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Knowledge, Attitude, and Practice of Radiation Safety among Radiographers in the Government Hospital in Tai'an City

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Abstract
Radiographers are professionals tasked with operating equipment emitting radiation, such as X-rays and Computer Tomography (CT). The focus on their Knowledge, Attitude, and Practice (KAP) concerning Radiation Protection (RP) establishes a significant and imperative study area. This study endeavours to comprehensively investigate the KAP of RP among Radiographers in the Government Hospital in Tai'an City, aiming to explore correlations with various demographic and professional factors. In conclusion, the study asserts that myriad factors distinctly influence the KAP of RP among radiographers in the government hospital in Tai'an City.

Keywords: Radiation Safety; Knowledge, Attitude and Practice

1.0 Introduction

Medical imaging technology, an integration of information technology and medicine, has emerged as one of the most fascinating study areas in medical diagnostics (Gou Liang et al., 2002). Similar to X-ray technology, the identification of the internal structure of the human body is achieved by confirming the degree of X-ray absorption by organs of varying densities (Li & Zhang., 2013). Currently, especially in malignant tumours (Deng J, Xu S et al., 2018), the use of radiological equipment in clinical applications is growing. Nevertheless, radiation technology, being a double-edged sword, also poses implications for the health of the practitioners involved.

2.0 Literature Review

X-ray radiation is harmful to human health. Patients undergoing X-rays inevitably expose themselves to direct X-rays, while medical radiographers operating inspection machines are susceptible to scattered and leaking rays (Žauhar & Dresto-AlaB, 2021). These exposures can result in cumulative radiation doses that, over time, may increase the risk of harmful effects such as tissue damage or the development of radiation-induced cancers. While the benefits of X-ray technology are undeniable, the potential risks associated with radiation exposure must be carefully managed to protect the health and safety of patients and healthcare professionals. The

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radiographer's perception of RP is characterized by overcautiousness, carelessness, and lack of understanding. Moreover, different hospitals and regions of radiographers have different levels of knowledge about radiation protection (Zhou, 2016).

In recent years, studies have shown that radiographers in many regions of China demonstrate a relatively low overall level of protective awareness for both patients and accompanying individuals (Hu et al., 2010). There are differences in the level of radiation knowledge among practitioners in different medical fields. Some studies have also found that factors such as training, education, and position significantly affect radiographers' radiation knowledge. Therefore, the KAP (Knowledge, Attitude, and Practice) survey allows us to understand the current status of radiographers' knowledge, attitudes, and practices of RP and to develop targeted training and education programs accordingly to enhance the implementation of RP.

To date, no study has focused on the KAP of radiation safety among radiographers in the Government Hospital in Tai'an City, China. Hence, conducting regional research would provide valuable data and insights for local initiatives to raise awareness of radiation safety among medical professionals. This study concentrates on investigating radiation safety knowledge, attitudes, and practices among radiographers in Tai'an City. To identify possible gaps in the knowledge, attitudes, and practices of radiographers in different environments, to understand the current state of awareness of RP among radiographers in the Department of Radiology in Tai'an City, and to contribute to the improvement of safety awareness among radiographers in the region by providing relevant data and insights.

3.0 Methodology

3.1 Research Design

A cross-sectional study design was conducted in which the researcher administered a Knowledge, Attitude, and Practice (KAP) questionnaire to radiographers in the Radiographers Department across 18 governmental public hospitals in Tai'an. The radiographers were provided with explanations about the KAP questionnaire and requested to complete it before returning it.

3.2 Research Instrument

Knowledge, Attitude, and Practice (KAP) on Radiatiin safety, which was developed by Alvin et al. (2017), was used in this study. This KAP questionnaires gather in-depth information on individual characteristics such as educational background, professional competence, frequency of being exposed to radiation and various aspects of radiation safety, including the knowledge of radiographers of RP principles, their attitudes towards radiation safety guidelines, and their adherence to best practices in their daily work. In addition, this questionnaire asked a wide range of questions about radiation safety knowledge, attitudes, and practices, thereby providing a holistic understanding of the perspectives of radiographers on radiation safety. This questionnaire was translated into Chinese through a back-to-back translation process and validated by the researcher. The mean KAP score was 35.22 (SD=6.2). Cronbach's alpha of the translated KAP was 0.81; item-scale correlation ranged from 0.33–0.71.

3.3 Inclusion and exclusion criteria

The inclusion criteria for this study are:

- Senior radiographers or academicians who have at least a degree in medical imaging or medical techniques.
- Senior Radiographers who can understand Chinese.
- Radiographers who work at least five years.

The exclusion criteria is:

- Other health care professionals who work in the department, such as nurses and medical assistants,

3.4 Sampling and sample size

A cluster random sampling strategy was used to determine the participants. The sample size for this study was determined using the Raosoft Sample Size Calculator Online Software (2004). It was decided that the margin error of the study was set at 5%, with a confidence level of 95% and a response distribution of 50%. Currently, there are 373 Radiographers in the Government Hospital in Tai'an City. Hence, using the Raosoft sample size calculator, with a statistical significance (alpha) of 0.05 (95% confidence interval [95% CI]), 190 radiography participants are sufficient to provide 80% power of the study. Given the possibility of an alteration rate of 10%, the total sample that should be obtained is 210 radiographers.

3.2 Data collection

The data was collected at the 18 governmental public hospitals in Tai'an City from March 31, 2023, to May 31, 2023.

4.0 Findings

4.1 Descriptive analysis of the participants in the study.

A total of 245 questionnaires were distributed to the radiographers, and 230 questionnaires were returned, yielding a 93.9% response rate. The study respondents comprised 120 male radiographers (52.17%) and 110 female radiographers (47.83%). The age of respondents varied from 25 to 55 years, with an average age of 32.85 (4.84) years. Most respondents fell into the 35 to 45-year-old age group, accounting for 50.87% of the total respondents. In terms of their professional backgrounds, the average length of service among these respondents was 10.85 ± 6.84 years, with the range extending from 1 to 27 years. Intriguingly, a substantial portion of the respondents, amounting to 56.09%, reported not receiving any specific training on radiation safety. Moreover, 45.65% of the respondents indicated that they had not experienced radiation exposure in their work, as shown in Table 1 below.

Table 2. Distribution of Participants According to Exposure and Practice

Variable		Respondents (N)	Frequency (%)
Gender	Male	120	52.17
	Female	110	47.83
Age (Years old)	≤34	117	50.87
	35-45	113	49.13
Education level	Technical secondary school and below	8	3.48
	Junior college	39	16.96
	Undergraduate	125	54.35
	Postgraduate and below	58	25.22
Length of service (Years)	≤10	91	39.57
	>10	139	60.43
Hospital grade	The secondary III	111	48.26
	The grade III A	119	51.74
Receiving radiation safety training	No	129	56.09
	Yes	101	43.91
Radiation exposure while working	No	105	45.65
	Yes	125	54.35

4.3 Specific analysis

Table 2 summarizes participant distribution based on exposure to ionizing radiation and adherence to RP practices. Out of 161 participants (70.0%), exposure occurred at least once per week, while the remaining 30.0% had less frequent exposure. Only 132 participants (57.39%) consistently followed RP policies, procedures, and personal protective equipment (PPE) usage. This indicates that, although most are regularly exposed to ionizing radiation, a significant number do not adhere to recommended RP practices. Possible reasons for this lack of adherence include inadequate training, insufficient awareness of risks, or practical challenges in implementing RP measures.

Table 2. Distribution of Participants According to Exposure and Practice

Variable	Participants (No)	Frequency (%)
Exposure frequency (/week)		
Less than once/week	69	30.00
1 - 3 times/week	75	32.61
More than three times/week	86	37.39
Adherence to RP policies, procedures & PPE		
Adherent	132	57.39
Not adherent	98	42.61
Applicability & convenience of RP policies, procedures & PPE (yes)		
Lead aprons	144	62.61
Thyroid shields	121	52.61
Leaded gloves	150	65.22
Eyeglasses	138	60.00
Distance from the radiological device without protection during the procedure (meter)		
Less than 1 meter	8	3.48
1 - 2 meters	72	31.3
More than 2 meters	150	65.22

Table 3 provides overview of participants' knowledge regarding radiation doses in various clinical scenarios. This information is critical for understanding participants' awareness levels when making informed decisions about radiological investigations and minimizing the potential risks associated with ionizing radiation. The results reveal that 60.00% of participants correctly identified the background radiation equivalent dose, and 63.91% accurately recognized the radiation equivalent dose in chest X-rays. However, participants' understanding of the equivalent number of chest X-rays in different radiological investigations varied considerably.

Table 3. Distribution of Physician-knowledge Regarding Radiation Dose

Variable	Correct answers (No)	Frequency (%)
Radiation dose		
Background radiation dose (mSv)	138	60.00
Chest X-ray radiation dose (mSv)	147	63.91
Equivalent number of chest x rays in radiological investigations		
Ray-ray	69	30.00

CT	40	17.39
MRI	81	35.22
Ultrasound	167	72.61

Table 4 provides a detailed overview of participants' attitudes and perceptions regarding RP policies and procedures in their hospitals. The data highlights strengths and areas for improvement, particularly in physician understanding, confidence, and adherence to radiation safety measures.

Table 4. Distribution of Physician-knowledge Regarding Radiation Dose

Variable	Correct answers (No)	Frequency (%)
Policies and procedures on radiation precautions are clear and easy to understand	150	65.22
I feel confident about the steps I need to take when caring for patients needing radiation precautions	92	40.00
I know whom to contact if I have questions about what radiation precautions are needed for a particular patient	135	58.70
I can clearly explain the radiation precautions needed to patients and their visitors.	115	50.00
I feel safe when caring for patients needing radiation precautions	63	27.39
I feel the institutional policies and procedures are based on current regulations.	81	35.22
I feel confident the institution is carefully monitoring my radiation exposure.	35	15.22

As depicted in Table 4, a majority of participants (65.22%) found their hospital's RP policies and procedures to be clear and easily understandable. Additionally, 40.00% expressed confidence in understanding the necessary steps when caring for patients requiring radiation precautions. A notable 58.70% knew whom to contact if questions arose regarding radiation precautions for specific patients, while 50.00% felt capable of clearly explaining these precautions to patients and visitors. However, the data also revealed areas of concern. Only 27.39% of participants felt safe when caring for patients undergoing radiology examinations, which is notably low. Furthermore, 35.22% believed their hospital's policies were aligned with current regulations, and a significant 15.22% expressed confidence in their institution's careful monitoring of radiation exposure.

4.4 Result of analysis of factors affecting workers

Table 5 presents the associations between sociodemographic characteristics and the level of knowledge, attitude, and practice regarding X-ray protection. The table includes odds ratios (OR) with 95% confidence intervals (CI) and corresponding p-values to assess the significance of these associations. The odds ratios indicate:

1. There are no significant associations for KAP with gender, age and hospital grade.
2. There are as significant associations for knowledge with undergraduate, junior college, and technical secondary school and below compared to postgraduate education level. However, there are no significant associations with attitude or practice for any education level.
3. There is a significant association for KAP with a length of service greater than ten years compared to less than or equal to 10 years.
4. There is a significant association for knowledge KAP among participants who received radiation safety training compared to those who did not.
5. There are no significant associations between radiation exposure and knowledge or attitude. However, there is a significant association with practice for participants who experience radiation exposure while working compared to those who do not.

In summary, Table 5 presents the associations between various sociodemographic characteristics and the level of knowledge, attitude, and practice regarding X-ray protection. It highlights significant associations with education level, length of service, receiving radiation safety training, and radiation exposure while working. Unfortunately, it is disappointing to note that there are no significant associations with gender, age, or hospital grade in this study.

Table 5. Association between sociodemographic characteristics and level of knowledge, attitude, and practice of X-ray protection

Variable	Knowledge		Attitude		Practices	
	OR (95%CI)	p	OR (95%CI)	p	OR (95%CI)	p
①Gender						
Male	1		1		1	
Female	1.04(0.41-2.61)	0.940	1.93(0.77-4.87)	0.163	0.56(0.20-1.53)	0.255
②Age						
≤34	1		1		1	
35-45	0.98(0.43 - 2.20)	0.958	1.49(0.69 - 3.24)	0.312	1.03(0.46 - 2.29)	0.943
③Education level						
Postgraduate	1		1		1	
Undergraduate	0.31(0.14-0.66)	0.002	0.890.44-1.80)	0.744	0.39(0.19 - 0.81)	0.012
Junior college	0.17(0.06-0.50)	0.001	0.710.28-1.79)	0.467	0.12(0.05-0.32)	<0.001
Technical secondary school and below	0.23(0.03-1.56)	0.133	3.570.73-17.39)	0.116	0.19(0.04-1.02)	0.053
④Length of service						
≤10	1		1		1	
>10	2.66(1.20-5.90)	0.016	2.36(1.12 - 4.97)	0.023	2.85(1.31-6.18)	0.008
⑤Hospital-grade						

The secondary III			1		1	
The grade III A	1.43(0.77-2.69)	0.257	1.42(0.79-2.54)	0.239	1.18(0.66-2.10)	0.576
⑥Receiving radiation safety training						
No	1		1		1	
Yes	5.42 (2.39-12.30)	<0.001	2.63(1.21-5.72)	0.015	2.48 (1.17-5.27)	0.018
⑦Radiation exposure while working						
No	1		1		1	
Yes	2.26(0.84-6.08)	0.107	0.80(0.31-2.08)	0.652	3.60(1.29-10.05)	0.015

The variables represented by bars ① to ⑦, as shown in Figure 1 correspond to gender, age, education level, length of service, hospital grade, receiving radiation safety training, and radiation exposure while working, respectively. This graph comprehensively illustrates the influence of various factors, including gender, age, education level, length of service, hospital grade, receipt of radiation safety training, and radiation exposure at work, on radiographers' knowledge, attitudes, and practices.

In conclusion, the results presented in Table 5 suggest that factors such as length of service, training, and educational level significantly influence participants' KAP regarding radiation safety training precautions. To improve radiation safety, it is crucial to provide continuous education and training to participants, especially those with limited experience or lower educational levels. Implementing a targeted approach will help improve compliance with radiation safety precautions, ultimately promoting a safer healthcare environment for participants and patients.

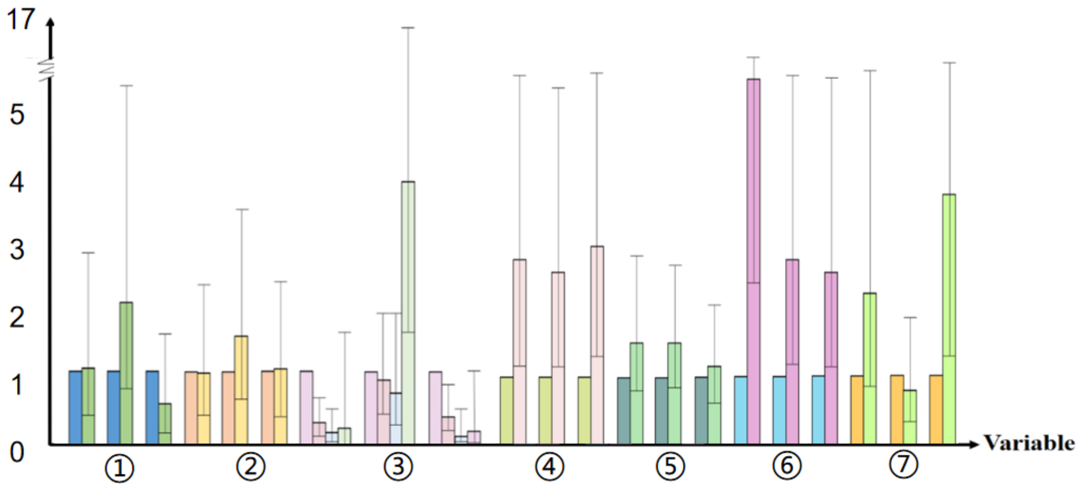

Fig. 1: Association Between Sociodemographic Characteristics and Level of Knowledge, Attitude, and Practice of X-ray Protection

5.0 Discussion

In this study, we assessed the KAP of radiographers in the field of RP in Tai'an City, China. Through an online questionnaire, we collected and analyzed the relevant data. The survey results showed that Tai'an City radiographers have insufficient RP knowledge. Only 35.22% have a good understanding of radiation prevention and control, and only 53.91% can strictly follow RP regulations. However, only 35.22% of respondents possessed a good knowledge of radiology control and prevention (scores above 80), indicating that the radiation safety knowledge level of X-ray workers in Tai'an City needed to be improved compared to other areas in China (Fang et al., 2020). This indicates that radiographers in Tai'an City need an effective pre-service and on-the-job training program in radiation prevention and control.

In terms of attitude, the survey also reflected several problems. Only 35.22% of the technologists believed that the policies and procedures of their hospitals were based on the latest regulations, and 15.22% of the technologists believed that the hospitals conducted strict monitoring of radiation exposure. The results highlight deficiencies in the RP system in some hospitals and also show a need for more clarity in the responsibilities of RP in these hospitals. Concerning hands-on practice, we found significant differences in the performance of radiographers from different regions and backgrounds. These differences may stem from variations in educational backgrounds, healthcare systems, policies, and the implementation of monitoring in these regions. However, attitudes toward RP are crucial drivers for positive changes in behaviour and practice (Kong et al., 2011).

Although China's Ministry of Health has made clear regulations on training related to radiation prevention and control, such as RP training for new radiation workers conducted at least four days before installation, radiological diagnostic and therapeutic workers must be trained and pass relative examinations, and the training of on-duty personnel shall not be less than two years, with each session lasting no less than two days (Zhang et al., 2018), there are still difficulties and challenges in practice. Our study found that many radiographers have not received any RP training. To change this situation, we recommend implementing the following strategies: updating and enforcing RP-related regulations, improving the frequency and quality of training, promoting a safety-first culture, and providing adequate resources and equipment. Implementing these strategies can effectively raise awareness of RP among healthcare professionals, thereby protecting the health of radiographers and patients.

6.0 Conclusion& Recommendations

In summary, radiographers in Tai'an City need to improve in RP knowledge, attitudes, and practices, with years of experience and training being the main factors affecting their performance. To improve the RP level of radiographers, attention should be paid to updating and enforcing relevant regulations on RP, increasing training efforts, improving the quality of training, advocating a culture of prioritizing safety, and investing sufficient resources and equipment. The combined implementation of these measures is expected to improve the RP level of radiographers to safeguard their own health and that of their patients.

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Paper Contribution to Related Field of Study

This paper will contribute to the field of radiography, radiation protection and health among radiographers.

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