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ARTICLE

Factors influencing radiologic technologists' commitment to radiation protective equipment utilization in fluoroscopy units: an analysis using the health belief model scale

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Abstract – Objective: This study aimed to assess the perceptions of radiologic technologists towards the use of radiation protective equipment (RPE) in fluoroscopy units and to identify the Health Belief Model constructs, "perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy", that predict RPE utilization among radiologic technologists.
Methods: A cross-sectional observational study was conducted among 228 radiologic technologists in Saudi Arabia. Data were collected using a self-administered questionnaire that included socio-demographic characteristics, frequency of RPE utilization, and the Health Belief Model. Logistic regression was used to identify the predictors of RPE utilization.
Results: The findings indicate that 63% of radiologic technologists reported always being committed to using RPE, while 37% reported not fully committed. Perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy showed significant associations with RPE utilization between the two groups of radiologic technologists: those who always use RPE and those who are not fully committed ($p < 0.05$). Logistic regression showed that perceived benefits were a significant predictor of RPE utilization (AOR = 0.20, 95% CI: 0.60–0.67, p = 0.009), and type of hospital was also a significant predictor (AOR=0.09, 95% CI: 0.1–0.97, p = 0.047).
Conclusion: The study highlights the need for interventions to improve the consistent use of RPE among radiologic technologists in fluoroscopy units. Emphasizing the importance of RPE usage, addressing barriers, and providing adequate cues to action can help enhance radiologic technologists' commitment to using RPE and reduce radiation exposure risks. Tailoring interventions to the specific hospital setting and considering the perceived benefits of using RPE are crucial for promoting a culture of safety and accountability in different healthcare settings.

Keywords: Radiation protection / fluoroscopy units / radiological technologist / radiation protective equipment / health belief model

1 Introduction

Radiation protective equipment (RPE) is essential in radiology departments (RDs), including fluoroscopy units, to protect patients, medical professionals, and other personnel from harmful radiation exposure (Antunes-Raposo *et al.*, 2022; Budosova *et al.*, 2022). Diagnostic and therapeutic procedures in the RDs involves the use of radiation, which can emit ionizing radiation that can cause long-term health effects such as cancer and short term effects such as burns and cataracts (Biso *et al.*, 2020; Budosova *et al.*, 2022). RPE such as lead aprons, thyroid collars, and radiation glasses provide physical barriers between the body and radiation, preventing the absorption of harmful radiation. For example, when using a 0.5-mm lead apron, the X-ray transmittance for 70–100 kilovolt peak (kVp) was between 0.5% and 5%, and when using a lead composite or lead-free apron with a 0.5-mm lead equivalent thickness, the X-ray transmittance ranged from 0.6% to 6.8% (Cheon *et al.*, 2018). Proper use of RPE is crucial to ensure the safety and well-being of everyone in the radiology department (Mayer *et al.*, 2018).

Radiologic technologists play a critical role in RDs by capturing high-quality images for diagnostic and treatment purposes (Neep *et al.*, 2014). However, some radiologic technologists may not be fully committed to using RPE despite the known risks of radiation exposure (Salim *et al.*, 2022). There are various reasons for this, including issues with the fit

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or comfort of RPE, a lack of understanding of the risks associated with radiation exposure, or the perception that RPE is unnecessary for certain procedures. Additionally, some radiologic technologists may feel pressured to prioritize patient care over their own safety and may perceive RPE as hindering their ability to provide care (Mc Fadden *et al.*, 2022; European Society of R. *et al.*, 2019). Also, previous studies from Saudi Arabia reported a higher radiation doses received by radiologic technologists in fluoroscopy units than other departments (Shubayr *et al.*, 2021b; Shubayr *et al.*, 2021a).

The Champion's Health Belief Model Scale (HBM) is a tool used to assess health perceptions and behaviors related to specific health issues (Champion *et al.*, 2008). The scale includes six domains: "perceived susceptibility to a health issue, perceived severity of the health issue, perceived benefits of taking action to address the health issue, perceived barriers to taking action, cues to action, and self-efficacy" (Champion *et al.*, 2008). Employing the HBM in the context of using RPE can help to assess the perceptions of radiologic technologists towards RPE usage. By understanding the perceptions of radiologic technologists regarding the susceptibility and severity of potential radiation exposure, the benefits of RPE usage, and the barriers to its implementation, RDs can develop targeted interventions to improve RPE compliance. This assessment can also help to identify cues to action and increase self-efficacy, which can lead to more effective implementation of RPE protocols.

The HBM has been applied to understand adherence to COVID-19 prevention practices among the general public and health care workers (Zewdie *et al.*, 2022; Tong *et al.*, 2020; Lee *et al.*, 2022). Moreover, the HBM has been applied to large-scale factory workers (Tessema *et al.*, 2022), farmers (Abdollahzadeh *et al.*, 2021), waste water workers (Wright *et al.*, 2019), sugarcane factory workers (Panakobkit *et al.*, 2019), among others. However, there is a lack of research that employs the HBM constructs for RPE use among radiologic technologists. A possible reason for the lack of studies using the HBM to study RPE use among radiologic technologists is that RPE use is considered a mandatory and regulated practice in most countries, and not a voluntary or optional behavior. Therefore, radiologic technologists may not have much choice or autonomy in using RPE, and their beliefs or perceptions may not play a significant role in their RPE use. However, this assumption may not be valid in all contexts, as there may be variations in the availability, quality, accessibility, and compliance of RPE among different settings and countries. Moreover, radiologic technologists may have different levels of knowledge, awareness, motivation, and confidence in using RPE effectively and consistently. Therefore, it may be useful to apply the HBM to understand the factors that influence RPE use among radiologic technologists and identify potential gaps or barriers that need to be addressed. Therefore, the aim of this study is to assess the perceptions of radiologic technologists towards the use of RPE in RDs using the HBM and to identify the HBM constructs that predict RPE utilization among radiologic technologists. The results of the study will help identify areas where education and training can be targeted to improve adherence to RPE usage and reduce radiation exposure risks.

2 Materials and methods

2.1. Population, sampling and study area

A cross-sectional observational study was conducted from June 2022 to February 2023 in Saudi Arabia. The study focused on radiologic technologists working in various hospitals and medical centres across the country. The minimal sample size of 130 participants was determined using G*Power software based on independent samples t-test, considering an effect size of 0.15, a p-value of 0.05, and a power of 95%. A simple random sampling method was employed to select the participants. To gather data, an online survey was created using Google Forms. The survey link was distributed to radiologic technologists by their supervisors, who facilitated communication and distribution through email and social media platforms such as WhatsApp. A total of 228 questionnaires were collected and used for subsequent analysis.

2.2 Ethical considerations

This study was approved by the ethical committee at Jazan University. The participant's consent was taken at the beginning of the survey. The data obtained were only used for research purposes.

2.3 Data collection tools

Data were collected using a self-administered structured questionnaire that include three sections. The first section comprised the socio-demographic items, including gender, age, marital status, education level, type of hospital, and work experience. The second section included an item about how radiologic technologists committed to RPE utilization in their daily practices in RDs with two options for response, full committed or not fully committed. The third section addressed the HBM for RPE utilization using a five-point Likert-type scale (*strongly disagree*, *disagree*, *neutral*, *agree*, *strongly agree*) (Moreira *et al.*, 2020). The HBM scale used in this study consisted of a total of 39 items related to radiography occupation. These items were categorized as follows: (1) Perceived susceptibility of occupational-related health problems (six items that assessed individuals' perception of their vulnerability to experiencing health issues related to radiography occupation), (2) Perceived severity of occupational-related health problems (seven items that aimed to measure individuals' perception of the seriousness or impact of occupational-related health problems), (3) Perceived benefits of using RPE (four items that assessed individuals' beliefs about the advantages or positive outcomes associated with the use of RPE), (4) Perceived barriers to using RPE (seven items that explored the obstacles or challenges individuals perceived when it came to using RPE), (5) Cues to action of using RPE (nine items that assessed the various prompts or triggers that could motivate individuals to use RPE), (6) Perceived self-efficacy of using RPE (six items that aimed to measure individuals' confidence in their ability to effectively use RPE). To assess the viability and relevance of the questionnaire,

Table 1. Demographic and professional characteristics of 228 participants.

Characteristic		$N = 228$
Gender	Male	177 (78%)
	Female	51 (22%)
Age	20–29	99 (43%)
	30–39	60 (26%)
	40–49	45 (20%)
	≥ 50	24 (11%)
Marital status	Single/not committed	87 (38%)
	Married	141 (62%)
Education level	Diploma	102 (45%)
	Bachelor	126 (55%)
Type of hospital	Public	192 (84%)
	Private	36 (16%)
Years of experience	1–9	117 (51%)
	10–19	78 (34%)
	≥20	33 (15%)
RPE Utilization	Fully committed	144 (63%)
	Not fully committed	84 (37%)

a preliminary study was conducted including 15 participants and no modifications of the items were warranted. The Cronbach's Alpha coefficients of the subscales ranged from 0.77 to 0.92, indicating satisfactory internal consistency. As a result, these subscales were deemed suitable for utilization in the current study.

2.4 Statistical analyses

The data analysis was performed using the Statistical Package for Social Sciences (version 26 software from IBM Corp.). Descriptive statistics were used to analyze the participants' characteristics. The Kolmogorov–Smirnov test was employed to assess the normality of the data. Nonparametric tests, namely the Mann–Whitney, were utilized to examine the associations between variables. Logistic regression analysis, employing the ENTER method, was conducted to compare the dependent variable "RPE utilization" with a set of independent factors (socio-demographic items and HBM constructs). Adjusted odds ratios (AOR) and their 95% confidence intervals were calculated for all independent variables. Statistical significance was considered at a p-value of 0.05.

3 Results

In the current study, a questionnaire was administered to 228 radiologic technologists who were working in fluoroscopy units. As shown in Table 1, the majority of the radiologic technologists, accounting for 78% of the participants, were male. Among the surveyed radiologic technologists, 43% belonged to the age group of 20–29 years. Furthermore, it was observed that 62% of the radiologic technologists were married. In terms of educational qualifications, 55% of the radiologic technologists held bachelor's degrees, while 45% possessed a diploma. Most of the radiologic technologists in this study work in public hospitals (84%). The majority had 1–9 years of experience (51%). Regarding the question about their commitment to using RPE, 63% of the radiologic technologists stated that they fully adhere to RPE utilization, while 37% reported not fully committed.

Table 2 displays the mean scores obtained from participants in the study for the HBM constructs and their association with RPE utilization. The overall results indicate that perceived benefits had the highest mean score (3.35 ± 0.85), and perceived barriers (2.65 ± 1.01) had the lowest mean score. Based on RPE utilization, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy showed significant associations between the two groups of radiologic technologists: those who always use RPE and those who are not fully committed ($p < 0.05$).

*P-value based on Mann-Whitney U test.

Table 3 shows the results of the multivariate logistic regression analysis to identify independent predictors of RPE utilization. Logistic regression showed that perceived benefits were a significant predictor of RPE utilization (AOR = 0.20, 95% CI: 0.60–0.67, $p = 0.009$), and type of hospital was also a significant predictor (AOR=0.09, 95% CI: 0.1–0.97, $p = 0.047$).

4 Discussion

The findings of this study provide important insights into the health behavior of radiologic technologists towards the use of RPE in the fluoroscopy units. Our findings regarding the commitment of RPE utilization among radiologic technologists revealed that 63% ($n = 144$) of the radiologic technologists reported that they are always committed to the use of the RPE, while 37% ($n = 84$) reported not fully committed. According to a study conducted in Bangladesh, the majority of workers (92.5%) utilize RPE, while a small proportion (7.5%) do not (Salim *et al.*, 2022). Additionally, another study revealed that radiologic technologists adhere to RPE usage, with 83.1% applying it for themselves and 78.9% for patients (Mojiri *et al.*, 2011). However, our study found that a substantial number of radiologic technologists (37%) reported being not fully committed to RPE usage, which indicate immediate interventions to emphasize the importance of using RPE consistently to reduce radiation exposure risks in the workplace.

The HBM is a theoretical framework that explains health behaviors based on individual beliefs and perceptions about a health threat and the benefits and barriers of preventive actions. Higher scores on HBM indicate stronger beliefs or perceptions about the use of RPE. Table 2 indicates that the radiologic technologists have moderate levels of beliefs and perceptions about radiation exposure and RPE use, with mean scores ranging from 2.65 to 3.35 on a 5-point Likert scale. The highest mean score is for perceived benefits (3.35), followed by self-efficacy (3.06), perceived susceptibility (2.89), cues to action (2.86), perceived seriousness (2.77), and perceived barriers (2.65). This suggests that the radiologic technologists recognize the benefits of using RPE and have confidence in their ability to do so, but they also perceive some barriers and have low levels of perceived susceptibility and seriousness of radiation exposure. Thes perceptions among radiologic

Table 2. Health belief model constructs and RPE utilization.

HBM constructs	No of items	Min	Max	Mean (SD)	RPE utilization Mean (SD)		*p*-value*
					Fully committed	Not fully committed	
Perceived susceptibility	6	1	5	2.89 (0.83)	2.94 (0.77)	2.79 (0.93)	0.446
Perceived severity	7	1	5	2.77 (0.96)	2.88 (0.90)	2.39 (0.99)	0.03
Perceived benefits	4	1	5	3.35 (0.85)	3.61 (0.79)	2.88 (0.77)	<0.001
Perceived barriers	7	1	5	2.65 (1.01)	2.88 (0.95)	2.25 (1.04)	0.004
Cues to action	9	1	5	2.86 (0.89)	3.04 (0.76)	2.54 (1.00)	0.036
Self-efficacy	6	1	5	3.06 (0.95)	3.3 (0.83)	2.65 (1.03)	0.005

Table 3. Factors influencing utilization of radiation protective equipment in a multivariate logistic regression analysis.

Predictor	*p*-value	Adjusted odds ratio	95% Confidence interval	
			Lower	Upper
Gender:				
Female – Male	0.877	0.86	0.14	5.47
Age groups (years):				
30–39 – 20–29	0.137	4.39	0.62	30.91
40–49 – 20–29	0.175	4.72	0.5	44.51
≥ 50 – 20–29	0.939	1.16	0.03	52.44
Marital status:				
Married – Single	0.964	1.05	0.14	8.04
Education level:				
Bachelor – Diploma	0.245	2.96	0.47	18.49
Type of hospital:				
Private – Public	**0.047**	0.09	0.01	0.97
Years of experience:				
10–19 – 1–9	0.654	1.45	0.29	7.22
≥20 – 1–9	0.512	3.12	0.1	92.83
HMB covariates				
Perceived susceptibility	0.246	1.95	0.63	6.01
Perceived severity	0.946	1.05	0.26	4.22
Perceived benefits	**0.009**	0.20	0.06	0.67
Perceived barriers	0.289	0.56	0.19	1.65
Cues to action	0.399	1.74	0.48	6.28
Self-efficacy	0.053	0.37	0.13	1.01

technologists can be influenced by various factors. Firstly, the familiarity of radiologic technologists with their work environment and frequent exposure to radiation can lead to a sense of desensitization and a perception that the risks are minimal or less serious than they actually are (Hyun *et al.*, 2016). Secondly, the lack of immediate effects from radiation exposure, as opposed to immediate and visible harm caused by other hazards, can make it challenging for radiologic technologists to recognize the immediate seriousness of radiation exposure (Makkawi *et al.*, 2021b; Alasmari *et al.*, 2021; Makkawi *et al.*, 2021a; De Giorgi *et al.*, 2023). Additionally, reliance on safety measures, such as engineering controls and monitoring devices, may create a perception that the risk is adequately managed, leading to a lower perceived susceptibility (Bertho *et al.*, 2023). Trust in regulatory bodies such as the International Atomic Energy Agency (IAEA), Occupational Safety and Health Administration (OSHA) and the local regulatory agency, and their guidelines can further contribute to the perception that the risk is effectively controlled. Lastly, as reported in previous studies, some radiologic technologists may have limited knowledge or awareness about the potential health effects of radiation exposure, which can result in a lower perceived susceptibility and seriousness (Mohd Ridzwan *et al.*, 2021; Antunes-Raposo et al., 2022).

The study compares the mean scores of the HBM constructs between two groups of radiologic technologists: those who always use RPE and those who are not fully

committed. The group that always uses RPE has significantly higher mean scores for perceived seriousness, perceived benefits, perceived barriers, cues to action, and self-efficacy than the group that not fully committed ($p < 0.05$). This suggests that the group that always uses RPE has a stronger belief that radiation exposure is a serious health threat, that using RPE can reduce the risk of radiation exposure and its consequences, that there are few obstacles or drawbacks to using RPE, that they receive adequate reminders and encouragement to use RPE, and that they have the confidence and ability to use RPE correctly and consistently. The only HBM construct that does not show a significant difference between the groups is perceived susceptibility, which means that both groups have similar levels of awareness of their vulnerability to radiation exposure.

The results of the logistic regression analysis showed that type of hospital and perceived benefits were significant predictors of RPE utilization among radiologic technologists. Higher utilization of RPE was found to be significantly associated with perceived benefits. In comparison to previous studies conducted on industrial workers, perceived benefit towards RPE utilization was not identified as an independent predictor in previous studies (Wright *et al.*, 2019; Tessema *et al.*, 2022). The disparity in findings between radiologic technologists and industrial workers could potentially be attributed to differences in educational level, media exposure, and organizational and cultural factors among the participants. Also, the differences in RPE utilization across hospital types may be attributed to variations in organizational culture, level of resources available, or differences in management practices. Therefore, interventions to improve RPE utilization need to be tailored to the specific hospital setting. For example, public hospitals may need to focus on addressing resource constraints and improving the availability and accessibility of RPE, while private hospitals may need to focus on improving management practices that promote a culture of safety and accountability. A supplementary study, aimed at investigating the differences observed across different hospital settings, would be a valuable and informative endeavor.

The strength of the study lies in its use of a well-established and empirically supported model to understand the health behavior of radiologic technologists, who are exposed to ionizing radiation on a regular basis. The study also used a reliable and valid instrument to measure the HBM constructs and controlled for potential confounding variables, such as age, gender, education, and work experience. The study provided valuable insights into the factors that motivate or hinder radiologic technologists from using RPE, which can inform the development of effective interventions to improve their radiation protection practices. However, it is important to note the limitations of our study. Firstly, the study design was cross-sectional and observational, which precludes us from establishing causal relationships between the HBM constructs and RPE utilization. Additionally, we used a relatively small sample size, which may limit the generalizability of our findings to other settings. Furthermore, our study only used the HBM to assess radiation-related health beliefs of the study subjects. While the scale has been validated and widely used previously, it may not capture all the determinants of RPE utilization among radiologic technologists.

5 Conclusion

This study explored the perceptions of radiologic technologists towards the use of RPE in fluoroscopy units using the HBM. The results showed that most radiologic technologists were committed to using RPE (63%), but a considerable proportion were not fully committed (37%), indicating the need for immediate interventions to emphasize the importance of consistent RPE usage to reduce radiation exposure risks in the workplace. The results also revealed that the radiologic technologists recognize the benefits of using RPE and have confidence in their ability to do so, but they also perceive some barriers and have low levels of perceived susceptibility and seriousness of radiation exposure. Moreover, the study examined the mean scores of the HBM constructs among two groups of radiologic technologists and found the group that always uses RPE showed significantly higher mean scores for perceived seriousness, perceived benefits, perceived barriers, cues to action, and self-efficacy compared to the group that were not fully committed. This indicates that the group that consistently uses RPE has stronger beliefs about the seriousness of radiation exposure, the benefits of using RPE, fewer barriers to usage, more cues to action, and higher self-efficacy in using RPE correctly and consistently. Furthermore, the study identified two significant predictors of RPE utilization, the type of hospital and perceived benefits among the two groups. Overall, our study emphasizes the importance of promoting RPE compliance and emphasizes the importance of educating radiologic technologists on the benefits of using RPE. Strategies to promote the perceived benefits of RPE utilization may include training programs, provision of adequate RPE, and regular feedback on the effectiveness of RPE utilization.

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Conflicts of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics approval

All ethical considerations were adhered to, including obtaining institutional review board approval. Confidentiality and anonymity were strictly maintained.

Informed consent

This study obtained informed consent from all participants.

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