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Original article

Radiographers' Adherence to Patient and Public Protection Measures from Radiation Exposure during Projection Radiography

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Abstract
Projection radiography is the most common diagnostic imaging tool. X-rays are one of the main types of ionising radiation. Improper use of ionizing radiation can pose a risk for healthcare workers, patients, and the general public. It is necessary to apply required precautions and adhere to protection measures when dealing with IR to decrease its potential risk. The study aimed to assess radiographers' adherence to patient and public protection measures from radiation exposure during projection radiography. A questionnaire was developed to conduct a cross-sectional study. The questionnaire had multiple dimensions, including technical procedures for reducing the exposure of patients to radiation, patient communication and clinical preparation, and public radiation protection in the workplace. The study sample included radiographers from public hospitals in Misrata, Libya. Results showed that 71.8% of participants properly collimated the radiation field, 78.8% adhered to using the correct distance between the source and image receptor, and 81.2% adhered to using correct exposure factors. On the other hand, statistical analysis showed that thyroid shields and gonad shields were not used for patients among 88.2% and 84.7% of radiographers, respectively. But 96.5% of the of sample adhered to verify that the patient is free of foreign objects, 83.5% adhered to ask female patients about pregnancy, 56.5% adhered to clearly explain the examination procedures, and 94.1% adhered to instruct the patient on the importance of remaining still. On the other hand, 55.3% of respondents indicated that periodic calibration of imaging devices was not conducted, and 65.9% indicated that there was no periodic radiation survey. However, lead aprons for non-patient personnel were not used among 45.9% of radiographers. On the other hand, 91.8% of respondents adhered to closing the room door during examinations, and 50.6% indicated there were warning signs. In Conclusion, there was significant adherence of participants to key aspects of patient radiation protection. On the other hand, there was a deficiency in adherence to certain public protection measures in the workplace, particularly in the practice of periodic calibration of devices, periodic radiation survey, and utilisation of the lead apron for non-patient personnel.
Keywords. Radiographers, Patient Protection, Public Protection, Radiation Exposure, Projection Radiography

Introduction

X-rays were discovered by Roentgen in 1895 and were so called because their nature was unknown at the time. Unlike ordinary light, X-ray are invisible, but it travels in a straight line and affects photographic film in the same way as light. On the other hand, X-rays are much more penetrating than light and can easily pass through the human body. Projection radiography (Conventional X-ray imaging) is the most common, fastest, and least expensive diagnostic imaging tool available [1]. X-rays are one of the main types of ionising radiation (IR). IR affects tissue through direct interaction or indirect interaction [2]. In direct interaction, macromolecules such as DNA are directly attacked by IR [3]. In indirect interactions, tissue is indirectly affected by IR through the generation of reactive oxygen species and reactive nitrogen species [4]. When IR enters living tissue, it can damage living cells. However, IR can randomly cause damage to all cellular components and induce a variety of DNA effects. So, x-ray is utilised in well-protected conditions [5]. Improper use of IR can cause several health effects for healthcare workers, patients, and the general public. The biological effects of IR are divided into two categories: stochastic effects and deterministic effects. Stochastic effects occur randomly and are associated with the probability of genetic mutations or developing cancer.

On the other hand, deterministic effects cause tissue reactions and are directly related to the radiation dose [6]. Stochastic effects are more prevalent at low doses of radiation, which usually occur due to routine medical imaging [7]. It is necessary to apply required precautions and adhere to protection measures when dealing with IR to decrease its potential harmful effects [8,9]. However, it is widely assumed that there is no truly safe dose of IR. The ALARA (As Low As Reasonably Achievable) principle is applied to ensure radiation safety; this principle aims to reduce radiation exposure to as Low as reasonably achievable while adhering to the limits of effective dose recommended by the International Commission on Radiological Protection (ICRP) [10]. General principles of radiation protection were suggested by ICRP as three key pillars: justification, optimisation, and dose limitation.

Due to the medical exposure of patients to radiation having unique considerations, it is improper to apply dose limits or dose constraints. Dose limits are not at all relevant, since IR, used at the proper dose of radiation for the particular medical goal, is an essential tool that will cause more benefit than harm [11]. To decrease the harmful consequences of radiation exposure, any medical exposure to radiation must be justified, and the examinations which use IR must be optimised. Justification means that the examination must be medically indicated and useful. Optimisation means that the imaging should be performed using doses that are as low as reasonably achievable, consistent with the diagnostic task [12]. Therefore, it is important to conduct such a study to evaluate the adherence of radiographers to patient and public radiation protection. This assessment is a primary step in identifying limitations and developing training and corrective strategies that

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contribute to ensuring the protection of patients and the public from potential risk of IR. Furthermore, the findings of such studies support hospital quality management and safety policies and ensure compliance with international radiation protection standards. Accordingly, this study aimed to assess radiographers' adherence to patient and public protection measures from radiation exposure during projection radiography.

Methods

Study design

This study was a cross-sectional study conducted via questionnaire. The questionnaire was distributed for responses between December 11, 2025, and February 10, 2026.

Participants

Participants were limited to a convenience sample of radiographers from public hospitals in Misrata, Libya. The questionnaire was manually distributed to participants. A total of 94 questionnaires were returned, of which 9 were excluded due to incomplete responses, and thus 85 questionnaires were included in data analysis. Participants were informed about the voluntary nature of their participation and the objective of the study. To adhere to ethical standards for a study of this nature, the survey was completely anonymous and collected no personally identifiable information to ensure full confidentiality.

Study Tool

The questionnaire was designed as a primary tool for data collection. In its final form, the questionnaire included four dimensions: Dimension1: demographic characteristics of the participants. Dimension 2: optimization of radiation protection procedures and clinical dose management. Dimension 3: patient communication and clinical preparation. Dimension 4: public and environmental protection. The questionnaire was reviewed by a panel of experts and specialists for their feedback, finalization, and to ensure the validity of the questionnaire. A pilot study was conducted to ensure the reliability of the questionnaire and that it could be easily understood. The pilot study was conducted on 7 randomly selected radiographers; Their results were excluded from the study.

Data Analysis

The data were coded, entered into and analyzed using SPSS system files. Descriptive analysis was performed using frequency, per cent, arithmetic mean, and the standard deviation. In another categorization, when the mean ranged from 1 to less than 1.67, the response was “Yes,” denoting a high degree of agreement. A mean between 1.67 and less than 2.34 corresponded to the response “Sometimes,” which indicated a moderate degree of agreement. Finally, a mean between 2.34 and 3 was associated with the response “No,” signifying a low degree of agreement.

Results

Dimension1. Demographic characteristics of participants

(Table 1) shows the characteristics of the study sample about gender, age, and experience of the work, demonstrating its diversity for the study.

Table1. Shows the distribution of participants within different subgroups.

Subgroups	Labeling	Frequency	Percent
Gender	Male	43	50.6%
	Female	42	49.4%
	Total	85	100.0%
Age	21 – 30	72	84.7%
	31 – 40	11	12.9%
	41 – 50	1	1.2%
	51 – 60	1	1.2%
	Total	85	100.0%
Experience of the work	< 10	59	69.4%
	10 – 20	20	23.5%
	> 20	6	7.1%
	Total	85	100.0%

Dimension2. Technical procedures for reducing the radiation exposure of patients

Our results in (Table 2) showed that 71.8% of participants properly collimated the radiation field, 78.8% adhered to using the correct distance between the source and image receptor, and 81.2% adhered to using correct exposure factors. On the other hand, statistical analysis showed that thyroid shields and gonad shields were not used for patients among 88.2% and 84.7% of radiographers, respectively. However, the statement with the highest adherence was, "Utilisation of the correct exposure factors ". The statement with the lowest adherence was, "Utilisation of thyroid shield for patients".

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Table 2. The results of the statistical analysis for Dimension 2.

Item		Yes	Sometimes	No	Mean	Std. Deviation	Level of adherence
Proper collimation of radiation field	Fr	61	19	5	1.34	0.59	High
	%	71.8	22.4	5.9			
Utilisation of thyroid shield for patients	Fr	5	5	75	2.82	0.52	Low
	%	5.9	5.9	88.2			
Utilisation of gonad shield for patients	Fr	4	9	72	2.80	0.51	Low
	%	4.7	10.6	84.7			
Utilisation of the correct distance between the source and image receptor	Fr	67	17	1	1.22	0.51	High
	%	78.8	20	1.2			
Utilisation of correct exposure factors	Fr	69	16	0	1.19	0.39	High
	%	81.2	18.8	0.0			

Dimension3. Patient communication and clinical preparation

Our results revealed that 96.5% of the study sample adhered to verifying that the patient is free of foreign objects before imaging, and 83.5% adhered to asking female patients about pregnancy. Additionally, 56.5% of participants adhered to clearly explaining the examination procedures to the patient before imaging, and 94.1% adhered to instructing the patient on the importance of remaining still during imaging. However, there was a high level of adherence with all statements in this section.

Table 3. The results of the statistical analysis for Dimension 3.

Item		Yes	Sometimes	No	Mean	Std. Deviation	Level of adherence
Verify that the patient is free of foreign objects before imaging.	Fr	82	3	0	1.04	0.19	High
	%	96.5	3.5	0.0			
Asking female patients about pregnancy	Fr	71	13	1	1.18	0.41	High
	%	83.5	15.3	1.2			
Clearly explain the examination procedures to the patient before imaging	Fr	48	36	1	1.45	0.52	High
	%	56.5	42.4	1.2			
Instruct the patient on the importance of remaining still during imaging	Fr	80	5	0	1.06	0.24	High
	%	94.1	5.9	0.0			

Dimension4. Public radiation protection in the workplace

Our results in (Table 4) showed that 55.3% of respondents indicated that periodic calibration of medical imaging equipment was not conducted, and 65.9% indicated that there was no periodic radiation survey in departments and surrounding areas. However, statistical analysis showed that lead aprons for non-patient personnel were not used among 45.9% of radiographers. On the other hand, 94.8% of respondents adhered to closing the room door during examinations, and 50.6% indicated there were warning signs indicating radiation hazards in the work environment. However, there were different degrees of agreement with the statements in this section. The statement with the highest adherence was, " Closing the room door during examinations." The statement with the lowest adherence was, " Conducting periodic radiation surveys in departments and surrounding areas."

Table 4. The results of the statistical analysis for Dimension 4.

Item		Yes	Sometimes	No	Mean	Std. Deviation	Level of adherence
Conducting periodic calibration of medical imaging devices.	Fr	10	28	47	2.44	0.70	Low
	%	11.8	32.9	55.3			
Conducting periodic radiation survey.	Fr	7	22	56	2.58	0.64	Low
	%	8.2	25.9	65.9			
Use of the lead apron for all non-patient personnel.	Fr	21	25	39	2.21	0.82	Moderate
	%	24.7	29.4	45.9			
Closing the room door during examinations.	Fr	78	5	2	1.11	0.38	High
	%	91.8	5.9	2,4			
There are warning signs that indicate radiation hazards in the work environment.	Fr	43	5	37	1.93	0.97	Moderate
	%	50.6	5.9	43.5			

Discussion

Radiographers must take practical steps to protect patients, staff and themselves. Patient protection from unnecessary

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primary and secondary radiation exposure is imperative. Collimation, cones, and filters are essential tools to avoid unnecessary irradiation of the tissue and reduce scatter radiation. Exposure parameters, such as short exposure times, geometric factors, and source-to-image distance (SID), should be selected appropriately to avoid movement dullness and image blurring and to provide excellent diagnostic information. These measures support the implementation of the ALARA principle [13]. International recommendations such as the European consensus recommendation on patient contact shielding [14], the American Association of Physicists in Medicine [15], the Swiss Society of Radiobiology and Medical Physics [16], and the British Institute of Radiology [17] generally do not recommend the use of patient contact shielding in projection radiography, even for vulnerable patient groups.

Conversely, some European societies, such as the Commission on Radiological Protection in Germany [18], or the Nordic Society for Radiation Protection [19,20], consider shield application based on modality, usability, examination method and workload, but provide limited guidance or leave usage unspecified, particularly for pediatric or pregnant patients [21]. Regarding technical procedures for reducing the exposure of patients to radiation, our results showed that there was significant adherence among radiographers to using proper collimation, correct distance between the source and image receptor (SID), and the correct exposure factors. These results reflect significant adherence to radiation protection measures and the ALARA principle; the use of collimation leads to protect normal surrounding tissue by minimising secondary scattered radiation, while adhering to the correct SID prevents geometric distortion and ensures X-ray images with anatomical accuracy.

Furthermore, optimising exposure factors (KV, mAs) and minimising exposure time prevent motion artefacts, achieving an ideal balance between reduction of absorbed dose and radiographic image quality; this positively impacts efficiency of clinical practice and reduces the need for repeat examinations. On the other hand, our data showed that there was no adherence to using thyroid shields and gonad shields consistently. The results reflect a response to recommendations from international organizations against the routine use of personal protective equipment for patients, while the limited continued use of tools is related to considerations regarding the protection of sensitive organs. Our findings are consistent with a study by Abuzaid et al. (2019), which showed that there was significant adherence of radiographers to radiation protection measures related to patients, particularly with regard to the application of radiation field determination and exposure factors. However, there was no adherence of radiographers to using a gonad shield for patients [22]. Effective communication between radiographers and patients is very important for the successful execution of radiographic procedures. Ineffective communication during radiological procedures may lead to repeat examinations and the production of inferior quality radiographs.

Communication errors in radiography may result in repeat examinations, which increase the IR dose to a patient [23]. Before radiographic exposure, all external radiopaque objects, such as jewelry, buttons, zippers, and hairpins, must be removed from the area of examination to avoid image artefacts that can cause repeat procedures. However, to adhere to the ALARA principle, radiographers must ensure proper patient preparation, thereby minimizing unnecessary radiation dose resulting from repeat exposures [24]. Several organizations, such as the National Institute of Environmental Health, the National Academy of Sciences, and the International Committee on Radiological Protection, recommended asking women about pregnancy status and menstrual date before radiological procedures [25,26]. In terms of patient communication and clinical preparation, our results revealed that there was adherence among radiographers to verify that the patient is free of foreign objects before imaging, asking female patients about pregnancy, clearly explaining the examination procedures to the patient before imaging, and instructing the patient on the importance of remaining still during imaging. In general, the results showed adherence to effective patient communication and clinical preparation, which is reflected in the lack of examination repeat, obtaining a high-quality image, and avoiding exposure of pregnant women to radiation. In contrast to our study, Fiagbedzi et al. (2022) showed that routine inquiry into the possibility of pregnancy in patients undergoing radiological examinations did not reach the required degree of adherence [27].

Regular equipment calibration and Periodic radiation surveys of the X-ray room are important requirements to verify structural shielding integrity and ensure that radiation leakage remains within permissible limits. However, strict adherence to ensuring proper door closure during exposures and utilizing lead aprons for co-patient or staff is mandatory to prevent unnecessary radiation exposure [28]. Regarding public radiation protection in the workplace, our data demonstrated that there was no adherence to the practice of periodic calibration of medical imaging devices and conducting periodic radiation surveys in departments and surrounding areas. On the other hand, there was strict adherence to closing the room door during examinations. However, there was insignificant adherence to using the lead apron for all non-patient personnel and clear, prominent warning signs indicating radiation hazards in the work environment. These results indicate a lack of technical control to ensure the safety of the public from possible radiation leakage. This deficiency in protection can be attributed to a lack of necessary tools, coupled with the lack of continuous training for technicians. In agreement with our results, Ali et al. (2016) showed that adherence to radiation control procedures was weak, as some important measures to protect the public and the surrounding environment were not adhered to, such as conducting periodic radiation surveys and conducting a calibration of medical imaging devices [29]. In contrast to our study, Fiagbedzi et al. (2022) showed a high level of adherence to safety measures related to the protection of the environment and the public [27].

Study Limitations

This study has certain methodological limitations that should be acknowledged. First, the use of a convenience sampling

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technique may limit the generalizability of the findings to all radiology departments. Second, a uniform three-point scale (Yes, Sometimes, No) was maintained across all questionnaire items for consistency; for static workplace items such as warning signs (Table 4), the "Sometimes" response reflects partial availability across different examination rooms, inconsistent visibility, or occasional obstruction rather than an absolute absence.

Conclusion

There was significant adherence of participants to key aspects of patient radiation protection. On the other hand, there was a deficiency in adherence to certain public protection measures in the workplace, particularly in the practice of periodic calibration of devices, periodic radiation surveys, and utilisation of the lead apron for non-patient personnel.

Data Availability Statement

The questionnaire used in this study is available from the corresponding author upon reasonable request.

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Conflicts of Interest

The authors declare no conflicts of interest.

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