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Evaluation of Radiation and Radiation Protection Awareness Level Among Radiographers Working in Public and Private Hospitals of Gilgit-Baltistan (GB), Pakistan

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ABSTRACT

Radiation, in terms of ionizing or non-ionizing form, has always had a pivotal role in the field of medical diagnosis and treatment. Its uses also contain a lot of risk and increase the risk of cancer. Numerous challenges with radiation awareness, hazards, protections, safety measures, and dosimetry usage need to be evaluated in radiology departments of public and private hospitals located in Gilgit-Baltistan (GB). This study aims to assess the radiation protection awareness and practices among radiographers working in public and private hospitals of Gilgit-Baltistan (GB). This study included 18 public sectors and 21 private sector hospitals (total of 39) in GB. Mostly general radiography, computed tomography, and dental radiography are used in all hospitals included in this study, along with that some hospitals also using mammography, MRI, and interventional radiology. All hospitals included in this study have limited resources of radiation facilities. This Cross-sectional study was carried out using a validated questionnaire, which was completed by 74 (67 male & 7 female) radiographers. The data was collected through purposive sampling and analyzed using Statistical Package for Social Sciences (SPSS), version 21.0. This study concludes that 93.2 % of radiographers are well-aware that X-ray emits ionizing radiation, but only 36.5 %, and 32.4.0%, respectively, think that Ultrasound and MRI emit ionizing radiation. And 97.3 % of radiographers are aware of the radiation sensitivity of the Human Reproductive Organs.

Keywords: *Radiation Protection, Computed tomography, Mammography, Demographic information, Radiography*

1. Introduction

Radiation is energy spread out from a source through waves or particles. Natural radiation comes from several naturally occurring radioactive elements in the environment [1-3].

X-ray is one of the major types of radiation, and its applications are increasing day by day in medicines for diagnostic and therapeutic purposes from the day first of its discovery. Radiation from medical applications represents most radiation doses from artificial sources to which workers and the public are exposed [4, 5]. It is the consequence of the recent advancement in imaging technology. Whereas the uses of ionizing radiation revolutionized medical science, it is a double-edged sword since it is a potential source of health hazards. Globally, the developing countries carry out approximately 3.6 billion imaging annually, resulting in a 70% rise in collective effective dose attributed to medical diagnostic imaging. Exposure to ionizing radiation can cause harmful biological effects in living organisms, including DNA damage, genetic mutations, leading risk of cancer [5-8].

Physicians' and radiologists' awareness of radiation exposure during diagnostic and therapeutic procedures is important. This awareness becomes more crucial as medical imaging technology expands [9-11].

Radiation exposure has health risks for both patients and medical workers. Unnecessary radiation exposure should be discouraged, as it increases the rates of cancer growth. Research shows that insufficient knowledge of the harmful effects of ionizing radiation and safety protections caused multiple examinations, increasing exposure time for patients and workers [6, 15, 16]. Physicians and radiation workers should work collectively to minimize radiation risk related to medical imaging. Medical personnel not only rationalize the x-ray exposure before performing radiological examination but also protect themselves and the public from radiation hazards, and sometimes, this practice changes from place to place [12, 17, 20]. It demands adequate knowledge of radiation, its harmful effects, and radiation protection [18, 19].

For occupational exposure, the International Commission on Radiological Protection has established dose limits and recommended 20 millisieverts (mSv) per year, averaged over five years. However, the annual occupational exposure limit is 50 mSv. Likewise, the US Nuclear Regulatory Commission recommended less than 5 mSv cumulative fetal exposure during pregnancy [24].

Evaluation of knowledge level is critical to classify any deficiencies to overcome them and ultimately diminish radiation risks to all taking part in the process of radiologic examination.

Gilgit-Baltistan (GB), located in Pakistan's extreme north, encounters unique healthcare challenges due to its remote location. Despite limited facilities, the region has witnessed significant advancements by establishing various public and private health units equipped with medical imaging facilities.

However, research on radiation hazards and protection measures among medical workers in GB remains rare. This knowledge gap demands an assessment of radiation awareness among radiographers in GB's hospitals.

This study aims to assess the awareness of radiation protection and practices among radiographers working in public and private hospitals in Gilgit-Baltistan (GB).

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2. Methodology

This study carried out on medical imaging technologists / radiographers working in different public and private hospitals in Gilgit-Baltistan (GB), Pakistan. This study is a short cross-sectional survey-based design on a structured self-administered questionnaire. The data were gathered from medical imaging technologists/radiographers through a self-administered questionnaire developed based on suggestions provided by five experts, including three doctors and two researchers with experience in radiological imaging. The questionnaire consisted of 25 questions, assessing respondents' demographics, awareness of radiation hazards, knowledge of protective measures, and overall radiation literacy. The questionnaire was categorized into two major sections: i) Demographic information, including sex, age, experience, and education level, etc. ii) The second section consists of 21 questions regarding radiation awareness, radiation protection knowledge, and imaging device knowledge.

The data was collected through purposive sampling from 74 radiographers of 39 hospitals (18 public sector and 21 private sector) of GB. Participants were handed out hard copies of the questionnaire by the author himself after proper consent to participate in the survey. Where needed, they understood the questionnaire or were interviewed in Urdu and their local languages.

All public sector hospitals are run under the Gilgit-Baltistan government, and each hospital is supervised by a Medical Superintendent (MS). In contrast, all private hospitals are run under the concerned Board of Directors (BOD) and supervised by a Medical Officer (MO). To ensure ethical standards, we obtained the necessary institutional and formal approval from the relevant MS or MO. Additionally, we sought permission from the respective heads of each healthcare unit to ensure compliance with all regulations and protocols, as there were no separate ethical committees.

The data obtained were analyzed using the Statistical Package for Social Sciences (SPSS), version 21.0, and all results are shown in the results section. To achieve accurate results about radiographers' knowledge and awareness, a numerical value of 1 for the correct answer and 0 for the wrong answer was assigned to each answer. Ultimately, the total score of each section was calculated in terms of 100.

3. Results

This research includes 74 radiographers from 39 public and private hospitals in GB, Pakistan. Table 1 indicates that there are 67 (90.5 %) males and 7 (9.5 %) females. 44.5 % of radiographers with working experience of 5 - 10 years fall in the age group of 31 – 40 years old. 73 % radiographers have vocational high school certificates, and only 27 % have university level education. Out of these 74, 51.4 % of radiographers were from public sector institutions these 74, 51.4 % of radiographers were from public sector institutions, and 48.6 % were from private sector institutions, almost from all districts of GB. The results are entered into the following tables.

3.1 Demographic Information of Participants

Table 1. Demographic details of the study variables.

Variable	n	%		n	%
Gender			Institution		
Male	67	90.5	Public	38	51.4
Female	7	9.5	Private	36	48.6
Work Experiences			Districts		
< 5 years	19	25.7	Gilgit	22	29.7
5 - 10 years	33	44.6	Skardu	27	36.5
> 10 years	22	29.7	Ghanche	10	13.5
Age			Hunza	4	5.4
18 - 30	24	32.4	Kharmang	6	8.1
31 - 40	29	39.2	Shigar	1	1.4
> 40	21	28.4	Astore	4	5.4
Education					
Vocational High School	54	73.0			
University associate degree	20	27.0			

3.2 Response to Tissue Radiation Sensitivity and Radiation Awareness Per Imaging Modality

Table 2. Tissue radiation sensitivity (assessment of basic knowledge either different organ is radiation sensitive/resistant)

Variable	Radiation Sensitive (Yes)		Radiation resistant (Yes)	
	n	%	n	%
Reproductive Organ	72	97.3	2	2.7
Central Nervous System	68	91.9	6	8.1
Bone Marrow	71	95.9	3	4.1
Thyroid Gland	69	93.2	5	6.8

Radiation sensitivity is the relative susceptibility of cells, tissue and organs to the harmful effects of ionizing radiation. It varies from tissue and organs to organs. Human reproductive organs are more radiosensitive than those of bones and teeth. Radiation has some prompt and delayed effects on tissues and organs of the human body according to its radiation sensitivity. Radiographers should know which human organ is more radiosensitive or radio resistant. Table 2 declared that 97.3 % of radiographers are aware about radiation sensitivity of the Human Reproductive Organs. Respectively 91.9 %, 95.9 %, and 93.2 % of radiographers avowed that Bone Marrow, Central Nervous System, and Thyroid Gland are radiation susceptible.

3.3 Responses Patterns by Imaging Modality, Expertise, and Protective Equipment Use, Categorized Education Level

Table 3. Imaging Modality, Expertise, and Protective equipment use.

Variable	Yes		No	
	n	%	n	%
Does X-Ray emit harmful radiation?	69	93.2	5	6.8
Does ultrasound emit harmful radiation?	27	36.5	47	63.5
Does computed tomography emit harmful radiation	41	55.4	33	44.6
Does Magnetic resonance imaging emit harmful radiation?	24	32.4	50	67.6
Does Mammography emit harmful radiation?	34	45.9	40	54.1
Imaging expertise obtained at school?	15	20.3	59	79.7
Imaging expertise obtained with own effort?	23	31.1	51	68.9
Imaging expertise obtained from college?	68	91.9	6	8.1
Do you use lead aprons?	44	59.5	30	40.5
Do you use lead screen?	42	56.8	32	43.2
Do you use other protective equipment (Gloves or Collar etc.)	33	44.6	41	55.4

Table 3 identified that 93.2 % of radiographers are aware that the X-Ray emits harmful/ionizing radiation. Respectively 55.4 %, 45.9%, 36.5%, and 32.4% of radiographers marked that Computed Tomography (CT), Mammography, Ultrasound, and MRI emit dangerous / ionizing radiation. 91.9 percent of the radiographers in the hospitals of GB took their imaging expertise from colleges, and the rest acquired their expertise by their own efforts or school level. Overall radiographers are aware of radiation hazards and radiation shielding. There are only 44.6 percent who took necessary protective measures (gloves, collar, etc.), while 44 (59.5 %) & 42 (56.8 %) utilized lead aprons and lead screens respectively.

3.4 General Knowledge Responses Regarding Radiation

Table 4 revealed that most radiographers working in different hospitals in GB believe that staff has adequate knowledge of radiation safety and protection. More than half of the participants know medical physics imaging and symbols used for ionizing and non-ionizing radiation. Most radiographers know X-ray warning symbols used for pregnant/expected women. Most radiographers do not use their dosimeter as that may not be available.

Table 4. General awareness of radiation.

Variable	Yes		No	
	n	%	n	%
Do you believe staff have adequate knowledge of radiation safety and protection?	67	90.5	7	9.5
Do you have enough knowledge of medical imaging physics?	37	50.0	37	50.0
Do you know what the symbol uses for ionizing radiation?	39	52.7	35	47.3
Do you know the symbol used for nonionizing radiation (radio frequency) radiation?	38	51.4	36	48.6
Do you know the X-ray warning symbol for pregnant or expected women?	50	67.6	24	32.4
Do you use a personal dosimeter?	15	20.3	59	79.7

Table 5 shows a socio-demographic comparison of public and private hospitals in GB. The sample of 38 (51.4%) public hospitals and 36 (48.6%) private hospitals. Most participants were aware that X-rays emit harmful radiation (Public hospital = 94.7% and Private hospital = 91.7%). Furthermore, participants agreed that ultrasound does not emit dangerous radiation (Public hospital = 65.8% and Private hospital = 80.6%). Participants reported that they obtained imaging expertise from their efforts (Public hospital = 60.5% and private hospital = 77.8%). Furthermore, most of the participants reported that they obtained imaging expertise at college (Public hospitals = 94.7% and Private hospitals = 88.9%). The chi-square ($\chi 2$) test was used to determine the statistical significance of various parameters. Among them, the only statistically significant result was observed for the parameter 'Imaging expertise obtained with own effort,' with $\chi^2 = 2.59$ and P = 0.04. This indicates that many participants reported acquiring their imaging expertise through self-learning rather than formal training. All other parameters yielded higher P-values and lower χ^2 values, indicating non-significant results. The confidence interval for the decision further supports these findings.

Table 5: Socio-demographics

	Public		***Private***		χ^2	***p-value***
	Yes n (%)	**No n (%)**	**Yes n (%)**	**No n (%)**		
Does X-Ray emit harmful radiation?	36 (48.6)	2 (2.7)	33 (44.6)	3 (4.1)	**0.28**	**0.59**
Does ultrasound emit harmful radiation?	13 (17.6)	25 (20.3)	7 (9.5)	29 (39.2)	**2.04**	**0.15**
Does computed tomography emit harmful radiation	24 (32.4)	14 (18.9)	21 (28.4)	15 (20.3)	**0.18**	**0.67**
Does Magnetic resonance imaging emit harmful radiation?	16 (21.6)	22 (29.7)	12 (16.2)	24 (32.4)	**0.61**	**0.44**
Does Mammography emit harmful radiation?	20 (27.0)	18 (24.3)	20 (27.0)	16 (21.6)	**0.06**	**0.80**
Imaging expertise obtained at school?	6 (8.1)	32 (43.2)	9 (12.2)	37 (50.0)	**0.97**	**0.33**
Imaging expertise obtained with own effort?	15 (20.3)	23 (31.1)	8 (10.8)	28 (37.8)	**2.59**	**0.04***
Imaging expertise obtained from college?	36 (48.6)	2 (2.7)	32 (43.2)	4 (5.4)	**0.85**	**0.36**
Do you use lead aprons?	24 (32.4)	14 (18.9)	20 (27.0)	16 (21.6)	**0.44**	**0.51**
Do you use lead screen?	21 (28.4)	17 (23.0)	21 (28.4)	15 (20.3)	**0.07**	**0.79**
Do you use other protective equipment (Gloves, Collar etc.)	17 (23.0)	21 (28.4)	16 (21.6)	20 (27.0)	**0.01**	**0.98**

4. Discussion

This study aimed to examine the knowledge level of radiation, and radiation protection amongst radiographers working in different public and private hospitals of GB. The literature revealed that there are various researches about radiation safety awareness of healthcare workers in different parts of the world [7]. However, no such study was performed in GB to evaluate the radiographer's knowledge level regarding radiation dose and protection. As radiographers have a key role in the radiation department [15], his/her knowledge level about radiation and its protection is a prime need. This study is the first attempt to examine the knowledge level and awareness about radiation, radiation hazards, and its protection. This study includes 74 radiographers working in the whole of GB. The questions were designated to assess general awareness regarding radiation, its types, and its protections. A limitation of this study is that there are fewer radiographers. Another is their lower education level, which may affect the response to each question.

Medical imaging is now an integral part of practice, and critical for accurate diagnosis and effective treatment. Radiographers have a major role in radiation imaging, so radiation protection is radiographers' professional responsibility. Furthermore, it is vital to recognize the potential risk of radiation exposure in the process and prioritize radiation protection awareness. The patient and the radiation workers must take the minimum and permissible dose [7, 21]. If radiographers are not aware of radiation and radiation protection, then the patients may be irradiated with unjustified radiation doses [14, 15]. It is essential to do a comprehensive benefit-risk assessment of ionizing radiation use.

According to this research, radiographers hold different degrees, age groups, and working experiences. 91.5 % of the population has acquired imaging expertise from colleges, and 75 % of radiographers have more than 5 years of working experience. The result revealed that 93.2 % of radiographers know that X-ray emits harmful/ionizing radiation. The results of some other parameters identified that the knowledge level of radiographers holding higher degrees and experience was higher than others. Interestingly high number of radiographers mention that MRI and Ultrasound do not emit ionizing radiation, which is an indication of basic knowledge of physics for understanding imaging technologies, for college-educated radiographers (Table 3). Like Sharma et al. [13] this research also concluded that awareness level highly depends on working experience and educational background. There are only 59.5 %, 56.8 %, and 44.6 % radiographers who used simultaneously lead aprons, lead screens, and protective equipment like gloves & collars, etc. (Table 3). Radiation protection knowledge among radiographers should be kept on top priority and they should have full control of radiation procedures. It is their responsibility that they use sufficient protective measures and follow safe radiation practice. In case there may increase the chance of cancer risk and other health problems among radiographers.

Although this research was conducted in one of the least developed and remotest regions of Pakistan, the results (in both basic radiation awareness and radiation protection cases majority questions marked correct by more than 60% of radiographers) showed adequate knowledge about radiation and radiation protection, and obviously, the facilities and the protective measures are substandard and not satisfactory (we have seen that due to unavailability of facilities almost 80% radiographers not used personal dosimeters and more than 50% not use other protective equipment like Gloves, collar etc.) as compared to other parts of Pakistan and developed countries (Table 3 and Table 4).

In exploring general awareness regarding radiation, it was found that out of 74 radiographers, 37, 39, 38, and 50, respectively, know about medical imaging physics, symbols of ionizing / nonionizing radiation, and X-ray warning symbols for expected women. Only 15 radiographers use personal dosimeters (Table 4). Both public and private hospital radiographers were given approximately the same responses for all fields (Table 5).

Insufficient clinical examination practice has been identified as a contributing factor to the increased use of medical imaging, as evidenced by several studies [7, 22, 23]. These faults can also lead to the harmful effects of unwanted radiation exposure among healthcare professionals and inappropriate application of radiation doses in imaging practices. So, it is recommended that training courses regarding the diagnostic application of ionizing radiation be arranged to enhance the awareness level of radiographers. It is also recommended that heads of institutions should provide personal dosimeters to all radiographers and monitor them regularly. The radiographers are responsible for working under the guidelines issued by different national and international organizations to create safer situations for imaging.

5. Conclusion

Based on the outcomes of this study, it is concluded that the majority radiographers working in different public and private hospitals of GB are aware of the basics of radiation and radiation protection. But majority neither use protective equipment nor use any personal dosimeters. This failure to use protective measures may lead to excessive radiation exposure to themselves and patients, which may increase the chance of cancer etc. The awareness level of the radiographers mostly depends on working experience and educational backgrounds. Hospitals and concerned authorities must offer academic and professional development opportunities to radiographers in radiation protection and safety.

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7. Conflict of Interest

Authors have no conflict of interest.

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