

Assessment of Knowledge and Awareness among Computed Tomography Technologists on Computed tomography radiation Exposure Parameters

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ABSTRACT

Introduction: Computed tomography (CT) is essential in modern diagnostics but contributes substantially to medical radiation exposure. Dose optimization strategies—such as Diagnostic Reference Levels (DRLs), Automatic Tube Current Modulation (ATCM), and individualized protocols—are vital to minimize exposure, yet their use depends on CT technologists' knowledge and institutional support.

Methods: An observational, prospective, cross-sectional study was conducted from April to June 2025 in public, private, and academic hospitals across Nepal. Registered CT technologists were included, excluding students, interns, and incomplete responses. Ethical approval was obtained from the Nepal Health Research Council with written consent. Using Cochran's formula, the required sample was 270; 197 respondents participated via convenience sampling.

Results: Awareness of DRLs (79.70%) and As Low as Reasonably Achievable (ALARA) (98.50%) was high, but only 46.20% applied Diagnostic Reference Levels (DRLs) and 40.10% routinely used shielding. Confidence in adjusting CT parameters (73.60%) and explaining risks (83.20%) was common, yet only 20.80% attended dose-optimization training in the past two years. About 52.80% had access to dose-monitoring software, while fewer than 40% reported regular protocol reviews. Pediatric adjustments (90.40%) and pregnancy screening (91.90%) were widely practiced.

Conclusions: CT technologists in Nepal demonstrate strong awareness but inconsistent application of radiation-safety practices. Strengthening training, audits, and institutional and regulatory support is vital to ensure patient safety.

Keywords: *Computed Tomography (CT); Dose Optimization; Knowledge Assessment; Radiation Safety*

INTRODUCTION

Computed tomography (CT) is an indispensable diagnostic tool that enhances diagnostic accuracy and clinical decision-making. However, it contributes disproportionately to medical radiation exposure, raising concerns about radiation-induced risks, especially in radiosensitive groups such as children and pregnant women.^{1,2} Dose-reduction strategies such as Diagnostic Reference Levels (DRLs), Automatic Tube Current Modulation (ATCM), iterative reconstruction, and patient-specific protocols are widely endorsed,^{3–6} but their effectiveness depends on CT

technologists' knowledge and judgment.⁷

International studies reveal wide variability in technologists' understanding of dose optimization.^{8–11} While awareness of DRLs and ATCM is common, knowledge of tube voltage, current, pitch, and scan length remains inconsistent.^{12,13} These gaps are compounded by limited training, weak continuing professional development, and lack of institutional support such as audits and monitoring software.^{14–16} Despite these concerns, no national-level study has been conducted in Nepal.

This study aims to evaluate the knowledge, confidence, training, and institutional support of CT technologists

in Nepal regarding dose optimization, with emphasis on pediatric and pregnancy imaging, radiation risk communication, and professional responsibility.

METHODS

This was an observational, prospective, cross-sectional study conducted to assess the knowledge; awareness, training background, and institutional support related to CT dose optimization among CT technologists in Nepal. The study was conducted between April and June 2025 across a variety of healthcare institutions in Nepal. The study sites included public, private, and academic hospitals, as well as diagnostic imaging centers, encompassing both urban and semi-urban areas to ensure geographic and institutional diversity. The study population consisted of CT technologists who were actively involved in operating or supervising computed tomography imaging and were registered with the Nepal Health Professional Council (NHPC). Participants were required to have at least an A-level or higher academic qualification in radiologic technology.

Ethical approval for the study was obtained from the Nepal Health Research Council (NHRC) with Ref No.2155. All participants provided written informed consent before participation. Confidentiality and anonymity were maintained by coding all responses and securing digital data files in password-protected storage.

Inclusion criteria were CT technologists actively operating or supervising CT systems and registered with the NHPC. Exclusion criteria included student radiographers, interns not independently operating CT systems, and any participant with incomplete survey data.

The sample size was calculated using Cochran's formula for estimating a proportion in a single population. Assuming a 95% confidence level ($Z = 1.96$), a 5% margin of error ($d = 0.05$), and a 50% expected response distribution ($p = 0.50$), the required sample size for an infinite population was 384. Given the finite population of approximately 900 registered CT technologists in Nepal, the sample size was adjusted using the finite population correction formula. This yielded a minimum required sample size of 270 participants. However, due to a lower response rate, the final analysis included data from 197 respondents. Stratified random sampling was initially planned to ensure proportional representation across various subgroups, including years of CT experience, educational qualifications, and institutional affiliation (government, private, academic). However, because of logistical constraints and reliance on voluntary participation, the final sample reflected characteristics of the convenience sampling.

Data were collected using a structured, self-administered Google Forms questionnaire adapted from international

literature and validated CT dose optimization tools. It included five domains: demographics, knowledge of CT exposure parameters, awareness of optimization strategies (ALARA, ATCM, DRLs), training and institutional support, and confidence in protocol adjustment and risk communication. Content and face validity were ensured by expert review, and a pilot with 15 CT technologists refined clarity. Psychometric testing was not performed, as the instrument was designed to assess factual knowledge and practice awareness.

Data were entered into Microsoft Excel and analyzed using SPSS version 25. Descriptive statistics (mean, standard deviation, frequency, percentage) summarized participant characteristics and response patterns. Associations between demographic/professional factors and knowledge outcomes were assessed using chi-square tests. Binary logistic regression was used to identify independent predictors of adequate knowledge, with a dichotomized composite score as the dependent variable. Statistical significance was set at $p < 0.05$.

RESULTS

All 197 CT technologists completed the survey. Most were men (71.10%), and the largest age group was 25–34 years (62.40%). The majority held a bachelor's degree (82.70%), while 16.8% had a master's. Nearly half worked in government hospitals (44.70%), followed by private (28.90%) and academic institutions (24.40%). CT experience varied: 23.90% had <1 year, 32% had 1–3 years, and 29.04% had >6 years (Table 1).

Table 1: Demographic Characteristics of CT Technologists

Characteristic	Category	n (%)
Gender	Male	140 (71.10%)
	Female	57 (28.90%)
Age Group	Under 25	30 (15.20%)
	25–34	123 (62.40%)
	35–44	36 (18.30%)
	≥45	8 (4.10%)
Academic Qualification	Bachelor's degree	163 (82.70%)
	Master's degree	33 (16.80%)
	Pursuing Bachelor's	1 (0.50%)
Workplace Setting	Government hospital	88 (44.70%)
	Private hospital	57 (28.90%)
	Academic institution	48 (24.40%)

	Other	4 (2.00%)
CT Experience	< 1 year	47 (23.90%)
	1–3 years	63 (32.00%)
	4–6 years	29 (14.70%)
	> 6 years	58 (29.40%)

Knowledge of CT Dose and Parameters

Almost all respondents (98.50%) recognized CT as a major radiation source, and 98.50% were familiar with the ALARA principle, though only 94.90% reported applying it daily. Awareness of DRLs was high (79.70%), yet only 46.20% applied them in practice. Most understood that tube voltage affects both contrast and dose, but responses showed variability in knowledge of AEC and dose units (Figure 1).

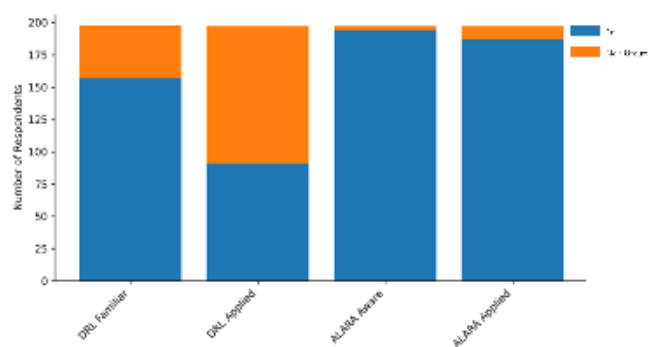


Figure 1. DRL and ALARA knowledge versus practical application

Shielding Practice

Only 40.10% reported routine use, while a comparable proportion never used shielding, and a smaller group reported occasional use (Figure 2).

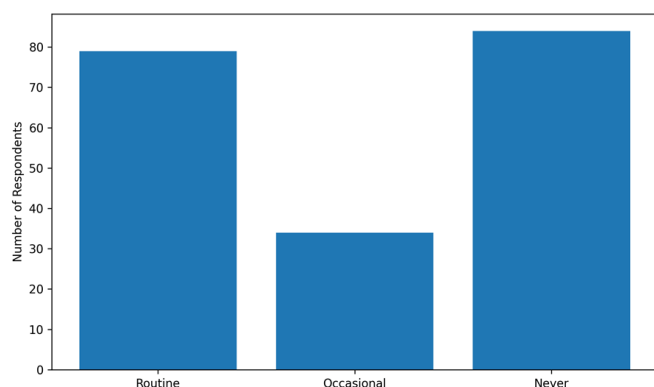


Figure 2. Frequency of Gonadal Shielding use in CT

Confidence and Practice

Confidence was generally high: 73.60% felt capable of

adjusting scan parameters, and 83.20% were comfortable explaining radiation risks to patients (Figure 3). However, only 40.10% reported routine use of shielding (Figure 2).

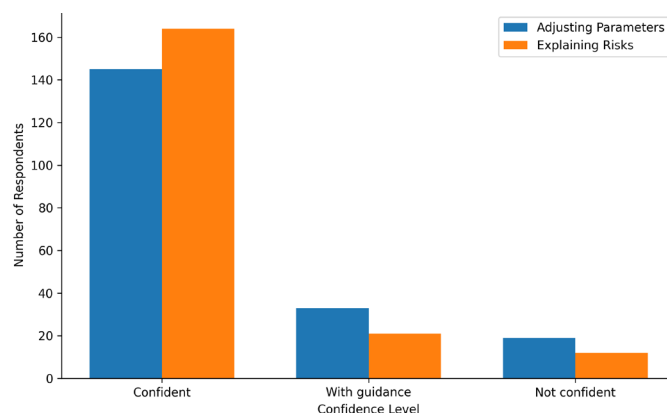


Figure 3. CT technologists' confidence in adjusting scan parameters and explaining radiation risks (N = 197).

Only 41 (20.80%) had attended dose-optimization training in the past two years. Dose-monitoring software was available to 104 (52.80%), absent in 63 (32.0%), and unknown to 30 (15.20%). Routine protocol review was reported by 77 (39.10%), whereas 93 (47.20%) said protocols were not updated and 27 (13.70%) were unsure.

Availability of Training and Institutional Support (Figure 4).

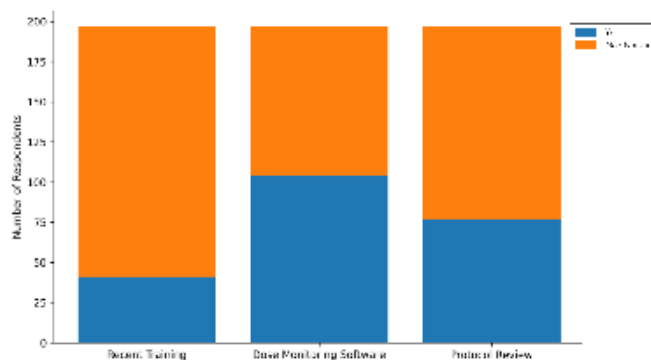


Figure 4. Training and Institutional Support

Most CT technologists reported dose-conscious practices for vulnerable groups. 90.40% adjusted scan parameters for pediatric patients, and 71.60% had dedicated pediatric protocols. 57.40% routinely considered alternative imaging for children or pregnant patients, while 91.90% screened women of childbearing age for pregnancy. However, only 40.10% reported routine use of shielding during CT scans (Figure 5).

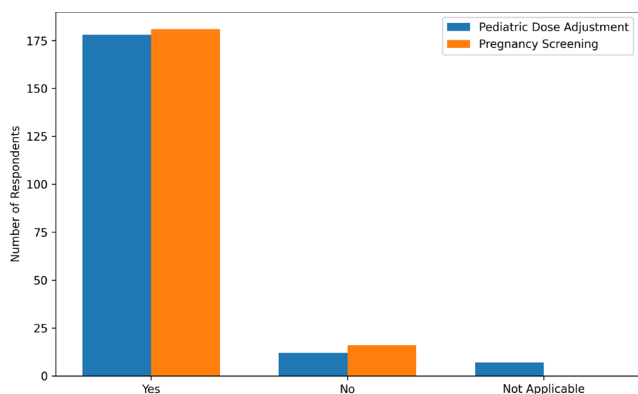


Figure 5. Awareness of Pediatric and Pregnant Patient Considerations

Training and Curriculum Insights

Only 20.80% had attended dose optimization training in the past two years. The most preferred learning methods were formal training programs (49.20%) and workshops (24.40%). While 83.20% felt confident explaining radiation risks to patients, 81.70% believed the current radiation safety curriculum needs improvement.

Table 2: Demographic Professional Factors Vs Knowledge adequacy

Variable	χ^2	df	p-value
Gender	0.22	1	0.64
Age group	0.29	3	0.96
Workplace setting	4.31	6	0.63
Academic qualification	0.05	1	0.82
CT experience	0.27	3	0.97
Training attendance (past 2 yrs)	0.08	1	0.78

NS = not significant ($p \geq 0.05$)

All chi-square tests showed no statistically significant association between adequate knowledge (composite score ≥ 7) and any demographic or professional factor examined.

Binary logistic regression was used to assess independent predictors of adequate knowledge. The model included CT experience level, academic qualification, and recent training attendance. No variable was found to be a significant predictor:

Table 3: Logistic Regression Analysis

Predictor	Adjusted OR (95% CI)	p-value
Years of experience	1.01 (0.77–1.32)	0.966
Master's degree	1.17 (0.51–2.67)	0.711
Attended training	0.85 (0.42–1.72)	0.650

These findings indicate that demographic and professional factors were not significantly associated with knowledge adequacy among CT technologists in this study.

The survey reveals high baseline awareness of radiation-safety principles but identifies critical shortcomings in DRL implementation, shielding practice, formal training, and institutional protocol governance. Targeted educational programme and strengthened departmental policies are recommended to close these gaps.

DISCUSSION

This national survey revealed a significant knowledge–practice gap among CT technologists in Nepal. Almost all respondents recognized CT as a major radiation source (98.50%) and were familiar with ALARA (98.50%). Awareness of DRLs was also high (79.70%), yet only 46.20% applied them in practice and 40.10% routinely used shielding. Confidence was encouraging, with 73.60% able to adjust CT parameters and 83.20% were comfortable explaining radiation risks, but this was not matched by professional development, as only 20.80% had attended dose-optimization training in the past two years. Institutional support was limited: 52.80% reported access to dose-monitoring software and fewer than 40% cited routine protocol reviews. Pediatric and pregnancy-related practices were stronger, with 90.40% adjusting parameters for children and 91.90% screening for pregnancy, though only 71.60% reported dedicated pediatric protocols and fewer than half routinely considered alternative imaging. No demographic or professional variables, including age, gender, qualification, or experience, were significantly associated with knowledge adequacy.

Our findings are consistent with reports from Saudi Arabia and Iran, where high awareness of DRLs and ALARA coexisted with limited adherence in practice.^{6,9,10} In contrast, studies from the UAE and European countries demonstrated greater compliance with optimization principles, supported by national DRLs, mandatory Continuing Professional Development (CPD), and systematic protocol audits.^{5,17} These comparisons suggest that the challenges in Nepal are not due to lack of awareness but reflect systemic barriers, including absence of enforceable national guidelines, non-mandatory CPD, limited availability of dose-monitoring software, and weak departmental governance.

The pattern observed in pediatric practices further supports this interpretation. Although most respondents reported adjusting scan parameters for children and screening for pregnancy, fewer had dedicated pediatric protocols or considered alternative imaging. Similar gaps have been noted in international studies, particularly in resource-limited settings where protocol standardization and pediatric-specific training remain underdeveloped.

^{7,13,17} The consistency of these findings across different contexts highlights the need for structured, competency-based training and stronger institutional support to ensure translation of knowledge into consistent practice.

This study has limitations. Data were self-reported, raising the possibility of recall and social desirability bias. Convenience sampling and a modest response rate may restrict representativeness. The absence of objective performance measures, such as audit data or dose records, limited assessment of actual practice.

CONCLUSIONS

This national survey highlights that CT technologists in Nepal

possess strong theoretical awareness of radiation safety principles, including ALARA and DRLs, but demonstrate inconsistent application in daily practice. Key gaps exist in DRL implementation, shielding use, structured training, and institutional support such as dose-monitoring tools and protocol audits. Bridging this knowledge–practice divide requires coordinated efforts through mandatory continuing education, standardized national guidelines, and stronger regulatory and institutional frameworks to ensure safe and optimized CT imaging across the country.

Conflict of Interest: None

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