Radioprotection 2024, 59(1), 36–41
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https://doi.org/10.1051/radiopro/2023044

Available online at:
www.radioprotection.org

ARTICLE

Evaluating the knowledge and attitudes towards radiation protection in portable radiological examinations among nurses in pediatric intensive care units

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Received: 5 November 2023 / Accepted: 13 December 2023

Abstract – This study aims to assess the knowledge and attitudes towards radiation protection among nurses in pediatric intensive care units (PICUs), where portable radiological examinations are frequently conducted. In this study, we employed a descriptive cross-sectional research design using a 17-item self-administered questionnaire. The study comprised 160 nurses, mostly female (91%), with an even split in educational background between diploma and bachelor's degree holders. The majority had 1–5 years (39%) and 6–10 years (33%) of experience, while only a small fraction (6.2%) had undergone training in radiation protection. The overall scores of knowledge and attitudes were 2.9 ± 1.4 out of 7 and 3.1 ± 0.9 out of 4, respectively. A statistically significant variation in knowledge scores was noted between those with a Bachelor's degree (3.2 ± 1.4) and a Diploma (2.7 ± 1.3) ($p = 0.044$). A positive correlation between knowledge and attitude scores was statistically validated (Spearman's rho = 0.19, $p = 0.014$), and training in radiation protection was identified as a significant factor affecting these scores (estimate = –1.38, $p = 0.025$). The study reveals a poor level of knowledge and a good attitude towards radiation protection among PICU nurses in the Jizan Region. This emphasizes the need for targeted educational interventions and training programs in radiation safety to enhance the quality of care in pediatric radiological procedures.

Keywords: Knowledge / attitude / radiation / portable radiographs / radiation protection

1 Introduction

The utilization of medical imaging involving ionizing radiation serves as an indispensable tool in contemporary healthcare settings, often facilitating precise disease diagnosis and treatment planning (Babaloui *et al.*, 2018). Approximately 30–50% of critical medical decisions are predicated upon the results of radiological tests (Anim-Sampong *et al.*, 2015). Despite the obvious merits, ionizing radiation carries an inherent risk, including stochastic and deterministic effects that escalate with dose magnitude and exposure duration (Luntsi *et al.*, 2016; Alyami *et al.*, 2022; Alomairy, 2022). The potential for cellular damage and long-term carcinogenic effects necessitates stringent protective measures for both healthcare providers and patients.

Radiation safety, as defined by the International Commission on Radiological Protection (ICRP), aims to safeguard humans without unnecessarily hampering activities generating radiation exposure. It embodies key principles like "time, distance, and shielding," which are vital for occupational, medical, and public radiological protection (Alzubaidi *et al.*, 2017).

In pediatric intensive care units (PICUs), mobile radiography stands as the primary diagnostic modality due to the logistical challenges associated with moving critically ill children attached to medical devices (Babaloui *et al.*, 2018). This scenario raises the stakes for nurses, who frequently experience elevated exposure to ionizing radiation (Dianati *et al.*, 2014). The range and frequency of radiation exposure among nurses differ globally, often dictated by their specific job roles (Hirvonen *et al.*, 2019).

Nurses in PICUs are frontline caregivers who are intimately involved in the radiological processes, from patient preparation to post-procedure care (Alyami *et al.*, 2022; Shubayr and Alashban, 2021). Their evolving role entails a understanding of radiation science and safety protocols to safeguard patients, healthcare workers, and the general public (Luntsi *et al.*, 2016). However, it has been observed that some nurses demonstrate apprehension in radiation settings, impacting their efficiency and possibly compromising patient care (Yusuf *et al.*, 2020; Alyami *et al.*, 2022).

Literature indicates a conspicuous gap in the radiation knowledge among nurses. Studies from Finland and Bandar

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Abbas reveal inconsistencies in nurses' understanding of radiation protection, particularly those without specialized training (Babaloui *et al.*, 2018; Kurtul, 2018). Saudi Arabia, too, shows a paucity of studies addressing the knowledge and attitudes of nurses regarding radiation safety.

In light of these concerns and the scarce local data, this study aims to evaluate the knowledge and attitudes related to radiation protection among nurses working in PICUs in the southern region of Saudi Arabia. Such an investigation is crucial for enhancing radiation safety education, fostering inter-professional cooperation, and consequently improving patient care. The outcomes will inform educational curricula and institutional policies, serving as a resource for healthcare administrators and stakeholders focused on optimizing radiation safety protocols in clinical settings.

2 Materials and methods

2.1 Study design and population

This study employed a cross-sectional descriptive research design to examine the knowledge and attitudes of nurses concerning radiation protection in PICUs across a purposive selection of seven hospitals in Saudi Arabia. Data collection occurred over a finite time span, specifically from January to February 2022. The study's focus was on PICUs because nurses in these units frequently assist in executing radiographic examinations for critically ill patients who are not transportable to radiology departments. Sample size calculations were conducted using G*Power statistical software, taking into account an effect size of 0.3, an alpha level of 0.05, and a statistical power of 0.95 for independent T-tests. Based on these parameters, the minimum required sample size was determined to be 134 participants. However, a total of 160 nurses participated, exceeding the calculated minimum requirement, thereby enhancing the study's statistical power. A convenience sampling strategy was implemented to facilitate participant recruitment. The survey instrument was disseminated electronically via Google Forms and was conveyed to the potential nurse respondents through their supervisory channels via email. To optimize response rates, two email reminders were sent at three-week intervals.

2.2 Ethical considerations

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

2.3 Data collection tool and scoring

The data collection instrument used was a structured, 17-item, self-administered questionnaire, adapted from previous research, which was validated and tested for reliability in prior studies by Yusuf *et al.* (2020) and Luntsi *et al.* (2016), ensuring its suitability for this investigation. The questionnaire used for data collection was structured into three distinct Sections: (1) demographic Information, which captured data on participants' age, gender, work experience, level of education, and specific hospital and working unit; (2) nurses' Knowledge on Radiation, consisting of seven questions designed to assess the nurses' understanding of radiation issues; and (3) attitude of Nurses towards Radiation, which included four questions focusing on the nurses' attitudes toward radiation protection. For Sections 2 and 3, the response options were "Yes," "No," or "I don't Know," with correct answers scoring 1 point and incorrect answers or "I don't Know" responses scoring 0 points. The possible score range for knowledge was 0–7 points, and for attitudes, it was 0–4 points, yielding an overall range of 0–11 points. Participants who scored above 70% of the total possible score in each category (*i.e.*, above 4.9 for knowledge and above 2.8 for attitudes) were classified as having good knowledge and attitude. Conversely, those who scored less than 70% were considered to have poor knowledge and attitude.

It should be noted that the nurses in the PICU in our study setting do not use personal dosimeters, which is in line with the guidelines of the national regulatory authority and the dominant practice in the ICU context. Consequently, the questionnaire used in our study did not include an item about the use of personal dosimeters.

2.4 Data analysis

Data analysis was conducted using IBM SPSS Statistics, Version 26. Descriptive statistical measures such as frequencies, percentages, and means were calculated to summarize the dataset. For inferential statistics, a range of tests were employed, including the independent T-test, Analysis of Variance (ANOVA), Spearman's rank-order correlation, and linear regression models. A p-value threshold of less than 0.05 was set to determine statistical significance.

3 Results

Table 1 presents the demographic characteristics of the participants and their respective knowledge and attitude scores towards radiation protection. The study involved 160 participants, predominantly female (91%). The participants were divided into four age groups: 21–25 years (10%), 26–30 years (33%), 31–35 years (38%), and 36 years and above (19%). The education level of the participants was evenly split between those with a diploma and those with a bachelor's degree. In terms of years of experience, the majority of the participants had between 1–5 years (39%) and 6–10 years (33%) of experience, with fewer having 11–15 years (22%) and 16 years and above (6.2%). Only a small proportion of the participants (6.2%) had training in radiation protection.

In the study, females had slightly higher mean knowledge (3.0 ± 1.4) and attitude scores (3.1 ± 0.9) than males (knowledge: 2.5 ± 0.8, attitude: 2.9 ± 0.7). The 26–30 age group had the highest mean knowledge score (3.26 ± 1.3), while the 36 and above age group had the highest attitude score (3.1 ± 0.92). Participants with a Bachelor's degree had a higher mean knowledge score (3.2 ± 1.4) compared to those with a Diploma (2.7 ± 1.3), with a significant difference observed across education levels ($p = 0.044$), but both groups had similar attitude scores (3.1). Participants with 16 years and above experience had the highest mean knowledge score (3.2 ± 1.69),

Table 1. Demographic characteristics of participants and their respective knowledge and attitude scores towards radiation protection.

Characteristic	$N = 160$	Knowledge score (mean ± SD)	p value	Attitude score (mean ± SD)	p value
Sex					
Male	15 (9.4%)	2.5 ± 0.8	0.227	2.9 ± 0.7	0.303
Female	145 (91%)	3.0 ± 1.4		3.1 ± 0.9	
Age groups (years)					
21–25	16 (10%)	2.94 ± 1.48	0.081	2.69 ± 0.95	0.21
26–30	53 (33%)	3.26 ± 1.3		3.25 ± 0.81	
31–35	61 (38%)	2.64 ± 1.33		3.08 ± 0.99	
36 and above	30 (19%)	3 ± 1.49		3.1 ± 0.92	
Education					
Diploma	80 (50%)	2.7 ± 1.3	**0.044**	3.1 ± 1.0	0.607
Bachelor	80 (50%)	3.2 ± 1.4		3.1 ± 0.9	
Years of experience					
1–5	62 (39%)	3.13 ± 1.49	0.27	2.95 ± 1.03	0.6
6–10	53 (33%)	2.6 ± 1.17		3.23 ± 0.78	
11–15	35 (22%)	3.06 ± 1.35		3.2 ± 0.83	
16 and above	10 (6.2%)	3.2 ± 1.69		3 ± 1.15	
Training in radiation protection					
Yes	10 (6.2%)	3.7 ± 1.6	0.073	3.4 ± 0.7	0.288
No	150 (93.8%)	2.9 ± 1.4		3.1 ± 0.9	
Overall		2.9 ± 1.4		3.1 ± 0.9	

Table 2. Nurses' knowledge and perceptions of radiation protection.

Items	Yes	No	I do not know
Radiation can cause harmful effects	151 (94.4%)	0	9 (5.6%)
X-rays used in medical imaging can cause more harm than benefit	67 (41.9%)	59 (36.9%)	34 (21.3%)
Radiation that is used in ward and theatre (*i.e.*, outside the radiology departments) are more dangerous than those in the radiology department	62 (38.8%)	38 (23.8%)	60 (37.5%)
Radiation is used for boosting the immune system	19 (11.9%)	99 (61.9%)	42 (26.2%)
Generally, we receive radiation in our everyday life	81 (50.6%)	58 (36.2%)	21 (13.1%)
The lifespan of radiology workers is less compared to other health workers	51 (31.9%)	49 (30.6%)	60 (37.5%)
Objects in the room emit radiation after an X-ray exposure	40 (25%)	47 (29.4%)	73 (45.6%)

while those with 6–10 years of experience had the highest attitude score (3.23 ± 0.78). Lastly, participants who had training in radiation protection scored higher in both knowledge (3.7 ± 1.6) and attitude (3.4 ± 0.7) compared to those who did not have. However, except for differences linked to education level, none of these differences are statistically significant.

Table 2 presents the knowledge of nurses regarding radiation protection. A high percentage of nurses (151 out of 160, 94.4%) were aware that radiation can cause harmful effects. However, only 67 (41.9%) believed that X-rays used in medical imaging can cause more harm than benefit, and 62 (38.8%) thought that radiation used in wards and theaters (*i.e.*, outside the radiology departments) are more dangerous than those in the radiology department. Only 19 nurses (11.9%) believed that radiation is used for boosting the immune system, while 81 (50.6%) were aware that we generally receive radiation in our everyday life. The belief that the lifespan of radiology workers is less compared to other health workers was held by 51 nurses (31.9%). Lastly, only 40 nurses (25%) believed that objects in the room emit radiation after an X-ray exposure. It's important to note that for some items, a significant proportion of nurses responded with "I don't know" (ranging from 21 to 73 responses), indicating areas where further education may be beneficial.

Table 3 presents the responses of participants to questions about their practices related to radiation protection. A high percentage of participants (144 out of 160, 90%) reported that they stay away from patients during exposure. Similarly, 140 participants (87.5%) reported using a lead apron during radiographic exposure. When asked about reading the safety radiation policy, 133 participants (70.6%) responded affirmatively. However, only 99 participants (61.9%) reported that they come to the immediate vicinity after X-ray exposure.

Table 3. Attitude of nurses towards radiation.

Items	Yes	No	I do not know
Do you stay away from patients during Exposure?	144 (90%)	13 (8.1%)	3 (1.9%)
Do you use lead Apron during radiographic Exposure?	140 (87.5%).	16 (10%).	4 (2.5%)
Do you read the safety radiation policy?	133 (70.6%)	40 (25%)	7 (4.4%)
Do you come to immediately the vicinity after X-ray exposure?	99 (61.9%)	44 (27.5%)	17 (10.6%)

Table 4. Result of linear regression model between the overall score of knowledge and attitudes with demographic variables.

Predictor	Estimate	SE	*t*	*p*
Intercept	6.07	0.95	6.41	<0.001
Sex:				
Female *vs.* male	0.66	0.51	1.29	0.199
Age:				
26–30 *vs.* 21–25	0.93	0.53	1.76	0.081
31–35 *vs.* 21–25	−0.13	0.61	−0.22	0.828
36 and above *vs.* 21–25	0.13	0.76	0.18	0.859
Education:				
BS − diploma	0.19	0.37	0.51	0.609
Experience:				
6–10 *vs.* 1–5	0.14	0.43	0.31	0.755
11–15 *vs.* 1–5	0.96	0.54	1.78	0.076
16 and above *vs.* 1–5	0.63	0.86	0.73	0.467
Training:				
No *vs.* Yes	−1.38	0.61	−2.26	**0.025**

The result of the correlation between knowledge and attitude scores demonstrates a positively significant correlation (Spearman's rho = 0.19, *p*-value = 0.014). Table 4 presents the results of a linear regression model examining the relationship between demographic variables and the overall scores of knowledge and attitudes. The result shows that none of the demographic variables, except for training in radiation protection, have a statistically significant impact on the overall scores of knowledge and attitudes. Those who did not receive training scored significantly lower than those who did (estimate = −1.38, $p = 0.025$).

4 Discussion

The significance of this study is manifold. Given that PICUs often necessitate frequent radiographic examinations for critical diagnoses and interventions, the role of nurses in ensuring radiation protection is pivotal. Despite their pivotal role, nurses in PICUs may not have specialized training in radiation protection, which could potentially compromise the safety of both healthcare providers and patients. This study revealed a number of interesting findings about the knowledge and attitudes towards radiation protection among the participants. Females showed slightly higher knowledge and attitude scores than males, although the difference was not statistically significant. This is consistent with previous studies that have also found gender differences in knowledge and attitudes towards radiation protection (Al Ewaidat *et al.*, 2018; Luntsi *et al.*, 2016). The 26–30 age group exhibited the highest knowledge score, while the highest attitude score was observed in the 36 and above age group, although the difference was not statistically significant.

Our analysis revealed a significant difference in knowledge scores based on education level, indicating that education plays a significant role in knowledge about the topic. Participants with a bachelor's degree had a higher knowledge score compared to those with a diploma. This has been emphasized by several studies (Babaloui *et al.*, 2018). Interestingly, those with 16 years and above experience had the highest knowledge score, suggesting that experience could also contribute to increased knowledge. Several previous studies suggest that years of experience have an impact on the knowledge level of radiation protection (Shah *et al.*, 2011). A study also found that Malaysian nurses had higher knowledge levels in radiation protection, indicating that experience may contribute to their knowledge (Rahimi *et al.*, 2021).

A significant proportion of nurses were aware that radiation can cause harmful effects, but there were misconceptions about the harm and benefits of X-rays used in medical imaging. Furthermore, only a small percentage believed that radiation is used for boosting the immune system, indicating areas where further education may be beneficial. These findings are similar to those of other studies, which have also reported gaps in knowledge about radiation protection among healthcare workers (Dianati *et al.*, 2014; Kurtul, 2018).

The study also found a statistically significant positive correlation between knowledge and attitude scores. This suggests that as knowledge about radiation protection increases, attitudes towards it may also become more positive. This is in line with previous research that has found a positive relationship between knowledge and attitudes towards radiation protection (Babaloui *et al.*, 2018).

The linear regression model revealed that training in radiation protection was the only demographic variable that had a statistically significant impact on the overall scores of knowledge and attitudes. Those who did not receive training scored significantly lower than those who did, highlighting the importance of training in improving both knowledge and attitudes towards radiation protection. This finding highlights the recommendations of previous studies, which have emphasized the importance of incorporating radiation protection standards into student curricula. Prior research consistently demonstrates the significant role of training in enhancing knowledge and attitudes about radiation protection among healthcare professionals. For example, studies variously show that inadequate training negatively impacts service provision, while increased training attendance and awareness-raising

efforts lead to improved outcomes (Alduraibi *et al.*, 2021; Goula *et al.*, 2021; Shati Qutbi *et al.*, 2021).

The results showed that the nurses had good attitudes towards radiation despite their average knowledge of it, and the reason could be the presence of the technologist with the nurses during the examinations and giving them the necessary instructions. We recommend that management consider holding frequent seminars and symposiums within the hospitals to educate all employees about radiation safety. This will assist most personnel in remaining constantly aware of various protective methods and the necessity to adhere to safety requirements. The findings of this study will assist stakeholders and hospital management in training nurses on radiation protection curriculum development and improvement, as well as radiographers in understanding nurses' level of radiation protection knowledge in order to improve cordial interdisciplinary relationships during portable radiological examinations.

4.1 Limitations

This study has several limitations that should be considered when interpreting the results. One key limitation is the sample size. While our study provides valuable insights into the knowledge and attitudes towards radiation safety among nurses in the PICU, the number of participants may limit the generalizability of our findings. Increasing the sample size in future studies could help confirm the trends observed in this study and provide a more understanding of the factors influencing radiation safety practices.

5 Conclusion

Despite the benefits of radiation, it also has risks, and when one's lacking knowledge and behavior towards it, it can cause a lot of harm. Among the health workers most exposed to after technicians are nurses. Therefore, this study was conducted, and we found that the nurses had poor knowledge of radiation, but most of them had a good behavior towards it. However, more needs to be done to improve and develop the content of curricula for ionizing radiation in nursing establishments, and nurses should be encouraged and urged to pursue further studies through educational intervention programs for hospital management. We recommend that management consider organizing regular lectures and seminars within hospitals in order to educate staff about radiation protection.

Acknowledgements

The author extends his appreciation to the Deputyship for Research and Innovation, Ministry of Education in Saudi Arabia for funding this research work through the project number ISP22-23.

Funding

This work was supported by the Deputyship for Research and Innovation, Ministry of Education in Saudi Arabia [grant numbers ISP22-23].

Conflicts of interest

The author declares that he has no conflicts of interest in relation to this article.

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 did not require informed consent.

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Cite this article as: Alomairy N.A. 2024. Evaluating the knowledge and attitudes towards radiation protection in portable radiological examinations among nurses in pediatric intensive care units. *Radioprotection* 59(1): 36–41