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Radiation Protection in Diagnostic Radiography: Separate Surveys of Technologists' Self-Reported Practices and Patients' Experiences

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Abstract **Objectives:** Radiation protection in diagnostic radiography involves optimization practices and communication with patients. Examining technologists' self-reported practices alongside patients' awareness and experiences can provide complementary information about these aspects of care. This study explored both perspectives through separate surveys in Jeddah, Saudi Arabia. **Methods:** An exploratory cross-sectional study was conducted in Jeddah, Saudi Arabia, during February-March 2025 using convenience sampling. Two independent groups completed separate structured questionnaires: 61 radiologic technologists working in general diagnostic X-ray departments and 110 patients undergoing diagnostic X-ray examinations. Technologist responses were collected through self-administered online questionnaires (n = 26) and face-to-face researcher-administered questionnaires entered directly into Google Forms (n = 35), while all patient responses were collected electronically. The questionnaires assessed technologists' self-reported radiation protection practices, institutional support andbarriers andpatients' self-rated awareness, reported experiences andprotective behaviors. Patient responses were not linked to individual technologists andpractices were not directly observed. The limited sample sizes restrict generalizability. Data were summarized using frequencies and percentages. Associations were evaluated using Pearson's chi-square or exact tests according to expected cell counts, with Monte Carlo estimation for selected larger tables. All tests were two-sided, with significance set at $p<0.05$. **Results:** Among patients, 97.3% agreed that patients have the right to request protective equipment, 10.0% reported requesting additional protection and39.1% reported receiving lead shielding. Self-rated knowledge of radiation risks was not significantly associated with requesting protection ($p = 0.220$), but differed across age groups ($p<0.001$). Among technologists, 91.8% reported familiarity with ALARA and88.5% agreed that they had received adequate radiation protection training during their education or employment. The proportions reporting "always" were 85.2% for ensuring companions left the room, 80.3% for collimation, 59.0% for patient-specific exposure adjustment and45.9% for providing lead shielding. Experience was not significantly associated with shielding frequency ($p = 0.533$), exposure adjustment ($p = 0.085$), or collimation ($p = 0.794$). The most frequently reported barriers were workload (60.7%) and time constraints (49.2%). **Conclusion:** These separate surveys identified variation in technologists' self-reported radiation protection practices and infrequent patient requests for protective equipment. Reported shielding frequency alone cannot establish whether practice was appropriate, because examination-specific indications and protocols were not assessed. The findings support further evaluation of protocol-based optimization, staff training andpatient communication.

Key Words Radiation Protection, ALARA, Diagnostic Radiography, Radiologic Technologists, Patient Safety, Saudi Arabia, Radiation Safety Culture

INTRODUCTION

Conventional X-ray imaging remains a cornerstone of diagnostic care because it is rapid, widely accessible andsupports clinical decision-making across a broad range of conditions. Research on computed tomography exposure during childhood and adolescence has examined subsequent cancer risk, highlighting the importance of radiation protection in medical imaging [1]. Despite the relatively low effective dose of a single radiographic examination compared with computed tomography, the very high global volume of radiography means that even small per-examination doses can translate into meaningful cumulative exposure at the population level, making day-to-day radiation protection in routine radiography a persistent patient-safety priority [2,3].

International guidance frames medical radiation protection around three core principles-justification, optimization (ALARA) and dose limitation for occupational/public exposure-emphasizing that safe imaging depends not only on equipment availability but also on consistent implementation of optimized practice [3,4].

Previous research has reported variation in radiation protection practices among imaging personnel. A review examined factors associated with radiographers' compliance across different settings [5], while a questionnaire-based study reported differing levels of adherence to patient, staff and environmental protection practices [6]. These findings support further examination of specific reported practices and their context. However, differences in study populations, measurement tools and clinical settings should be considered when comparing findings.

Saudi research has examined radiation protection knowledge, attitudes and practices among radiology health workers in Makkah [7]. A separate study in Jeddah examined radiology technologists' perceptions of occupational hazards [8]. Patient communication is also an important component of safety in medical imaging [2]. Assessing patients' self-rated understanding and reported experiences alongside staff reports can provide complementary information about radiation protection. However, whether patients request protective equipment should not be treated as a direct measure of their knowledge or the appropriateness of their care.

A study at Mulago Hospital in Uganda assessed radiation safety awareness among 22 radiation workers and 50 patients using separate questionnaires [9]. Building on research involving staff and patient perspectives, the present study examines both groups specifically in general diagnostic radiography in Jeddah, Saudi Arabia.

Therefore, this study aimed to describe radiologic technologists' reported familiarity with ALARA and radiation protection practices alongside patients' self-rated understanding of radiation risks and reported examination experiences in general diagnostic radiography in Jeddah, Saudi Arabia. It also examined associations between technologists' experience and their reported practices andbetween selected patient characteristics and patient responses. Two separate, independent convenience samples were surveyed; patients were not matched to the technologists who performed their examinations. Accordingly, the findings provide complementary perspectives rather than direct comparisons of the same imaging encounters or verification of technologist practices through patient responses.

METHODS

Study Design and Setting

This exploratory cross-sectional study used two separate questionnaires to describe radiologic technologists' reported familiarity with ALARA and radiation protection practices and patients' self-rated awareness and reported experiences in general diagnostic radiography in Jeddah, Saudi Arabia. Data were collected during February-March 2025. The two participant groups were independent and patient responses were not linked to individual technologists or imaging encounters. Practices were not directly observed.

Patient respondents reported undergoing examinations at 41 hospitals. Hospital names were recorded in the survey responses. Seven hospitals with larger numbers of respondents were listed individually in Table 1, while 34 additional hospitals, contributing 44 patients, were grouped under "Other" for presentation purposes. The number of patient respondents varied across hospitals and proportional representation by hospital was not controlled. Technologist participants were recruited from 13 hospitals selected by the data collectors. The data collectors confirmed these hospitals as the sources of participants recruited through online invitations and face-to-face administration. Hospital identification was based on the collectors' recruitment information rather than a hospital-name item in the technologist questionnaire. Hospital-specific response counts were not available in the response dataset.

Survey for Radiological Technologists

The first questionnaire targeted radiologic technologists working in general diagnostic X-ray and assessed their reported familiarity with ALARA, radiation protection training, practice frequencies, institutional support, perceived barriers and suggested improvements. It consisted of nine multiple-choice questions, one checkbox question and one open-ended question (optional). A total of 61 responses were collected: 26 through a self-administered online questionnaire using Google Forms and 35 through face-to-face, researcher-administered questionnaires. During face-to-face administration, researchers asked the questionnaire items and entered the technologists' answers directly into Google Forms. Both collection modes therefore contributed to the same electronic response dataset, without subsequent transcription from paper forms. The recruitment groups were kept separate: technologists who were sent the online questionnaire were not recruited for face-to-face administration, preventing overlap between the two collection modes.

Survey for Patients

The second survey focused on patients who had undergone general diagnostic X-ray procedures. This survey assessed patients' self-rated understanding of radiation risks, attitudes toward requesting protective equipment and reported examination experiences. It included eight multiple-choice questions, covering topics such as general demographic information, whether they were offered lead shields during their procedures, their self-rated understanding of radiation risks and their overall experience with radiation safety measures. A total of 110 responses were collected, all through Google Forms.

Sampling and Recruitment

A non-probability convenience sampling approach was used, with eligible participants recruited according to accessibility and willingness to participate. Radiologic technologists working in general diagnostic X-ray were recruited through

two separate routes: Invitations to complete a self-administered online questionnaire and face-to-face researcher-administered questionnaires. For face-to-face participation, researchers recorded responses directly in Google Forms. Technologists invited through the online route were not recruited for face-to-face administration. Patients who underwent general diagnostic X-ray examinations during the study period were approached by trained data collectors and invited to complete the survey electronically using an iPad (Google Forms). Participation was voluntary and anonymous, which was intended to reduce social desirability and reporting bias.

Although the survey reached multiple institutions, proportional representation between hospitals and between public and private sectors was not controlled and responses were collected based on voluntary participation.

No formal sample-size calculation was performed before data collection. The initial recruitment targets were 100 patients and 100 radiologic technologists. These were practical recruitment targets rather than statistically calculated sample sizes. During the data collection period, 110 patients and 61 technologists participated. The total number of individuals invited to participate was not recorded; therefore, response rates could not be calculated for either group.

Questionnaire Development and Validity

Questionnaire items were developed based on relevant literature and international radiation protection guidelines. Both questionnaires were reviewed by two reviewers: the study supervisor and a professor in the field of radiologic technology. The review assessed the suitability of the questions for the study objectives and the appropriateness of their organization and sequence. No pilot testing or formal psychometric reliability testing was conducted. Accordingly, the findings should be interpreted as exploratory, self-reported results.

Inclusion Criteria:

- Radiologic technologists who work (or have worked during the study period) in general diagnostic X-ray departments in Jeddah hospitals (governmental or private)
- Patients who underwent general diagnostic X-ray examinations in Jeddah hospitals during February-March 2025 and were able to provide informed consent

Exclusion Criteria:

- Imaging modalities outside general radiography (CT, mammography, dental imaging)
- Emergency or critically ill patients for whom participation was not feasible because of clinical instability or inability to provide informed consent

Consent

Ethical approval was obtained from the Bioethics Committee of Scientific and Medical Research at the University of Jeddah (approval number: UJ-REC-422 on 7 May 2026). The first page of each questionnaire explained the study and included an agreement-to-participate question. Participants completing the questionnaires themselves indicated their consent electronically before answering the survey questions. For face-to-face administration, researchers read the same consent information to the technologists and recorded their agreement in Google Forms before proceeding. Participant anonymity and data confidentiality were maintained throughout the study.

Statistical Analysis

Categorical variables were summarized using frequencies and percentages. Expected cell counts were examined before selecting association tests. Pearson's chi-square test was used when no expected count was below 1 and no more than 20% of expected counts were below 5. When these conditions were not met, Fisher's exact test was used for 2×2 tables and the Fisher-Freeman-Halton exact test for larger contingency tables. Where full enumeration was computationally demanding, p-values were estimated using Monte Carlo sampling with 1,000,000 simulations and a fixed random seed of 20261014. All tests were two-sided, with statistical significance defined as $p<0.05$. Association effect sizes were summarized using Cramér's V, calculated from the uncorrected Pearson chi-square statistic. Wilson score 95% confidence intervals were calculated for selected key proportions.

Analyses used complete responses for the variables involved in each comparison. One free-text lead-shielding response, categorized as "Other," was excluded from the experience-by-shielding analysis, resulting in N = 60; the other technologist association analyses included 61 respondents. Patient association analyses included 110 respondents. No hospital-level weighting or adjustment for clustering was applied. The revised association analyses were performed using Python and SciPy version 1.17.0.

RESULTS

Sample of Patients (N = 110)

Sample Characteristics and Demographics: A total of 110 patients completed the survey. Participants were 52 males (47.3%) and 58 females (52.7%). The most common age group was 18-25 years (n = 54, 49.1%), followed by 46-55 years (n = 26, 23.6%). Patients reported examinations at 41 hospitals. Of the 110 patients, 44 (40.0%) reported examinations at 34 hospitals grouped under "Other" (Table 1).

Knowledge, Attitude and Practice

Chest radiography was the most frequently reported examination (n = 36, 32.7%), followed by head/skull (n = 25, 22.7%) and upper extremities (n = 22, 20.0%) (Table 2). Lead shielding was reported by 43 patients (39.1%; 95% CI: 30.5-48.4%), while 67 (60.9%) reported not receiving shielding. Eleven patients reported requesting additional protective equipment (10.0%; 95% CI: 5.7-17.0%). Most participants agreed that patients have the right to request protective equipment (107/110, 97.3%; 95% CI: 92.3-99.1%). Regarding perceived knowledge of radiation risks, 56 patients (50.9%) reported "I know a lot" or "I know" (Table 2).

Table 1: Patient Demographic Characteristics and Reported Examination Hospitals

Variable	Categories	Frequency (N = 110)	Percentage
Gender	Male	52	47.3
	Female	58	52.7
Age	18-25	54	49.1
	26-35	7	6.4
	36-45	10	9.1
	46-55	26	23.6
	> 55	13	11.8
Hospital	King Abdullah Complex	13	11.8
	Fakeeh Medical Group	13	11.8
	King Fahad Hospital	12	10.9
	Saudi German Hospital	9	8.2
	King Fahad Military Hospital	7	6.4
	King Abdulaziz Hospital	7	6.4
	East Jeddah Hospital	5	4.5
	Other*	44	40.0

"Other" includes 44 patients from 34 additional hospitals. These hospitals were grouped together for presentation purposes and their names were recorded in the original survey responses

Table 2: Patients' Self-Rated Knowledge, Attitudes, and Reported Experiences

Variable	Categories	Frequency (N = 110)	Percentage
Organ under examination	Head or skull	25	22.7
	Chest	36	32.7
	Abdomen	5	4.5
	Pelvis	6	5.5
	Upper extremities	22	20.0
	Lower extremities	16	14.5
Having been provided with lead shielding equipment	Yes	43	39.1
	No	67	60.9
Requesting additional protective equipment during examination	Yes	11	10.0
	No	99	90.0
Agreeing with the right of patients to request protective equipment	Agree	107	97.3
	Disagree	3	2.7
Rating of own understanding of radiation risks	I know a lot	35	31.8
	I know	21	19.1
	I know somewhat	35	31.8
	I do not know much	16	14.5
	I do not know at all	3	2.7

Table 3: Association between Examination Region and Patient-Reported Provision of Lead Shielding

	Having been Provided with lead shielding Equipment N (%)		
Examination Region	Yes	No	p-value
Head or skull	12 (48%)	13 (52%)	0.560
Chest	12 (33.3%)	24 (66.7%)	
Abdomen	2 (40%)	3 (60%)	
Pelvis	1 (16.7%)	5 (83.3%)	
Upper extremities	11 (50%)	11 (50%)	
Lower extremities	5 (31.3%)	11 (68.8%)	

Fisher–Freeman–Halton test with Monte Carlo estimation (1,000,000 simulations), two-sided $p \approx 0.560$; N = 110; Cramér's V = 0.193

The Association between Study Variables:

No statistically significant association was found between the body region examined and patient-reported provision of lead shielding (Monte Carlo estimated $p \approx 0.560$; Table 3). No statistically significant association was found between patients' self-rated understanding of radiation risks and requesting additional protective equipment (two-sided Fisher-Freeman-Halton exact test, $p = 0.220$; Table 4).

Neither gender nor age was significantly associated with agreement about patients' right to request protective equipment (two-sided exact $p = 0.102$ and $p = 0.542$, respectively; Table 5). Self-rated knowledge of radiation risks differed significantly across age groups (Monte Carlo estimated $p<0.001$; Table 6). Descriptively, 72.2% of patients aged 18-25 selected "I know a lot" or "I know." No statistically significant association was found between gender and self-rated knowledge ($\chi^2 = 2.349$, df = 4, $p = 0.672$).

Sample of Technologists (N = 61)

Sample Characteristics: Sixty-one technologists participated. Most reported less than one year of experience (37/61, 60.7%; Figure 1).

Knowledge and Training

Most technologists reported familiarity with ALARA (56/61, 91.8%). Additionally, 54/61 (88.5%) agreed that they had received adequate radiation protection training during their education or employment, while 7/61 (11.5%) selected a neutral response (Figures 2-3).

Table 4: Association between Self-Rated Knowledge of Radiation Risks and Requests for Additional Protective Equipment

Rating own Understanding of Radiation Risks	Requesting Additional Protective Equipment N (%)		p-value
	Yes	No	
I know a lot	7 (20%)	28 (80%)	0.220
I know	1 (4.8%)	20 (95.2%)	
I know somewhat	3 (8.6%)	32 (91.4%)	
I do not know much	0 (0%)	16 (100%)	
I do not know at all	0 (0%)	3 (100%)	

Fisher–Freeman–Halton exact test, two-sided p = 0.220; N = 110; Cramér's V = 0.247.

Table 5: Associations between Patient Demographics and Agreement with the Right to Request Protective Equipment

Demographic Variable	Categories	Agreeing with the Right of Patient to Request Protective Equipment		p-value
		Agree	Disagree	
Gender	Male	49 (94.2%)	3 (5.8%)	0.102
	Female	58 (100%)	0 (0%)	
Age	18-25	53 (98.1%)	1 (1.9%)	0.542
	26-35	7 (100%)	0 (0%)	
	36-45	10 (100%)	0 (0%)	
	46-55	24 (92.3%)	2 (7.7%)	
	> 55	13 (100%)	0 (0%)	

Gender versus agreement: Fisher's exact test, two-sided p = 0.102; N = 110; Cramér's V = 0.177; Age versus agreement: Fisher–Freeman–Halton exact test, two-sided p = 0.542; N = 110; Cramér's V = 0.176

Table 6: Associations between Patient Demographics and Self-Rated Knowledge of Radiation Risks

Demographic Variable	Categories	Rating own Understanding of Radiation Risks					p-value
		I know a lot	I know	I know somewhat	I do not know much	I do not know at all	
Gender	Male	14 (26.9%)	9 (17.3%)	19 (36.5%)	9 (17.3%)	1 (1.9%)	0.672
	Female	21 (36.2%)	12 (20.7%)	16 (27.6%)	7 (12.1%)	2 (3.4%)	
Age	18-25	28 (51.9%)	11 (20.4%)	13 (24.1%)	2 (3.7%)	0 (0%)	<0.001
	26-35	3 (42.9%)	0 (0%)	2 (28.6%)	2 (28.6%)	0 (0%)	
	36-45	1 (10%)	2 (20%)	5 (50%)	2 (20%)	0 (0%)	
	46-55	1 (3.8%)	5 (19.2%)	9 (34.6%)	10 (38.5%)	1 (3.8%)	
	> 55	2 (15.4%)	3 (23.1%)	6 (46.2%)	0 (0%)	2 (15.4%)	

Gender versus self-rated knowledge: Pearson $\chi^2 = 2.349$, df = 4, p = 0.672; N = 110; Cramér's V = 0.146; Age versus self-rated knowledge: Fisher–Freeman–Halton test with Monte Carlo estimation (1,000,000 simulations), p<0.001; N = 110; Cramér's V = 0.330

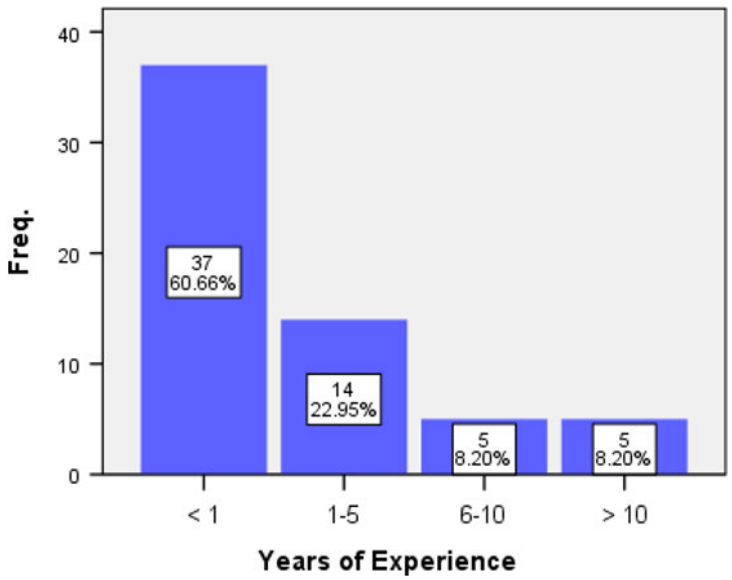


Figure 1: Level of Experience of the Technologists

Self-Reported Practices

Among technologists, 52/61 (85.2%) reported always ensuring companions left the room during exposure and49/61 (80.3%; 95% CI: 68.7-88.4%) reported always performing collimation. Additionally, 36/61 (59.0%; 95% CI: 46.5-70.5%) reported always adjusting exposure settings (kVp/mAs) based on patient size or body part, while 28/61 (45.9%; 95% CI: 34.0-58.3%) reported always providing lead shielding (Table 7).

The shielding item measured reported frequency of provision rather than whether shielding was clinically indicated or consistent with examination-specific protocols.

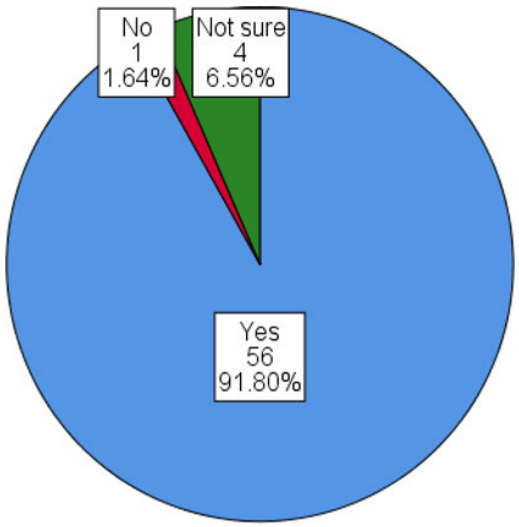


Figure 2: Technologists' Familiarity with ALARA

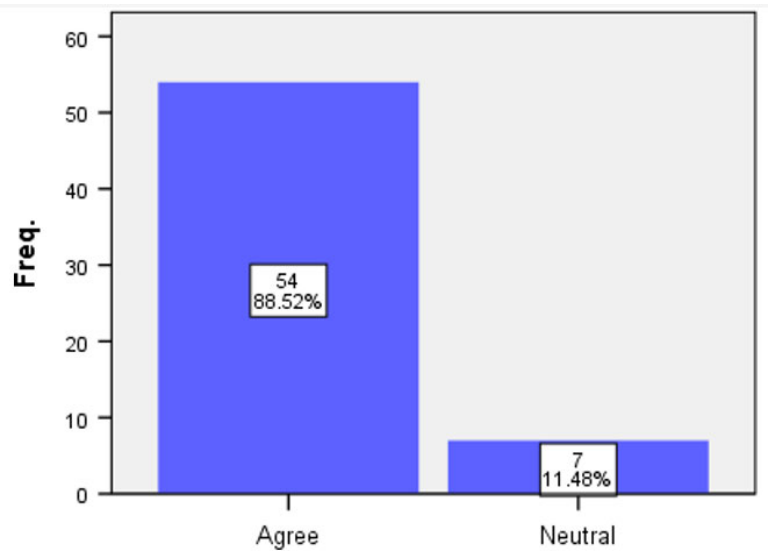


Figure 3: Radiation Protection Training Exposure

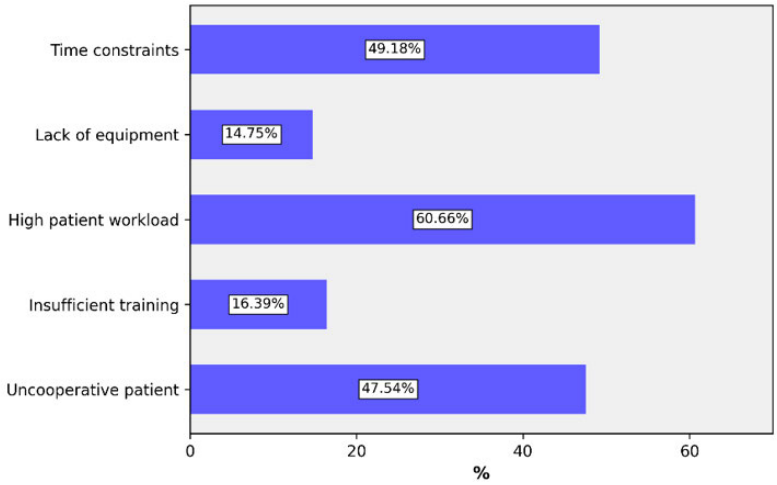


Figure 4: Reported Barriers to Radiation Safety Compliance Participants could select more than one Barrier. Percentages were Calculated using all 61 Technologists as the Denominator and therefore do not Sum to 100%

Table 7: Technologists' Self-Reported Radiation Protection Practices

Question	Answer	Frequency (N = 61)	%
How often do you provide lead shielding (apron, thyroid collars) during X-ray procedures?	Always	28	45.9
	Sometimes	26	42.6
	Never	6	9.8
	Other*	1	1.6
How often do you adjust exposure settings (kVp/mAs) based on patient size or body part?	Always	36	59.0
	Sometimes	13	21.3
	Never	12	19.7
How often do you perform proper collimation to limit radiation field?	Always	49	80.3
	Sometimes	11	18.0
	Never	1	1.6
Do you ensure all patient companions leave the room during X-ray exposures?	Always	52	85.2
	Often	8	13.1
	Only for long scan time	1	1.6

* "Other" represents one free-text response describing situation-dependent use of lead protection for accompanying relatives and pregnant patients. This response was retained as a separate category in the descriptive results (N = 61) and excluded from the Always/Sometimes/Never association analysis in Table 9 (N = 60). The response reflects the participant's reported practice and should not be interpreted as a clinical recommendation

Table 8: Technologists' Reports of Institutional Training and Equipment Availability

Question	Answer	Frequency (N = 61)	%
How often does your hospital conduct training courses on radiation safety?	Annually	19	31.1
	Twice a year*	20	32.8
	Rarely	18	29.5
	Never	4	6.6
Does your hospital provide sufficient radiation protection equipment (e.g., lead aprons, shields)?	Yes	59	96.7
	No	2	3.3

The original questionnaire option was "Biannually," intended by the researchers to mean twice a year. The wording may have been interpreted differently by respondents

Table 9: Associations between Years of Experience and Self-Reported Radiation Protection Practices

	Reported Practice Frequency, n (%)			
Years of experience	Always	Sometimes	Never	p-value
Provide Lead Shielding				
<1	15 (41.7%)	16 (44.4%)	5 (13.9%)	0.533
1-5	7 (50%)	7 (50%)	0 (0%)	
6-10	2 (40%)	2 (40%)	1 (20%)	
>10	4 (80%)	1 (20%)	0 (0%)	
Adjust Exposure Settings (kVp/mAs) Based on Patient Size / Body Part?				
<1	20 (54.1%)	7 (18.9%)	10 (27%)	0.085
1-5	11 (78.6%)	3 (21.4%)	0 (0%)	
6-10	1 (20%)	2 (40%)	2 (40%)	
>10	4 (80%)	1 (20%)	0 (0%)	
Performing Proper Collimation to Limit Radiation Field				
<1	30 (81.1%)	6 (16.2%)	1 (2.7%)	0.794
1-5	10 (71.4%)	4 (28.6%)	0 (0%)	
6-10	4 (80%)	1 (20%)	0 (0%)	
>10	5 (100%)	0 (0%)	0 (0%)	

Experience versus lead shielding: Fisher–Freeman–Halton test with Monte Carlo estimation (1,000,000 simulations), two-sided $p \approx 0.533$; N = 60; Cramér's V = 0.208

Institutional Support and Reported Barriers

Most technologists reported that their hospitals provide sufficient radiation protection equipment (59/61, 96.7%). However, training frequency varied: 39/61 (63.9%) selected "Annually" or "Biannually" (the latter intended to mean twice a year), whereas 22/61 (36.1%) reported that training was rarely or never offered (Table 8). The most frequently reported barriers were high patient workload (37/61, 60.7%), time constraints (30/61, 49.2%) anduncooperative patients (29/61, 47.5%). Insufficient training was reported by 10/61 (16.4%) andlack of equipment by 9/61 (14.8%) (Figure 4).

Associations with Experience

Years of experience were not significantly associated with the reported frequency of providing lead shielding ($p = 0.533$; N = 60), adjusting exposure settings ($p = 0.085$; N = 61), or performing collimation ($p = 0.794$; N = 61). All three associations were evaluated using the Fisher-Freeman-Halton test with Monte Carlo estimation based on 1,000,000 simulations (Table 9).

One respondent with less than one year of experience provided a free-text response categorized as "Other" in Table 7. This response was excluded from the Always/Sometimes/Never analysis of lead shielding in Table 9, resulting in N = 60. Percentages were calculated within each experience group using the included responses.

- **Experience Versus Exposure Adjustment:** Fisher-Freeman-Halton test with Monte Carlo estimation (1,000,000 simulations), two-sided $p \approx 0.085$; N = 61; Cramér's V = 0.278
- **Experience Versus Collimation:** Fisher-Freeman-Halton test with Monte Carlo estimation (1,000,000 simulations), two-sided $p \approx 0.794$; N = 61; Cramér's V = 0.153

DISCUSSION

Patient Perspective

Most patients agreed that they had the right to request protective equipment (97.3%), whereas 10.0% reported requesting additional protection. These findings describe two distinct responses: agreement with a patient right and reported behavior during an examination. Their differing frequencies should not automatically be interpreted as inadequate awareness or unsafe behavior, because the questionnaire did not assess why patients did not make requests or whether additional protective equipment was appropriate for their examinations. Clear communication about radiation risks and examination-specific protection remains relevant to patient-centered imaging care [2].

Although requests for protective equipment were descriptively more frequent among patients reporting the highest knowledge level, the overall association was not statistically significant ($p = 0.220$). These findings do not establish that greater self-rated knowledge translates into requesting protective equipment. The association between age group and self-rated knowledge suggests that age-related differences in perceived understanding warrant further investigation. However, the study did not assess the reasons for these differences or test the effectiveness of age-tailored patient education. These findings support further investigation of patients' understanding and communication needs. Patient-centered communication is emphasized in imaging safety guidance [2,3], but the present study did not evaluate whether providing information changes patient behavior or improves radiation protection.

Technologist Practice

Most technologists reported familiarity with ALARA and high proportions reported always ensuring companions left the room during exposure and performing collimation. Reported frequencies varied across practices: 59.0% reported always adjusting exposure settings based on patient size or body part, while 45.9% reported always providing lead shielding. These responses describe frequency and do not establish the appropriateness of individual clinical decisions. Previous studies have examined radiation protection knowledge and practices among imaging personnel in different settings [6,10-12]. However, differences in questionnaires, participant characteristics and clinical settings limit direct comparisons with the present findings. Technologists with less than one year of experience accounted for 60.7% of the sample. The reported practice frequencies therefore predominantly reflect responses from this experience group. Although the analyses did not identify statistically significant associations between experience and the assessed practices, the small numbers in the more experienced groups limit the conclusions that can be drawn from these comparisons.

The shielding findings require cautious interpretation. The questionnaires recorded whether patients reported receiving shielding and how frequently technologists reported providing it, but did not assess examination-specific indications, departmental shielding protocols, or the appropriateness of individual decisions. Consequently, lower reported shielding frequency cannot by itself be classified as poor compliance. Shielding should be considered separately from the other assessed practices, including collimation and patient-specific exposure adjustment. Further research incorporating protocol review and direct observation is needed to evaluate the appropriateness of these decisions. Experience was not significantly associated with the assessed self-reported practices. However, these findings do not establish that institutional factors are more influential than experience, because their associations with practice were not directly tested.

Institutional and Systemic Factors

Most technologists reported sufficient radiation protection equipment, while 36.1% reported that training was rarely or never offered. Workload and time constraints were commonly selected as perceived barriers to radiation safety practices. These responses identify concerns for further investigation, but the study did not test whether equipment availability, training frequency, or reported barriers were associated with individual practices.

International radiation safety guidance emphasizes that sustainable protection requires system-level infrastructure: clear local protocols aligned with global recommendations, continuous competency maintenance and monitoring systems that identify non-adherence patterns early [3,4] Whether training frequency is associated with the reported variation in practice requires further investigation. Accordingly, strengthening institutional safety culture may require a shift from "knowledge provision" to "behavioral standardization," supported by audit-and-feedback cycles and workload-aware protocols [2,3,13,14].

The reported variation in practice and the barriers identified by participants provide topics for further investigation into departmental safety culture and implementation conditions. The present study did not directly test the relationship between technologists' knowledge and their practices. Recent work emphasizes that leadership engagement, structured safety practices and routine reinforcement are central to sustaining safety behaviors in radiology services [13]. A previous questionnaire-based study reported associations between radiation protection adherence and participant characteristics, including age, years of experience, marital status and department type [14]. These findings provide context for further research, but differences in samples and measurement tools limit direct comparison with the present study.

Implications for Policy and Education

The findings identify potential areas for staff training and patient communication initiatives, whose effectiveness should be evaluated in future studies. At the technologist level, departments may consider reviewing examination-specific optimization protocols and providing periodic competency refreshers aligned with international guidance [3,4]. Patient education videos have been evaluated in radiation therapy

settings [15]. Whether similar approaches improve understanding or communication among patients undergoing diagnostic radiography requires separate evaluation.

Safety culture initiatives in radiology may draw on leadership engagement, teamwork and structured opportunities to discuss safety concerns [13]. Potential approaches for general radiography departments include reviewing local protocols and introducing audit-and-feedback processes. These are proposed directions for evaluation and their effectiveness was not tested in the present study.

Study Contribution

This study provides complementary descriptions of technologists' self-reported radiation protection practices and patients' awareness and experiences in general diagnostic radiography in Jeddah. Its contribution lies in considering both perspectives within the same geographical context while acknowledging that the samples were independent and the imaging encounters were not linked. The findings identify topics for further investigation, including protocol-based practice assessment and communication about radiation protection.

Future Directions

Future multicenter studies should incorporate observational components (e.g., direct workflow auditing) and, where feasible, objective indicators such as dose metrics or protocol adherence logs to validate and extend these self-reported findings [3,4,14]. Longitudinal or interventional designs evaluating standardized training frequency, audit-and-feedback programs and patient education tools would be especially valuable for establishing causality and determining which implementation strategies most effectively improve consistent optimization in routine radiography.

Future analyses using multivariate logistic regression could better identify independent predictors of radiation protection practices.

Recruitment across multiple hospitals provided responses from different institutional settings. However, hospital participation and respondent selection were not proportional or random and hospital-level differences were not analyzed. Future studies should use a defined sampling framework, record hospital identifiers for both participant groups and account for clustering when assessing variation across institutions.

CONCLUSION

These two separate convenience surveys provide an exploratory description of technologists' self-reported radiation protection practices and patients' awareness and experiences in general diagnostic radiography in Jeddah. Most patients agreed that they had the right to request protective equipment, but few reported making such requests. Technologists reported varying frequencies of radiation protection practices and identified workload and time constraints as perceived barriers. Self-rated patient knowledge differed across age groups but was not significantly associated with requesting protective equipment. Technologist experience was not significantly associated with the assessed practices. Reported shielding frequency alone does not establish whether individual decisions were clinically appropriate. Further studies using representative samples, direct observation and protocol-based assessment are needed to evaluate practice and test potential training and patient communication interventions.

Limitations

This exploratory cross-sectional study used two separate voluntary convenience samples without a formal sample-size calculation. Initial recruitment targets were 100 patients and 100 technologists; the final samples included 110 patients and 61 technologists. The number of individuals invited to participate was unavailable, preventing calculation of response rates and assessment of nonresponse. Selection bias and limited sample sizes restrict the representativeness and generalizability of the findings.

All findings were based on participant reports rather than direct observation, objective knowledge testing, or dose measurements. Recall and social desirability bias may have affected responses. Technologist questionnaires were completed either independently online or through face-to-face researcher administration, which may have introduced differences in how participants responded. Although both questionnaires underwent expert review, no pilot testing or formal psychometric reliability assessment was performed. The training-frequency option "Biannually" was intended to mean twice a year, but its ambiguous wording may have affected respondents' interpretation.

Patient respondents reported examinations at 41 hospitals, with unequal contributions across institutions. Hospital-level weighting and adjustment for clustering were not applied. Consequently, the reported statistical uncertainty does not account for possible similarities among participants from the same hospital. The samples should not be considered representative of all hospitals or imaging departments in Jeddah.

Technologists with less than one year of experience constituted 60.7% of the technologist sample, while the more experienced groups were small. Several contingency tables contained sparse or zero cells. Although exact tests or Monte Carlo estimation were used where appropriate, small subgroup sizes limit precision and the ability to detect associations. Nonsignificant findings should not be interpreted as evidence of equivalence.

Patients were not matched to the technologists or departments responsible for their examinations. The two surveys therefore provide complementary perspectives rather than linked assessments of the same imaging encounters. Shielding questions assessed reported frequency or provision, without determining examination-specific indications or the appropriateness of individual decisions. Finally, the cross-sectional design cannot establish temporal relationships or causality and the effectiveness of proposed training, protocol, or patient education interventions was not evaluated.

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