssi *et al.,* 2024). Therefore, establishing a national RP policy in Palestine would provide healthcare institutions with clear, enforceable guidelines to improve worker safety. Efficient institutional support is wanted to ensure that all healthcare workers have access to vital protective tools, periodic training, and radiation hazard warning signs (Sulieman *et al.,* 2017; Abuzaid *et al.,* 2019a; Saida *et al.,* 2024). A key barrier to efficient adherence to RP protocols was the inconsistent use of lead goggles, with many healthcare employees failing to wear it despite another protective tools being available. This might reflect a lack of appropriate awareness or a perception that the hazard of exposure is minimal in particular contexts. Previous researches have also specified such barriers in healthcare settings, where comfort and prosperity override adherence to safety protocols (Miller *et al.,* 2010). Additionally, the lack of periodic training and the variability of RP support services based on specialty, gender, department, and educational qualifications indicate a fragmented approach to radiation safety. Regular, comprehensive periodic training programs could be implemented to ensure that all healthcare workers are consistently updated on radiation safety standards and the correct use of safety equipment in healthcare facilities. (Jafri *et al.,* 2022; Alomairy, 2024). Training programs should also take into account gender and educational disparities in RP adherence to address gaps in knowledge and promote uniform adherence across the workforce (Erkan *et al.,* 2019; Khalilia, 2025a).

This study had some limitations. The sample was restricted to healthcare professionals in Palestinian hospitals, and the data collection was based on self-reported responses, which may have led to response bias. Additionally, the study did not include observational data to directly assess the practices of healthcare professionals in radiation environments. Unlike the research conducted by Allam *et al.,* (2024) which included a broader spectrum of participant's specialty, this study focused solely on physicians, nurses, and radiologic technologists from six hospitals in Palestine. Future studies could expand the sample size and include observational assessments to provide a more comprehensive understanding of RP adherence in Palestine. Additionally, future research could investigate barriers to advanced education in radiation safety, and assess the effectiveness of current training programs across different professional groups.

CONCLUSION

This study provides valuable insights into the present status of RP practices and support services in Palestinian hospitals in the West Bank. Although there is a general awareness of the importance of radiation safety, significant gaps remain in training, equipment use, and institutional support services. To improve RP in Palestine, it is essential to implement regular training programs, enhance institutional support, and establish a strong regulatory framework. By addressing these gaps through targeted interventions based on gender, education, and occupation can significantly improve radiation safety standards in radiation-intensive environments across healthcare facilities in Palestine.

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