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Radiation Protection Measures in Radio-Diagnostic Centers in Gaza Hospitals, Palestine

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Abstract

Whereas radio-diagnostic centers have potential to present hazardous effects due of ionizing radiation. Radio-diagnostic workers awareness, practices regarding radiation protection issues, availability of radiation protection devices and effective personal radiation exposure monitoring process has an important role to safe working in these places. We carried out this study in nine governmental Gaza governorates hospitals. The study instrument was close-ended structured questionnaire consists of five parts. 182 radio-diagnostic workers participated in the work. Based on the obtained data, the participants reported that 35.2% of personal radiation protection devices are available in the radio-diagnostic centers at governmental Gaza governorates hospitals. In spite the fact that 74.8% of participants have awareness about radiation protection issues, but it is only about 53.4% of participants follows the radiation protection practices. There is an obvious poor of personal radiation exposure monitoring process. Conclusively, the results represented in this work reflect that majority of participants believe there is no radiation safety officer to provide the service. Therefore, there is a desperate need for rules, regulations and radiation protection act in the field of radiation in medical field.

Keywords: Radiation protection, Radio-diagnostic, Awareness, Practices.

Contents

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1. Introduction

Ionizing radiation in medical imaging is one of the powerful diagnostic tools in medicine. Radiation which is applied in radiology departments has hazardous effects on biological systems [1, 2].

The level of awareness concerning with radiation protection influences in staff behavior. If they have not enough information related to mentioned issue, their action will not be safe and resulted to adverse effects [3, 4].

All of these individuals may be considered radiation workers, depending on their level of exposure and on national regulations. All workers require appropriate monitoring continuously by common personnel dosimeters like film badge and thermo-luminescence dosimeter. They must also receive education and training appropriate to their jobs and protect by tools and equipment [5]. In Gaza governorates hospitals, there is no radiation protection program, lack of clear information about radiation protection measures and guidelines. Therefore, the study results will help in implementing modification to alleviate risk factors. In addition, to develop an action plan and new management strategies for radiation protection enhancements and provide clear information to the decision makers.

2. Objectives

The main objective of the study is to evaluation of radiation protection measures at governmental Gaza governorates hospitals. The other specific objectives are:

- To identify the availability of radiation protection devices in the radio-diagnostic centers.
- To measure the level of radio-diagnostic workers awareness about radiation protection issues.
- To measure the level of radio-diagnostic workers practices about radiation protection issues.
- To evaluate the personal radiation exposure monitoring process.
- To help the planners and decision makers to modify the future plans regarding radiation protection to be more and to develop radiation safety culture.

3. Materials and Methods

The present study is a descriptive analytical cross sectional study. We carried out this study in nine governmental Gaza governorates hospitals. The target population of this study is the radio-diagnostic workers who have been working at radio-diagnostic centers in these hospitals. This estimated approximately 185 medical radiographers and 45 radiologists. The hospitals were selected because of their large and diverse of their radio-diagnostic services.

The sample size was calculated by using sample size calculator from the survey system on the web, with confidence level of 95% and confidence interval of 5. The calculated sample size was 144 of the 230 radio-diagnostic workers. We decided to give rise this number to 182 in order to increase the response rate and to compensate the uncertainties. The study instrument was face to face interview through close-ended structured questionnaire.

The validity of the questionnaire was tested by six specialists in the fields of radiology, medical physics, public health and statistics.

A pilot study was conducted before starting real data collection. It was served as a pre-test for the questionnaire to check the ambiguity in the question statements and the time taken to complete the questionnaire. Twenty radio-diagnostic workers were chosen to participate in the pilot study. They were selected by the convenience method from the hospitals that have been previously identified. Slight modifications were also done on the questionnaire. The questionnaire content reliability and internal consistency determined by using Cronbach's Alpha in SPSS.

3.1. The Questionnaire Consists of Five Parts and Includes the Following

Part one: consisted of eight questions about socio-demographic factors and related work information. This includes: age, sex, occupation, academic qualification, years of experience, name of hospital, type of radio-diagnostic machines who use it, and daily work hours inside the radio-diagnostic rooms.

Part two: consisted of ten questions related to the availability of radiation protection devices in the radio-diagnostic centers. This contains (lead apron, gonad shield, lead curtains, lead shields or barrier, thyroid shields, lead glass, lead gloves, breast shields, radiation warning signs and caution lights).

Part three: consisted of eighteen questions to measure the level of radio-diagnostic workers awareness about radiation protection issues. This also gives some information about the general understanding of radiation protection issues.

Part four: consisted of fifteen questions related to describe of radio-diagnostic workers practices about radiation protection issues.

Part five: consisted of six questions to evaluate the personal radiation exposure monitoring process.

Data checked, coded, entered and analyzed using SPSS 20 (Statistical Package for the Social Science Inc. Chicago, Illinois USA, version 20) statistical package.

4. Results and Discussion

Tale (1), shows 79.1% (n=144) of participants are medical radiographers and 20.9% (n=38) are radiologists. Most of radio-diagnostic workers that formulate 82.8%% (n=144) have a bachelor degree.

There is a wide variation in sex of radio-diagnostic workers, where 76.1% (n=144) of the study participants are males and 23.9% (n=43) females. This result indicates that the most of radio-diagnostic workers are males and this is attributed to the community culture towards women who working in radiology field and their fear from transmitting the risk of radiation to their future generations.

The study shows that the participants ages were between 30 and 39 years which formulates 46.4% (n=84) of the participants, this indicates that the radio-diagnostic population are young labors.

The study population was categorized into four groups according to their practical experience and refers that most of the radio-diagnostic workers have sufficient practical experience in radio-diagnostic field.

Clearly, it is found that the largest number of study participants from Al Shifa Medical Complex, who formulates 31.3% (n=57) of the study participants. However, the lowest number of study participants from Abdel Aziz Rantessi hospital who formulates 4.9% (n=9) of the participants, this result is not a surprise since the participants proportions depend on the number of radio-diagnostic workers in each hospital, where Al Shifa Medical Complex is a major one.

Basic X-ray machines is the most common used, which formulates 83% (n=151) of participants. While 14.8% (n=27) of participants used with mammography machines, this result is reasonable because the basic X-ray machines are the most prevalent in terms of the number and use in the hospitals. Whereas, the dealing with the mammography machines restricted to females workers.

Most of radio-diagnostic workers that formulate 34.1% (n=60) working between 3 and 4 hours inside the radio-diagnostic rooms per day, while 27.8% (n=49) of the participants working between 2 and 3 hours per day.

Table-1. Socio-demographic and related work factors of the study participants.

Item	Frequency	Percentage
1. Age		
From 20-29 years	44	24.3%
From 30-39 years	84	46.4%
From 40-49 years	38	21%
More than 50 years	15	8.3%
2. Sex		
Male	137	76.1%
Female	43	23.9%
3. Occupation		
Radiologist	38	20.9%
Medical radiographer	144	79.1%
4. Academic qualification		
Diploma	16	9.2%
Bachelor	144	82.8%
Higher degree	14	8%
5. Practical experience		
1-4 years	32	18%
5-9 years	64	36%
10-14 years	48	27%
15-20 years	34	19.1%
6. Name of hospital		
Abu Yousef Al Najjar hospital	12	6.6%
European Gaza hospital	16	8.8%
Nasser medical complex	29	15.9%
Al Aqsa Martyrs hospital	20	11%
Al Shifa Medical complex	57	31.3%
Al Naser pediatric hospital	12	6.6%
Abdel Aziz Rantessi Martyr	9	4.9%
Kamal Adwan Martyr hospital	17	9.3%
Beit Hanoun hospital	10	5.5%
7. Type of radio-diagnostic machine		
Basic X-ray	151	83%
CT scan	80	44%
Fluoroscopy	107	58.8%
Panorama	44	24.2%
Mammography	27	14.8%
Portable X-ray	76	41.8%
8. Daily work hours in radio-diagnostic rooms		
1-2 hours	21	11.9%
2-3 hours	49	27.8%
3-4 hours	60	34.1%
4-5 hours	32	18.2%
More than 5 hours	14	8%

The personal radiation protection devices are the principal for radiology workers [6]. A visible warning sign and caution light required to alert individuals to radiological conditions [7]. However, according to the participants knowledge, it is about 35.2% of personal radiation protection devices are available in the radio-diagnostic centers at governmental Gaza governorates hospitals, Table 2.

As it displays in the figure (4.26), the maximum rate about the availability of personal radiation protection devices specified to lead aprons and thyroid shields by 95.6% (n=174) and 75.8% (n=138) respectively. The minimum rate that related to the availability of personal radiation protection devices specified to lead curtains, breast shields and gonad shields by 5.5% (n=10), 7.1% (n=13) and 15.9% (n=29) respectively.

Table-2. Participants response about the availability of radiation protection devices.

Radiation protection devices	Yes(frequency and percentage)	No(frequency and percentage)	Don't know (frequency and percentage)
Lead aprons	174(95.7%)	7(3.8%)	1(0.5%)
Gonadal shields	29(16%)	142(78%)	11(6%)
Lead curtains	10(5.5%)	135(74.2%)	37(20.3%)
Lead shields / barriers	73(40.2%)	92(50.5%)	17(9.3%)
Thyroid shields	138(75.9%)	41(22.5%)	3(1.6%)
Lead glass	76(41.8%)	98(53.8%)	8(4.4%)
Lead gloves	38(20.9%)	134(73.6%)	10(5.5%)
Breast shields	13(7.1%)	155(85.2%)	14(7.7%)
Radiation warning signs	41(22.5%)	132(72.5%)	9(5%)
Caution lights	48(26.4%)	122(67%)	12(6.6%)
Average	35.2%	58.1%	6.7%

As shown in Figure1 in spite the fact that 74.8% of participants have awareness about radiation protection issues, but it is only about 53.4% of participants follows the radiation protection practices. This result is surprising and alarming. Clearly it seems unsatisfactory and indicates that the approximately half of participants have negative practices toward radiation protection issues.

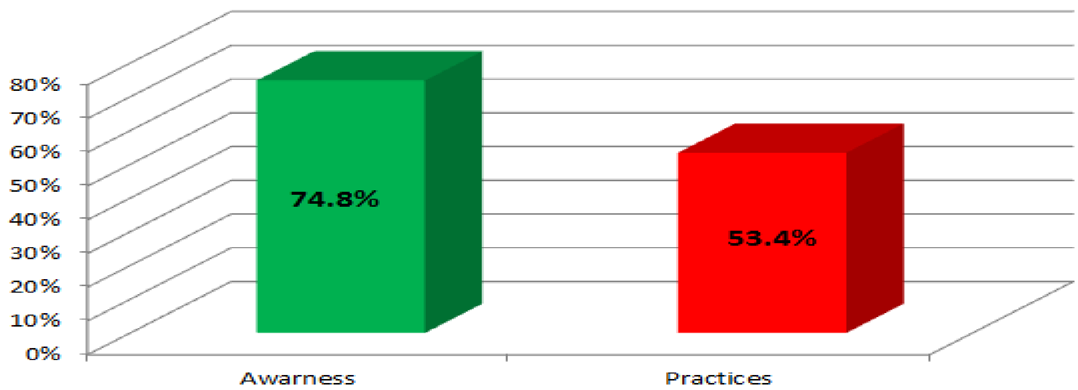

Figure-1. Study participant awareness and practices level regarding radiation protection issues.

Table 3 shows that the radiation protection advisers are not available in the most of radio-diagnostic centers that surveyed. About 60.4% (n=111) of study participants have a personal radiation exposure monitoring device. Approximately 55% (n=61) of participants who have personal radiation exposure monitoring device use this device during their work in radio-diagnostic rooms, while 31.5% (n=35) of participants sometimes use this device and 13.5% (n=15) of participants don't use this device during their work in radio-diagnostic rooms.

The most of participants who have a dosimeter don't receive guidance about the proper handling with the personal radiation exposure monitoring devices, this represents about 75.7% (n=84) of participants. There are a big problem in personal radiation exposure monitoring process, majority of the participants 64.9% (n=72) believe that the measurements results doesn't take into consideration by the safety officers. There is no one of radio-diagnostic workers receive a new personal radiation exposure monitoring device when the devices collect to measure of radiation dose.

Table-3. Responses of study participants to evaluation the personal radiation exposure monitoring processitems

Items	Frequency and percentage
1. Does the hospital have Radiation Protection Adviser (RPA)?	
Yes	8(4.4%)
No	174(95.6%)
2. Does the hospital provide you with any personal radiation monitoring device?	
Yes	111(60.4%)
No	71(39.6%)
3. If yes, do you use it during your work in the radio-diagnostic rooms?	
Yes	61(55%)
Sometimes	35(31.5%)
No	15(13.5%)
4. Did you receive a guidance about the proper handling with the personal radiation monitoring device?	
Yes	27(24.3%)
No	84(75.7%)
5. Are the measurements results taken into consideration by the safety officers?	
Yes	39(35.1%)
No	72(64.9%)
6. Do you receive another personal radiation monitoring device when the device collect to measure of radiation dose?	
Yes	0(0%)
No	111(100%)

As shown in Figure (2) there are a miscellaneous reasons advanced by the study participants about the negligence in personal radiation exposure monitoring process. Majority of participants 64.9% (n=63) believe that there is no radiation safety officer to provide the service. While about 57.7% (n=56) believe that another reason was put forward by the participants. This is due to the carelessly of hospital management, that represent about 57.7% (n=56). Another opinion reports that there is lack of fund to purchase these devices and this represents about 32.0% (n=31). Finally, 24.7% (n=24) of participants believe that the radio-diagnostic workers do not request the dosimeters.

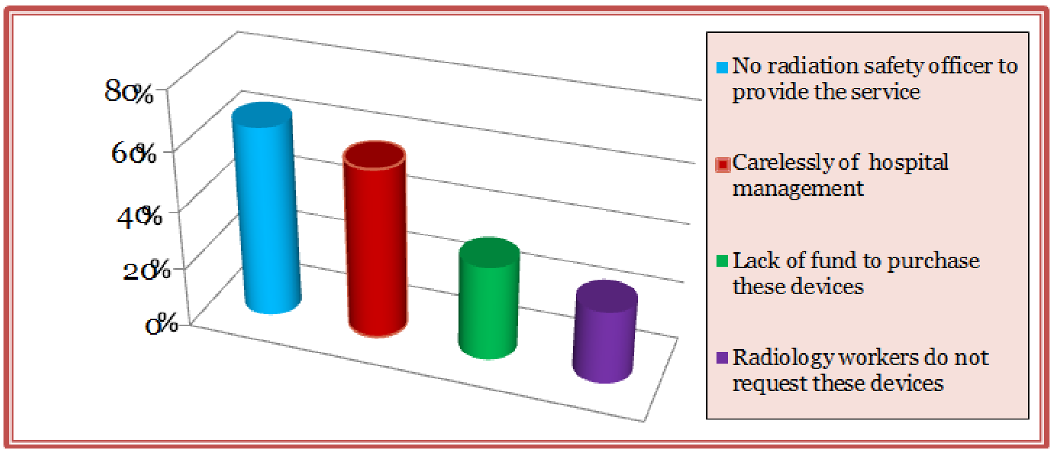

Figure-2. Participants response about the reasons for lack of personal radiation exposure monitoring devices.

The independent samples t-test, frequency, one-way analysis of variance (ANOVA), mean and the standard deviation were carried out and developed in order to identify the relationship between the level of availability the personal radiation protection devices, awareness and practices regarding radiation protection issues and evaluation of personal radiation exposure monitoring process as a dependent variables. However, the socio-demographic and work related factors for workers as independent variables.

According to one-way variance (ANOVA) analysis, (P value=0.003), the results in Table 4 reflect there is a difference in the practices mean among the radio-diagnostic workers according to their age groups. The highest mean value (72) was for age group more than 50 years, while the lowest mean value (49.05) was for age group between 30 and 39 years. Clearly that the calculated p-value is less than the significant level which is equal 0.05 (p-value < 0.05).So, the alternative hypothesis that there is statistically significant relationship between the participants practices regarding radiation protection and their age groups is accepted.

Clearly that there is a statistically significant difference according to the participants age groups (p-value=0.037), this difference is highest among radio-diagnostic workers with age groups more than 50 years, with mean value (41.11). The lowest mean (23.11) is among age group between 20 and 29 years. This is logical result and reflects that the new employees are not included in the personal radiation exposure monitoring process.

Table-4. The dependent variables according to participants age groups

Items	Age	No.	Mean	Std.	F	Sig.
Availability of devices	From 20-29 years	44	40.00	21.67	**2.024**	**0.112**
	From 30-39 years	84	34.29	19.59		
	From 40-49 years	38	30.26	15.85		
	More than 50 years	15	39.33	18.31		
Awareness	From 20-29 years	44	73.61	14.68	**2.18**	**0.092**
	From 30-39 years	84	74.07	14.26		
	From 40-49 years	38	74.42	14.47		
	More than 50 years	15	83.70	9.73		
Practices	From 20-29 years	44	53.03	21.23	**4.721**	**0.003**
	From 30-39 years	84	49.05	21.45		
	From 40-49 years	38	55.44	25.66		
	More than 50 years	15	72.00	18.55		
Radiation monitoring	From 20-29 years	44	23.11	26.22	**2.879**	**0.037**
	From 30-39 years	84	33.93	25.67		
	From 40-49 years	38	25.00	26.78		
	More than 50 years	15	41.11	33.85		

The results in Table 5 shows that there are no statistically significant differences the dependent variables due to participants sex.

Table-5. The dependent variables according to participants sex

Items	Sex	No.	Mean	Std.	t	Sig.
Availability of devices	Male	137	34.67	18.87	**-0.474**	**0.636**
	Female	43	36.28	21.05		
Awareness	Male	137	74.53	14.72	**-0.266**	**0.791**
	Female	43	75.19	12.32		
Practices	Male	137	52.99	23.25	**-0.047**	**0.963**
	Female	43	53.18	21.01		
Radiation monitoring	Male	137	29.56	27.34	**-0.548**	**0.584**
	Female	43	32.17	26.82		

According to one-way variance (ANOVA) analysis in Table 6 (p-value=0.029).There is a statistically significant relationship between radio-diagnostic workers awareness toward radiation protection issues due to their occupation. There are a highly statistically significant differencesbetween the radio-diagnostic workers evaluation regarding personal radiation exposure monitoring process and their occupation (p-value=0.000).

Table-6. The dependent variables according to participants occupation

Items	Occupation	No.	Mean	Std.	t	Sig.
Availability of devices	Radiologist	38	32.63	17.96	-0.902	0.368
	Medical radiographer	144	35.83	19.84		
Awareness	Radiologist	38	70.32	15.30	-2.199	0.029
	Medical radiographer	144	75.96	13.73		
Practices	Radiologist	38	48.07	25.94	-1.635	0.104
	Medical radiographer	144	54.86	21.89		
Radiation monitoring	Radiologist	38	8.77	16.32	-5.952	0.000
	Medical radiographer	144	35.88	26.76		

Clearly in Table 7 that there is a statistically significant difference in the radio-diagnostic workers practices according to their academic qualification (p-value=0.008). This result may be attributed to the quality of education materials and curriculum given to the three different groups.

There is statistically significant difference between the evaluation regarding personal radiation exposure monitoring process among radio-diagnostic workers and their academic qualifications (p-value=0.013).

As shown in Table 8 there is a statistically significant difference in the radio-diagnostic workers awareness level due to their years of practical experience (p-value=0.017).

There is a highly statistically significant difference in the radio-diagnostic practices due to their practical experience years (p-value=0.000).

Table-7. The dependent variables according to participants academic qualification

Items	Education	No.	Mean	Std.	F	Sig.
Availability of devices	Diploma	16	31.25	19.28	0.435	0.648
	B.Sc.	144	36.11	20.11		
	Higher degree	14	35.71	16.51		
Awareness	Diploma	16	78.13	10.44	0.462	0.631
	B.Sc.	144	74.50	14.68		
	Higher degree	14	75.00	14.25		
Practices	Diploma	16	70.42	19.62	4.967	0.008
	B.Sc.	144	52.04	22.32		
	Higher degree	14	55.24	23.45		
Radiation monitoring	Diploma	16	47.92	27.13	4.433	0.013
	B.Sc.	144	30.09	26.76		
	Higher degree	14	20.24	25.47		

This result may be attributed to long-term of occupational radiation doses for those who have more than 20 years of work. So, this group of radio-diagnostic workers has become more concerned about the health impacts from radiation exposures than those who have less period of experience. Hence, they applied the protection procedures more carefully to decrease the probability of radiation risks on their health.

There are a highly statistically significant differences in the evaluation of personal radiation exposure monitoring process due to their practical experience years (p-value=0.000).

Table-8. The dependent variables according to participants practical experience

Items	Experience	No.	Mean	Std.	F	Sig.
Availability of devices	From 1-4 years	32	39.06	24.14	**1.261**	**0.287**
	From 5-9 years	64	35.31	19.92		
	From 10-14 years	48	30.83	15.96		
	From 15-19 years	19	39.47	17.79		
	More than 20 years	15	32.00	16.56		
Awareness	From 1-4 years	32	78.99	12.91	**3.088**	**0.017**
	From 5-9 years	64	71.09	14.21		
	From 10-14 years	48	73.61	14.24		
	From 15-19 years	19	78.07	13.67		
	More than 20 years	15	81.48	13.55		
Practices	From 1-4 years	32	53.13	18.97	**7.493**	**0.000**
	From 5-9 years	64	47.19	22.04		
	From 10-14 years	48	49.72	22.04		
	From 15-19 years	19	67.02	22.50		
	More than 20 years	15	75.11	19.76		
Radiation monitoring	From 1-4 years	32	13.54	20.93	**5.414**	**0.000**
	From 5-9 years	64	32.29	25.70		
	From 10-14 years	48	30.21	25.65		
	From 15-19 years	19	33.33	31.43		
	More than 20 years	15	48.89	29.86		

As shown in Table 9 there are highly statistically significant differences in the participants evaluation of availability of radiation protection devices(p-value=0.000), participants awareness (p-value=0.028) and participants practices (p-value=0.001) due to their hospitals.

Table-9. The dependent variables according to participants hospitals

Items	Hospital	No.	Mean	Std.	F	Sig.
Availability of devices	European Gaza hospital	16	31.25	10.25	**8.337**	**0.000**
	Nasser Medical Complex	29	43.45	20.58		
	Abu Yousef Al Najjar hospital	12	22.50	6.22		
	Al Aqsa Martyrs hospital	20	34.00	11.42		
	Al Shifa Medical Complex	57	38.77	19.28		
	Abdel Aziz Rantessi hospital	9	63.33	11.18		
	Al Naser hospital	12	31.67	23.29		
	Kamal Adwan hospital	17	22.35	16.78		
	Beit Hanoun hospital	10	15.00	9.72		
Awareness	European Gaza hospital	16	70.83	15.52	**2.221**	**0.028**
	Nasser Medical Complex	29	71.26	13.03		
	Abu Yousef Al Najjar hospital	12	70.37	17.14		
	Al Aqsa Martyrs hospital	20	74.17	16.74		
	Al Shifa Medical Complex	57	78.36	12.93		
	Abdel Aziz Rantessi hospital	9	69.14	14.46		
	Al Naser hospital	12	85.65	14.88		
	Kamal Adwan hospital	17	73.53	8.68		
	Beit Hanoun hospital	10	71.67	13.21		
Practices	European Gaza hospital	16	43.33	26.22	**3.484**	**0.001**
	Nasser Medical Complex	29	42.76	21.49		
	Abu Yousef Al Najjar hospital	12	56.11	16.69		
	Al Aqsa Martyrs hospital	20	42.00	25.05		
	Al Shifa Medical Complex	57	59.53	21.19		
	Abdel Aziz Rantessi hospital	9	54.81	22.80		
	Al Naser hospital	12	67.22	13.77		
	Kamal Adwan hospital	17	56.08	19.73		
	Beit Hanoun hospital	10	63.33	25.39		
Radiation monitoring	European Gaza hospital	16	25.0	21.08	**1.58**	**0.134**
	Nasser Medical Complex	29	24.71	28.74		
	Abu Yousef Al Najjar hospital	12	45.83	18.97		
	Al Aqsa Martyrs hospital	20	27.50	26.64		
	Al Shifa Medical Complex	57	26.90	28.65		
	Abdel Aziz Rantessi hospital	9	42.59	22.22		
	Al Naser hospital	12	38.89	32.05		
	Kamal Adwan hospital	17	27.45	25.65		
	Beit Hanoun hospital	10	43.33	26.29		

Clearly in Table 10 that there is a statistically significant difference in the radio-diagnostic workers practices according to their daily work hours (p-value=0.008). This difference is high among radio-diagnostic workers who work more than 5 hours (67.1), the lowest is among radio-diagnostic workers who work between 2 and 4 hours (46.7).

Table-10. The dependent variables according to participants daily work hours in radio-diagnostic rooms

Items	Daily work hours	No.	Mean	Std.	F	Sig.
Availability of devices	From 1-2 hours	21	32.4	21.2	**0.504**	**0.733**
	From 2-3 hours	49	36.9	22.7		
	From 2-4 hours	60	36.0	18.5		
	From 4-5 hours	32	33.1	17.5		
	More than 5 hours	14	40.0	15.2		
Awareness	From 1-2 hours	21	74.6	13.6	**1.928**	**0.108**
	From 2-3 hours	49	73.7	15.9		
	From 2-4 hours	60	72.3	14.8		
	From 4-5 hours	32	80.7	11.3		
	More than 5 hours	14	75.0	11.9		
Practices	From 1-2 hours	21	56.2	20.5	**4.192**	**0.003**
	From 2-3 hours	49	52.9	21.9		
	From 2-4 hours	60	46.7	21.7		
	From 4-5 hours	32	62.3	22.8		
	More than 5 hours	14	67.1	21.8		
Radiation monitoring	From 1-2 hours	21	31.0	29.5	**1.002**	**0.408**
	From 2-3 hours	49	32.7	26.1		
	From 2-4 hours	60	25.6	27.7		
	From 4-5 hours	32	35.9	28.4		
	More than 5 hours	14	25.0	25.9		

5. Conclusion

A descriptive analytical cross sectional study, based on the analysis of data collected by a close-ended structured questionnaire consists of five parts which designed for matching the study needs and 182 radio-diagnostic workers participated in the work. We conducted the independent samples t-test, frequency and one-way analysis of variance (ANOVA). These tests detect the difference between the availability of personal radiation protection devices, awareness and practices level regarding radiation protection issues and evaluation of personal radiation exposure monitoring process as a dependent variables. However, the socio-demographic and work related factors among radio-diagnostic workers are independent variables.

According to the results displayed in chapter four, the participants reported that 35.2% of personal radiation protection devices are available in the radio-diagnostic centers at governmental Gaza governorates hospitals.

The results indicate unsatisfactory practices toward radiation protection issues, where approximately half of participants have negative practices. In general, the results revealed that there is an obvious poor of personal radiation exposure monitoring process. There is also a statistically significant difference in the participants awareness level due to their years of practical experience and occupation.

Overall, the results represented in this work reflect that majority of participants believe there is no radiation safety officer to provide the service. Therefore, there is a desperate need for rules, regulations and radiation protection act in the field of radiation in medical field.

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