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ARTICLE

Assessment of radiation knowledge and awareness among radiology staff in tertiary hospitals: a study in Wuxi, China

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Abstract – A number of previous studies have shown that the knowledge of radiation dose and its associated carcinogenic risk among radiology staff is inadequate. Underestimation of radiation dose and cancer risk in diagnostic procedures is prevalent, which may lead to suboptimal scanning parameters and potential overuse of radiation in daily practice. This study aimed to evaluate the knowledge of radiation dose and associated risks in common diagnostic radiological examinations among radiology staff in comprehensive tertiary hospitals in Wuxi, China. An online questionnaire survey was conducted among radiology staff from seven general tertiary hospitals.

Keywords: Radiation dose / radiation risk / diagnostic radiological examinations / radiology staff

Advancements in diagnostic radiology, including technologies like multi-slice spiral CT, have transformed the field in recent decades. These advancements have resulted in faster scanning speeds and higher resolution, making radiological examinations increasingly relied upon by clinicians (Sun *et al.*, 2016; Cool *et al.*, 2019). Previous studies have primarily focused on techniques for reducing radiation dose and have often overlooked the awareness of radiation dose and associated risks among radiology staff (Mossman *et al.*, 1982; Bochicchio *et al.*, 2001; Amis *et al.*, 2016; Furmaniak *et al.*, 2016; Faggioni *et al.*, 2017; Hong *et al.*, 2018). There have been few recent studies attempting to raise awareness of the potential risks and knowledge gaps regarding radiation dose during medical imaging examinations. Some reports have indicated a knowledge deficit among radiology staff concerning radiation dose and associated risks from common imaging tests (Faggioni *et al.*, 2017). While these studies were mainly conducted in Western developed countries, as well as in South Africa and Asia-Pacific countries such as Morocco, Iran, India, Palestine, Korea, and Hong Kong, no such studies have been conducted in mainland China (Azmoonfar*et al.*, 2016; Moifo *et al.*, 2017; Dauda *et al.*, 2019; Tahiri *et al.*, 2022; Bayatiani *et al.*, 2023; Mohebbi *et al.*, 2023). Therefore, we undertook this study to investigate the knowledge of radiation dose and related cancer risk associated with common radiological examinations among radiology staff in tertiary hospitals in China. In our study, we have chosen Wuxi where situated in eastern China and is known for its relatively developed economy as our research location.

An online survey questionnaire was conducted to investigate the knowledge and awareness of radiation dose levels and associated risks among radiology staff, including radiologists, radiologic technologists, and nurses, from seven tertiary comprehensive hospitals in the study area. The design of the questionnaire and the answer options were adapted from several previously published studies (Mossman *et al.*, 1982; Bochicchio *et al.*, 2001; Amis *et al.*, 2016; Furmaniak *et al.*, 2016; Faggioni *et al.*, 2017; Hong *et al.*, 2018). The questionnaire consisted of 17 questions (all details are given in Appendix).

A total of 216 questionnaires were collected, including 110 doctors (50.9%), 88 technicians (40.7%), and 18 nurses (8.3%) (Tab. 1).There was no statistically significant difference in the number of correct answers among the radiologists group, technicians, and nursing group.

The underestimation of CT ionizing radiation doses and their potential carcinogenic risks by radiology staff suggests a possible tendency for radiation overuse, such as extensive and excessive scanning (preferring larger scan ranges), failure to adopt low-dose scanning protocols (excessive pursuit of image quality while neglecting the minimum requirements for diagnosis), and neglecting reasonable shielding protection for non-scanned areas (Fig. 1). The data from this study showed that 74% of respondents overestimated the dose of CXR. In contrast to the general underestimation of CT and

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Table 1. Number of subjects in each group and their mean scores.

Group of subjects	Number of subjects, n (%)	Mean score of out of 15	Standard deviation
Radiologists	110 (50.9%)	4.6	±2.1
Technicians	88 (40.7%)	4.1	±1.6
Nurses	18 (8.3%)	3.7	±2.2
Total	216 (100%)	4.3	±2.0

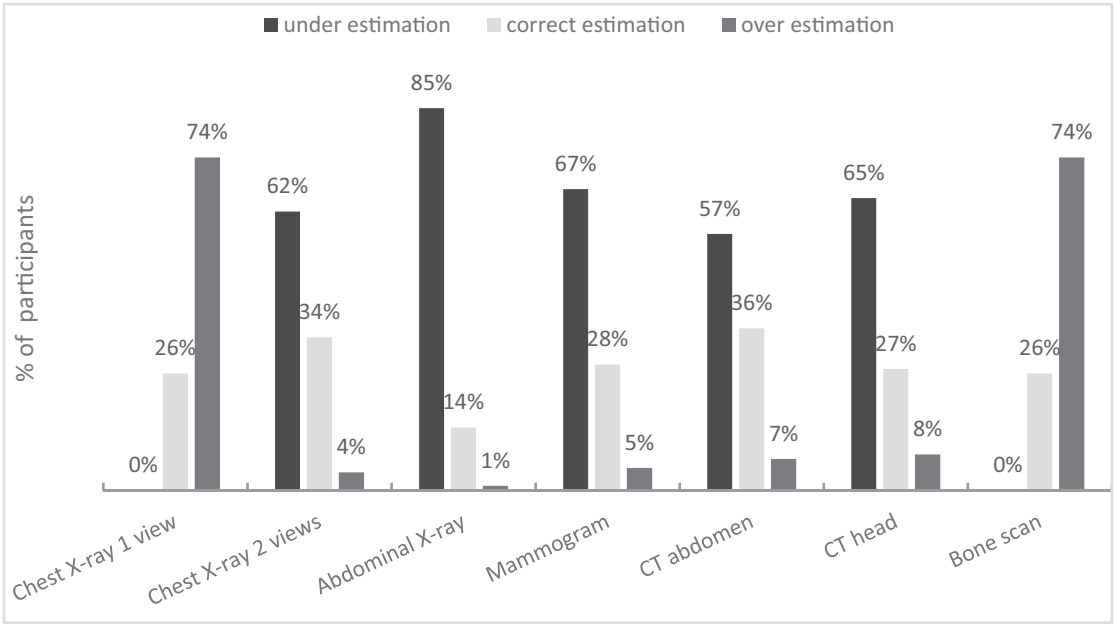

Fig. 1. Percentages of subjects who underestimated and overestimated the radiation dose for radiological examinations.

X-ray examination doses, a significant portion (74%) of radiology staff incorrectly believed that nuclear medicine examinations had higher doses. The management of radiation examinations for pregnant women is a complex topic (Mossman KL *et al.*, 1982). In general, CT scans and X-ray examinations should only be used when absolutely necessary and urgent. Our data reveals that only 8% of individuals were able to handle this situation correctly, and 17% of participants even suggested terminating the pregnancy. In reality, radiation impact on the fetus from X-ray or CT examinations outside the abdominal and pelvic region is primarily due to scattered radiation, resulting in very low and almost negligible doses (Mainprize *et al.*, 2023). Therefore, radiology staff should carefully weigh the benefits of appropriate imaging examinations against the associated radiation risks in order to select the optimal examination plan for pregnant individuals.

In the past 3 yr, particularly during the COVID-19 pandemic, CT has emerged as a diagnostic tool for COVID-19 pneumonia, leading to its more frequent use among the general public. In addition, some recent literature shows that it was significant for conducting regular training for relevant personnel (Dauda *et al.*, 2019; Bayatiani *et al.*, 2023; Mohebbi *et al.*, 2023). The aim of this study is to assess the level of knowledge and awareness regarding radiation dose and associated cancer risk among radiology staff in Wuxi, China. By focusing on radiology staff in Wuxi's tertiary hospitals, we can obtain valuable insights into the current understanding and perceptions of radiation dose and associated risks among professionals working in a region with a relatively developed healthcare system. The findings from this study will contribute to the existing literature on radiation knowledge and awareness, shedding light on potential knowledge gaps and areas that require further attention and education.

In conclusion, this study seeks to address the gap in knowledge regarding radiation dose and associated cancer risk among radiology staff in Wuxi, China. By examining the perspectives of professionals in a representative region, we aim to contribute to the growing body of literature on radiation awareness and ultimately enhance patient safety, optimize imaging practices, and ensure the provision of high-quality care in the field of medical imaging in Wuxi and potentially beyond. The results of this study may help identify specific areas for improvement in radiation education programs and serve as a basis for implementing targeted interventions aimed at enhancing radiation knowledge and promoting safe and responsible utilization of medical imaging resources.

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Conflicts of Interest

The authors of this manuscript declare no relationships with any companies, whose products or services may be related to the subject matter of the article.

Data availability statement

The original data can be accessed through the following link: https://book.yunzhan365.com/pwbhe/pcrx/mobile/index.html

Author contribution statement

Jiaqi Yuan, analyzed data and wrote the paper.
Dujuan Liu, performed the research and wrote the paper.
Jianming Ni, designed the study and writing-editing.

Ethics approval

Institutional Review Board approval was obtained.

Informed consent

Informed consent has been obtained.

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Appendix

Questionnaire on radiation risk and doses (Correct answers arehighlighted in italics). The growing demand for radiological examinations has resulted in an increase in medically-induced radiation exposure, posing a threat to public health in terms of elevated cancer risks. This survey questionnaire aims to understand the knowledge and awareness of radiation doses and cancer risks associated with common imaging examinations among radiology staff in our city's tertiary hospitals. This questionnaire is completely anonymous, and we will not obtain any information about you or your hospital. The results submitted by you and your colleagues will not be shared with your organization's management. If you are unfamiliar with specific questions, there is no need to search for answers deliberately; we simply hope to obtain genuine information. If you have no knowledge of a question, you may select an option that you consider plausible!

1 What is your current designation in the radiology department?
   (a) Radiologist
   (b) Technologist
   (c) Nurse
2 Average natural background radiation is in the range
   (a) 20–30 mSv
   (b) *2–3 mSv*
   (c) 0.2–0.3 mSv
   (d) 0 mSv
3 National annual radiation threshold for the public is
   (a) *5 mSv*
   (b) 10 mSv
   (c) 20 mSv
   (d) 30 mSv
4 Approximate effective dose received by a patient in asingle-view chest X-ray is
   (a) 0.5 mSv
   (b) 1 mSv
   (c) *0.02 mSv*
   (d) 0.05 mSv
5 Approximate effective dose received by a patient in atwo-view chest X-ray is
   (a) Almost equal to single-view chest X-ray
   (b) Twice the single-view chest X-ray
   (c) *5 times the single-view chest X-ray*
   (d) 10 times the single-view chest X-ray
6 Effective dose from asingle-view AXR is equivalent to
   (a) 0–1 chest X-ray (CXR)
   (b) 1–10 CXR
   (c) *10–50 CXR*
   (d) 50–100 CXR
7 Effective dose from aCT abdomen is equivalent to
   (a) 10–100 CXR
   (b) *100–500 CXR*
   (c) More than 1000 CXR
   (d) 1 CXR
8 Effective dose from CT head is equivalent to
   (a) 10–50 CXR
   (b) *50–100 CXR*
   (c) 100–500 CXR
   (d) less than 10 CXR
9 Dosage from two-view unilateral mammogram is
   (a) Almost equal to single-view chest X-ray
   (b) Twice the single-view chest X-ray
   (c) *10–20 times the single-view chest X-ray*
   (d) 50–100 times the single-view chest X-ray
10 Approximate effective dose received by a patient in awhole body bone scan is
   (a) 1–5 mSv
   (b) *5–10 mSv*
   (c) 10–20 mSv
   (d) 100 mSv
11 Approximate estimated risks offatal cancer from CXR
   (a) No: 0
   (b) *Minimal: 1 in 1,000,000 to 1 in 100,000*
   (c) Very low: 1 in 100,000 to 1 in 10,000
   (d) Low: 1 in 10,000 to 1 in 1,000
   (e) Moderate:1 in 1,000 to 1 in 500
12 Approximate estimated risks offatal cancer from Coronary CT angiography
   (a) Minimal: 1 in 1,000,000 to 1 in 100,000
   (b) Very low: 1 in 100,000 to 1 in 10,000
   (c) *Low: 1 in 10,000 to 1 in 1,000*
   (d) Moderate:1 in 1,000 to 1 in 500
13 Approximate estimated risks offatal cancer from CT head
   (a) Minimal: 1 in 1,000,000 to 1 in 100,000
   (b) *Very low: 1 in 100,000 to 1 in 10,000*
   (c) Low: 1 in 10,000 to 1 in 1,000
   (d) Moderate:1 in 1,000 to 1 in 500
14 Approximate estimated risks offatal cancer from Whole body PET/CT
   (a) Minimal: 1 in 1,000,000 to 1 in 100,000
   (b) Very low: 1 in 100,000 to 1 in 10,000
   (c) Low: 1 in 10,000 to 1 in 1,000
   (d) *Moderate: 1 in 1000 to 1 in 500*
15 Approximate estimated risks offatal cancer from CT chest
   (a) Minimal: 1 in 1,000,000 to 1 in 100,000
   (b) Very low: 1 in 100,000 to 1 in 10,000
   (c) *Low: 1 in 10,000 to 1 in 1,000*
   (d) Moderate:1 in 1,000 to 1 in 500
16 A pregnant woman underwent CT abdomen and pelvis with contrast as her pregnancy status was not enquired by the CT technologist before performing CT. What should be the course of action according to ACR guidelines?
   (a) Reassure the mother that the risk to the fetus is negligible
   (b) Suggest medical termination ofpregnancy as an option
   (c) Do genetic analysis by amniocentesis orchorionic villous biopsy
   (d) Do MRI ofthe fetus to look for CNS anomalies

17 Have you received any training concerning knowledge about radiation and its risks?
   (a) Yes
   (b) No
18 In what ways you acquire knowledge on radiation and its risks ? (multiple choice)
   (a) From theoretical teaching in medical school
   (b) From academic conferences
   (c) From department ofenvironmental protection radiation training
   (d) From education ofdepartment
   (e) From media
   (f) From colleagues
   (g) Others