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Assessment of Knowledge, Awareness, and Practice Towards Radiation Protection among Physicians: A Cross-Sectional Study at Tobruk

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Abstract:
Physicians who request radiological imaging must have a broad background in determining the importance of diagnostic imaging requests for their patients, as well as an adequate understanding of the associated risks. Although the radiological doses are relatively low and the likelihood of delayed effects is minimal, it is vital to minimize exposures as low as reasonably achievable. Successfully achieving this objective requires a thorough understanding and unwavering commitment to following radiation protection procedures. This cross-sectional study aims to investigate physicians' knowledge of radiation safety and their attitudes towards radiation protection. 121 non-radiologist physicians at Tobruk Town completed a survey between January and July 2023. Data was entered into Microsoft Excel and analyzed with SPSS, revealing several areas of inadequate knowledge. The proportion of physicians who had undergone a radiation protection course was less than 33%. A limited number of physicians demonstrated the ability to precisely respond to several scientific and knowledge-based questions. Only 18% of the participants demonstrated the ability to recognize the ALARA principle, and only 10% accurately ordered organs based on their radiation sensitivity. This study linked Libyan physicians' inability to participate in the radiation safety training course to their insufficient level of knowledge. To bridge this knowledge gap, it is necessary to increase awareness of potential hazards and practice radiation protection against ionizing radiation through continuing medical education and training programs.

Keywords: ALARA, Knowledge, Physician, Radiation Protection.

تقييم المعرفة والوعي والممارسة تجاه الحماية من الإشعاع بين الأطباء: دراسة مقطعية في طبرق

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الملخص
يجب أن يكون لدى الأطباء الذين يطلبون التصوير الإشعاعي خلفية واسعة فيما يتعلق بتحديد أهمية طلبات التصوير التشخيصي لمرضاهم وفهم كافٍ للمخاطر المرتبطة بها. على الرغم من أن الجرعات الإشعاعية منخفضة نسبيًا واحتمال حدوث تأثيرات متأخرة ضئيل، فمن المهم للغاية تقليل التعرض للأشعة إلى أدنى حد ممكن. يتطلب تحقيق هذا الهدف بنجاح فهمًا شاملاً والتزامًا ثابتًا باتباع الإجراءات الوقاية من الاشعة. تهدف هذه الدراسة المقطعية إلى دراسة تقييم معرفة الأطباء فيما يتعلق بسلامة الإشعاع ومواقفهم تجاه الحماية من الإشعاع. أكمل 121 طبيبًا غير متخصصين في الأشعة في مدينة طبرق استبيانًا بين يناير ويوليو 2023، وتم إدخال البيانات في Microsoft Excel وتحليلها باستخدام SPSS. كشف عن العديد من مجالات المعرفة غير الكافية. كانت نسبة الأطباء الذين خضعوا لدورة الحماية من الإشعاع، إما أثناء دراستهم الجامعية أو في بيئتهم المهنية، أقل من 33٪. أظهر عدد محدود من الأطباء القدرة على الاستجابة بدقة للعديد من الأسئلة العلمية والمعرفية. على سبيل المثال، أظهر 18% فقط من المشاركين القدرة على التعرف على مبدأ ALARA(أقل ما يمكن تحقيقه بشكل معقول) ، و10% فقط من المشاركين قاموا بترتيب الأعضاء بدقة بناءً على حساسيتهم للإشعاع. ربطت هذه الدراسة عدم قدرة الأطباء الليبيين على المشاركة في دورة تدريبية حول السلامة من الإشعاع بمستوى

معرفتهم غير الكافي. ولسد هذه الفجوة المعرفية، من الضروري تعزيز الوعي بالمخاطر المحتملة والحماية من الإشعاع المؤين من خلال برامج التعليم والتدريب الطبي المستمرة.
الكلمات المفتاحية: ALARA، المعرفة، الطبيب، الحماية من الإشعاع.

Introduction

Millions of people worldwide benefit from the diagnostic and therapeutic use of ionizing radiation. According to the United Nations, over 3,600 million radiological imaging procedures are conducted annually to diagnose various diseases, and 7.5 million treatments, including radiotherapy, are administered to patients each year. Primary diagnostic radiological modalities include fluoroscopy, X-ray, computed tomography (CT), mammography, and positron emission tomography (PET) [1].

The average annual radiation dose to the general population is 2.5 millisieverts (mSv), with medical exposure resulting in around 15% of this burden [1,2]. Within the last twenty years, there has been a widespread rise in medical exposure, primarily due to the use of CT scanning. According to estimates, while most medical exposures are beneficial for therapeutic purposes, over 20% of these exposures are considered to be detrimental to clinical outcomes. Estimates suggest that this and other unnecessary medical radiation exposure is responsible for 100-250 of the cancer deaths that occur annually in the UK [2].

Radiation protection refers to the scientific field concerned with maintaining worker and public health by minimizing exposure to unnecessary radiation. The basic principle of radiation protection is to assess the potential risks and advantages associated with the application of radiation. Exposure is regarded as justifiable only when the advantage obtained from using a source exceeds the risk involved related to exposure.

In radiation protection, the objectives are precise measurement of radiation exposure to workers and the general public, as well as the development and implementation of techniques to minimize this radiation. [3]

Radiation has non-stochastic (deterministic) and stochastic biological effects. Deterministic effects are dose-dependent, meaning medical effect and severity are proportional to the amount of dose. The stochastic effect causes biological harm at an unknown dose. The amount of dose determines the probability of the response, not its severity. Most stochastic effects come from modest radiation doses. Stochastic effects put doctors and patients at risk. Despite the modest quantity of exposure, it is necessary to minimize radiation to avoid dose buildup in doctors and patients. Thus, a patient should only have a radiograph if the benefits outweigh the risks [3].

A set of rules have been established to improve knowledge about radiation risks and the appropriate procedures to be followed in order to protect those undergoing medical treatment or investigation. The specified measures include the POPUMET regulations, ALARA (as low as reasonably possible) philosophy, and the global commitment of the World Health Organization (WHO) on radiation safety in hospital settings. By incorporating radiation protection into conventional medical practice, these regulations and principles encourage all those involved in healthcare services to pay attention to radiation safety standards. Essential principles that direct this attempt are the procedures of risk assessment, risk management, and risk communication [3,4].

No study has evaluated the level of awareness regarding radiation protection among physicians in Libya [3] Consequently, this study aims to assess the knowledge, awareness, and attitude of non-radiologist physicians regarding radiation hazards and protection at Tobruk City University Hospitals and Clinics. [4] [6]

Several studies worldwide investigated doctors' opinions on the risks of ionizing radiation in diagnostic procedures and radiation protection. [7] [8]

surveys published by researchers revealed an inadequate level of radiation safety knowledge among healthcare personnel. [9] In addition, the majority of participants lacked any radiation safety training course. Although radiologists and oncologists were more often exposed to ionizing radiation, their knowledge of the risks was similar to that of non-radiologists. The overall knowledge evaluations ranged from 40% to 60% [10] [11]

Methodology

This study was a cross-sectional assessment conducted over a period of three months, from January 2023 to March 2023. The survey focused in particular on all physicians rather than the non-radiologists who work at various departments of Tobruk Hospitals and Clinics.

Following the distribution of the questionnaires, the participants received instructions to promptly complete them, ensure their anonymity, and promptly return them. This eliminated the need for the participants to explore the internet for responses that were correct. They also received instructions to stay in the room until they had presented all possible replies. There was no set time limit for filling out the questionnaire. We carefully directed the participants not to respond to the questionnaire again if they had already done so to prevent duplications. All participants were duly notified that their involvement in this research was entirely voluntary. Our study included a validated questionnaire acquired from Khamtuikrua et al. [12]. The questionnaire covered three sections: demographic data, awareness and attitude of radiation protection measures, and knowledge of the hazards associated with radiation.

Participants answer the following demographic information in the first section of the questionnaire: age, gender, years of work experience, primary interest, duration of professional experience, the percentage of total working

hours the respondent spent exposed to radiation in the previous 12 months, and previous participation in a radiation hazards and protection course.
The second section of the study targeted participants' knowledge of radiation risks and their regular application of personal protection equipment, namely a lead apron and a thyroid shield while working in a radiation-exposed area.
The third section involved requesting participants to estimate the effective radiation doses linked to different imaging modalities and the corresponding number of chest X-ray scans (CXR equivalent) that generate the same doses. Furthermore, the study assessed their knowledge of the radiosensitivity of various organs in the body and their ability to distinguish between imaging techniques that involve ionizing radiation and those that do not.
Participants were requested to select the range of an estimated equivalent number of chest X-ray scans considered acceptable. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) report provided the answers to these questions [13]
In this section a group of multiple-choice questions. Each question had four answer choices, one of which indicated the correct answer. Each correctly answered question obtained a single point, whereas any wrong or missing answer received 0 points under the assessment model.

Statistical analysis
Statistical Packages for Software Sciences (SPSS) version 26 (IBM Corp., Armonk, NY) was employed to conduct all data analyses, and Microsoft Excel (Microsoft® Corp., Redmond, WA) was employed to input data.

Ethical approval
The Human Research Ethics Committee of the Faculty of Medical Technology at Tobruk University approved the questionnaire and methods developed for this study. To obtain permission for data collection from the hospital, a formal letter was received from the hospital's administrator. After explaining the study's objective and that the data would be used for scientific purposes, all participants gave informed consent.

Results
A convenient sample size of 140 questionnaires was distributed, however only 121 were correctly and completely filled out and returned, providing an 86.4% response rate.
The average age of participants was 39 ± 9 years (25-60 years). Most participants were male (55.4%) and female (44.6%). The participants who answered the questionnaire of our study are outlined in Table 1, which contains their characteristics.
The mean estimated percentage of time that participants had worked in a radiation-exposure environment during normal working hours over the previous year was 30.5% ± 21.8% (0%-110%).
Approximately 17% of the participants had already received professional radiation protection training. An estimated 83% of the physicians had never undergone any radiation protection-focused training or course before.

Table 1. Background characteristics of the participating physicians from Tobruk Hospital and Clinic (n = 121)

Items	No (%)
Age	121(100) SD (39±)
Gender	
Male	67(55.4)
Female	54(44.6)
Main interest	
Medicine	57(47.1)
Surgery	64(52.9)
Years of clinical practice	
< 5	58(47.9)
5 to 10	35(28.9)
11 to 20	23(19)
> 20	5(4.13)
Radiation exposure in the past 12 –months	
<25%	51(42)
25% - 50%	32(26)
>50% - 100%	38(31)
Training in radiation protection	
Yes	20(16)
No	101(84)

Awareness of radiation hazards

In terms of the potential risks that medical radiation could be hazardous to human beings, the majority of participants (61.1% of them) indicated a strong belief in the matter. However, a significant majority of respondents (35.9%) believed that it wasn't presenting a major risk, while just only a small percentage of respondents (3%), on the other hand, believed that it wasn't causing any risk. Figure 1.

A total of 7% and 20% of the participants reported regularly using a lead apron and a thyroid shield when working in an environment exposed to radiation, respectively. Nonetheless, more than 67% of the participants said they had never worn lead shielding in such radiation-exposure work as shown in Figure 2.

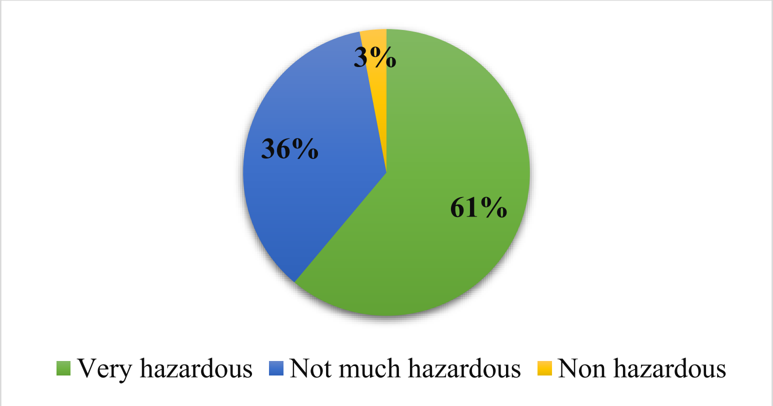

Figure 1. Distribution of medical radiation hazard

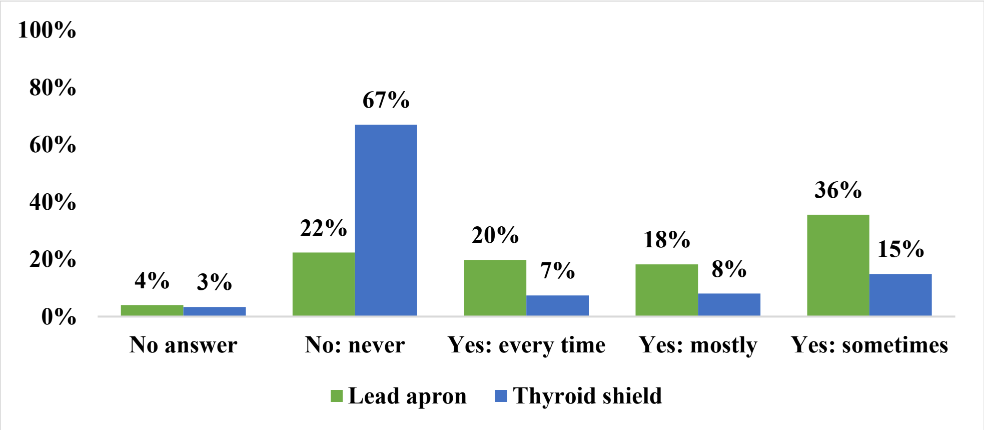

Figure 2. Physicians' distribution based on their regular commitment to wearing lead aprons and thyroid shields in a radiation-exposure workspace

Radiation Protection Knowledge

The International Commission on Radiological Protection (ICRP) established as low as reasonably achievable (ALARA) as the basic principle of radiation protection, and on average, 17.9% of participants correctly identified this principle. Roughly 3% of the participants correctly specified the precise distance that must be carefully maintained between a worker and a radiation source. Most of the participants were unaware that patients are not bound by an annual recommended dose. Approximately 35% of the participants indicated their preference for selecting "I don't know" as their primary answer to the majority of questions. Moreover, less than 5% of the participants provided correct answers to all the questions in Figure 3.

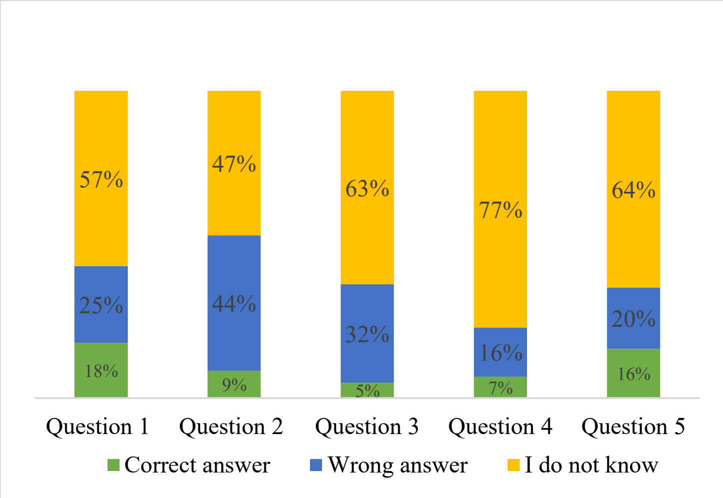

Figure 3. Participants' answers to questions related to general principles of radiation protection

By asking participants to categorize the sensitivity of various organs to radiation, a significant majority (70%) provided incorrect answers regarding the radiosensitivity. Specifically, 84%, 75%, 79%, and 63% of participants incorrectly categorized the kidney, bladder, stomach, and gonads, respectively. It was observed that the kidney had the least sensitivity, while the gonads were the most sensitive as shown in figure 4.

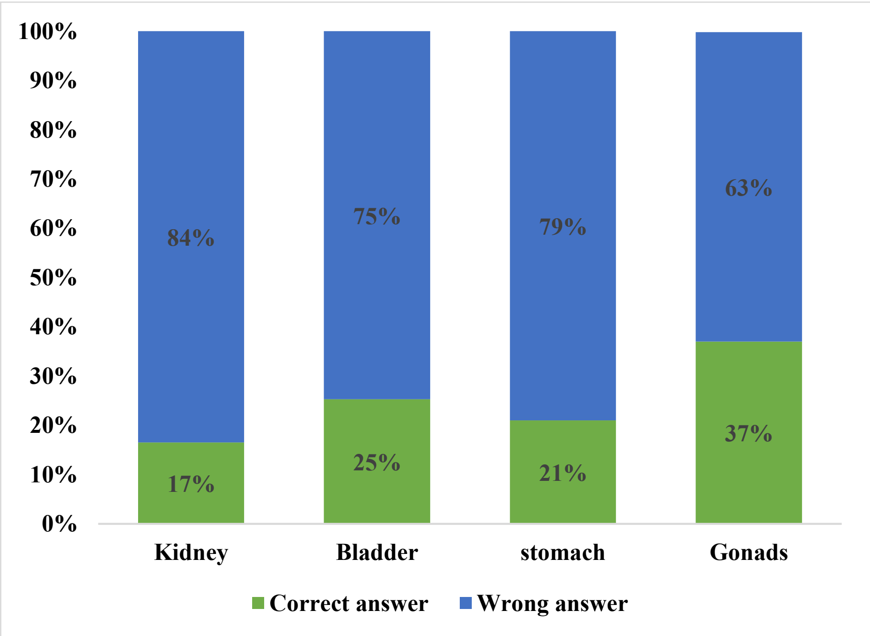

Figure 4. Knowledge about the degree of radio-sensitivity of different organs.

A majority of the participants (75%) provided inaccurate responses, indicating that tests involving ionizing radiation, such as Barium of upper and lower GI, CT scan abdomen, and IVU, are not radiation-related. On the other hand, investigations that do not involve radiation, such as ultrasound of the abdomen, Doppler ultrasound of the lower limb, MRI of the abdomen, and MRI of the brain, are indeed radiation-related Figure 5. Only 9% of the participants accurately categorized all the investigations that were provided.

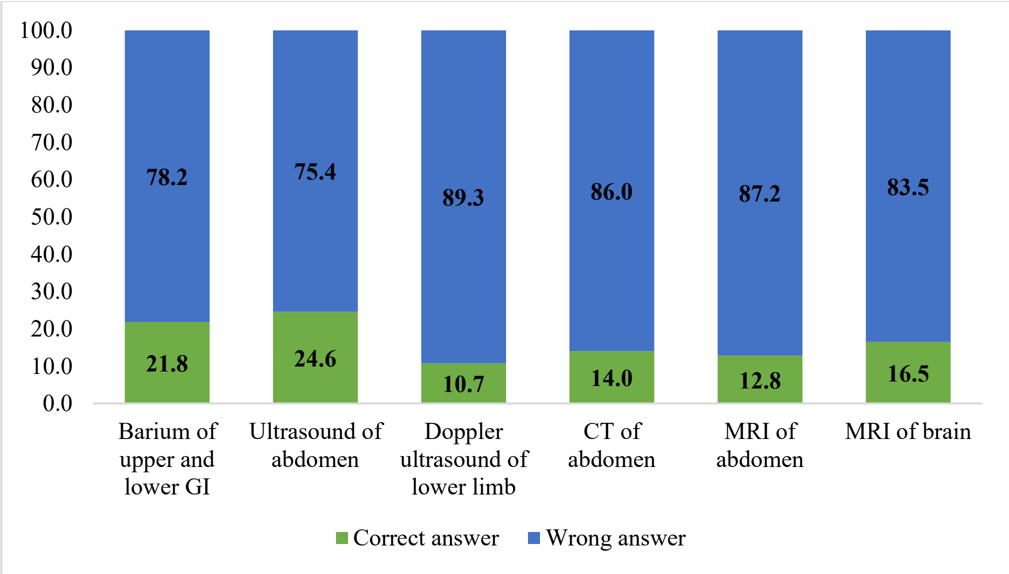

Figure 5. Participants' identification of image modalities that use ionizing radiation and those that do not use ionizing radiation

The overall average correct dose estimation rate was 6%, with only 9.9% of participants correctly estimating the CT scan abdomen. For the CT scan L-spine, 8.3% of participants provided an accurate estimate of the dose. About 5% of participants provided an accurate barium dose estimate for a meal. For an IVU, (2.5%) of participants estimated the radiation dose accurately. However, most participants answered “I don’t know” (62%).
Table 2 displays the percentages of correct answers, underestimations, overestimations, and "I don't know" responses for each imaging modality in relation to the chest equivalent dose, without any discernible correlation.

Table 2. Estimations of radiation doses used in various investigation

Dose in(CXR Equivalent)	1 to 99	100 to 199	200 to 499	Don't know	No answer
CT abdomen	8.3	14.0	**9.9**	25.6	42.1
CT of head	4.1	**8.3**	11.6	31.4	44.6
Barium meal	9.9	5.8	**5.0**	36.4	43.0
IVU	8.3	6.6	**2.5**	39.7	43.0

Discussion

Recently, there has been a significant increase in the use of medical procedures, including radiological examinations. As a result, there has been a gradual increase in radiation exposure for both patients and medical personnel [1, 2, 5]. As a result, this research is critical because it is the first attempt to assess the level of knowledge, awareness, and attitude towards radiation protection measures among physicians in Tobruk Twon.
Previous studies have clearly demonstrated that continuous and long-term exposure to ionizing radiation could increase the risk of cancer and other disorders in several anatomical areas throughout the body [2, 6]. This aligns with the results of our questionnaire, in which a significant proportion of respondents (63%) defined radiation exposure from everyday activities as very hazardous. Furthermore, a few participants said that they often used a lead apron and a thyroid shield when working in a location that included radiation exposure. In contrast, the findings of Friedman et al indicate that the use of body and thyroid shields was considerably high, with rates of 99% and 73% respectively [14].
The results of the questionnaire revealed that a small proportion of the physicians, roughly 20%, had participated in a radiation protection course either during their undergraduate studies or at their professional environment. Consistent with the findings of YA Alshabi et al, 89.5% of physicians reported lacking previous training in radiation safety. The inability of doctors to acquire sufficient knowledge and awareness may be attributed to the absence of a comprehensive training program on ionizing radiation safety during their medical residency [15]. The given situation suggests the need to establish and develop courses or training workshops in both medical colleges and hospital settings, taking into account the frequent updates in biological and physical knowledge, as well as radiation safety standards.
Our findings showed that the great majority of the participants (80%) did not know that investigations involving ionizing radiation fared less well, and it was surprising to observe that 75% of participants were unaware that

sonography has no ionizing radiation, and 87% of participants were unaware that MRI does not involve ionizing radiation. The percentages observed were greater than those documented in other studies [2, 3]. This outcome could be due to a lack of radiation protection training; 84% of the physicians who participated in our study had no training. This lack of awareness may stem from the lower availability and utilization of MR facilities in certain centers, as well as their relative costs. These factors suggest a pressing need for enhanced educational initiatives aimed at healthcare professionals. By improving understanding of image modality and its safety, we can ensure better patient care and informed decision-making within medical practices.
Insufficient understanding of radiological matters was clearly apparent, as only 18% of our participants were able to recognize the ALARA principle, despite its fundamental importance in the radiation protection philosophy. The estimated number is considerably smaller than the percentages recorded in previous studies, which ranged from 20% to 50%. [3,16,17,18].
In addition, Physicians should have the ability to evaluate the possible radiation doses associated with various medical imaging procedures and estimate the effective doses in chest X-ray equivalent units. This approach has demonstrated its usefulness not just in prior non-radiology-oriented research but also in facilitating patients and their family's comprehension of the relative hazards. [17,18] On average, only 6% of the physicians demonstrated the ability to estimate the effective dose equivalent in relation to a chest X-ray dose for a CT scan of the abdomen, a CT scan of the lumbar spine, an IVU, and a barium meal examination. Comparable findings from other studies in the literature suggest that, on average, less than 6% of non-radiologists were able to differentiate between these equivalent doses.
Surprisingly, 85% of the participants who contributed part in our study were unable to recognize the gonads as the organ that is most sensitive to harm from ionizing radiation. This contradicts the findings of a study conducted in Turkey by Zekioğlua and Parlar, which demonstrated that the majority of the physicians who participated possessed an exceptionally high level of knowledge [19,20].
However, in this study, the majority of physicians chose to select "don't know" or leave the question without an answer rather than randomly guessing the correct answers. Such choices may be a positive indication that they are aware of their lack of knowledge and, hence, the importance of receiving training in radiation protection.
The results seem to support the ICRP reports, which suggested that a significant number of imaging procedures were obtained globally without sufficient justification [20, 21].
This understanding demonstrates how important it is for physicians to pursue ongoing education and professional development. Healthcare professionals can improve patient safety and guarantee that imaging procedures are both justified and optimized by giving radiation protection training their highest priority.

Conclusion

According to the findings of this study as well as those of other studies, the lack of knowledge physicians have about radiation doses and safety leads to an increase in the risk of radiation exposure for both patients and radiology staff. This is a matter that warrants attention, especially considering an increasing number of radiological examinations, and this was connected to the fact that they did not attend any training program. Considering this reality, and to help physicians to request radiological tests taking into account the potential risks and benefits, they need to possess an awareness of ionizing radiation doses and its associated hazards. If this awareness is inadequate, patients may be subjected to more investigations and exposed to radiation doses that are higher than the required levels.

Limitations

The most significant issue that we had in this study was the relatively small size of the sample. This was the most significant challenge that we faced in this investigation. It is therefore necessary to do additional studies with a larger number of participants in order to acquire an improved understanding of the subject matter. In addition, the percentage of physicians who participated in our questionnaire was 71%, and it would have been advantageous to have a greater percentage.
The low levels of knowledge that were acquired in this study were the result of a number of different variables. A formal education on this subject was never received by the undergraduate student. In postgraduate education, there is a lack of awareness of fundamental scientific ideas, and there is no coordinated continuing teaching on radiation protection in hospitals. Radiation dose badges and other radiation safety equipment were not readily available, which may be one of the primary reasons why they were not utilized. In addition, there was an inadequate supply of radiation safety equipment. Due to the fact that there was no consistent monitoring of radiation exposure throughout the year, it is difficult to determine the typical amount of radiation exposure that occurs in hospitals.
It was our belief that the following solutions would be beneficial to the understanding of individuals who are physicians:

1. Make a suggestion that it is necessary to design and run training workshops or courses on radiation protection, both within medical schools and in hospitals, taking into account the rapid changes that occur in the biological and physical information that is accessible as well as the radiation safety requirements.
2. A approach that may improve awareness among physicians and limit the number of unneeded investigations is to develop a collaboration between the departments of the hospital and the radiology departments in order to set local protocols for when to order radiographic investigations and what to order.

References

1. Ionizing radiation, health effects and protective measures. WHO. 2016. [[Last accessed on 2020 Jul 21]]. Available from: http://www.who.int/topics/radiation_ionizing/en/
2. 2.Ebdon-Jackson, S., Frija, G., & European Society of Radiology. (2021). Improving justification of medical exposures using ionising radiation: considerations and approaches from the European Society of Radiology. Insights into Imaging, 12, 1-11.
3. Frane N, Bitterman A. StatPearls [Internet] Treasure Island (FL): StatPearls Publishing; 2022. Radiation safety and protection. [PubMed] [Google Scholar]
4. Algohani, K. A., Aldahhasi, A. A., Algarni, A. H., Amrain, K. Y., & Marouf, M. A. (2018). Awareness of radiation protection measures among radiologists and non-radiologists. The Egyptian Journal of Hospital Medicine, 70(3), 371-375.
5. Dsouza, A. I., Dcunha, S., & Suresh, S. (2013). A study on the awareness on occupational health safety among health care professionals in radiology department in a selected hospital. RGUHS Journal of Medical Sciences, 3(2).
6. Swapna, L., Koppolu, P., Takarji, B., Al-Maweri, S., Velpula, N., Chappidi, V., & Ch, L. (2017). Knowledge on radiation protection & practice among dental students. British journal of medicine and medical research, 19(7), 1-7.
7. Abdellah, R. F., Attia, S. A., Fouad, A. M., & Abdel-Halim, A. W. (2015). Assessment of physicians' knowledge, attitude and practices of radiation safety at Suez Canal University Hospital, Egypt. Open journal of radiology, 5(4), 250-258.
8. Salih, S., Zeidan, Z. A., Alzalabani, A., Albadrani, M. S., & Yousef, M. (2014). Awareness and knowledge towards ionizing radiation hazard among medical students, interns and residents in Al-Madinah Al-Munawarah, KSA. Life Sci J, 11(3), 6-10.
9. Emayof, M. A., Nweh, W. A., Qaseem, H., & Mohammed, H. (2025). Original Article Knowledge, Attitude, and Practice of Dentists towards Radiation Safety Procedures: A. مجلة البيان العلمية, 7(19), 204-194.
10. Günalp M, Gülünay B, Polat O, Demirkan A, Gürler S, Akkaş M, et al. Ionising radiation awareness among resident doctors, interns, and radiographers in a university hospital emergency department. Radiol Med. 2014; 119:440–447. [PubMed] [Google Scholar]
11. Keijzers, G. B., & Britton, C. J. (2010). Doctors' knowledge of patient radiation exposure from diagnostic imaging requested in the emergency department. Medical journal of Australia, 193(8), 450-453.
12. Khamtuikrua, C., & Suksompong, S. (2020). Awareness about radiation hazards and knowledge about radiation protection among healthcare personnel: a quaternary care academic center–based study. SAGE Open Medicine, 8, 2050312120901733.
13. Hamarsheh, A., & Ahmead, M. (2012). Assessment of physicians' knowledge and awareness about the hazards of radiological examinations on the health of their patients. EMHJ-Eastern Mediterranean Health Journal, 18 (8), 875-881, 2012.
14. Friedman, A.A., Ghani, K.R., Peabody, J.O., Jackson, A., Trinh, Q.D. and Elder, J.S. (2013) Radiation Safety Knowledge and Practices among Urology Residents and Fellows: Results of a Nationwide Survey. Journal of Surgical Education, 70, 224-231. http://dx.doi.org/10.1016/j.jsurg.2012.10.002.
15. Alshabi, Y. A., Yasawy, M. A., Makhdoom, A. K., Kablaghli, R. A., Alanazi, K. S., Eid, S. M., & Imran, W. M. (2022). Knowledge regarding ionizing radiation exposure safety among orthopedic surgeons at hospitals in Al-Madinah. Cureus, 14(10).
16. Madrigano, R. R., Abrão, K. C., Puchnick, A., & Regacini, R. (2014). Evaluation of non-radiologist physicians' knowledge on aspects related to ionizing radiation in imaging. Radiologia brasileira, 47, 210-216.
17. Najjar, R. H., Alsulaiman, A. M., Alraddadi, J. S., Alrohaimi, N. H., Algarni, B. A., Al-Arafa, A. M., & Alsubait, R. A. (2022). Assessment of Physicians' Knowledge and Awareness About the Hazards of Radiological Examinations on the Health of Their Patients at a Tertiary Care Hospital, Riyadh, Saudi Arabia. Cureus, 14(7)

18. .18. Hamarsheh, A., & Ahmead, M. (2012). Assessment of physicians' knowledge and awareness about the hazards of radiological examinations on the health of their patients. EMHJ-Eastern Mediterranean Health Journal, 18 (8), 875-881, 2012.
19. Alotaibi, A. E., & Muhyi, N. A. (2019). Assessing the radiation protection knowledge among non-radiologists. International Journal of Medicine in Developing Countries, 3(2), 159-159.
20. Zekioğlu, A., & Parlar, Ş. (2021). Investigation of awareness level concerning radiation safety among healthcare professionals who work in a radiation environment. Journal of Radiation Research and Applied Sciences, 14(1), 1-8.
21. Krille, L., Hammer, G. P., Merzenich, H., & Zeeb, H. (2010). Systematic review on physician's knowledge about radiation doses and radiation risks of computed tomography. European journal of radiology, 76(1), 36-41.