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RESEARCH ARTICLE

A STUDY TO CHECK THE KNOWLEDGE OF RADIATION PROTECTION AMONG STUDENT'S AND RADIOGRAPHERS IN UTTARAKHAND, INDIA

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Abstract

Background: Radiation protection is an important aspect of the utilization of imaging modalities and radiological practices, as patient and healthcare workers are at risk of chronic health problems, if ionizing radiation is improperly managed. Student and radiographer knowledge of radiation protection should be at an adequate level to encourage a safe radiological practice culture.

Objective: This study aimed to measure and compare the level of radiation protection knowledge inquiry between radiography students and registered radiographers in Uttarakhand, India.

Methods: A cross-sectional questionnaire-based survey was employed among radiography students and professional radiographers in Uttarakhand through institutions and diagnostic centers. Questionnaires focused on essential aspects of radiation protection to evaluate the level of knowledge, such as awareness of the ALARA principle, use of protective equipment, understanding of radiation units and dose limits, and adherence to established safety protocols. The data collected were analyzed using descriptive statistics, as well as practical and comparative methods to evaluate differences between student and radiographer knowledge level.

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Results: Overall, preliminary results agree with other similar regional or national studies, suggesting that while the majority of participants reported moderate to good knowledge of basic radiation safety procedures such as shielding, distance and time; they also reported very little knowledge of units of radiation; monitoring dose; and advanced safe procedures in radiation safety. Radiographers tended to have a higher level of knowledge than students, which can be explained by practical experience and professional training.

Conclusion: The study clearly indicated the necessity of continual education and workshops or a reputable training program to enhance radiation protection knowledge for students and practicing radiographers in Uttarakhand. Increased awareness and compliance with radiation safety will help protect patients and healthcare workers and, ultimately, lead to safer medical imaging.

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Introduction:-

Radiation is defined as the emission and propagation of energy from an energy source through space and objects as waves and particles.[1] Radiation can broadly be grouped into two types (ionizing radiation (e.g., x-rays, gamma rays, alpha and beta particles) and non-ionizing radiation (e.g., radio waves, microwaves, visible light)). Ionizing radiation is an important component of medical imaging and radiotherapy because it is able to penetrate tissues and can provide benefits in both diagnosis and treatment; however, ionizing radiation can negatively affect the health of the patient and health care workers if they are improperly or overly exposed.[2]

Effects of Radiation Exposure:-

Radiation has biological effects categorized into two types:

Deterministic Effects (Non-stochastic):

Deterministic effects only occur when the amount of radiation received exceeds a threshold amount. These effects occur with increasing severity in relation to increasing radiation doses. For example, skin erythema, radiation burns, cataracts, sterility, and tissue damage [1].

Stochastic Effects:

Stochastic effects have no threshold, in that they can occur from small doses of ionizing radiation. While the probability of occurrence increases with increasing dose, the severity does not. Examples of stochastic effects are cancer induction, leukemia, and hereditary effects from genetic mutations [2][3].

For clinicians, it is essential to understand that both deterministic and stochastic effects occur to assure that medical imaging provide benefits with minimal risk.

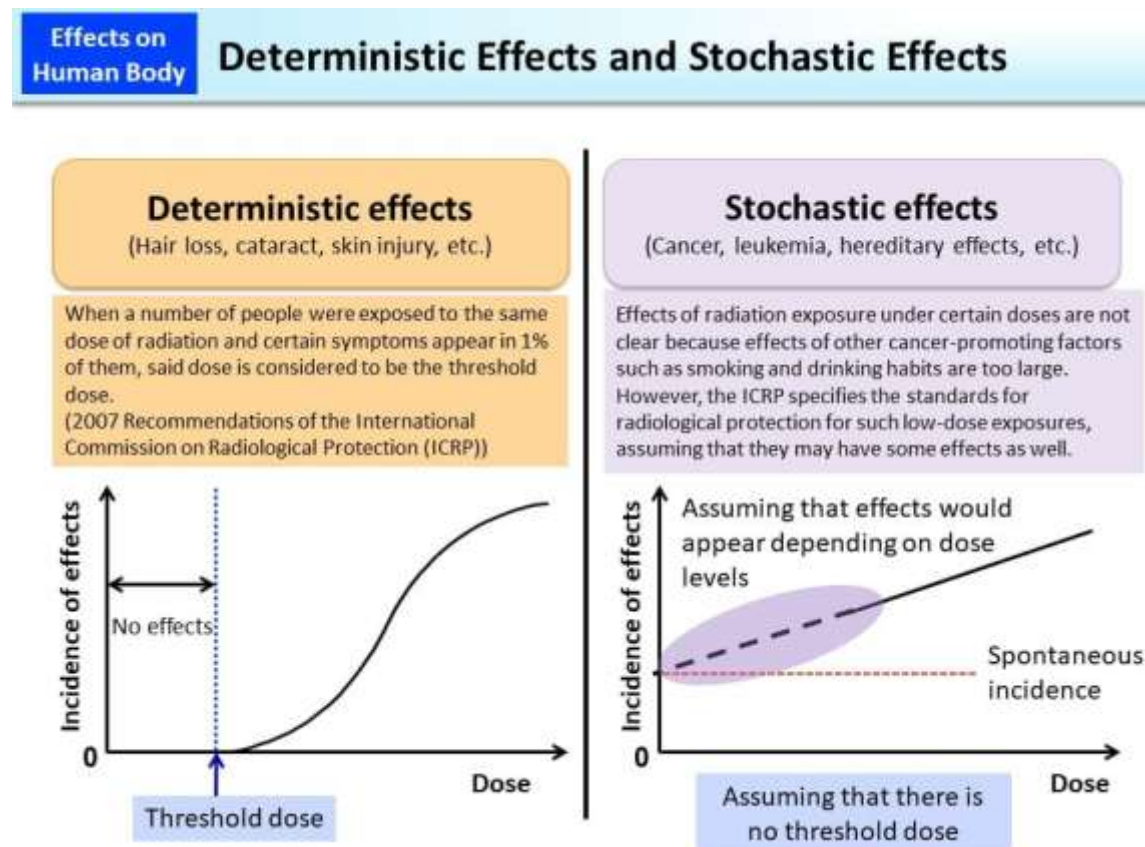


Figure 1: -Deterministic Effects vs Stochastic Effects [22]

Radiation Protection and the ALARA Principle:-

To alleviate the harmful effects of radiation, the principle is ALARA, which stands for "As Low As Reasonably Achievable", which has been accepted by the International Commission on Radiological Protection (ICRP) and the Atomic Energy Regulatory Board (AERB) [3][4].

The ALARA principle is governed by three rules:

- Time: The total time an individual is exposed to radiation should be decreased; this decreases the total radiation dose received.
- Distance: The farther the distance from the radiation source, the less exposure by the inverse square law relationship.
- Shielding: If a protective method is used, etc... Loss of shielding is even worse for the patient. Protective methods include lead aprons, thyroid shields, lead-lined walls, and protective barriers.

The use of the ALARA principle (for patient safety and safety from radiation) should be applied routinely and considered and taught to all healthcare workers involved in radiation management, most importantly, radiographers, and students.

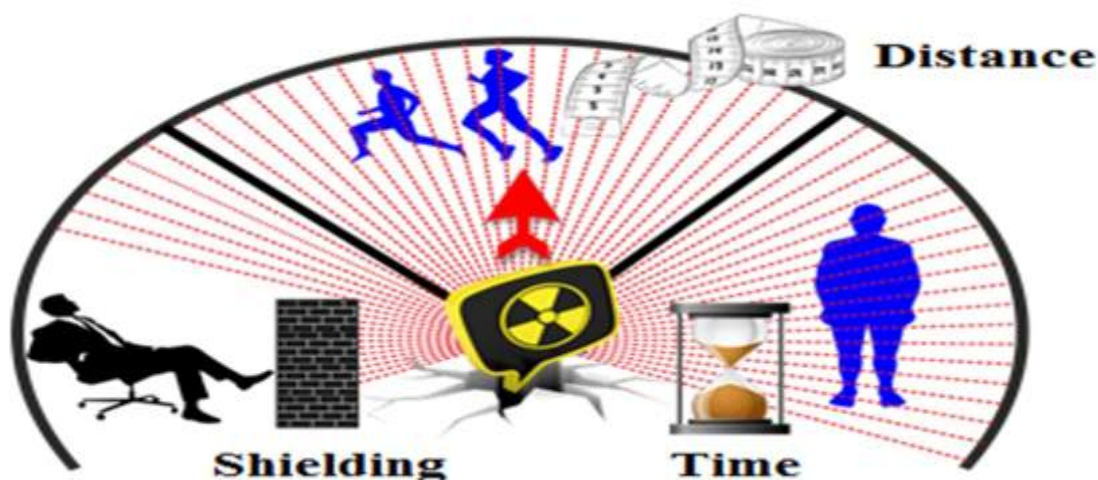


Figure 2. ALARA Principle [23]

Need for the Study:-

While organizations such as the ICRP and the AERB offer strict guidelines for radiation protection, there are still knowledge gaps, particularly among students and early-career healthcare workers [6][7][8]. Research from India and across the globe has shown that while concepts such as ALARA have a higher level of theoretical knowledge, compliance with practical safety methods, such as dosimeters, thyroid shields, and distance, tends to be low [3][6][7].

Uttarakhand is establishing itself as a growing diagnostic healthcare location and is a place that many students wish to practice radiography. A number of radiography students and radiographers are involved in patient care, but it is unclear how much they know about radiation protection practices [5]. This study will evaluate the awareness of radiation protection in students and radiographers in the Uttarakhand region, identify knowledge-practice gaps, and propose structured training programs to mitigate risks to the radiographer and patient health.

Literature Review and Related Work

Radiation protection is an important part of health care practice, especially in diagnostic radiology, where both patients and health care workers are commonly exposed to ionizing radiation. The International Commission on Radiological Protection (ICRP) and World Health Organization (WHO) both suggest continuous education and actions according to established principles for radiation protection (e.g., ALARA, shielding, distance, and time) to reduce unnecessary exposures. While there are recommendations available globally, prior research reports knowledge and practice gaps with students and health professionals.

Global Context:-

Salih et al. (2023) reported findings from a cross-sectional survey of final year nursing students in the United Arab Emirates [6]. It was revealed that more than half of the surveyed students had never participated in a course on radiation protection. While 72% of the students could identify ALARA correctly, only 51% could functionally apply it. Additionally, students demonstrated an insufficient understanding of occupational dose limits and safe practice. The results present a clear gap for nursing students' learning of formal radiation protection training in the nursing curriculum.

Varying with the findings of Salih et al., Sharma et al. (2025) studied students in radiology in India, where a substantially total of 98.1% had recognised ALARA and 90.8% acknowledged using dosimeters [7]. Yet, almost 48% of students had never undertaken formal education in radiation protection. More critically, 15.6% of participants acknowledged they did not consistently use protective equipment (lead aprons and thyroid shields) during their program. The study acknowledged that while there are understanding and awareness within the profession surrounding the theoretical construct, radiation protection training and application demonstrated a weakness in practice.

Singh et al. (2025) conducted a study of 154 students in diploma-, bachelor-, and master-level programs in radiography in Moradabad, India [8]. Overall, knowledge scores averaged 80.14%. Students scored highest for awareness of ALARA (85%) and safety measures (e.g., shielding, time, distance) (82%). In contrast, the understanding of radiation measurement units diminished, with Sieverts (70%) and Grays (65%) being the lowest scores. Knowledge scores also increased with the academic year the students were in, which allows for a stronger case for programmed curriculum design.

Indian and Regional Context:-

In the Indian context, Bulbul et al., (2024) conducted a study to assess the knowledge of radiation among paramedical students (n = 100) at Dev Bhoomi Uttarakhand University, Dehradun[9]. The study showed that 91% of students understood harmful effects of radiation, 86% understood form basic protective also measures. 87% understood the harmful effects of radiation during pregnancy and breast feeding. Importantly, 86% students were willing to gain more knowledge and this impli2es awareness and eagerness to learn.

This implies, students in Uttarakhand have some knowledge base, yet, they lack systematic and structured training for applying their practical knowledge for protecting against radiation. Other Indian studies suggest that in general, radiography students have higher knowledge levels than nursing or general paramedical students (Pallavi, 2018; Purwantini et al., 2022; [10] Oidial et al., 2022), however consistently applying protective measures as part of clinical practice and providing education remains poor. In the Indian context, Bulbul et al., (2024) conducted a study to assess the knowledge of radiation among paramedical students (n = 100) at Dev Bhoomi Uttarakhand University, Dehradun. The study showed that 91% of students understood harmful effects of radiation, 86% understood form basic protective also measures. 87% understood the harmful effects of radiation during pregnancy and breast feeding. Importantly, 86% students were willing to gain more knowledge, and this implies awareness and eagerness to learn.

This implies students in Uttarakhand have some knowledge base, yet they lack systematic and structured training for applying their practical knowledge for protecting against radiation. Other Indian studies suggest that in general, radiography students have higher knowledge levels than nursing or general paramedical students (Pallavi, 2018; Purwantini et al., 2022; Oidial et al., 2022), however consistently applying protective measures as part of clinical practice and providing education remains poor.

Synthesis of Findings:-**Despite variations across global and Indian studies, there are some alarming consistencies:**

- Theory vs Practice Gap – There is generally high level of student awareness of terms such as ALARA, etc., but no evidence that these principles are consistently implemented in clinical practice.
- Inadequate formal training – A significant number of students and health care professional participants reported that they have never undertaken a formal radiation protection course.
- Discipline Differences – Radiography students, in general, generally have higher levels of awareness compared to nursing or paramedical students, but there are gaps in knowledge and monitoring of dosages across them all

- Need region-specific research – There is lots of research in the general national level range, but little is known specifically about awareness levels in Uttarakhand amongst, both, students and practicing radiographers.

Synthesis of Findings:-

While existing literature provides useful information about radiation protection knowledge in health care students, to the best of our knowledge, no comprehensive studies have examined both students and practicing radiographers in Uttarakhand, India. Most of the available research is only with students in radiology courses in urban institutions or with paramedical groups who had limited radiographic exposures. Therefore, it is important to assess the current knowledge, practices, and training needs of both students and radiographers in Uttarakhand. This assessment will provide local evidence, in the form of findings, to provide practical evidence in which to make changes in the education, training and accounting for policies about radiation safety within the state.

Methodology:-**Study Design:-**

The current study have a cross-sectional descriptive design and will investigate the knowledge of radiation protection among students and radiographers in Uttarakhand. A cross-sectional survey design is appropriate as it provides a snapshot of the participants' knowledge and behaviors at a specific time.

Study Population:-**The study population includes:-**

- Students from the selected colleges/universities registered in paramedical/allied health science programs (for example BMRIT, BPT, BMLT, B.Optomety, BOTT in Uttarakhand).
- Radiographers working in government and private health care institutions in Uttarakhand.

Inclusion Criteria:-

- Students between the 1st year and final year of study who provides informed consent.
- Registered radiographers working in the diagnostic radiology department in Uttarakhand.

Exclusion Criteria:-

- Students or radiographers who refuse to participate.
- Situated responses to the questionnaire.

Sample Size and Sampling Technique:**The sample size targeted approximately 200 combined radiographers and students:**

- Students: approximately 120 radiographers were selected from allied health courses in Uttarakhand colleges/university.
- Radiographers: a convenience sample of about 80 radiographers were recruited from different hospitals and diagnostic centers.

Due to the logistical challenges involved in contacting various institutions and health care centers, a convenience sampling method will be used to draw the sample.

Data Collection Tool:-

Data was collected through a structured questionnaire using a similar questionnaire that has previously been validated. The questionnaire contained closed multiple-choice and true/false questions, which were divided up into the following sections:

1. Demographic Data: Age, sex, course/year (for students), years of professional experience (for the radiographers), and type of institution.
2. Understanding of Radiation Basics: Knowledge of ionizing vs. non-ionizing radiation, harmful effects, and units of radiation (mSv, Gy).
3. Radiation Protection Principles: Familiarity with ALARA, time, distance, shielding, and collimation.
4. Use of Protective Features: Knowledge and reported use of lead shields, thyroid shields, dosimeters, and protective barriers.

5. Attitude and Existing Training: Previously attended radiation safety training programs, and desire to learn, motivation for using safe practice (personal safety, patient safety, or institutional rules).

Data Collection Procedure:-

The questionnaires were distributed using both online means (Google Forms) and offline (print copies) to ensure maximum engagement.

Participation was voluntary and anonymous:-

Data Analysis:-

The data that is collected were coded and entered into Statistical Package for Social Sciences (SPSS, version XX) or MS Excel for analysis.

- Descriptive statistics (frequency, percentage, mean, standard deviation) were used to summarize demographic variables and knowledge scores.
- Inferential statistics (Chi-square test, t-test, or ANOVA) were used to identify associations between demographic characteristics (e.g., year of study, experience, gender) and knowledge levels.
- The level of significance used for this evaluation will be $p < 0.05$.

Results:-

Demographic Profile of Participants:-

The study involved 200 participants comprised of 120 students and 80 radiographers from various institutions in Uttarakhand. The cohort was 54% female and 46% male. Among students, 40% participated in a BMRIT program, 20% in BMLT, 15% in BPT, 15% in B.Optomety, and 10% in BOTT programs. The age distribution indicated that most of the students were in the 18–23 years age range while the majority of radiographers were aged 25-35 (mean 30 years) with 1–10 years of professional experience.

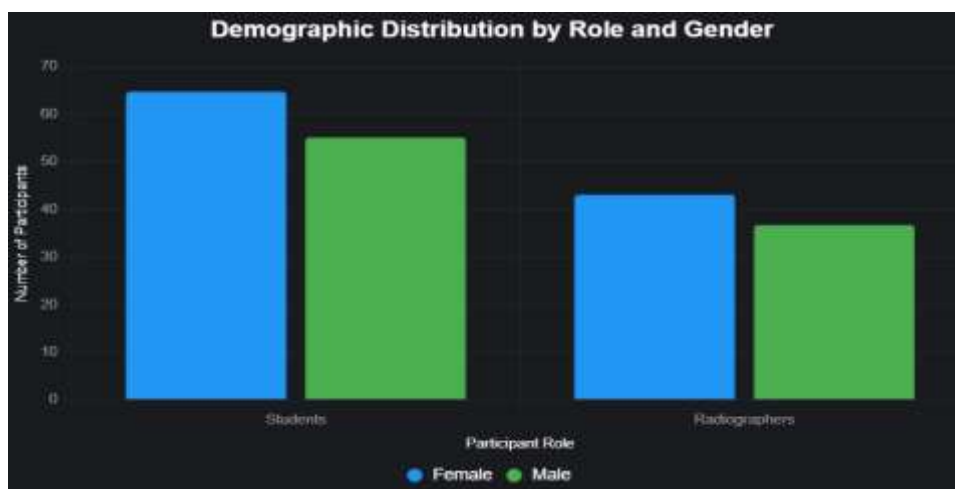


Figure 3:- Demographic Distribution by Role and Gender

Knowledge of Radiation Basics:-

Awareness of the ALARA Principle: 88% were aware of the ALARA principle and its meaning ("As Low As Reasonably Achievable"), while only 65% showed correct awareness of its application (time, distance, and shielding).

Time, Distance and Shielding:

- 72% recognised that less time associated with procedures reduced exposure.
- 69% realised that increasing distance would reduce the dose of radiation received.
- 76% recognised shielding offered protection for procedures.

Use of Protective Measures:-

- Lead Apron Use: 79% indicated that they always use a lead apron during procedures, while 21% offered their inconsistent use of this protective measure.

- Thyroid Shields: Only 48% of participants indicated they used thyroid shields as a standard practice.
- Dosimeter: 57% of radiographers indicated that they wore dosimeters, while only 28% of the students sampled indicated they wore dosimeter during their clinical posting.
- Protective Barriers: 63% of the participants demonstrated awareness using lead barriers/screens, while only 45% reported on having consistent access and usage of barriers/screens in clinical practice.

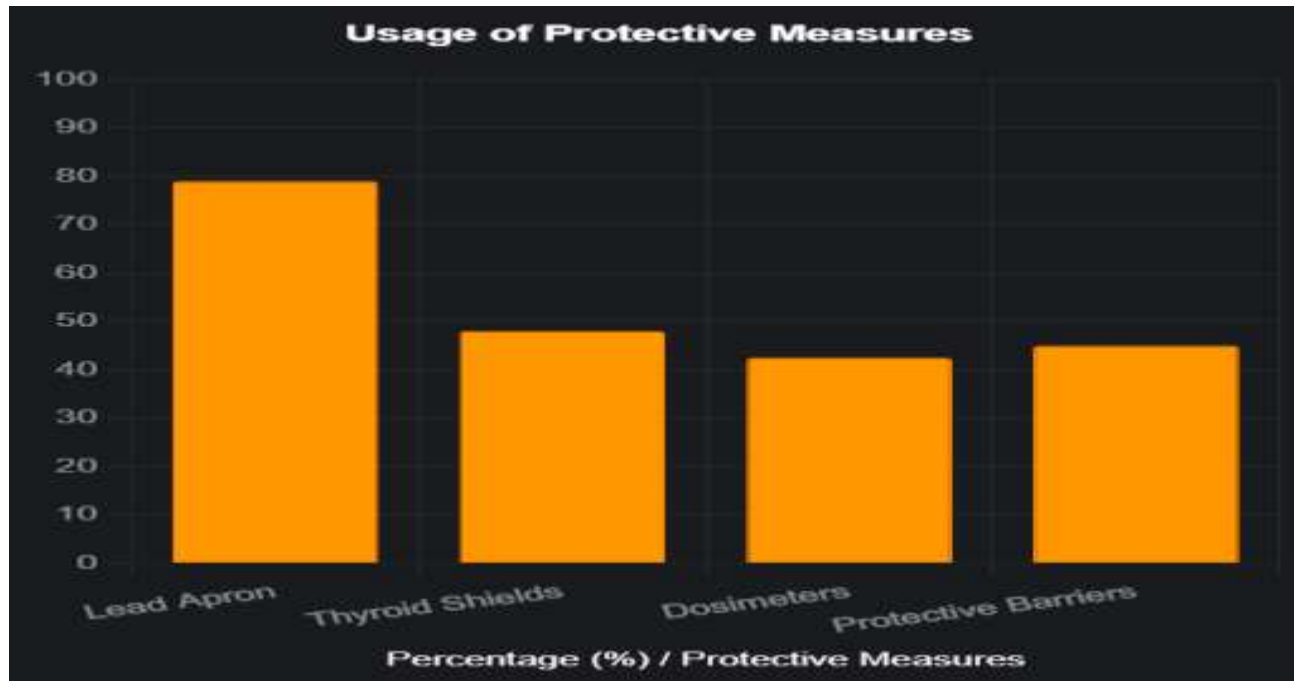


Figure 4:- Usage of Protective Measure

Training and Attitude Towards Radiation Protection:-

Training: 55% of participants reported they had formal training in radiation protection and 45% of participants had never been on training via a structured course of any sort.

- Reasons for Compliance:
- Personal safety (58%)
- Patient safety (25%)
- Institutional rules (12%)
- Fear of getting in trouble (5%)

Willingness to learn: 83% of participants indicated they would be interested in attending workshops, and refresher courses on radiation safety.

Comparison Between Students and radiographers:-

1. Radiographers have higher knowledge base radiation units than students (statistically significant, $p < .05$)
2. Students demonstrated better theoretical knowledge base concepts than radiographers (e.g. ALARA) but performed poorly in their clinical practice.
3. Radiographers indicated usage of protective equipment was more consistent than students, specifically dosimeter monitoring.

Knowledge Levels Overall:-

The proportion of participants in relation to cumulative scoring of agreement on the questionnaire shown below:

- High knowledge ($\geq 75\%$ correct, e.g.): 38%
- Moderate knowledge (50-74% correct): 46%
- Low knowledge ($< 50\%$ correct): 16%

Indicated that most participants in the study could be placed in moderate awareness, it would appear the levels of awareness do not translate to consistent implementation of principles of radiation protection in practice.

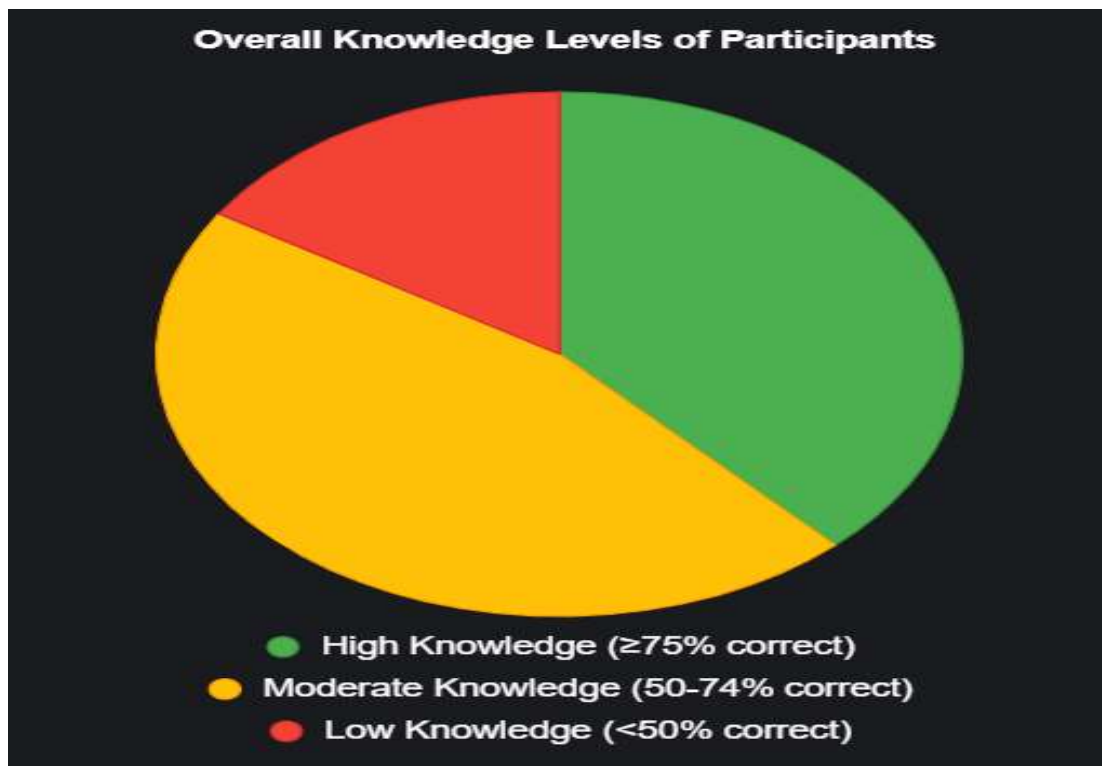


Figure 5:-Overall Knowledge Levels of Participant

Discussion:-

This study documents some important findings regarding radiation protection knowledge between students and radiographers in Uttarakhand and highlights the disparity between knowledge gained as a student and what is demonstrated in practice; indeed, concerning deficits were shown which are important to address.

Awareness of Key Principles:-

Notably, 88% of the survey participants were aware of the ALARA principle, which is a positive sign that basic radiation safety concepts are introduced during education. However, only 65% could appropriately describe the application of time, distance, and shielding during practice - for a concept that needs to be used on a daily basis, this is problematic and reflects a concerning detail - less than half of my cohort, despite the thyroid being particularly susceptible to radiation. Gaps in knowledge reflect similar tendencies observed by Sharma et al. (2025), where students in radiology were also noted to be inconsistently using protective equipment.

The dosimeter situation is even more shocking. There was a reported 57% of radiographers wearing a dosimeter, however only 28% of students reported wearing one during clinical postings. This also leaves the following questions: do we simply not give students a dosimeter? Or do we not teach the significance of a dosimeter? Either way, unaddressed, it is a major fault. The difference between awareness of protective barriers (63%) and accessibility (45%) is a clear and serious issue, but it is not just an educational issue, it is an issue in the healthcare setting where patients and staff are both exposed and at risk.

The positive aspect is that 83% seemed to want to attend workshops or educational updates. People learn; they recognize the importance. What we are seeing is not apathy, but a lack of an organized educational opportunity. The motivators are interesting to break down. The most common motivator for implementing in the workplace was personal safety at 58%—I understand that, from a self-preservation standpoint. But patient safety was only listed as

a primary reason by 25% of respondents. Shouldn't the welfare of the patient in healthcare come first? I think this indicates we need greater emphasis on the ethics of radiation protection.

Students vs. Radiographers:-

The comparison of these groups revealed interesting trends. Radiographers had significantly better knowledge of dose measurements and radiation units ($p < 0.05$), which can be attributed to the fact that they work with radiation on a daily basis. Interestingly, students had better theoretical knowledge regarding items like ALARA, likely from recent classroom learning; however, they had difficulty with practical knowledge (75% correct), 46% moderate, and 16% low. This distribution is comparable to similar studies conducted in India; however, this is not acceptable in the field of clinical imaging where safety is a priority. This shows the need to have mandatory structured education on radiation protection, embedded education throughout the healthcare curricula in Uttarakhand. By combining improved education with equipment access and institutional accountability, both students and radiographers can bridge the gap and establish a true culture of the safety of radiation for both patients and healthcare workers.

Conclusion:-

The current study evaluated the extent of participants' knowledge of radiation protection among students and radiographers in Uttarakhand, India. Results showed that although participants were aware of the harmful effects of ionizing radiation and had an understanding of principles such as ALARA, they could not translate this knowledge in to appropriate behavior in practice. The majority of participants acknowledged the need to limit exposure and the benefits of protective gear, although they did not consistently use lead aprons, thyroid shields and dosimeters, with students using protective gear even less often.

Although radiographers had a greater knowledge of the units of radiation dose and the frequency of use of monitoring devices, the students were more aware of the theory, but had little to no adherence to protective practices during clinical exposure. Furthermore, nearly half of the participants had never undertaken a formal radiation protection course even though a large number indicated that they would like to improve their knowledge through a workshop or training program.

These results highlight the immediate need for structured and continuous education on radiation protection to be taught in existing healthcare and paramedical programs in Uttarakhand. Recognizing all of the information provided, it would be imperative to have mandatory training sessions and strict enforcement of protocols for practicing radiographers as well. Improving awareness of radiation safety is essential not just for protecting healthcare

To conclude, while baseline knowledge exists, there is a clear and urgent need to bring about a change from awareness to active and consistent practice. By reinforcing education, providing regular refresher courses, and implementing institutional policies, a culture of radiation safety can be developed, which will reduce radiation risk and provide safer healthcare environments in Uttarakhand.

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