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Radiation knowledge among radiographers and radiography students

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PEER REVIEWED ARTICLE

Abstract

Objective

To evaluate the knowledge of radiation among radiographers and radiography students in Nepal

Methods

A validated questionnaire was conducted among radiographers and radiography students in 24th annual meeting and workshop of Nepal Radiological Society (NRS) on 10th September, 2015. The survey included multiple choice questions (MCQs) related to demographic characteristics (age, gender), academic qualification, work experience and knowledge of radiation. The data were analyzed using SPSS software version 21.0.

Results

Of total 102 respondents, 68.6% (70) were students and 31.4% (32) were radiographers. There were 65 male and 37 female with age ranging from 18 to 45, mean 23.70±5.11 years. Out of 14 MCQs related to knowledge of radiation, maximum score was 14 and minimum 5 with mean 9.99±1.94 (mean percentage 71.35%) (radiographers 10.63±2.10, 75.89% and students 9.70±1.80, 69.28%) respectively. Most participants failed in questions related to radiation units, minimum safe distance during portable radiography, fluoroscopy, and cancer risk of chest radiograph.

Conclusion

Overall awareness and knowledge of radiation was satisfying with definite possibilities for further improvement through regular trainings, workshops and continuing medical education (CME) programs related to radiation protection and safety. Furthermore, it is an urgent requirement of national radiation protection act in Nepal

Introduction

Medical exposure is the highest source of ionizing radiation to human beings.[1] In fact, more than 90% of radiation exposure from unnatural sources is from medical imaging.[2] Alone with its medical usage, it has also hazardous effects on biological systems.[3,4] Therefore, it is important that a radiographer should understand the potential risks of radiation and its advantages and benefits.[5] In order to reduce the adverse effects of x-radiation, adequate awareness of attributable risks of x-rays, safety methods and issues relating dose optimization in various radiological examinations is required.[6]Thus, it is extremely important to become aware of radiation procedures and consider the safety of both patients and radiation workers.[7]

International bodies, e.g. the International Commission on Radiological Protection (ICRP), the World Health Organization (WHO), the International Atomic Energy Agency (IAEA) etc., along with several guidelines published by the European Commission (EC) recognize the importance of education and training in radiation protection.[8] Nepal became member of IAEA in 2008.[9] Despite frequent visit of IAEA officials, there has not been substantial improvement in radiation protection till date in Nepal.[10]

In addition, it has been identified that radiography personnel often do not have sufficient knowledge about the risks posed by x-ray exposure and the measures that should be taken to mitigate those risks.[7]Exposure to large doses of radiation can increase the risk of developing cancer and genetic mutations, whereas small doses of radiation exposure have unpredictable effects.[11] The radiation dose of radiological examination is not easy to understand. That is why personnel should be restricted to "As Low as Reasonably Achievable" ALARA principle concept.[12] A key part of managing radiation safety is through education. Every person involved in radiation usage needs to know what radiation is and how to handle it because the number of diagnostic radiology procedures performed continues to grow exponentially every year.[13] With this manifold increase, there should be concern for radiation safety practice.[4]

The main underlying problem is to determine the basic awareness regarding medical radiation. In addition, having more than 90 years of history of radiology practice in Nepal[14,15], the present scenario is no radiation protection act.[16] According to author's review, there has been no survey on radiographers' awareness and knowledge of medical radiation in Nepal. The knowledge

related to radiation protection must be adequate and up-to-date.[17]We aimed to evaluate the necessity of knowledge of medical radiation among radiographers and radiography students.

Methods

To anticipate the knowledge of radiological examinations and awareness of radiation protection among radiology health professionals and students, a questionnaire survey was carried out on 24th Annual Meeting and Meeting of Nepal Radiological Society (NRS) on September 10, 2016, Kalikasthan, Kathmandu, Nepal. The survey included questions related to demographic characteristics (age, gender), academic qualification and work experience. There were 20 multiple choice questions (MCQ) of which, three questions were regarding the participant personal information regarding knowledge and perception in radiation protection, in two questions, multiple answers can be given and one query was related to opinion. Therefore, there were 14 MCQ altogether that could highlight the understanding of participants' awareness of radiation protection.

Participants

The total number of attendees in 24th Annual Meeting and Workshop of NRS was 200. However, there were 102 individuals who took interest in the survey, filled up the form and handed the completed survey to the author within allocated time period of twenty minutes. The survey was performed on 10th September, 2015 and the participants included radiographers, and students of radiography. Each correct answer was given 1 score and there was no negative markings for wrong answers. Questions related to the personal awareness and demanding multiple answers were freed from scoring system.

Data Analysis

Data from the survey were recorded from paper into SPSS Statistical Software (Version 20.1, Chicago, USA). A descriptive analysis was performed. The mean, standard deviations (SD), range, percentage were used for the description of quantitative variables whereas qualitative variables were transposed into quantitative variables and further data analysis was accomplished. Categorical response options were coded (e.g. yes 1; no 2) and were illustrated in frequencies and bar plots. A p-value less than 0.05 were considered significance.

Ethics

An Approval was obtained from the Executive Body of Nepal Radiological Society (NRS). A consensus informed form was used and the anonymity of the participants was completely ensured.

Results

Of total 102 participants, 70/102 (68.6%) were students and 32/102 (31/4%) were job holders working as Technologist and Radiographers in various diagnostic modalities, especially General Radiography, Fluoroscopy, Catheterization Laboratory, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI). There were 65 male and 37 female with age ranging from 18 to 45, mean 23.70±5.11 years. The demographic characteristics of participants are illustrated in Table 1.

Table 1: Demographic Characteristics of Participants

Particulars	Frequency	Percentage (%)
Gender		
Male	65	63.7
Female	37	36.3
Age in years		
(18-23)	55	54.0
(23-28)	32	31.4
(28-33)	6	5.9
(33-38)	7	6.9
(38-43)	1	0.9
(43-48)	1	0.9
Categories of participants		
Professionals	32	31.2
Students	70	68.6
Academic Qualification		
Diploma students	50	49.0
BScMIT students	19	18.6
Diploma graduates	16	15.7
BScMIT graduates	15	14.7
MScMIT graduates	2	2.0

The academic qualification and work experience of the participants was varying. There were Certificate Diploma Radiography (CDR) students, students of Bachelor of Science in Medical

Imaging Technology (B.Sc.MIT), graduates of CDR and B.Sc.MIT and Master of Science in Medical Imaging Technology (M.Sc.MIT) as well. The radiology health professionals had work experience ranging from 1 year up to 18 years. Among 14 questions, the maximum and minimum scores obtained were 14 and 5 with mean 9.99±1.94 (radiographers 10.63±2.10, 75.89% and students 9.70±1.80, 69.28%) respectively. The frequency of correct answers responded in the survey is demonstrated in Table 2.

Table 2: Response of participants during questionnaire survey

SN	Questions	Frequency of correct answer	Percentage (%)
1.	SI unit of absorbed dose equivalent	27	26.5
2.	CT scan involves the usage of x-rays	98	96.1
3.	Material of protective cloth for x-ray examination	100	98.0
4.	Mammography involves the usage of x-rays	100	98.0
5.	Standard minimum safe distance from x-ray machine while performing portable x-rays	37	36.3
6.	Highest permitted level of occupational radiation dose	73	71.6
7.	MRI involves the usage of x-rays	87	85.3
8.	If fluoroscopy is on, and if you are not operating or assisting in the procedure, do you step out of the room?	46	45.1
9.	Ultrasound involves the usage of x-rays	82	80.4
10.	SI unit for measurement of radioactivity	36	35.3
11.	Radiation is present inside CT scanner all the times 24 hours a day	91	89.2
12.	Probability for risk of cancer after undergoing a chest x-ray examination	65	63.7
13.	Pregnant nurse can work in fluoroscopy in first trimester	89	87.3
14.	Gamma rays are used for medical purpose	86	84.3

Every individual had obtained formal education/lecture/training course related to radiation protection and radiological examination. 16 individuals stated that they had inadequate knowledge about radiation protection and radiological examination. In Nepal, every student must undertake clinical posting and perform radiographic examinations just like radiography staff. Thus, every participant in this report has gained working practices either as an apprentice or as an employee. The mean score of 14 questions was 9.99±1.94 with level of awareness of radiation protection among whole participants as 71.35%. This indicated good level of knowledge among radiographers and future radiography professionals.

It is imperative for radiography fellows to become acquainted with the measurement units of radiation and radioactivity. However, 75/102 failed to respond the correct answer for international unit of dose equivalent as Sievert (Sv) and 66/102 were ignorant regarding the SI unit of measurement of radioactivity. Only 4 individuals were heedless about the usage of x-radiation in Computed Tomography (CT) scan. 2 were oblivious concerning the application of x-rays in Mammography. It was a great disappointment to recognize that 65 candidates could not mention the standard safe distance from x-ray machine while performing portable x-rays. Similarly, 29 were unaware of the highest permitted level of occupational radiation dose.

This has generated the worst and appalling condition of present radiography professionals and prospective x-ray specialist. This indicates how much horrific and risky occupation radiography might become when radiation experts are insensitive to the fundamental understanding of radiation safety. It was a mental upset to notice that 15 had misperception regarding utility of x-radiation in Magnetic Resonance Imaging (MRI) scan. Again, 20 also had misconception concerning function of x-rays in ultrasound imaging. There is no excuse for radiographers that they had no idea on the subject of composition of protective apparels used during x-ray examination. However, there were 2 fellows who were blind anent lead as the material of safety clothes during radiographic investigation. 59 thought it was necessary to inform patients that they will be irradiated to x-ray exposures during surgery in Operation Theatre (OT), but others had different opinion that it was not necessary. This also indicates the saddening circumstances of the deficiency of comprehension of participants. There were again 11 individuals who were unaware of x-radiation inside CT scanner room. They had misunderstanding that there is radiation inside CT gantry room all the times 24 hours a day. 37/102 had illusion that chest x-ray examination had significant probability risk of causing cancer. They overestimated the negligible chance of cancer risk of chest radiograph. 13 had illusion that pregnant women can work in fluoroscopy in first trimester. This estimated the very low level of knowledge of radiation protection in relation to pregnancy. Sixteen were totally dumb in relation to gamma rays usage for medical purpose. For the question of behavior during portable x-rays, 13 preferred staying at the nursing station and monitoring patients through central monitoring system, whereas 15 going out of the room, 1 going to the break room, 27 standing behind a lead apron and 3 standing behind a wall or a pillar near to the radiographer. Other fellows responded with more than one

option. 34 use lead aprons to protect themselves, 1 responded only to use protective eye glasses and 1 again to wear dosimeter only. Other individuals replied with multiple answers.

The score of the correct answers were categorized as adequate, optimal and minimal. Those participants had adequate knowledge who has obtained more than 10 questions correct out of 14. The score in between 8 and 10 was considered optimal and the score less than 7 were classified as minimal. In brief, adequate means 11, 12, 13 and 14, optimal is 8, 9 and 10, and minimal means 7 and less than 7. After transformation of data into three variables, we calculated the significance of knowledge with various demographic data.

Table 3: Analysis of level of knowledge with demographic characteristics (*Chi-square test, **Fisher's exact test); p-value<0.05 is afforded significance

Particulars	Level of knowledge			Total	p-value
	Adequate	Optimal	Minimal		
Age					
(18-23)	17	29	9	55	0.038**
(23-28)	14	15	3	32	
(28-33)	4	2	0	6	
(33-38)	7	0	0	7	
(38-43)	1	0	0	1	
(43-48)	1	0	0	1	
Total	44	46	12	102	
Gender					
Female	13	19	5	37	0.469*
Male	31	27	7	65	
Total	44	46	12	102	
Profession					
Radiographers	17	12	3	32	0.390**
Students	27	34	9	70	
Total	44	46	12	102	
Experience (professionals only)					
Less than 5 years	5	11	3	19	0.00086**
More than 5 years	12	1	0	13	
Total	17	12	3	32	

Fisher's exact test was performed to determine the relationship between the level of knowledge and the age distribution. There was statistical significance between these two variables at 95%

level of significance as the calculated p-value 0.038 is less than 0.05. Chi-square test (χ^2) was applied to determine the association between the level of knowledge and the gender distribution. At 95% level of confidence, there was no statistical difference between them. As the calculated p-value 0.469>0.05, there was correlation between the level of knowledge and the gender of the participants. This means that the correct answers given by personnel of particular gender was not by chance, they really have very good command of radiation protection (RP) principles.

Again, the response score was related to the profession of participant either radiography professionals or students. There was no statistical significance at 5% level of significance as the calculated p-value 0.390>0.05. Thus, the correct answers given by radiographers and prospective radiographers were related to their occupation. It had not been occurred by chance. They are in association with each other. Again, the level of knowledge was tested with experience of radiography professionals. Two categories were constructed; one was less than 5 years and another more than 5 years. It was noticed that there was statistical significance between the knowledge of RP principles and the experience of the radiographers at 5% level of significance. This difference has shown that the knowledge of RP could not be gained by experience. Thus, formal education is mandatory.

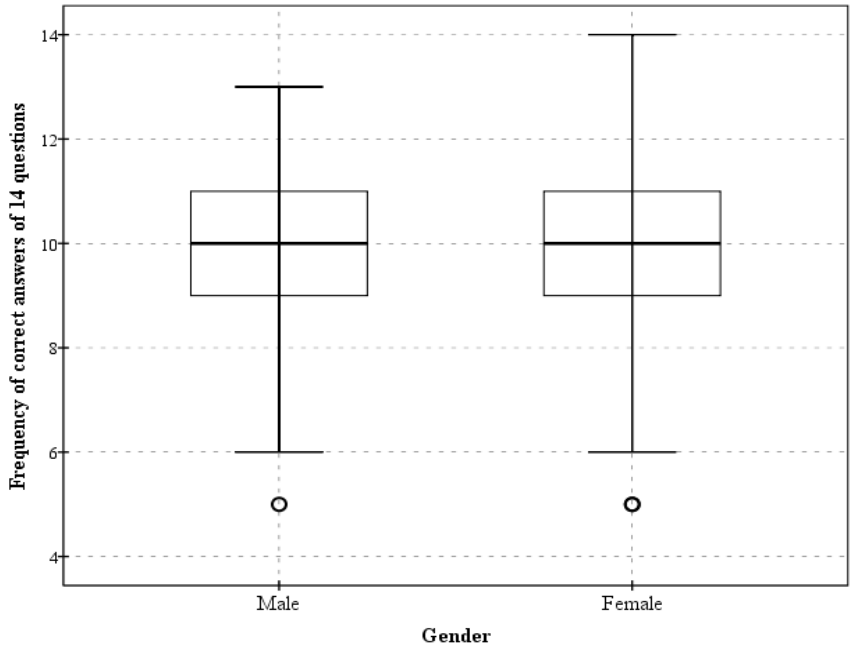

Figure 1: Box Whisker Plot showing the frequency of correct answers according to gender. Two female and one male are shown as outliers in the graph as small circles.

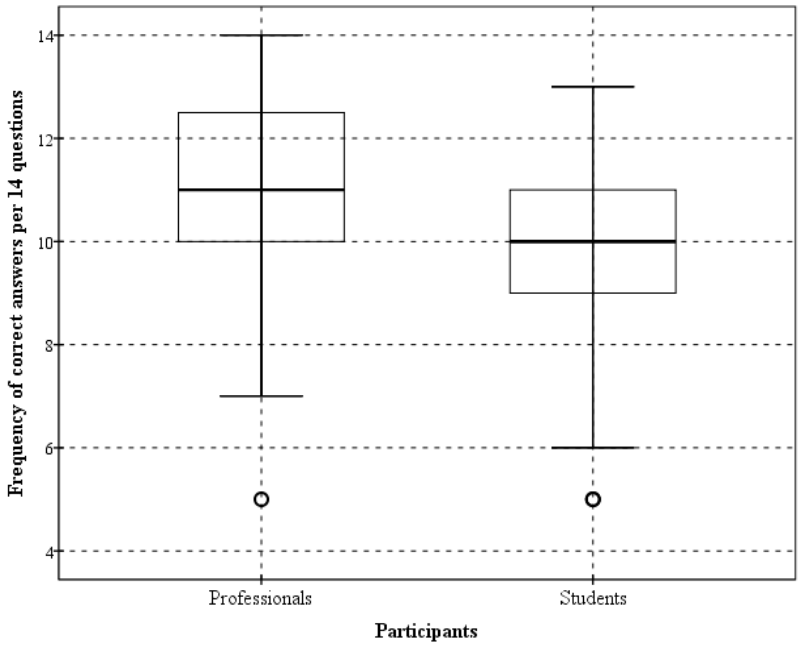

Figure 2: Box Whisker Plot showing frequency of correct answers according to profession of participants. Two students and one professional are shown by small circles as outliers.

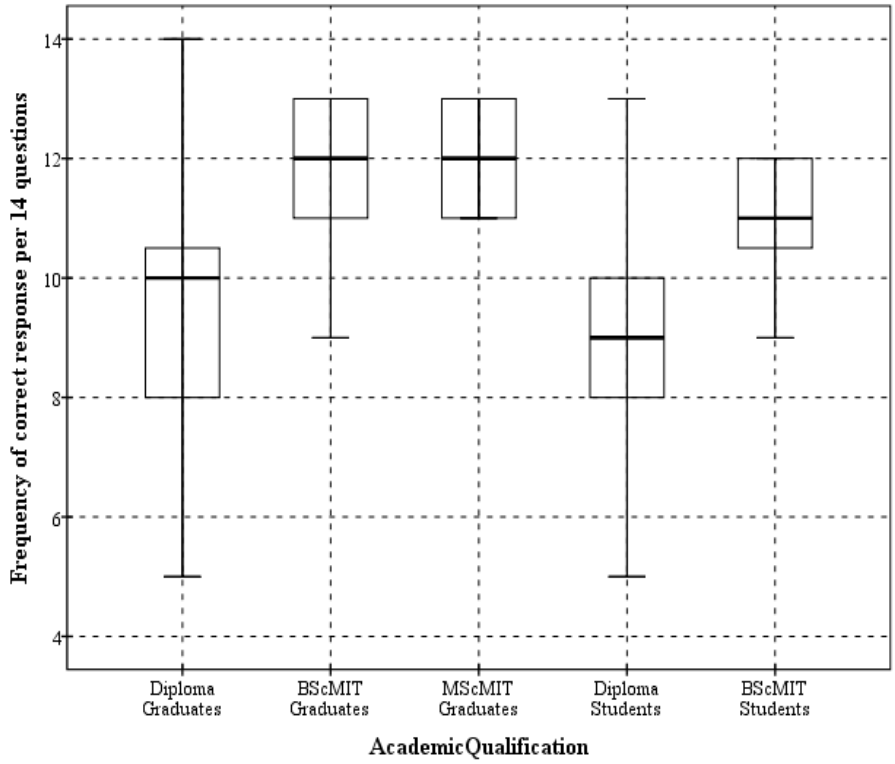

Figure 3: Box Whisker Plot showing frequency of correct answers according to academic qualification

Discussion

Radiography is a very powerful and valuable medical imaging tool in radiography.[6]It is a miracle to visualize internal anatomical structures without incision and surgery and diagnose various diseases. However, there are numerous negative consequences of x-radiation used in radiographic examination. The potential risks of radiation comprises of stochastic effect of which probability increases with dose and deterministic effect of which severity increases with dose.[47] In order to use reduce these adverse effects, adequate awareness of possible risks of x-rays, safety precautions and issues relating dose optimization are essential to protect patient and oneself from unnecessary x-ray exposure. It is the prime responsibility of a radiographer to provide radiation safety to the patient undergoing different types of radiological procedures and processes.[7] Thus, their knowledge related to radiation protection must be adequate and up-to-date. Radiographers are taught during their courses in diploma, undergraduate and graduate courses. Their curriculum should involve teaching various subjects that must aim specifically at the application of radiation in medicine.[7] Occupational radiation protection is necessity whenever radiation is used in the practice of medicine.[18]

Radiation protection is a general term applied to the profession or science relating to the protecting life and environment from radiation hazards.[13,19]The fundamental principles of radiation protection are justification, optimization and time. Based on the understanding of these fundamental principles, exposing only an individual(s) who should derive maximum benefits from such exposures to ionizing radiation (justification), making sure that radiation doses as result of medical exposures are only enough to achieve needed diagnoses (optimization) and reducing the time of exposure to sources of ionizing radiation are means of achieving radiation protection.[20] Consequently, uses of immobilizers, positioning aids, beam size (x-ray field) limiting devices, the type and state of x-ray machines are important factors in radiation protection.[4]

International Commission on Radiation Protection (ICRP) is the primary body in protection against ionizing radiation. ICRP is a registered charity and is thus an independent non-governmental organization established in 1928. It provides recommendations and guidance on protection against the risks associated with ionizing radiation.[21]Another organization widely

known as the world's "Atoms for Peace", International Atomic Energy Agency (IAEA), created in 1957 enact safety standards for protecting people and environmental from harmful effects of ionizing radiation.[22] The International Society of Radiographers and Radiological Technologists (ISRRT) is a global organization of radiographers and radiological technologists, dedicated to the advancement of the science and practice of radiography. It organizes education workshops in developing countries and supports profession of radiography worldwide.[23] Radiation protection of radiography professionals is very much neglected issue till date in Nepal.[24] There are numerous proof of unreported evidence of unethical exposure and improper patient protection in Nepal. There are professional organizations namely Nepal Radiological Society (NRS)[25], Nepal Radiologist's Association (NRA)[26] and Nepalese Association of Medical Physicist (NAMP)[27]. NRS, affiliated with ISRRT was established in 1990 AD. It represents radiologist, radiologic technologist, radiation therapist, medical physicist and radiographers. Though NRS conducts annual conferences, workshops and seminars, these are insufficient to disseminate the knowledge to wider audience all across the country. Therefore, further workshops, seminars, symposium, training courses and Continuing Medical Education (CME) programs are recommended on a regular basis in collaboration with ISSRT and other national and international organizations to raise the level of radiation awareness. In Nepal, radiographers are registered under Nepal Health Professional Council (NHPC), established in 1997 AD.[28] It is also a prime task of these councils to educate all the technical professionals and doctors properly. They should act in the front for the systemic and continuous delivery of educational training programs.

Questions regarding SI unit of dose equivalent, SI unit of radioactivity, minimum safe distance, fluoroscopy, and cancer risk of chest radiograph were the most unsuccessful issues most of the respondents failed. Over the past decades, many studies have been investigated from varying health profession and backgrounds on their knowledge of radiation protection. Most of the reports have demonstrated disappointing results. Some of the distinguished papers are mentioned below.

This study urges concerned authorities to establish a standard rules and regulations regarding radiation protection in Nepal. The urgent need to establish a national radiation protection authority to regulate the use of radiation in Nepal was emphasized by Bhatt et al[16] and Subedi et al[29]. It is strongly recommended that Nepal should draft an act and form a regulatory body of safe use of radio-isotopes as Nepal also lacks laws regarding radioactive sources.[30] However, the

international society should take better care for the security of staff, patients till the establishment of radiation act in Nepal.

We recommend better services from national and international authorities. Open University teaching from international authorities would definitely be a dramatic upsurge to improvement the present situation.

Rostamzadeh, Farzizadeh and Fatehi, Iran concluded that the majority of radiographers had no regard for radiation protection principles for either themselves or the patients. Apparently, not only hospital authorities, but also heads of departments ignore radiation protection principles for the patients and radiographers.[6]Alhasan et al, Jordan concluded the level of knowledge of radiation dose among 85 radiographers was less than 50%, which is inadequate. So, they recommended for annual assessment of their knowledge through national radiation agency.[31]Briggs-Kamara, Okoye and Omubo-Pepple, Nigeria reported that the level of awareness of radiographers is unacceptable. They concluded that concerted effort is to be made by regulatory bodies.[32]Zer, Khadoura and Yassin, Palestine stated that 74.8% of participants in questionnaire survey had awareness about radiation protection issues, but it was only about 53.4% who followed radiation protection practices.They concluded desperate need for rules, regulations and radiation protection act in the field of radiation in medical field.[33]Karami, Tahmasebi and Fatahi, Iran confirmed the need to highlight protection and safety principles to ensure the safety of radiographers and patients. In that regard, holding courses on radiation protection was useful.[34]Mojiri and Moghimbeigi, Iran demonstrated that the education regarding will have positive impact on radiographers' awareness.[18]Cheng et al, China stated that the level of radiation protection knowledge and awareness among radiation workers in Henan province, China needed to be improved. It was necessary to strengthen radiation protection knowledge by strengthening training and to improve safety awareness among the radiation staff, and more important, the hospital leaders as well.[35]Elamin, Sudan stated that radiographers showed a good knowledge of radiation hazards and protection. The study recommended conducting continuous in service training for radiation staff at all levels about radiation protection and safety.[4]

Sharma et al, India stated that as far as knowledge-practice gap is concerned, in spite of excellent knowledge (100%) about usage of personal protective devices was found among radiographers.[36] A limited understanding of radiation doses and associated risks may lead to unnecessary exposures with life time cumulative doses potentially leading to fatal malignancies. Teaching

needed to focus not only on image interpretation but also on the fundamental science of imaging techniques. Education needed to include not only image interpretation, but radiation awareness as well. In Nepal, the academic course is mainly focused on image capturing techniques and interpretation skills. Thus, it is high time the radiography students are taught adequate lessons of RP with practical considerations and the curriculum should be revised accordingly highlighting the radiation protection, safety methods, radiobiology and risky issues of radiation.[31]Radiography profession is more than a job for a radiographer; it is about satisfaction and dignity as they provide proper radiation protection to the patients. It is all about making a positive impact to the life of patients with quality health service and best safety methods.

Conclusion

The findings in this study indicate that radiographers and radiology students have optimal knowledge with mean score 9.99±1.94 out of 14 with 71.35%. Overall awareness and knowledge of radiation protection among the participants was very good. Nonetheless, we recommend that radiation protection and safety training should be a part of mandatory training. The knowledge about radiation protection and safety was satisfying with definitely possibilities for further improvement. Regular seminars, symposium, workshops, Continuing Medical Education (CME)s should be organized and implemented through collaboration between national and international organizations with the involvement of all government representatives and hospital administration departments. International organizations should take prompt actions conducting educational courses through Open University and training courses. It is urgent requirement that the government of Nepal draft Radiation Protection Act in Nepal.

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