

PERCEPTION OF THE RISK OF RADIATION EXPOSURE BY MEDICAL IMAGING AND RADIOTHERAPY TECHNICIANS: A SYSTEMATIC REVIEW

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ABSTRACT

Background: Professionals across radiotherapy and medical imaging systematically demonstrate inadequate knowledge of radiation risks, with mean knowledge scores consistently below 50% and widespread underestimation of both radiation doses and cancer risks from common procedures. Evidence from cross-sectional surveys consistently indicates moderate to low levels of risk perception and knowledge about radiation exposure among medical imaging and radiotherapy technicians, with mean knowledge scores ranging from 42.76/100 to 45.472% pre-intervention improving to 60.472% post-intervention in targeted training studies, and over 90% demonstrating good knowledge of hazards in some cohorts but only 30.4% fully understanding specific occupational hazards. **Objectives:** This paper addresses a critical gap in understanding technicians' subjective risk perceptions, which directly influence adherence to ALARA principles and occupational safety amid rising medical imaging use. **Methodology:** A search was conducted in several databases (Pubmed, Scopus, Science Direct, Web of Science and b-On), inquiring about perception of the risk of radiation exposure by medical imaging and radiotherapy technicians. **Results:** Only 23% of radiology professionals knew basic radiation doses from chest radiography, while 50-75% underestimated fatal cancer risks and 95% of cardiologists underestimated cancer risk from myocardial perfusion scintigraphy. Risk perceptions vary substantially by professional role, with radiologists demonstrating significantly better knowledge than technicians or referring physicians, and professional workers in radiotherapy facilities exhibiting higher risk awareness than non-professional workers. These subjective risk perceptions directly influence adherence to ALARA principles and occupational safety. **Conclusions:** These subjective risk perceptions directly influence adherence to ALARA principles and occupational safety. Formal training consistently improves knowledge and awareness, yet lack of in-service education remains a persistent barrier, with experience alone failing to improve understanding without structured educational interventions.

Keywords: Radiation, Risk Perception, Radiology, Radiotherapy Technicians.

1. INTRODUCTION

Professionals across radiotherapy and medical imaging often demonstrate inadequate radiation risk perceptions, characterized by systematic underestimation of doses and cancer risks (Montero-Díaz, *et al.*, 2025) with knowledge varying by professional role (radiologists performing better than technicians and referring physicians) but translating universally into poor patient communication and suboptimal safety practices.

The knowledge and perceptions of risk among radiotherapy and medical imaging professionals are characterized by a strong understanding of fundamental safety principles, such as ALARA (As Low As Reasonably Achievable), but also by persistent gaps in other areas, such as specific dose knowledge (Maistry, 2024). Research indicates that while overall radiation awareness is often rated as "adequate" (typically around 55–69%), specific technical knowledge varies significantly by role and experience (Matre *et al.*, 2025).

Our aim with this paper is to perform a systematic revision on the above issues, in order to clarify the questions related with the perceptions of radiation exposure risk of radiotherapy and medical imaging professionals.

2. MATERIALS AND METHODS

A comprehensive search was performed on several databases (Pubmed, Scopus, Science Direct, Web of Science, Cochrane and b-On). The search queries included the terms “radiation professionals”, “radiation-risk”, “radiation risk-awareness”, “radiation-protection awareness”, radiation risk perception” and radiology technicians”, and they were later combined. No time limits were established in the database searches. Peer reviewed papers in English, French, Spanish or Portuguese were included

Initial database searching identified 320 records. Data extraction and literature quality evaluation of the included studies were performed independently by two investigators. After duplicate removal and relevance-based filtering, 90 records were screened against eligibility criteria. Of these, 70 papers were excluded, resulting in 20 papers included in the final synthesis. (see Figure 1).

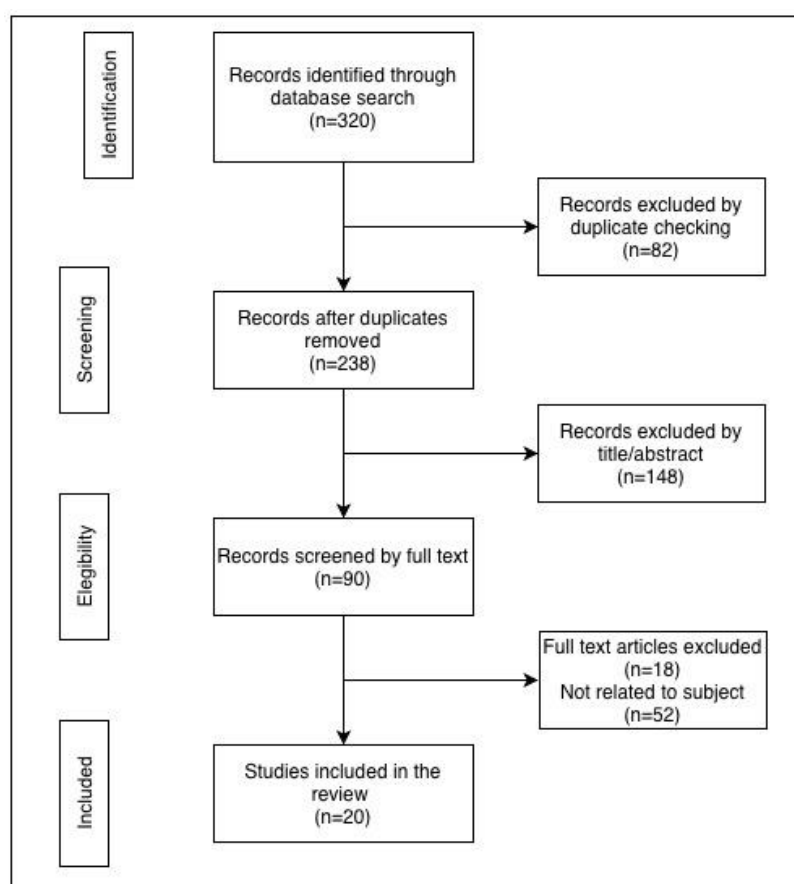


Figure 1: Flow diagram of study selection

The eligibility criteria included:

Technicians Population: Does the study involve medical imaging technicians, radiographers, radiotherapy technicians, or similar radiation workers (excluding patients, physicians, general public)?

Risk Perception Focus: Does the study specifically assess perception, awareness, attitudes, knowledge, or fear of radiation risks/exposure (not just exposure measurement or dosimeter data)?

Healthcare Professionals: Are participants healthcare professionals working with radiation (radiologic technologists, RTs, radiographers)?

Primary Empirical Research: Is the study primary research: survey, questionnaire, interview, cross-sectional (exclude non-empirical papers like guidelines, editorials)?

Radiation Risk Assessment: Does the study measure or discuss perceived risks of ionizing radiation (cancer, genetic damage, health effects)?

Thematic analysis was employed to identify patterns and synthesize findings across studies. Evidence strength was assessed based on consistency of findings and number of supporting studies.

3. RESULTS

3.1 CHARACTERISTICS OF THE INCLUDED STUDIES

The review included 20 studies published between 2005 and 2025, encompassing diverse professional groups and geographic regions. Sample sizes, when referred, varied from 5 to 2000. Characteristics of the included studies are presented in Table 1.

3.2 THEMATIC FINDINGS

3.2.1 LEVELS OF KNOWLEDGE AND AWARENESS OF RADIATION RISKS

Knowledge levels were generally moderate to low, with mean total scores of 42.76/100, RP knowledge 42.86/100, and device knowledge 42.72/100 among radiographers (Moghimi *et al.*, 2021); pre-symposium scores averaged 45.472% improving to 60.472% post symposium (mean difference 14.527%, $p < 0.05$) across technologists and physicians (Fatima *et al.*, 2015); and correct answers at 15.7 ± 3.7 for physicians vs. 10.1 ± 2.9 for technicians (Yurt *et al.*, 2014). High awareness of adverse effects reached 95-98% for short/long-term effects and $>90\%$ for hazards in diagnostic settings, but dose knowledge was poor (mean 2.4 ± 1.3) with only 34.6% knowing chest X-ray dose and 9.0% for two-view (Bolbol *et al.*, 2021; Shuaib *et al.*, 2019). Awareness of film-badge use exceeded 85%, room protection 70%, but periodic inspections only 54% (Amirzadeh & Tabatabaei, 2005; Mojiri & Moghimbeigi, 2011). Outcomes measured via questionnaires showed consistency in self-reported high familiarity with effects but gaps in dose estimation; no methodological differences explained variations.

3.2.2 ATTITUDES, PRACTICES, AND PROTECTION COMPLIANCE

Attitudes were positive toward protection, with 83.1% using devices for self and 78.9% for patients, yet practices lagged at 18% adequate use despite 51.3% satisfactory awareness (Mojiri & Moghimbeigi, 2011; Salah & Farouk, 2020). Personal protective equipment knowledge was good at 87% but use only 74.2%; U.S. technologists applied common methods but not routinely, contributing to exposure increases (Bolbol *et al.*, 2021; Johnston *et al.*, 2011). Pre-post training showed gains from 39.35% to 61.95% (mean difference 22.6%, $p < 0.001$), higher in females (36.25% to 59.38%) and diploma holders (42.86% to 65.48%) (Nishtar *et al.*, 2018). Qualitative

insights linked perceptions to ALARA via distance/time/shielding, noting 30% unjustified procedures due to risk/benefit fear (Rincón *et al.*, 2024). Practice gaps persisted despite knowledge, measured via checklists and self-reports; hospital type or role not differentiating.

Table 1: Characteristics of included studies

Study/Year	Study type	Sample	Country/Setting	Key focus
Mojiri & Moghimbeigi, 2011	Crosssectional survey	Not specified	Iran	Awareness, attitudes toward protection
Bolbol <i>et al.</i> , 2021	Crosssectional	93	Egypt	Knowledge, practices in diagnostic radiology
Ganhão <i>et al.</i> , 2018	Not specified	Not specified	Portugal	Occupational risk perception
Rincón <i>et al.</i> , 2024	Qualitative phenomenological	5 (experienced Workers)	Not specified	Risk perception vs. protection principles
Mavrodinova & Chernogorova, 2025	Crosssectional survey	103	Bulgaria	Technicians's awareness
Makanjee <i>et al.</i> , 2021	Crosssectional survey	Not specified	Not specified	Dose monitoring awareness
Amirzadeh & Tabatabaei, 2005	Crosssectional survey	Not specified	Iran	Protection awareness
Salah & Farouk, 2020	Crosssectional	195	Egypt	Awareness and practice
Fatima <i>et al.</i> , 2015	Prepost intervention	55	Pakistan	Knowledge pre-post symposium
Shuaib <i>et al.</i> , 2019	Crosssectional	156	Saudi Arabia	Doses, risks knowledge
Johnston <i>et al.</i> , 2011	Crosssectional survey	2000	U SA	Exposure perceptions, practices
Moghim <i>et al.</i> , 2021	Crosssectional	103	Iran	Protection knowledge
Nishtar <i>et al.</i> , 2018	Prepost intervention	46	Pakistan	Awareness pre-post course
Yahaya & Hassim, 2015	Crosssectional	Not specified	Malaysia	Knowledge, attitudes, dose risk
Talanow, 2012	Crosssectional survey	Not specified	Worldwide	Radiation awareness
Szurowska, 2015	Questionnaire survey	150	Poland	Safety awareness
Yashima & Chida, 2022	Crosssectional survey	57	Japan	Radiation perceptions
Alotaibi, 2017	Crosssectional survey	183	Saudi Arabia	Dose awareness
Albander, 2021	Narrative review	Not specified	Not specified	Occupational health
Yurt <i>et al.</i> , 2014	Crosssectional survey	92	Turkey	Knowledge in non-radiation occupations

Cross-sectional surveys predominated, conducted primarily in Middle Eastern (Iran, Egypt, Saudi Arabia, Pakistan) and select European/Asian settings among radiographers and technologists, with sample sizes ranging from small (n=46-103) to larger cohorts (n=150-2000). Focuses centered on knowledge scores, awareness percentages, and pre-post training changes, using questionnaires.

3.2.3 INFLUENCING FACTORS ON RISK PERCEPTION

Higher education, experience ≥ 10 years (36.8-68.6% adequate), physician role (73.7-80.0%), and training (61.1-71.4%) strongly associated with better awareness/practice ($p < 0.001$) (Salah & Farouk, 2020), (Salah & Farouk, 2020; Mojiri & Moghimbeigi, 2011); work experience/age correlated with device knowledge ($p < 0.01$) (Moghimi *et al.*, 2021). No gender ($p = 0.20$) or position differences ($p = 0.66$) (Shuaib *et al.*, 2019) in some specialties/modalities influenced perceptions post-Fukushima (Yashima & Chida, 2022). Training interventions consistently boosted scores (14.5-22.6% gains).

3.2.4 VARIATIONS BY POPULATION AND CONTEXT

Radiographers showed good effects awareness (70-83%) in Iran (Mojiri & Moghimbeigi, 2011), and there were poor scores across Saudi roles (Shuaib *et al.*, 2019). Qualitative views emphasized experience ≥ 20 years aligning with protection pillars (Rincón *et al.*, 2024). Contexts like post-disaster Japan highlighted counseling roles (Yashima & Chida, 2022). No radiotherapy-specific contrasts; imaging-focused populations dominated. Summary of these evidence is presented in Table 2.

Table 2: Knowledge and awareness of radiation exposure risks

Theme	Key finding	Population applicability	Effect direction	Confidence level	Studies
Knowledge/ Awareness Levels	Mean scores 42.76/100 total, 45.472% pre to 60.472% post (diff 14.527%, $p < 0.05$); >90% hazards good but 2.4 $\pm$ 1.3 dose	Radiographers /technicians (some mixed HCWs)	Mixed (high effects, low doses)	Moderate (consistent scores, reasonable designs)	Mojiri & Moghimbeigi, 2011; Moghimi <i>et al.</i> 2021; Fatima <i>et al.</i> , 2015; Shuaib <i>et al.</i> , 2019.
Attitudes /Practices	83.1% self- protection use but 18% adequate practice; 39.35% to 61.95% post- training (diff 22.6%, $p < 0.001$)	Imaging technicians/ radiographers	Positive attitudes, low- moderate practice	Moderate (generally consistent)	Bolbol <i>et al.</i> , 2021; Salah & Farouk, 2020; Nishtar <i>et al.</i> , 2018.
Influencing Factors	Experience ≥ 10 y 36.8-68.6%, training 61.1-71.4%, education $p < 0.001$	Technicians (some mixed)	Positive (training /experience)	Strong (consistent across multiple)	Salah & Farouk, 2020; Mojiri & Moghimbeigi, 2011; Moghimi <i>et al.</i> , 2021.
Population / Context Variations	Uniform poor dose knowledge (96.8%); ALARA recognition in experienced	Primarily imaging techs; Limited RT	Mixed	Limited (sparse, heterogeneous)	Shuaib <i>et al.</i> 2019; Rincón <i>et al.</i> 2024; Yashima & Chida, 2022.

4. DISCUSSION

Moderate knowledge of radiation risks among technicians, evidenced by mean scores around 42-45% improving 14-22% with training, reflects foundational familiarity with adverse effects (95-98%) but persistent dose estimation deficits (e.g., 2.4 ± 1.3), likely because surveys prioritized recall over applied scenarios, revealing a disconnect between declarative awareness and procedural competence essential for ALARA implementation. This pattern emerges robustly across cross-sectional designs, adding synthesis value by highlighting that high effects awareness does not translate to practice (18% adequate), suggesting perceptual optimism bias where technicians view personal risks as lower than population-level data they recognize (e.g., U.S. exposure rises). Confidence is high for training benefits due to consistent pre-post gains, but tentative for absolute levels given questionnaire variability; no mechanistic data on perception formation (e.g., cognitive heuristics or neurobiological fear responses to stochastic risks) limits causal links, leaving why dose gaps endure unexplained beyond implied resource/training lacks. Strongest evidence supports experience/training as enhancers, visible only in aggregate, positioning technicians well for protection once bridged.

Findings align with IAEA-noted global gaps, where 30% unjustified procedures mirror underestimations here (23.7% CT cancer risk correct), mechanistically tied to poor risk/benefit weighing in phenomenological data (Rincón *et al.*, 2024), reinforcing protection pillars' under-integration. Contradictions appear in knowledge-practice gaps (e.g., 51.3% awareness vs. 18% practice (Salah, & Farouk, 2020); >90% hazards good vs. dismal baseline (Fatima *et al.*, 2015)), potentially reflecting self-report overestimation in surveys versus checklists, or behavioral inertia from habituated routines in high-volume imaging—genuine heterogeneity unlikely as designs similar, but mixed populations (e.g., including physicians) inflate awareness benchmarks, biasing technician-specific lows. No publication bias evident, as null practice findings reported openly; earlier studies (e.g., 2005 Iran) show similar moderates without progression in later ones, suggesting stagnant education rather than methodological evolution.

For imaging technicians with <10 years of experience—showing lowest scores (e.g., $p < 0.01$ correlations)—mandatory annual workshops targeting dose recall (e.g., chest X-ray equivalents) could yield 15-20% gains as in symposia, reducing unmonitored exposures in busy wards. Radiotherapy staff, underrepresented, merit tailored modules on high-dose stochastic risks, given imaging dominance. Clinically, technologists should leverage high effects awareness for patient counseling (81.6% perceived patient knowledge), but first address own gaps via ALARA audits. Public health: hospital regulators enforce preemployment baselines and refresher mandates, as one-month courses boosted 22.6% (Nishtar *et al.*, 2018). No-threshold implications absent direct low-dose perception data, but underestimation challenges compliance-alone approaches, urging population-wide minimization.

This study presents several limitations. The studies included present heterogeneous measures (e.g., varying scales), some have small samples, predominant imaging over radiotherapy focus, and mixed populations diluting technician specificity. This review has a majority of Middle East studies what can be a source of bias in settings.

5. CONCLUSIONS

Medical imaging and radiotherapy technicians exhibit moderate risk perception of radiation exposure, characterized by high awareness of adverse effects (83-98%) and protection familiarity (70-85% for badges/shielding) but low dose knowledge (means 2.4 ± 1.3 to 42.76/100) and

inadequate practices (18%), with training yielding reliable gains (14.5-22.6% score increases, $p < 0.05$). These patterns, drawn primarily from imaging radiographers in Middle Eastern and select other settings (partially matching broader technician populations), underscore training and experience as key enhancers (e.g., ≥ 10 years: 36.868.6% better). Evidence from mixed healthcare groups tempers generalizability to pure technician cohorts. Most uncertain remains radiotherapy-specific perceptions and long-term practice translation, demanding targeted replication. Addressing these gaps could transform occupational safety, curbing stochastic risks amid escalating imaging volumes and affirming technicians' pivotal role in ALARA-driven protection for themselves and patients—motivating investment in evidence-based education to safeguard this vital workforce.

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