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Knowledge and Awareness Regarding Radiation Safety Among Radiology Study Program Students

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ABSTRACT

The increasing use of radiation in health services increases the risk to the public. The radiology study program as a producing institution has the challenge of ensuring that students fully understand and are aware of radiation safety. This study aims to determine the level of knowledge and awareness regarding radiation safety and related factors among radiology study program students.This was a quantitative study with a survey approach. The study instrument was a questionnaire that was delivered to 140 students from 7 radiology study programs in Indonesia consisting of 2 state institutions and 5 private institutions. The questionnaire consisted of 12 questions to evaluate knowledge regarding radiation safety, 16 questions to evaluate awareness regarding radiation safety and 6 questions to evaluate the learning experiences.Based on the study results on knowledge regarding radiation safety, 12.86% of respondents had "Poor" level of knowledge, 35.00% of respondents had "Moderate" level of knowledge, 20.71% of respondents had "Good" level of knowledge and 31.43% of respondents had "Very Good" level of knowledge. Respondents' radiation safety awareness in the "Poor" category was 3.57%, "Fair" 17.14%, "Good" 43.57% and the "Very Good" category 35.71%. Laboratory practical experience and the completeness of laboratory infrastructure had a positive effect on students' knowledge regarding radiation safety. Furthermore, clinical practice experience similarly had a positive effect on awareness regarding radiation safety. The study outcome can be applied as input for radiology study program educational institutions in developing learning to achieve competency regarding radiation safety.

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1. INTRODUCTION

Radiation is applied in various fields, one of which is the health sector. Activities for the use of radiation in the health sector are more focused on the scope of technological processes, analysis, equipment and instrumentation engineering, as well as the manufacture of medical devices. In this context, the development of radiation in the health sector is more driven to be aligned with user needs, especially with regard to efficiency, quality and application for both diagnostic and therapeutic purposes (Hanafiah, 2013). There are several advantages regarding the use of radiation, namely that it has the potential to speed up, simplify, reduce development costs, provide better health care, reduce health care expenditures and can facilitate the implementation of personalized medicine. Its application which go beyond diagnostics allows support in the selection of appropriate therapy, transmission of therapeutic response and follow-up; and direct the journey to personalized medicine (Paez et al., 2020) The increasing use of radiation can increase risks for both staff and the public. Therefore, understanding radiation safety procedures and work safety is very important (Paulo, 2020).

The radiology study program has the challenge of ensuring that students who will carry out learning related to radiation must fully understand and be aware of radiation safety procedures. In fact, one of the problems faced is that institutions that provide clinical experiences to students must be guaranteed to be safe from radiation hazards (O'cornor, 2021)

Currently there are 30 radiology study program educational institutions in Indonesia, which produce thousands of graduates every year (PDDIKTI, 2022). Based on this data, it is estimated that

every year thousands of students enter hospitals to carry out clinical practice in the field of radiation. Radiation safety learning materi is received by radiology study program students in the radiation protection course which as the implementation of Minister of Health Decree No. HK.01.07/Menkes//316/2020 concerning professional standards for radiographers. The regulation states that radiographers must be able to guarantee the accuracy and safety of radiation protection measures in radiological examinations according to radiation protection protocols. Considering the potential dangers of using radiation in the health sector, it is necessary to evaluate the knowledge and awareness of radiology study program students regarding occupational radiation safety. This evaluation can be used as review material for future radiation protection learning.

2. METHODS

This was a descriptive quantitative study with a survey approach. The study was conducted by measuring students' knowledge and awareness regarding radiation safety in the health sector by providing questionnaire to be filled out and analyzed. The questionnaire consisted of 12 questions to evaluate knowledge regarding radiation safety, 16 questions to evaluate awareness regarding radiation safety and 6 questions to evaluate the learning experiences. The questionnaire questions were developed based on the learning outcomes of the Radiation Protection course which include:

1. Principles, values and philosophy of radiation protection
2. Interaction of radiation with biological materials
3. Dosimetry: Exposure, absorbed dose, equivalent dose and effective dose
4. Radiation sources: natural, artificial, internal and external radiation sources
5. Personnel dosage monitoring (film badge, TLD badge)
6. Radiation assessment instrument
7. Radiation protection measures and building design in the field of diagnostics and nuclear medicine
8. Design of the radiotherapy room

Questions to evaluate knowledge were made in the form of a multiple choice quiz and the respondents were asked to choose the most appropriate answer from the options given. Questions to evaluate safety awareness were made in the form of statements about working conditions and the respondents were asked to choose the response that best suits them. The number of respondents this research was 140 respondents were involved in this study who were selected from 7 Radiology educational institutions in Indonesia consisting of 2 state institutions and 5 private institutions.

The respondents' answers were further scored. The correct answer was given a score of 1, and the wrong answer was given a score of 0. Furthermore, the total score for each sample was made and analyzed. Based on the total score result, each respondent was grouped into the following radiation safety knowledge score categories:

Score 0-3: had poor knowledge regarding radiation safety
Score 4-6: had moderate knowledge regarding radiation safety
Score 7-9: had good knowledge regarding radiation safety
Score 10-12: had very good knowledge regarding radiation safety

Meanwhile, regarding the assessment of radiation safety awareness, the respondents were grouped into the following categories:

Score 0-4: had poor awareness regarding radiation safety
Score 5-8: had moderate awareness regarding radiation safety
Score 9-12: had good awareness regarding radiation safety
Score 13-16: had very good awareness regarding radiation safety

Furthermore, the data were presented in the form of percentages on a pie chart to draw conclusion on the description of knowledge and awareness regarding radiation safety in the health sector. Scores on the level of knowledge and awareness regarding radiation safety were compared based on the characteristics and learning experiences of respondents and the learning experiences.

3. RESULTS AND DISCUSSION

Characteristics of Respondents

Characteristics of the study respondents can be observed in figure 1 as follows:

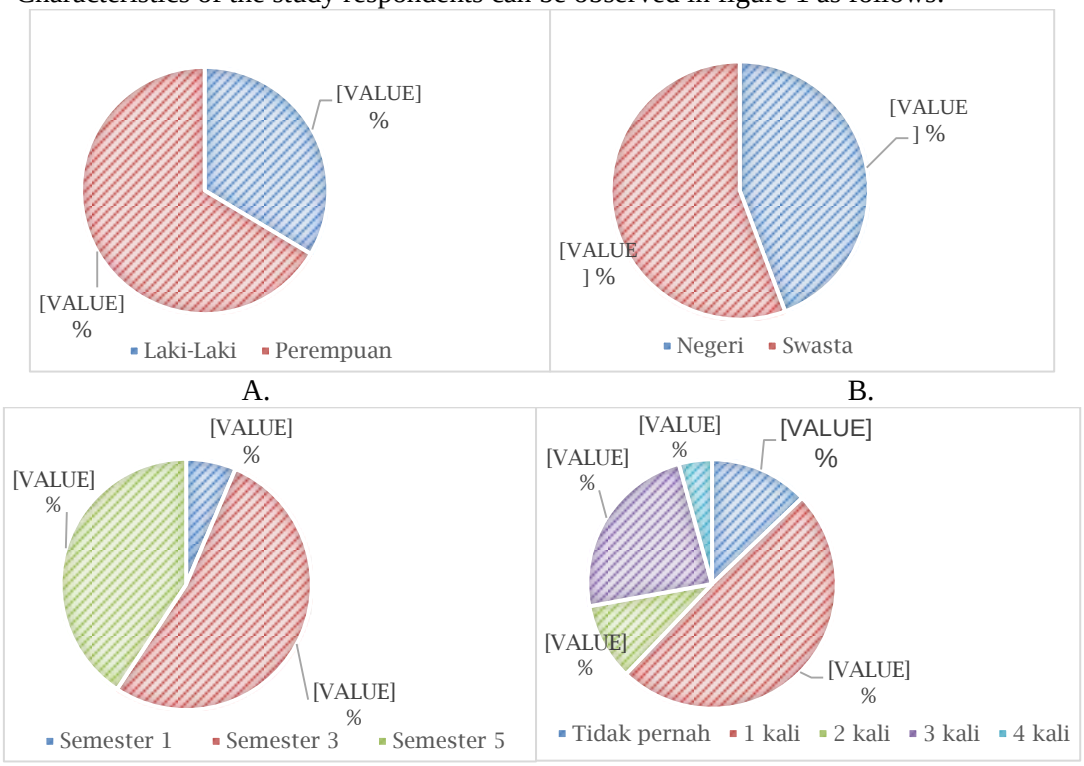

Figure 1. Characteristics of Respondents by A. Gender; B. Type of Institution; C. Semester; D. Clinical Practice Experience

Level of Knowledge and Awareness of Respondents regarding Radiation Safety

Table 1. Level of Knowledge and Awareness of Respondents regarding Radiation Safety

No.	Category	Level of Knowledge		Awareness	
		Frequency	Percentage (%)	Frequency	Percentage (%)
1.	Poor	18	12.86	5	3.57
2.	Moderate	49	35.00	24	17.14
3.	Good	29	20.71	61	43.57
4.	Very Good	44	31.43	50	35.71
	Total	140	100	140	100

Table 2. Mean Scores of the Level of Knowledge and Awareness by Gender

No	Gender	Mean	
		Level of Knowledge	Awareness
1	Male	10.74	6.60
2	Female	11.57	7.46

Table 3. Mean Scores of the Level of Knowledge and Awareness by Type of Institution

No	Type of Institution	Mean	
		Level of Knowledge	Awareness
1	State	9.26	13.21
2	Private	5.51	9.77

Table 4. Mean Scores of the Level of Knowledge and Awareness by Semester

No	Semester	Mean	
		Level of Knowledge	Awareness
1	1	3.44	9.22
2	3	8.62	12.65
3	5	5.88	9.86

Table 5. Mean Scores of the Level of Knowledge and Awareness by Clinical Practice Experience

No	Clinical Practice Experience	Mean	
		Level of Knowledge	Awareness
1	0 Field Practice	4.06	9.94
2	1 times of Field Practice	8.90	12.67
3	2 times of Field Practice	6.29	9.29
4	3 times of Field Practice	5.82	10.27
5	4 times of Field Practice	6.17	9.83

Statistical tests on the level of knowledge and awareness by the characteristics and learning experience of respondents

Table 6. Results for Differential Test on the Level of Knowledge and Awareness by Gender and Type of Institution

No	Result	Level of Knowledge		Awareness	
		Sig.	Information	Sig.	Information
1	Gender	0.177 (p > 0.05)	There was no significant difference	0.178 (p > 0.05)	There was no significant difference
2	Type of Institution	0.001 (p < 0.05)	There was a significant difference	0.001 (p < 0.05)	There was a significant difference

Table 7. Results for Differential Test on the Level of Knowledge and Awareness by Semester and Clinical Practice Experience

No	Result	Level of Knowledge		Awareness	
		Sig.	Information	Sig.	Information
1	Semester	0.027 (p < 0.05)	There was a significant relationship	0.001 (p < 0.05)	There was a significant relationship
2	Clinical Practice Experience	0.439 (p > 0.05)	There was no significant relationship	0.044 (p < 0.05)	There was a significant relationship

Table 8. Results for Differential Test on Knowledge Scores Based on Completeness of Radiation Protection Laboratory Infrastructure

No	Completeness of Radiation Protection Laboratory Infrastructure	Number	Mean Knowledge	Significance Value of Difference Test	Information
1	Complete	102	7.53	p = 0.023 (p < 0.05)	There was a significant difference in the level of knowledge regarding radiation safety between students from institutions
2	Incomplete	38	5.97		

					with complete radiation protection laboratory infrastructure and institutions with incomplete laboratory infrastructure.

Table 9. Results for Differential Test on Awareness Scores Based on Radiation Safety Laboratory Practice Experience

No	Laboratory Practice Experience	Number	Mean Awareness	Significance Value of Difference Test	Information
1	Yes	102	11.38	$p = 0.489$ ($p > 0.05$)	There was no significant difference in awareness regarding radiation safety between students from institutions with complete radiation protection laboratory infrastructure and institutions with incomplete laboratory infrastructure.
2	No	38	11.00		

Discussion

The use of radiation energy in the health sector is increasing in various aspects, including radiodiagnostics, nuclear medicine and radiotherapy. This is a result of the development of health technology which is growing very rapidly and has become a very important component in all branches and specialties of medicine (Donya et al., 2014). The increasing use of radiation in the health sector raises concerns about exposure to low dose radiation towards the general public (Fazel et al., 2009). In fact, more than 90% of radiation exposure from unnatural sources comes from medical imaging. Despite its medical uses, it also has harmful effects on biological systems. Therefore, it is important for a radiation personnel in the health sector to understand the advantages and benefits as well as the potential risks of radiation. Reduction of the adverse effects of x-rays, adequate awareness of the risks that can arise from x-rays, safety methods, and issues related to dose optimization in various areas of radiological examination are necessary. Therefore, it is very important to have an understanding regarding radiation protection and consider the safety of patients and radiation personnel (Surendra Maharjan, 2017). Every day, radiation personnel are exposed to occupational contact with a variety of diagnostic and therapeutic radiology interventions. Exposure of healthcare workers to various radiological waves results in acute complications (dermatitis, mucositis, and hair loss) as well as long-term complications (cataracts, skin problems, genetic problems, and cancer) due to a decrease in normal DNA function (Behzadmehr et al., 2021).

Radiology study program plays an important role since graduates produced as professional radiographers will become implementers of radiation safety programs in the health sector. Therefore, it is necessary to evaluate knowledge and awareness regarding radiation safety among radiology study program students, to ensure that the educational program developed achieves the expected goals. The current study involved 140 respondents selected from 7 radiology study institutions consisting of 2 state institutions and 5 private institutions. Evaluation was performed on the level of knowledge, awareness and learning model of radiation safety/radiation protection material

Assessment on the level of knowledge regarding radiation shows the following result:

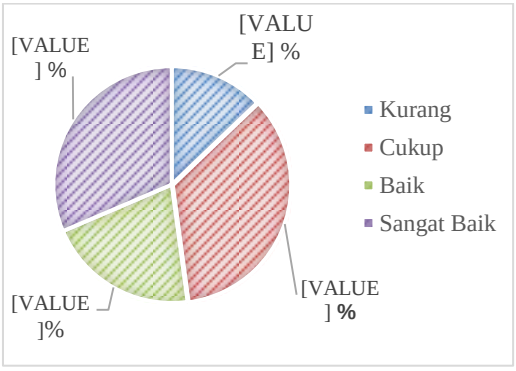

Figure 2. Level of Knowledge of Respondents regarding Radiation Safety

Based on the diagram, it can be seen that 35% of respondents still had moderate level of knowledge and 12% of respondents had poor level of knowledge. Such finding needs to be a concern considering the important role that students play after graduating, especially in implementing radiation protection for patients, themselves and society. Ideally, student knowledge should be in the good and very good criteria. Meanwhile, assessment on awareness regarding radiation shows the following result:

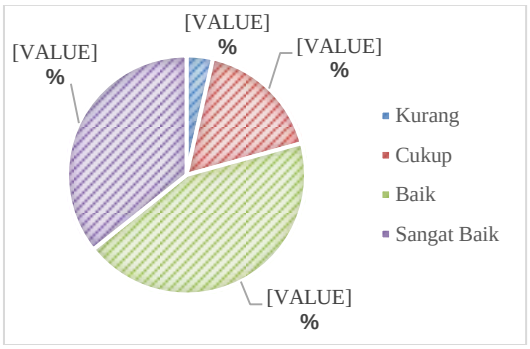

Figure 3. Level of Awareness of Respondents regarding Radiation Safety

In contrast to the level of knowledge, students' awareness regarding radiation safety in moderate and poor levels were lower byy only 17.14% and 3.57%, respectively. However, it should be noted that such level can have further impact on the patient's radiation dose exposure. Based on Table 6, it can be observed that the mean score for the level of knowledge among female respondents was 7.46, higher than that of male respondents, which was 6.60. Furthermore, based on table 6, the mean score for awareness among female respondents was 11.57, higher than that of male respondents, which was 10.74. However, statistical test showed that such differences were not significant. Thus, it can be interpreted that there was no difference in the level of knowledge and awareness between male and female respondents.

Based on the type of educational institution, the assessment revealed that the mean score for the level of knowledge of respondents from state institutions was 9.26, higher than that of respondents from private institutions, which was 5.51. Likewise, in assessment for awareness regarding radiation safety, respondents from state institutions had a mean score of 13.21, which was higher than that of respondents from private institutions, which was 9.77. The results of statistical tests showed that there were significant differences in the level of knowledge and awareness of radiation safety between respondents from the state and private sector. This may be due to various factors that can influence it. The type of institution usually influences the quality of new student input, learning facilities and infrastructure and many other things.

The level of knowledge and awareness of radiation safety was also influenced by the respondent's semester level. The highest mean score for the level of knowledge was obtained by respondents in semester 3 by 8.62 and the lowest was obtained by respondents in semester 1. This was similar with the assessment for the awareness regarding radiation safety, wherein the highest score was obtained by respondents in semester 3 by 12.65 and the lowest score was obtained by respondents in semester 1 by 9. 22. Such finding was related to the learning experience because radiation

safety/radiation protection courses are generally given before students undergo clinical practice in semester 2 or 3. So, the respondents' knowledge was still good because they had just received the material. Respondents in the semester 1 group had the lowest scores because they had not directly received radiation safety material. Further issue to be concerned for was a decrease in knowledge and awareness scores in the group of respondents in semester 5 compared to respondents in semester 3. Radiology study program institutions need to develop educational programs that are able to ensure that knowledge and awareness regarding radiation safety remains internalized by students during the education process. The method that can be applied is to include radiation safety values in clinical and laboratory practice assessment instruments every semester.

Clinical practice experience in health services did not have an effect on the level of knowledge, but had an effect on awareness regarding radiation safety. So far, radiation safety has not been a competency achievement in clinical practice activities so that the activities had no effect on respondents' knowledge. However, clinical practice can provide direct experience for students carrying out radiation examinations on patients. This may influence students' awareness regarding radiation safety. Daily interaction with radiation energy in carrying out examinations allows for increased awareness of radiation safety. Further analysis was performed on practical experience and laboratory infrastructure related to radiation safety. The study findings showed that practical experience and completeness of laboratory equipment had an effect on knowledge, but not on awareness regarding radiation safety. The study findings can applied as input by radiology study program institutions for increasing knowledge and awareness regarding radiation safety.

Radiation protection is the science and art of protecting humans and the environment from the harmful effects of ionizing radiation. Ionizing radiation in medical imaging is one of the powerful diagnostic tools, and accurate knowledge of radiation protection will influence the safety behavior of radiographers during practice (Mohammed Ahmed et al., 2015). Radiation protection, sometimes also called radiation safety, is very important for radiographer education students to know. This is due to the danger of ionizing radiation in radiology services that cannot be seen and felt by human senses but can cause stochastic reactions and non-stochastic effects. Stochastic effects damage a cell's genetic material and reprogram the cell to become dysfunctional. One impact of stochastic effects that needs concern is cancer due to radiation. Non-stochastic or deterministic effects are caused by radiation dose-dependent cell injury and necrosis. Skin injuries, cataracts, bone marrow damage are examples of tissue injuries. There are also categories related to diseases such as cataracts and thyroid malignancies (Uthirapathy et al., 2022). It was revealed that there was a correlation between the use of ionizing radiation in health services and an increase in cancer cases (Zekioğlu & Parlar, 2021).

Awareness of radiation safety is certainly prepared during radiographer education. Therefore, educational institutions have a responsibility to ensure that students have good understanding and awareness, so that they can apply radiation safety procedures in practice properly. Good education and training are important in the practices that implement radiation safety procedures (Zekioğlu & Parlar, 2021). On the other hand, insufficient knowledge and rumors about the dangers of radiation has caused excessive worry which can lead to poor service delivery (Zekioğlu & Parlar, 2021).

However, in reality the study findings on the evaluation of the level of knowledge and awareness regarding radiation safety practices among health care professionals showed gaps in knowledge about the biological effects of radiation, even in groups that continuously worked with radiation. Some healthcare professionals demonstrated an inadequate level of knowledge regarding the doses used in certain radiological imaging procedures, including those who actually underestimated such doses (Faggioni et al., 2017; Yurt et al., 2014). Radiation protection is at the heart of the radiographer's professionalism; therefore, a lack of basic radiation protection awareness is unacceptable. Radiographers play an important role as the final gatekeepers in the radiation protection chain (Paolicchi et al., 2016).

The study results still showed that there were students who had poor and moderate levels of knowledge and awareness regarding radiation safety that need intervention. Therefore, based on the study findings, several things can be suggested to increase knowledge and awareness of radiation safety. This study can be an initial reference for the importance of evaluating radiographer education programs related to radiation safety, both regarding the understanding and awareness aspects during

clinical practice. The curriculum needs to support students in realizing the importance of radiation safety aspects for themselves, patients as well as people in the surrounding environment. Further study is required to determine the factors that influence awareness regarding radiation safety so as to create more effective evaluation of improvements in radiation safety education.

4. CONCLUSIONS

Educational institutions, specifically radiology study program need to pay more attention to student competency achievement in radiation safety aspect. Such issue is crucial since students will carry out clinical learning in hospitals and they may have direct contact with radiation. Low knowledge and awareness regarding radiation safety can have detrimental effects on students and society. One way that can be applied to increase knowledge and awareness regarding radiation safety is through the development of learning models and media that are able to provide learning experiences in certain condition that is safe from radiation.

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