To Assess the Knowledge and Awareness of Radiation Dose and Risks Associated with Medical Imaging among the General Public in India

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ABSTRACT

To assess the knowledge and awareness of radiation dose and risks associated with medical imaging among the general public in India. Methods & Materials: This descriptive study employed a questionnaire-based approach to assess the knowledge and awareness of radiation dose and risks associated with medical imaging among the general public in India, individuals from the general public, focusing on those currently studying or with a high school qualification or higher. The questionnaire consisted of sections on social-demographic features, radiation awareness, patient dose, effects, and safety, with a total of 20 multiple-choice questions. The questionnaire was distributed in India through various channels, aiming for a wide response rate. Data from 201 completed questionnaires were meticulously examined, edited, tabulated, and analyzed using percentage tables and pie charts. The qualitative data was analyzed using the analysis tools provided by the Google Form platform. Result:Mixed knowledge levels among participants. Majority were male, with undergraduate degrees. Predominantly rural, 15-25 age group. Knowledge gaps found in radiation awareness, patient dose, and safety. Urgent need for education and awareness to promote radiation safety. Conclusion:Survey results highlight targeted educational interventions needed for improved radiation-related knowledge and awareness across gender, qualifications, location, and age. By enhancing radiation literacy, individuals can make informed decisions and contribute to a safer society.

Keywords: General Public, Ionising Radiation, Knowledge, Radiation Awareness

INTRODUCTION

Radiation refers to the energy emitted from a source, which can travel through various materials or empty space. It exists in the form of fast-moving particles and electromagnetic waves.[1]

Particulate radiation refers to the energy carried by traveling particles that possess a measurable rest mass and momentum and occupy a specific position at any given moment. These particles include protons, neutrons, electrons, and other subatomic particles. [2]

Subatomic particles exhibit high velocities, determined by their kinetic energy, but they are unable to reach the exact speed of light (3 x 108 m/s). Certain particles, such as protons, electrons, alpha particles, and cosmic rays, possess electric charges, whereas neutrons are uncharged. [3]

On the other hand, Electromagnetic radiation is energy carried by changing electric and magnetic fields, manifesting as traveling waves. [4]

Electromagnetic radiation serves as the medium for energy propagation in phenomena like light waves, infrared rays, radio waves, microwaves, ultraviolet rays, x-rays, and gamma rays. [5]

Both particle and electromagnetic radiations have the ability to cause ionization in atoms, a process where a neutral atom gains a positive or negative charge. This occurs when an orbital electron is removed from the atom, resulting in the formation of an ion pair. [6]

All radiation, whether particle or electromagnetic that has this ability to ionize the atom or matter either directly or indirectly is called ionizing radiation. [7]Matter, which comprises the entire physical universe, is composed of atoms. [8]

Many atomic processes, such as radioactivity, involve the emission of energy in the form of ionizing radiation. [9]

Radioactive materials undergo spontaneous decay, emitting ionizing radiation that possesses enough energy to remove electrons from atoms, resulting in the formation of charged ions or the breaking of chemical bonds. [10]

Ionizing radiation refers to a type of radiation that possesses enough energy to dislodge electrons from the atomic or molecular orbital shells in the tissues it interacts with. [11]

Prolonged exposure to significant amounts of ionizing radiation can lead to tissue damage and disruption of cellular function at the molecular level. [12]

Ionizing radiation is an unseen energy that exists in various natural and artificial forms. It originates from sources like the sun, the Earth's atmosphere, X-ray machines, and nuclear reactors. X-rays, gamma rays, and cosmic radiation are common examples of ionizing radiation. [13]

Human beings are constantly exposed to natural background radiation, which is present everywhere. This radiation arises from sources such as cosmic rays from space and radon, a radioactive gas found naturally on Earth. Its ubiquity makes exposure to background radiation unavoidable. [14]

The International Agency for Research on Cancer has classified radon as a known carcinogen specifically linked to lung cancer. [15]

Man-made radiation sources include X-ray equipment and nuclear reactors, which are used to generate nuclear energy. Ionizing radiation is a broad, complicated, and often misunderstood topic. [16]

Ever since W.C. Roentgen's discovery of X-rays in 1895, radiation has found diverse applications in fields such as energy, medicine, and industry. Its versatility has led to significant advancements and numerous beneficial uses across various sectors. [17]

Everyday life involves inherent exposure to ionizing radiation, and the average global exposure from various sources amounts to approximately 3 millisieverts (mSv) per year. [18]

The natural background radiation exposure accounts for approximately 2.4 millisieverts (mSv) per year, but it can vary significantly depending on the location due to diverse sources like cosmic rays, rocks, and the atmosphere. [19]
Medical radiation is the second leading contributor to radiation exposure, following natural radiation. It makes up approximately 20-50% of an individual's personal radiation dose.[20]

Medical radiation can be categorized into three main types: radiodiagnosis, radiotherapy, and nuclear medicine. [21]
Diagnostic imaging and therapy, which are part of medical imaging and therapeutics, are the primary man-made sources of radiation exposure and contribute to approximately 0.6 mSv/year. These advancements in medical technology have significantly enhanced healthcare services and improved patient outcomes. [22]

Nuclear medicine has witnessed a notable expansion in the realm of medical imaging, encompassing both diagnostic and therapeutic applications. It utilizes radioactive substances to diagnose and treat various conditions, offering comprehensive analysis of both structure and function. [23]

The utilization of hybrid imaging techniques like SPECT/CT and PET/CT has experienced significant growth, particularly in developed countries and primarily in the field of oncology. This expansion has resulted in an increase in the cumulative annual radiation dose received by patients undergoing whole-body imaging. [24]

Improper utilization of radiation can lead to adverse biological and environmental consequences. The effects of radiation exposure can vary based on factors such as the type of radiation, duration and intensity of exposure, and the individual's age and overall health. [25]

Ionizing radiation has two main types of biological effects: deterministic and stochastic. Deterministic effects occur after a certain threshold level of radiation exposure, where the severity of the response increases with the dose and can result in cell death. On the other hand, stochastic effects do not have a threshold and follow a "all or none" response, where the probability of occurrence increases with the dose of radiation. [26]

Ionizing radiation can lead to both deterministic and stochastic effects, which are influenced by the radiation dose and the individual's response. Exposure to ionizing radiation is linked to both acute and chronic health conditions, with the risk increasing as the radiation dose rises. [27]

Children are more vulnerable to the effects of ionizing radiation, and due to their young age, they may have a higher risk of delayed symptoms resulting from exposure to ionizing radiation. [28]

Acute effects of high-level radiation exposure can manifest rapidly, within hours or days. Symptoms may vary in severity, ranging from mild, such as nausea and vomiting, to severe, including radiation burns and radiation sickness. [29]

In contrast, long-term effects of radiation exposure develop over an extended period, typically spanning years or even decades. These effects can encompass an elevated risk of cancer, genetic mutations, and various chronic health conditions. [30]

The International Committee on Radiation Protection (ICRP), International Committee on Radiation Units (ICRU), and the International Atomic Energy Agency (IAEA) are organizations tasked with establishing guidelines for radiation protection. These organizations play a vital role in developing standards and recommendations to ensure the safety of individuals exposed to radiation. [31]

While radiation protection measures have been extensively established, the general public may lack basic knowledge about radiation, including the fact that food and drinking water they consume naturally contain low levels of radiation. [32]

Due to international nuclear accidents and the classification of radiation as a carcinogenic factor, the general public has developed a negative perception of radiation. [33]

The United Nations Foundation (UNF) has introduced the sustainable development goals (SDGs) to address various global challenges, including environmental concerns, education, and human rights. By promoting cognitive equality and encouraging social responsibility, the SDGs aim to foster balanced development within human society. [34]

Popularizing scientific knowledge to the public is a crucial matter, whether it is within the realm of universities or corporate social responsibility. [35]

When confronted with a contentious issue that surpasses their own understanding or capabilities, the majority of individuals tend to refrain from engaging in discussions, potentially leading to widespread misconceptions. [36]

Radiation has both positive and negative effects, making it imperative for the public to develop an accurate understanding of radiation in order to discern the authenticity of relevant issues. [37]

Despite the potential risks associated with radiation exposure, a significant number of individuals remain unaware of these dangers and fail to take adequate measures to protect themselves. [38]

Recent studies focusing on patient awareness and knowledge of ionizing radiation exposure primarily center around radiology, particularly Computed Tomography (CT), and consistently indicate a widespread lack of understanding regarding radiation and its impact on human health. [39]

Currently, there is a scarcity of information regarding the knowledge and awareness of ionizing radiation among patients undergoing nuclear medicine procedures. [40]

Frequently, the usage of complex terminology and jargon by medical personnel is not easily comprehensible to patients, resulting in unnecessary feelings of anxiety, fear, and distress. [41]

Studies further indicate disparities in risk perception and knowledge regarding the actual sources of ionizing radiation between the general public and radiation experts. [42]

These disparities can be attributed, in part, to how mass media portrays health risks, potentially misleading the general public by exaggerating certain sources while downplaying others. Additionally, the technical language used in radiation risk assessment also contributes to this gap, particularly considering educational disparities among the general population. [43]

Hence, it is crucial for the public to possess awareness regarding the sources and risks associated with radiation. Furthermore, numerous individuals harbor misconceptions about radiation, resulting in unwarranted fear or complacency. For example, some people believe that all forms of radiation are inherently harmful, while others assume that low levels of radiation pose no threat. [44]

These misconceptions can give rise to inappropriate behaviors, such as avoiding potentially beneficial medical procedures or neglecting to take necessary precautions to minimize exposure to harmful radiation sources. [45]

Therefore, it is crucial for the general public to possess a fundamental comprehension of radiation, its sources, and the potential risks involved. This knowledge enables individuals to make informed decisions regarding their health and safety with confidence.[46]

Therefore, the objective of this study was to assess the level of radiation awareness among the general public.
The aim of this study was to evaluate the extent to which the general public utilizes radiation protection and safety practices.

MATERIALS AND METHODS

Once approval was obtained, a self-structured questionnaire was prepared and thoroughly reviewed by the research guide. Only after obtaining their endorsement, the questionnaire was then distributed to the participants.

This study encompassed individuals from the general public who were either currently studying or had attained the highest qualification level of high school and above. These participants were invited to respond to the survey questions as part of the research process.

The questionnaire for this study consisted of multiple sections that encompassed social-demographic features, basic knowledge of radiation awareness, radiation patient dose, radiation effects, and radiation safety. It was administered using a Google Form and comprised a total of 20 multiple-choice questions.

The questions in the questionnaire were categorized as follows: 6 questions on radiation awareness, 2 questions on radiation patient dose, 9 questions on radiation effects, and 3 questions on radiation safety. The maximum achievable test score was 20. The questions were sourced from books as well as online resources related to radiation awareness.

The questionnaire was distributed to participants in India through various channels, including SMS, email, and popular online social platforms such as WhatsApp and Instagram. This diverse distribution approach aimed to reach a wide range of participants and maximize the response rate for the study.

The information pertaining to radiation awareness and the personal details of the participants was collected through a questionnaire. The questionnaire was randomly distributed to 300 respondents, out of which 201 respondents successfully completed and submitted the form. Ample time was allocated to ensure that the respondents had sufficient opportunity to thoroughly review and respond to the questionnaire.

The collected data underwent a meticulous process of examination, editing, tabulation, and analysis. The analysis included presenting the data in the form of percentage tables to provide a comprehensive overview. Additionally, pie charts were utilized to facilitate the presentation and analysis of specific data, enabling a visual representation of the findings.

The qualitative data obtained from the questionnaire was analyzed using the analysis tools provided by the Google Form platform itself. This platform facilitated the examination and interpretation of the results derived from the qualitative data collected through the questionnaire.

OBERVATIONS AND RESULT

A survey was conducted with 201 participants in India to assess their knowledge of radiation safety practices. The objective was to gain insights into the level of awareness and understanding among the general public regarding radiation. All 201 surveys issued were returned, resulting in a 100% response rate.

The participants' educational backgrounds varied, with 7% having completed high school, 7.5% intermediate education, 10.9% holding a diploma, 55.7% being graduates, 18.4% postgraduates, and 0.5% holding a PhD. The study consisted of 20 knowledge-based questions.

The scoring system assigned a value of 1 for accurate answers and 0 for erroneous responses. The total knowledge score for correct answers was 23, and the distribution of these scores followed a normal pattern. The mean score of the overall knowledge assessment was 10.5 out of 20, with a median score of 10.

Based on the scores, the participants' knowledge was categorized into two groups: a low level of knowledge (less than 5 points) and a high level of knowledge (17 points or higher).

Demographic Characteristics of Participants

Table 1: Distribution of the participants in Terms of Age (n=201)

AGE (YEARS)	
MEAN	40 YEARS
MEDIAN	40 YEARS
RANGE	15- 65 YEARS

Result shows that the mean age of participants was 40 years, and the median age of participants was 40 years ranged from 15 to 65 years.

Table 1.2: Distribution of the participants in Terms of Age (n=121)

AGE	FREQUENCY	PERCENTAGE
15-25 YEARS	156	77.6
26-35 YEARS	37	18.4
36- 45 YEARS	4	1.9
46- 55 YEARS	3	1.4
56-65 YEARS	1	0.49

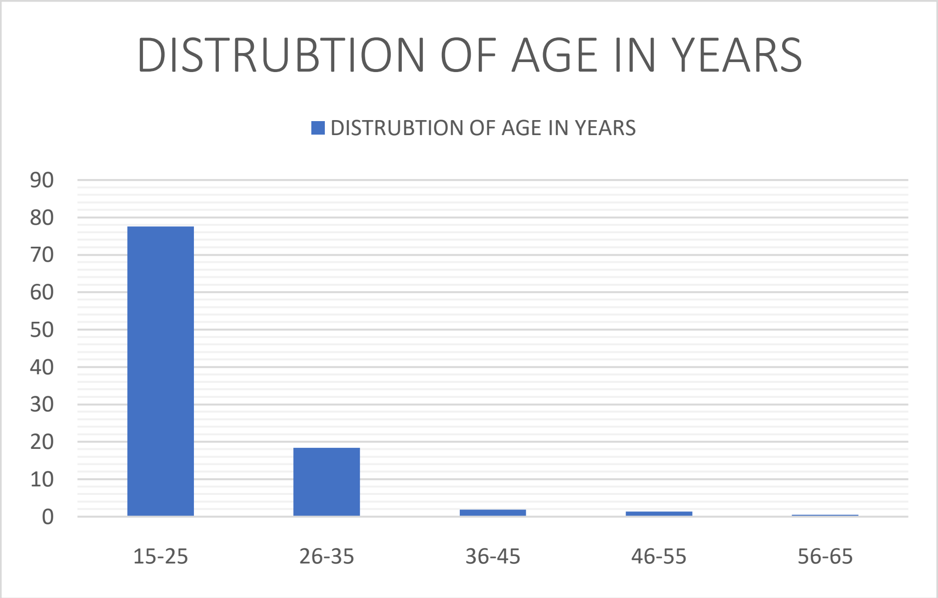

Fig 1: Distribution of Age

Result shows that 77.6% of the participants had Age: 15-25Years. 18.4% of the participants had Age: 26-35Years. 1.9% of the participants had Age: 36-45 Years. 1.4% of the participants had Age: 46-55Years. 01% of the participants had Age: 56-65 Years.

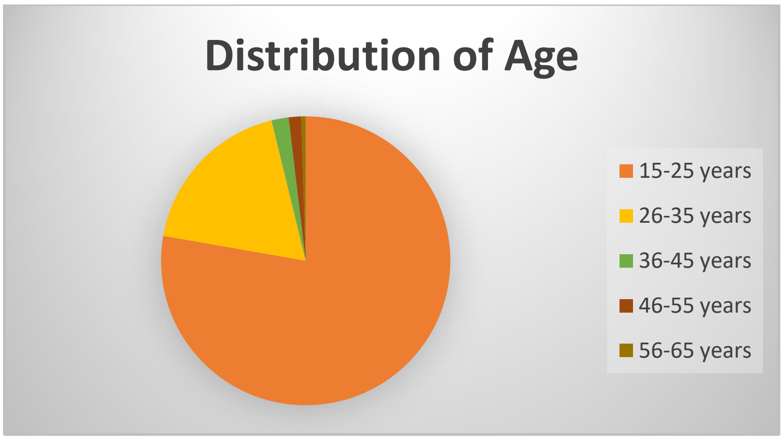

Fig 1.1: Distribution of Age

Table 2: Distribution of the participants in Terms of Gender (n=201)

GENDER	FREQUENCY	PERCENTAGE
MALE	**124**	**61.7**
FEMALE	**77**	**38.3**

Result shows that 61.7% of the participants had Gender: Male. 38.3% of the participants had Gender: Female.

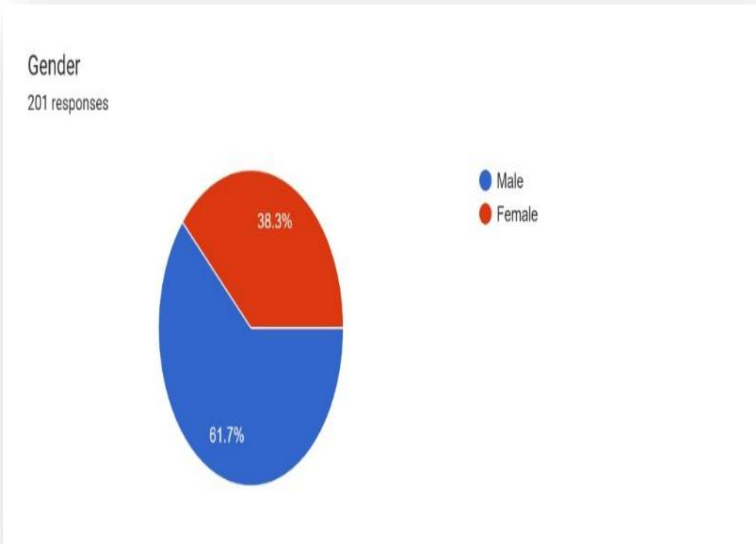

Fig2: Distribution of Gender

Table 3: Distribution of participants in the Terms of Education(n=201)

Qualification	Frequency	Percentage
High- School	14	7
Intermediate	15	7.5
Diploma	22	10.9
Graduation	112	55.7
Post -Graduation	37	18.4
PhD	1	0.5

Result shows that 7% of the participants had Education: High-School. 7.5% of the participants had Education: Inter-mediate. 10.9% of the participants hadEducation: Diploma. 55.7% of the participants had Education: Graduation. 18.4% of the participants had Education: Post -Graduation. 0.5% of the participants had Education: PhD.

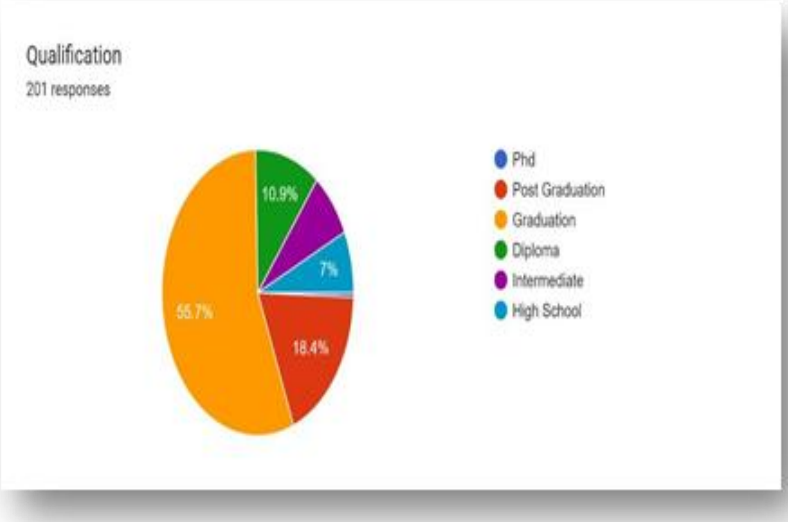

Fig3: Distribution of Qualification

Table 4: Distribution of participants in the Terms of Region / Area(n=201)

Area	Frequency	Percentage
Rural	**112**	**57.1**
Urban	**84**	**42.9**

Result shows that 57.1% of the participants from Region: Rural. 42.9% of the participants from Region : Urban.

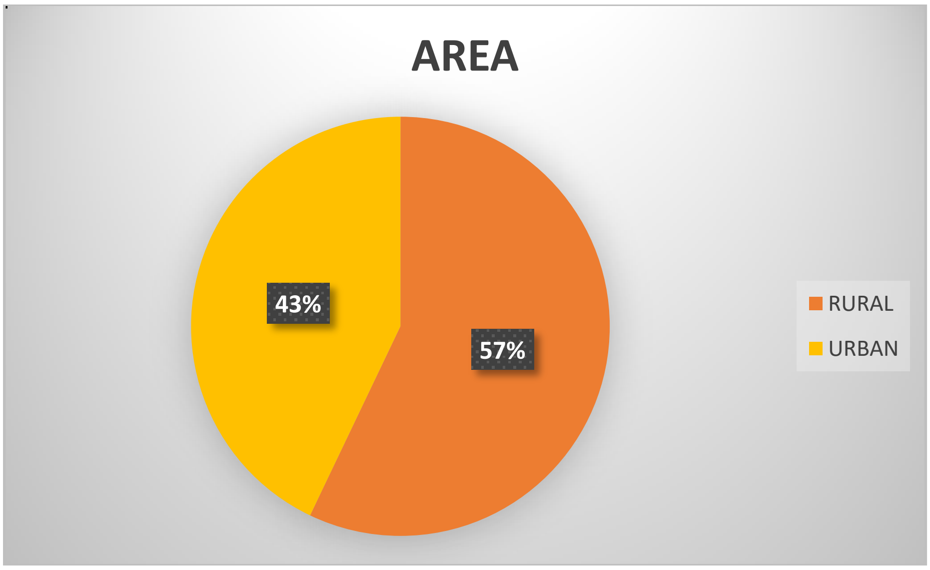

Fig4: Distribution of Area

Table 5: Distribution of the participants in Terms of Total point Distribution (n=201)

TOTAL POINTS DISTRIBUTION	
MEAN	10.5
MEDIAN	10
RANGE	0-20 POINTS

Result shows that the mean of the total point distribution is 10.5, the median of the total point distribution is 10 and the range is 0 to 20 points.

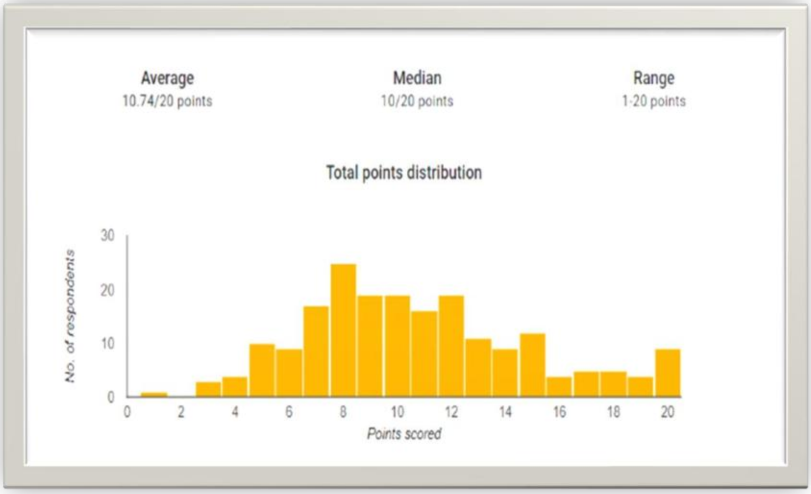

Fig5: Distribution of Total Points

DISCUSSION

The analysis of the data reveals several interesting findings and highlights areas of both knowledge and knowledge gaps among the participants. Let's discuss each section in detail:

In terms of gender distribution, the majority of respondents were male, accounting for 61.7% of the participants. This indicates a potential gender disparity in the sample, with male respondents being more inclined to participate in the survey. The results obtained in this analysis are consistent with the findings from the study conducted by E.K. Henriksen IN 2001.[53] Further exploration of gender-specific knowledge and awareness may be necessary to address this imbalance.

Regarding qualifications, the highest proportion of participants had completed their undergraduate degrees (55.7%), followed by postgraduate degrees (18.4%). This suggests that a significant number of participants had a higher level of education, which might influence their understanding of radiation-related topics. However, it is important to note that the sample size for Ph.D. holders was very small, with only one participant, limiting any definitive conclusions for this group. The findings from the study conducted by F. Paolicchi in 2016 align with the results obtained in this analysis.[54]

The distribution of participants based on their living area shows that the majority resided in rural areas (55.7%), while 41.8% lived in urban areas. This imbalance in representation could impact the generalizability of the findings, as rural and urban populations may have different levels of exposure to radiation and access to radiation-related information.

Analyzing the age distribution, the largest proportion of participants fell within the 15-25 age group (77.6%). This skew towards younger respondents suggests that the survey might have attracted a younger demographic or that younger individuals were more inclined to participate. Understanding the knowledge and awareness levels across different age groups would be beneficial in tailoring educational interventions to specific demographics.

Moving on to the individual sections:
Section A focused on radiation awareness. The analysis shows that a significant number of respondents had a good understanding of radiation awareness, as evidenced by the correct answers provided for questions 1-6. However, there were also respondents who lacked the correct knowledge, as indicated by their incorrect answers. This highlights the need for targeted educational interventions to address the knowledge gaps and improve overall radiation awareness among the participants.

Section B explored radiation patient dose. The findings indicate that a considerable number of participants demonstrated knowledge of radiation patient dose, as evidenced by the correct answers provided for questions 1 and 2. However, there were still respondents who lacked the appropriate understanding and provided incorrect answers. This suggests the importance of enhancing knowledge and awareness regarding radiation patient dose among the general public.

Section C analyzed questions related to radiation patient dose. The results showed a mix of correct and incorrect answers, indicating varying levels of understanding among the participants. While some individuals demonstrated knowledge and provided correct answers, others lacked the necessary understanding and provided incorrect responses. Targeted educational interventions can help address these knowledge gaps and improve overall proficiency in radiation patient dose.

Lastly, Section D examined radiation safety. The analysis reveals that a significant number of respondents possessed knowledge of radiation safety, as indicated by the correct answers provided for questions 1 and 2. However, there were also participants who did not have the correct knowledge and provided incorrect answers. This highlights the importance of further educating the public about radiation safety measures to ensure the well-being and protection of individuals. The study conducted by T. Coldwell in 2015 and BC Hacker in 1992 both reached similar conclusions as observed in this analysis.[55]-[56]

So, the analysis of the survey results provides valuable insights into the knowledge and awareness levels of the participants across different sections. It highlights the presence of knowledge gaps in radiation-related topics and emphasizes the need for targeted educational interventions to address these gaps. By enhancing public knowledge and awareness, efforts can be made to uplift the overall proficiency in radiation-related areas and promote radiation safety among the general public.

CONCLUSION

The survey analysis provides valuable insights into participants' knowledge and awareness of radiation. Gender disparity was observed, with more male participants, indicating the need for investigation and a more representative sample in future studies. Most participants had completed undergraduate degrees, but caution is required when drawing conclusions for Ph.D. holders due to limited representation. A higher proportion of participants from rural areas suggests different exposure levels and access to radiation information. The younger age group was overrepresented, calling for balanced representation across age groups in future studies. Addressing knowledge gaps through targeted interventions can enhance public knowledge and awareness of radiation and promote safety and well-being.

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