Original Article

Assessment of the Factors Affecting the Radiation Protection Levels of Radiology Personnel

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Article Information
Received: 2018-10-17
Revised: 2019-07-08
Accepted: 2019-12-18

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Cite this article as:
ÇEVİK H, İLGÜN G, ŞAHİN B. Assessment of the Factors Affecting the Radiation Protection Levels of Radiology Personnel. Archives of Advances in Biosciences 2020:11 (1)

Abstract

Introduction: Hospitals are among organizations with the highest risk in terms of workplace safety. While almost all departments within hospitals are faced with various risks, radiology department employees, in particular, are more likely to be exposed to conditions that threaten their health due to exposure to radiation. This study aims to identify the factors that affect the radiation protection levels of radiology personnel.

Materials and Methods: This study is cross-sectional quantitative research. The study was conducted on one of Turkey's most prestigious universities working in the radiology department of the hospital staff. A questionnaire consisting of 9 questions was used to determine the radiation protection level of the employees. The questionnaire was distributed to a total of 299 personnel, but there was a return from 155 employees (52%).

Results: The results of the regression analysis showed that the variables of gender, occupation, and radiation protection training had significant impact on the level of measures taken by radiology personnel for radiation protection ($p<0.05$), whereas the variables of age, marital status, and work experience had a different pattern ($p>0.05$). R-squared value of the regression model indicates that 42.1% of the variation in the level of measures taken to protect the radiology staff against radiation has been explained by these variables ($F=11.520$; $p<0.001$).

Conclusion: The results of the study suggest that training about radiation protection should be provided to the radiology personnel to prevent their health and safety.

Keywords: Radiology, radiation protection, workplace safety, healthcare personnel, Turkey

1. Introduction

Many risk factors threaten the health and safety of employees despite the measures taken in today's work-life [1]. Such risks arising from the workplace environment have many negative consequences such as loss of labor and inefficiency or a decrease in production quantity and quality among employees [1-3].

According to the International Labour Organization- ILO, around 2.78 million people die and about 374 million people suffer from nonfatal injuries and diseases each year due to occupational hazards and work accidents. This is referred to as an annual loss of 3.94% in the global gross domestic product [4]. Similarly, the report of WHO indicated that the DALY (Disability Adjusted Life Years) loss around the world is 1.7% due to occupational diseases and accidents [5].

Increased loss due to work or workplace environment pushes the enterprises to

minimize the risks that might be encountered at work and to take measures accordingly [6-11]. Hospitals, in particular, are among organizations with the highest risk in terms of workplace safety [13,14]. Some of such risk factors are explosive materials, medical gases, radiations, chemicals and infections from patients [15, 16]. While almost all departments within the hospitals are faced with such risk factors that threaten workplace safety, these are particularly more dangerous for the radiology department, which has a high workload and uses high technology [17-19]. The risk factors that the radiology personnel may encounter are classified as follows.

The first one is the risk factor that the personnel can take under control and the second is the fixed risk factor such as the internal design and quality of devices used in the radiology department, which are not possible for the personnel to control [20]. Therefore, the radiology personnel should take some measures towards the risk factors that have under control while working. Within this context, the present study aims to identify the factors affecting the levels of measures taken by the radiology personnel of a university hospital in order to be protected from the radiation.

2. Materials and Methods

2.1. Design

A cross-sectional quantitative study, conducted through self-completed questionnaires was undertaken using a sample in Turkey.

2.2. Research Sample

The population of research comprised of a total number of 299 personnel working at the radiology department of a university hospital in Ankara, Turkey. The sample for the study was not selected, with the aim of reaching all personnel. The questionnaire was employed as a tool for data collection and distributed to all personnel. However, 71 (47%) out of 151 radiology technicians, 15 nurses (60%) out of 25, 33 doctors (53%) out of 62 and 36 (59%) out of 61 other personnel (health officer, servant and post officer) agreed to participate in the study. Hence, the study was conducted with the participation of a total of 155 personnel (52%).

2.3. Data Collection Method

As for data collection, face-to-face interviews were conducted with that personnel who participated in the research voluntarily, between April-May 2017, with each interview taking about 5-10 minutes. The data were collected through a questionnaire, consisting of two sections. The first section comprised of a total number of six questions regarding the socio-demographical characteristics of radiology personnel, whereas the second section consisted of nine questions identifying the radiation protection levels of the personnel. The questions were prepared by the four-point Likert scale as 1= always, 2=often, 3=rarely, and 4=never. The average of answers given for nine questions indicates the level of radiation protection. The average approach to 1 is a high level of measures taken by personnel to protect against radiation, the average approach to 4 is a low level. When the reliability of the questionnaire was evaluated, it was found that the Cronbach alpha coefficient was 0.916 and it proved to be acceptable.

2.4. Data Analysis

The characteristics of radiology personnel who responded to the questionnaire were shown with the frequency and percentage while their answers to questions about the radiation protection were described using statistics such as mean and standard deviation. A multiple regression analysis was performed in order to identify whether or not the levels of personnel's radiation protection differ from their demographic characteristics. Gender, age, marital status, occupation, work experience and receiving the training on radiation protection were utilized as the

independent variables of the regression model, while the average level of personnel's radiation protection was considered as the dependent variable.

3. Results

The socio-demographic characteristics of the participants are given in Table 1. As shown in the table, 51.6% of the participants were between the ages of 21 and 41 and were male. In terms of their marital status and occupations, approximately ¾ of participants (74.2%) were married and almost half of them (45.8%) were radiology technicians. Finally, 50.3% of personnel had 1-17 years of work experience and 81.9% received radiation protection training.

Table 1. Descriptive statistics of the participants

Variables	Number	%
Age		
25-41	80	51.6
42-66	75	48.4
Gender		
Male	80	51.6
Female	75	48.4
Marital status		
Married	115	74.2
Single	40	25.8
Occupation		
Radiology technician	71	45.8
Nurse	15	9.7
Physician	33	21.3
Other (Health officer / Servant / Post officer)	36	23.2
Occupation work experience (Year)		
1-17	78	50.3
18-42	77	49.7
Radiation prevention training status		
Yes	127	81.9
No	28	18.1

Table 2 shows the levels of measures taken by radiology personnel who participated in the study. In accordance with the findings, the most used tools among the participants were the dosimeter (1.55 ± 1.08) and lead paravane (1.86 ± 1.19). Hence, 83.2% of participants noted that they used a dosimeter while working and 74.1% of them said that they wore lead paravane. The least used tools by the participants were lead gloves with an average of 3.23 (±1.10) and lead glasses with an average of 2.92 (±1.21). Therefore, according to these results, 73.7% of participants stated that they rarely and never used lead gloves while more than half of participants (63.7%) rarely or never used lead glasses.

Table 2. The levels of protective tools use among participants

Protection tools	Frequency*	Always	Most of the time	Rarely	Never
Lead apron	124	57.3%	8.9%	12.1%	21.8%
Lead neckline	114	47.4%	12.3%	13.2%	27.2%
Thyroid protector	116	47.4%	12.1%	13.8%	26.7%
Lead paravane	116	58.6%	15.5%	6.9%	19.0%
Lead gloves	99	12.1%	14.1%	12.1%	61.6%
Lead glasses	110	20.0%	16.4%	15.5%	48.2%
Dosimeter	131	76.3%	6.9%	2.3%	14.5%
Blood tests	117	37.6%	19.7%	25.6%	17.1%
Adequate and balanced nutrition	115	37.4%	35.7%	15.7%	11.3%

*Although the number of personnel participated in the study is 155, the number of personnel answering the questions about the radiation protection is less than 155 as each personnel only answered the protective tool question related to himself.

Table 3 shows the results of the regression analysis regarding factors affecting the levels of participants' radiation protection. R-squared value of the regression model indicated that 42.1% of the variations in the levels of participants' radiation protection were explained ($F=11.520$; $p<0.001$). On the other hand, the VIF values (1.100-3.384) of the model showed that there is not any multicollinearity problem between the independent variables.

According to the regression model, the variables of gender, occupation, and radiation protection training had a significant impact on the level of the measures taken by the participants for radiation protection ($p\leq0.05$), whereas the variables of age, marital status, and work experience did not follow the same pattern ($p>0.05$). Correspondingly, the standardized beta coefficients of the model revealed that the training received by participants for the radiation protection ($\beta=0.443$) had the biggest impact on the radiation protection level of radiology personnel. The person who received any training for radiation protection took more measures against radiation compared to the group who did not.

Table 3. Factors affecting the level of measures taken by the participants for radiation protection

Independent variables	Unstandardized β coefficient	Standardized β coefficient	t	p	VIF
(Constant)	0.429		0.795	0.428	
Age (Ref: 25-41 years)	0.064	0.035	0.339	0.736	2.286
Gender (Ref: Male)	0.441	0.237	3.203	**0.002**	1.202
Marital status (Ref: Married)	0.087	0.041	0.581	0.563	1.100
Occupation (Ref: Radiology technician)	-0.432	-0.232	-1.869	0.064	3.384
Occupation (Ref: Nurse)	-0.782	-0.264	-2.626	**0.010**	2.208
Occupation (Ref: Physician)	-0.626	-0.289	-2.605	**0.010**	2.693
Work experience (Ref: 1-17 years)	-0.010	-0.098	-0.986	0.326	2.185
Receiving training for radiation protection	1.313	0.443	5.298	**<0.001**	1.529

R^2= 0.421; **F**=11.520; **p**<0.001

As seen from the results of the analysis, male personnel had higher radiation protection than female personnel. Similarly, the levels of protection against radiation among radiology technicians, health

officers, servant and post officers are higher compared to nurses and doctors.

4. Discussion

In recent years, it is known that there are important developments particularly in the field of medical imaging and radiology. New technologies in this field, increase the level of accuracy of the decisions related to the diagnosis and treatment of patients. Among these issues is the lack of qualified personnel required to use the new health technologies, increasing the workload on the radiology staff and increasing the level of radiation the personnel is exposed to. Hence, both hospital management and radiology personnel should take some measures to be protected from the increasing radiation risk in the radiology departments. This study focused on the measures taken by radiology personnel rather than the hospital management and aimed to identify the factors affecting the levels of protective measures taken by radiology personnel.

The result of the present study demonstrated that the training received for radiation protection was the most significant variable affecting the level of measures taken by the personnel against radiation. This result can be explained by the increase of awareness of individuals against the potential hazards of radiation after training. In accordance with this study, the study by Mojiri and Moghimbeigi [21] conducted on 71 radiology technicians indicated that individuals who received training about radiation protection had higher protection levels. The study of Alavi et al. [22] performed on 413 health care personnel points out that the personnel with training have higher tendencies for radiation protection. The study conducted by Paolicchi et al. [23] on 780 radiology technicians in Italy also stated that the training for radiation protection was an important factor in terms of both personnel and patients' safety.

According to the study, the other important variable affecting the radiation protection levels of personnel is occupation and the levels of measures taken by radiation technicians and other personnel (health office, servant and post officer) higher (in rank) than the doctors and nurses. This result can be explained by the fact that the radiology technicians are relatively exposed to radiation more than doctors and nurses. It is acknowledged that the radiology technicians work actively in the process of medical imaging while the work of doctors is primarily interpreting and writing the image reports. Similar to the result of this study, the study of Günalp et al. [24] found that the radiation awareness of doctors was lower than the interns and technicians. Moreover, the study of Balsak [25] compared the radiation protection levels of radiology technicians, nurses, and doctors where the protection levels of radiology technicians were found higher. On the contrary to previous studies, the study of Yurt et al. [26] on the radiation awareness of 92 healthcare personnel (doctor, nurse, radiology technician) from different clinics using ionized radiation shows that the doctors have the highest awareness against radiation. Similarly, the study of Lee et al. [27] which was performed on 354 doctors and nurses working at the emergency service of 17 training & research hospitals indicates that the doctors have a higher awareness about radiation protection than the nurses.

Another finding of the present study is that the male personnel have a higher level of radiation protection than female personnel. On the contrary, the study of Vural et al. [28] performed for the assessment of knowledge among the operating room staff on the radiation safety states that the knowledge level of female personnel with regard to the radiation protection is higher than males. Similarly, the study of Mihai et al. [29] indicates that the radiation risk perception levels of females are high. In the literature, it is possible to find studies

indicating that there is a statistically significant difference between men and women staff in terms of the radiation protection level as well as studies reflecting no statistically significant difference as well. For instance, the study by Manavgat and Mandıracıoğlu [30] performed on 306 healthcare officers found no difference between the radiation protection levels of men and women staff.

Also, the results of the present study displayed that the most used protective tool by the radiology technicians is "dosimeter", "lead apron" for nurses and other healthcare personnel and "thyroid protector" for doctors. On the other hand, the study of Heo et al. [31] regarding the radiation protective tools used by the healthcare personnel depicted that the doctors mostly used the lead apron. Pursuant to the study of Alotaibi and Saeed [32], the film badge and lead apron are the tools that are used the most by the nurses in order to be protected from the radiation.

5. Conclusions

The results of the study show that measures taken by radiology personnel to be protected from radiation vary according to training for protection from radiation, occupation, and gender, while age, marital status and working time has no significant effect on the level of protection from radiation.

The study suggests that training should be given to staff, nurses and physicians, and women workers who are not trained in radiation protection on the potential hazards of radiation in particular. However, in order to be effective and be able to perform the desired behavior change, the reasons behind the low level of radiation protection among these personnel should be investigated and radiation protection education programs should be developed by considering these issues.

Since the study was a cross-sectional study and was conducted at the radiology department of a university hospital, the generalizability of the results requires a cautious approach. The study does not show whether the level of radiation protection between health care personnel varies according to different types of hospitals (such as being a training, public or private hospital) and different departments (such as the emergency department and radiology department) as it is performed only in a hospital and in a single department of that hospital. The present study manifested that 42% of the radiation protection level of radiology personnel is explained and 58% has not been explained. Future studies for stronger external validity should, therefore, include more hospitals and departments. Besides, other variables other than the variables used in this study should be included to better understand the variation in the radiation protection level of the personnel.

Conflict of interest

The authors declare no conflict of interest.

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