www.jcimcr.org

JCIMCR OPEN ACCESS Journal of Clinical Images and Medical Case Reports

ISSN 2766-7820

Research Article

Open Access, Volume 5

Awareness of radiation hazardous, protection and safety among the physicians in PHCC, Qatar: A cross-sectional study

Tamer F Ali[1]*; Abdelwahed Samir Abougazia[1]; Maryam M AlEmadi[2]; Amal S Mahran[1]; Ahmed A Ibrahim Khedr[1]

[1]Radiology Department, Consultant Radiologist, PHCC, Doha, Qatar.

[2]Senior Consultant, Family Medicine, PHCC, Doha, Qatar.

***Corresponding Author: Tamer F Ali**

Radiology Department, Consultant Radiologist, PHCC, Doha, Qatar.

Email: dr.tamer1973@gmail.com

Received: Jan 22, 2024

Accepted: Feb 14, 2024

Published: Feb 21, 2024

Archived: www.jcimcr.org

DOI: www.doi.org/10.52768/2766-7820/2871

Abstract

Background and aim of the work: The vision of PHCC is to be the leader in transforming the health and wellbeing of people's lives in Qatar. Radiology department covers medical imaging services all over the country as a frontline for patient management. Diagnostic radiology is the field of medicine that uses imaging studies and procedures to diagnose a patient. Using of ionizing radiation in medical imaging has been rapidly increasing since the discovery of X-Ray due to the advancements in medical imaging technology. The aim of this study is to evaluate the current awareness level of PHCC physicians toward the radiation hazardous, safety and protection.

Materials and methods: A cross-sectional survey, an online questionnaire gauging awareness of PHCC physicians toward the radiation safety and protection was distributed to PHCC physicians. Data was analyzed using descriptive statistics.

Results: 152 physicians shared in this survey, 59% were males and 49% were females. Majority of sharing physicians was family medicine (80%). The current study shows different levels of radiation awareness among primary health care physicians with wide variation so some physicians have a well understanding of the radiation exposure risks and therefore taking the required precautions that can minimize these risks, others showed lack knowledge and awareness of radiation safety.

Majority of participants could not identify correctly the patient absorbed dose from a chest X-ray as well as the approximate effective radiation dose from a chest X-ray compared to natural background radiation. On the other hand, majority of participants (87.5%) could identify lead as the correct material of radiation protection apron. While the majority could realize that children are the most sensitive to radiation, still a high percentage (41%) did not know this, similar result to identify the most sensitive organs to radiation. While majority (62%) thought that the risk for developing cancer increase with the dose value and may be present even with a single exposure. Majority of respondents had accurately realized that the approximate effective dose that a patient receive in a two-view CXR is considered twice the single-view CXR.

On the other hand, the study confirmed the high frequency of X-ray requests the PHCC physician needs in current daily work (94% are requesting sometimes, usually or always) while 5.5% rarely do. The study showed that about 53% of patients and/or their families are rarely or never asking

about the radiation risks of their requested procedure while 92% of participants explain these risks versus benefits of X-Ray to their patients (65.5% are usually or always do). 81% of participants never request X- Ray for pregnant ladies while 17% can request after observing the pros and cons of such an examination, notify the patient about the potential outcomes, and request a lead-vest to be worn by the patient. Majority of participants (85%) believe that both prescriber and practitioner share the professional responsibility for protecting patients from unnecessary radiation doses, and forbid unjustified exposure to ionizing radiation and place responsibility for protecting patients from unnecessary radiation which agrees with the recommendation of International Commission on Radiological Protection (ICRP). 60.5 % of participants could understand that pregnant women should not be submitted to or screening mammography. Only 53 % could identify CT as being the highest source of radiation dose among modalities used in medicine. Majority of participants (85%) could correctly identify US as being a non-ionizing radiation imaging modality and 35.5% could know that PET CT has a prolonged period of emitting radiation.

Conclusion: This study highlighted the need for more radiation safety education and training program for primary health care physicians to improve the level of radiation awareness and safe practices. Implementing of radiation safety training can help to reduce the radiation exposure risk in primary health care.

Keywords: PHCC; Radiation; Awareness; Radiologists; X-Ray.

Abbreviations: PHCC: Primary Health Care Cooperation; ALARA: As Low as Reasonably Achievable; ICRP: International Commission on Radiological Protection.

Background

The vision of PHCC is to be the leader in transforming the health and wellbeing of people's lives in Qatar. Radiology department covers medical imaging services all over the country as a frontline for patient management. In 1895, a German physicist -Roentgen- discovered a new kind of rays. This was more than 125 years. The X-rays are used every day all over the world representing millions of diagnostic radiology procedures. The development of medical imaging processes has, since its discovery, showed a great ability to give the human population great benefits when used for diagnosis. Diagnostic radiology is the field of medicine that uses imaging studies and procedures to diagnose a patient [1-5]. Using of ionizing radiation in medical imaging has been rapidly increasing since the discovery of X-Ray due to the advancements in medical imaging technology. Some recent studies have highlighted the carcinogenic potential of ionizing radiation even in low dose [6-8] which makes the importance of radiation protection awareness to be very important and necessitates the optimization of the use of radiation in medical imaging, this can be achieved through the collaborative effort of the radiology staff and referring physicians [9]. It is also a task of radiology staff to check if the X-Ray is obligatory as they are educated to have a good knowledge on the safety measures and optimization procedures. In addition, It is expected from them to disseminate the awareness regarding wise use of radiation among other staffs and the public. Therefore, radiation awareness is essential to ensure rational use of ionizing radiation in medical field [8-19].

Aim of the study: To evaluate the current awareness level of PHCC physicians toward radiation hazards, safety, and protection. This study can identify and measure the current awareness level of PHCC physicians toward radiation hazards, safety, and protection.

Materials and methods

Study design

A cross-sectional survey, an online questionnaire gauging awareness of PHCC physicians toward radiation safety and protection was distributed to PHCC physicians. Data was analyzed using descriptive statistics.

Study setting

A cross-sectional anonymized questionnaire survey was conducted for physicians in all PHCC health centers distributed across the different regions to collect their replies regarding the awareness of radiation safety and protection. The survey included demographic characteristics (age and work experience) and short questions related to radiation protection. Several questions were administered to each participant, questions were related to the general information regarding training, knowledge, and experience of medical radiation imaging as well as to measure the level of understanding of radiation hazards and protection.

Respondents were asked if they had read any published articles on radiation protection or attend any radiation protection courses, workshops or lectures before?

If they are aware about three principles of radiation protection (Justification, optimization, and dose limits) and if they are aware of that every single exposure to ionizing radiation is cumulative and therefore increases an individual's lifetime cancer risk and of their responsibility in limiting protecting patients from unnecessary radiation doses and unjustified exposure to ionizing radiation. We explored how often they request routine X- ray examinations and if they are checking the previous studies for any recent similar one before requesting. Also, they were asked if they outline the attendant risks and benefits of X-ray examinations to their patients before prescribing these examinations and if the patients and/or their families request information about the radiation risks when they were requesting?

The survey was online and consent for participation was digitally included in the questionnaire.

Study population

Inclusion criteria for the study: PHCC physicians.

Exclusion criteria for the study: Radiologists

Sampling

NA, the questionnaire was disseminated to all PHCC physicians through official mail & Microsoft teams, all replies were included in the study so no sampling was used.

Sample size calculation

NA, the questionnaire was disseminated to all PHCC physicians, all replies were included in the study so no sampling will be used.

Types of outcome measurements

The awareness of radiation hazards, protection, and safety among the physicians in PHCC was analyzed.

The outcome measures included:

- If respondents had read any published articles on radiation protection or attended any radiation protection courses, workshops or lectures before?
- If they are aware about three principles of radiation protection (Justification, optimization, and dose limits) and if they are aware of that every single exposure to ionizing radiation is cumulative and therefore increases an individual's lifetime cancer risk.
- If they are aware of their responsibility in limiting protecting patients from unnecessary radiation doses and unjustified exposure to ionizing radiation.
- How often they request routine X- ray examinations and if they are checking the previous studies for any recent similar one before requesting.
- If they outline the attendant risks and benefits of X-ray examinations to their patients before prescribing these examinations.
- The data was collected and calculated, and the results were expressed as percentages.

Quality control measures and good practices to be followed during the study:

The data is de-identified. The REPORT statement, which is an extension of the STROB statement checklist (international, collaborative initiative of epidemiologists, methodologists, statisticians, researchers and journal editors involved in the conduct and dissemination of observational studies, with the common aim of Strengthening the Reporting of Observational studies in Epidemiology) specially designed to assure the quality of reporting of secondary data analysis will be followed during analysis and writing of the research paper

- Gender
- Specialty
- Frequency of reading articles or attending course for radiation awareness.
- How often he requests routine X- ray examinations for the diagnosis of his patients?
- How frequent do you check the patient`s file for any recent radiological study before requesting new study?
- How frequent do patients and/or their families request information about the radiation risks when you are requesting?
- How frequent do you outline the attendant risks and benefits of X-ray examinations to your patients before prescribing these examinations?
- How frequent do you request X- Ray for pregnant ladies?
- Who is responsible for protecting patients from unnecessary radiation?
- What does the ALARA principle mean?
- Can pregnant women be submitted to or screening mammography?
- Material of protective apron.
- Imaging modalities with (higher radiation dose – non-ionizing - prolonged period of emitting radiation?)
- The percentage of total ionizing radiation the general public is exposed to from medical radiations
- Radiation doses in some common X-Ray studies.
- Organ's sensitivity to radiation in different ages.
- X-Ray in childbearing age ladies.
- Cancer risk with radiation.
- Should any procedure involving radiation be justified in relation to available alternatives?

Results

152 physicians shared in this survey, 59% were males and 49% were females.

Majority of sharing physicians was family medicine (80%).

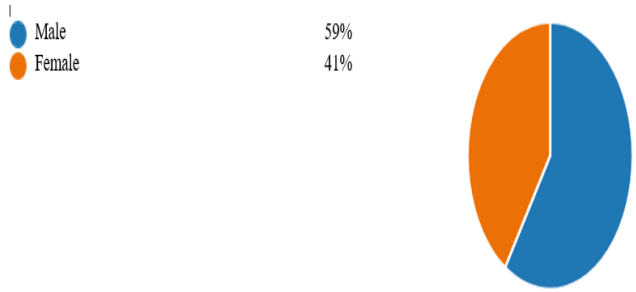

Figure 1: What is your gender?

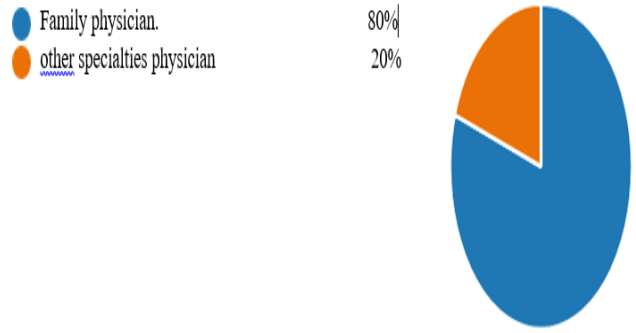

Figure 2: What is your specialty?

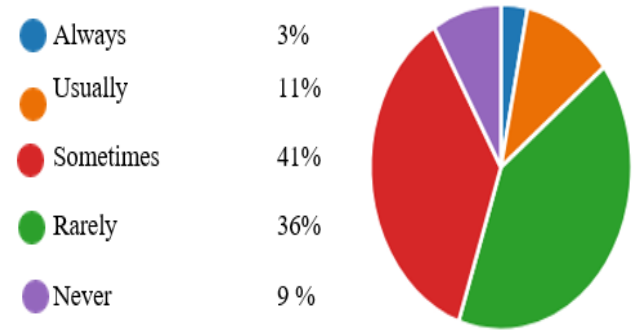

Figure 3: How frequent do you read any published articles on radiation protection?

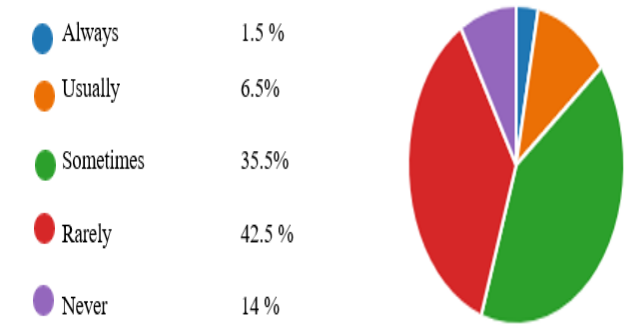

Figure 4: How frequent do you attend any radiology courses, workshops or lectures?

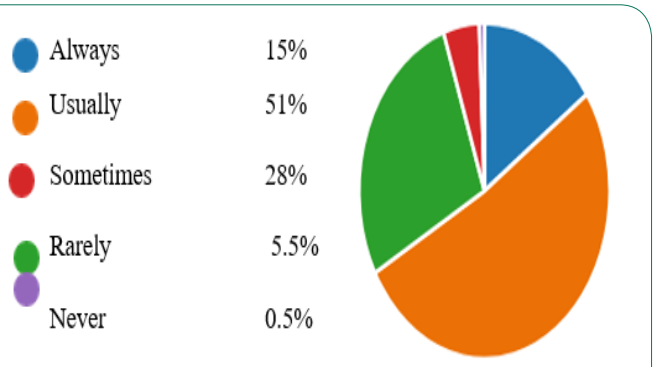

Figure 5: How often do you request routine X- ray examinations for the diagnosis of your patients?

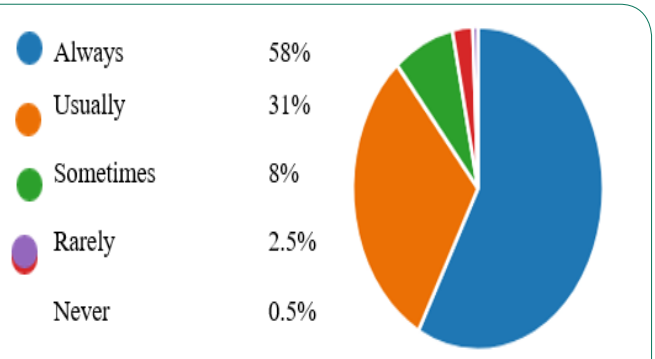

Figure 6: How frequent do you check the patient`s file for any recent radiological study before requesting new study?

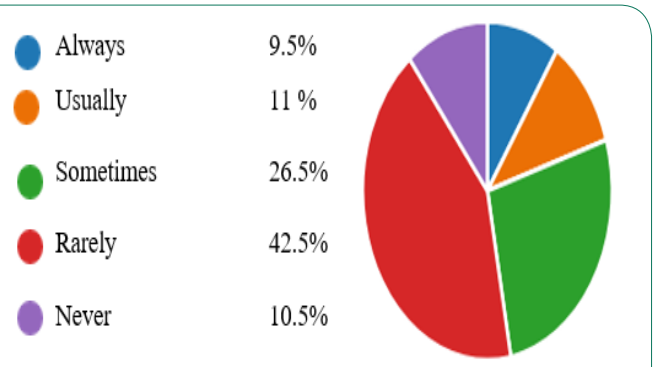

Figure 7: How frequent do patients and/or their families request information about the radiation risks when you requesting?

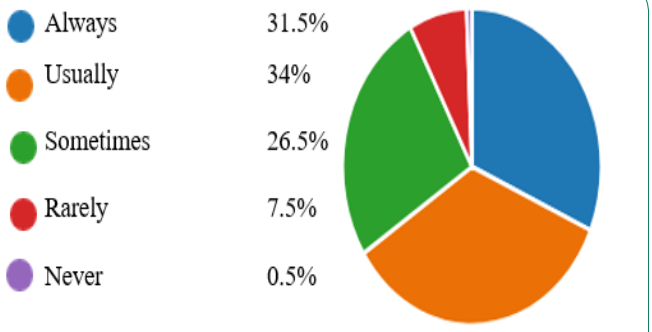

Figure 8: How frequent do you outline the attendant risks and benefits of X-ray examinations to your patients before prescribing these examinations?

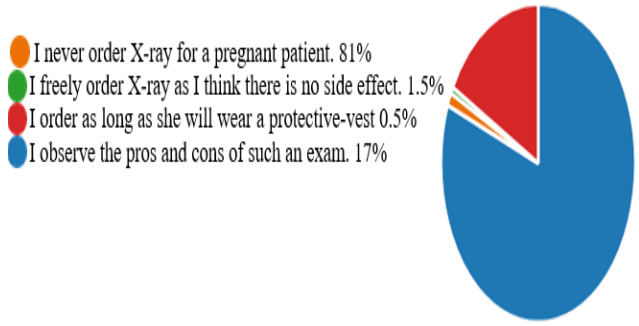

Figure 9: How frequent do you request X- Ray for pregnant ladies?

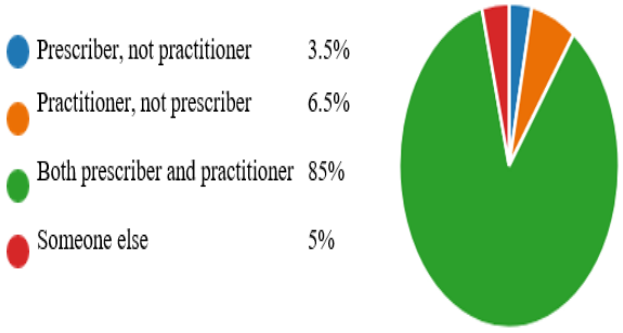

Figure 10: The International Commission on Radiological Protection (ICRP) recommendations defining professional responsibility for protecting patients from unnecessary radiation doses, and forbid unjustified exposure to ionizing radiation and place responsibility for protecting patients from unnecessary radiation on:

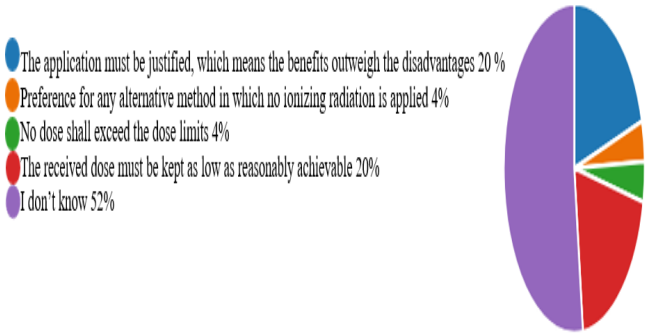

Figure 11: What does the ALARA principle mean?

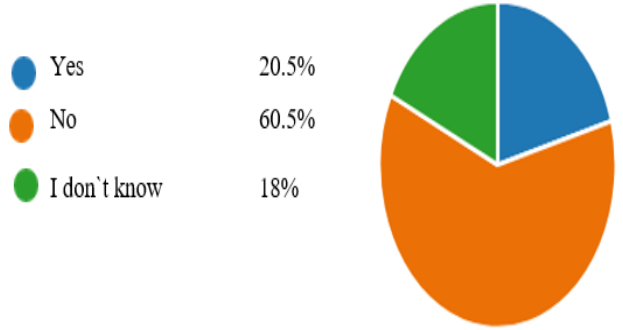

Figure 12: Can pregnant women be submitted to screening mammography?

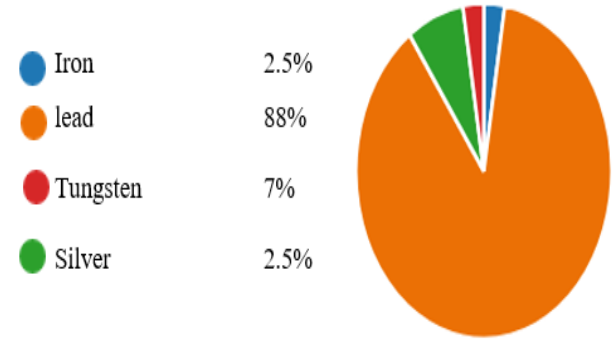

Figure 13: The apron used to protect from radiation is made from?

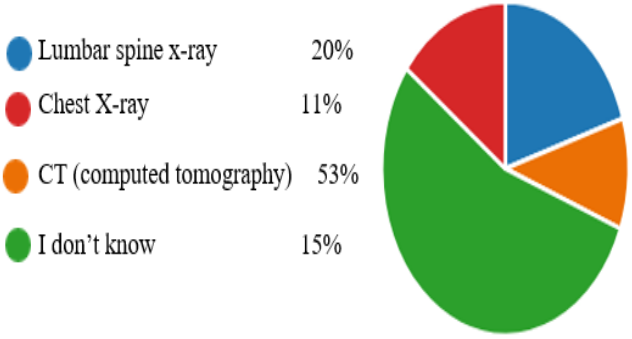

Figure 14: Which of the following modalities is responsible for most of radiation dose in medicine?

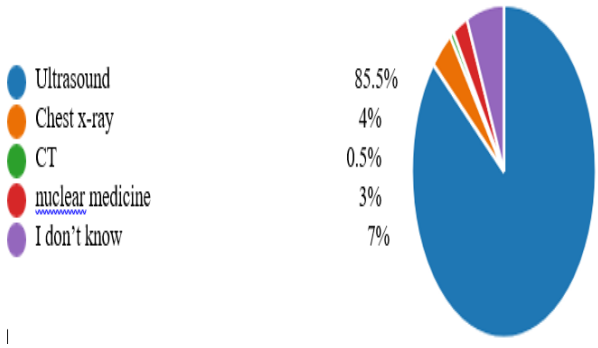

Figure 15: Which of the following does not use ionizing radiation?

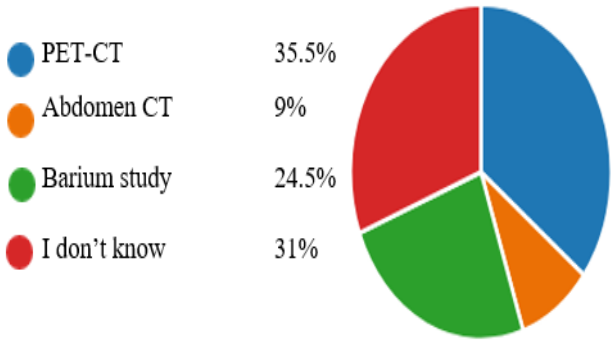

Figure 16: Which of the following has a prolonged period of emitting radiation?

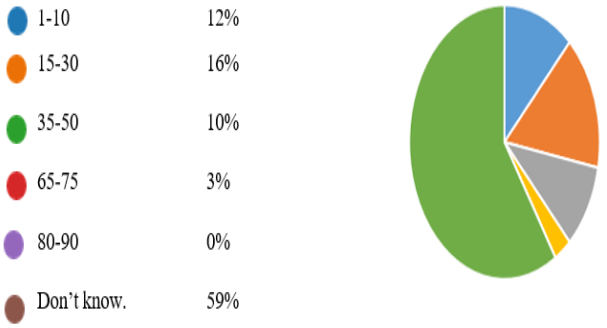

Figure 17: The percentage of total ionizing radiation that, the general public is exposed to from medical radiations

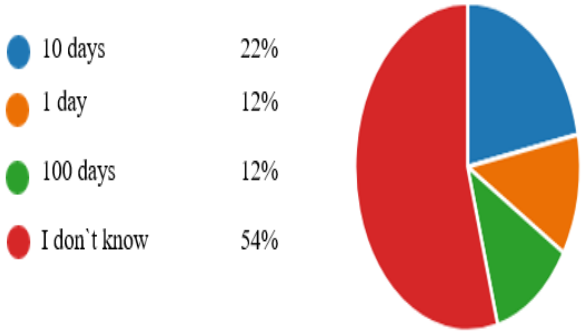

Figure 18: How does the approximate effective radiation dose from a chest X-ray compared to natural background radiation?

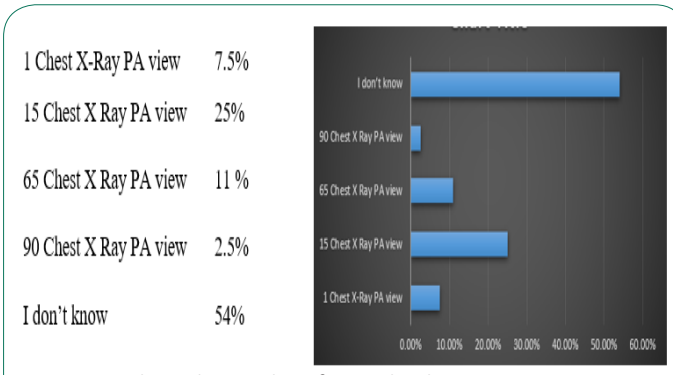

Figure 19: The radiation dose from 1 lumbar spine examination is equal to

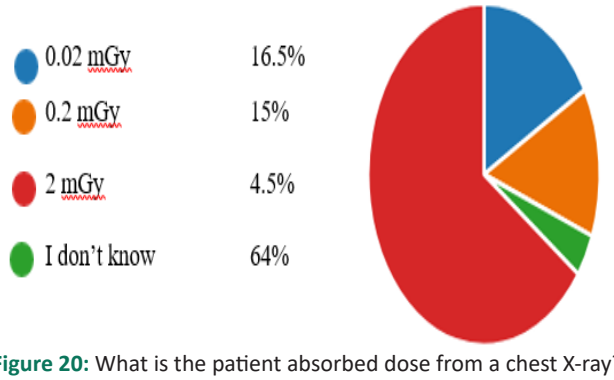

Figure 20: What is the patient absorbed dose from a chest X-ray?

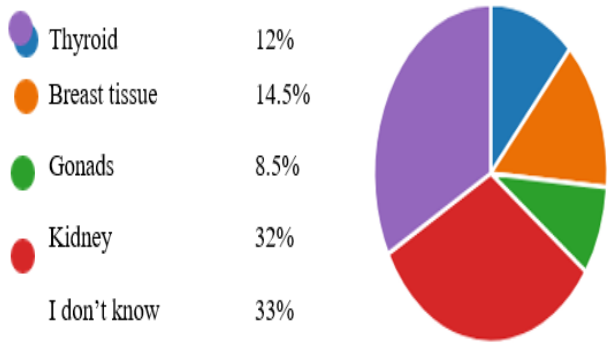

Figure 21: Which one of the following is the least sensitive to radiation?

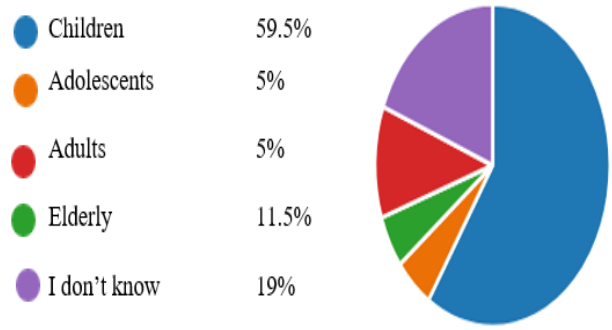

Figure 22: Which one of the following is most sensitive to radiation?

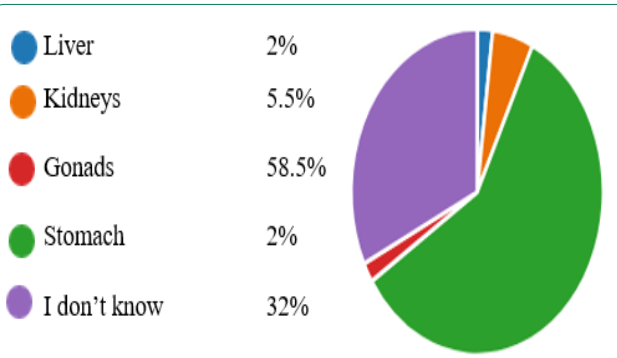

Figure 23: In pediatric population what are the most sensitive organs to radiation?

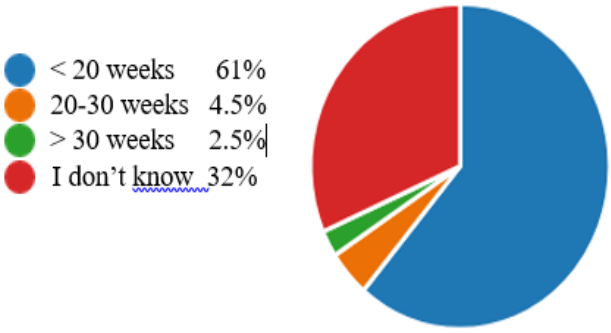

Figure 24: Fetal tissue is more susceptible to radiation

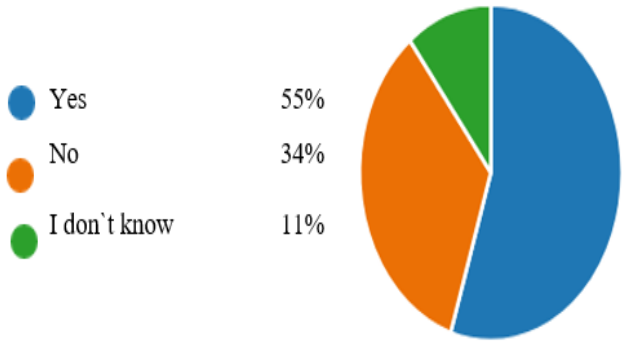

Figure 25: Should every woman in childbearing age be submitted to a pregnancy test before being submitted to radiography of the pelvis?

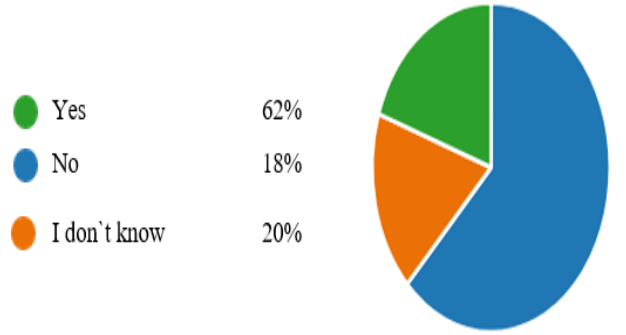

Figure 26: Does the risk for developing cancer increase with the dose value and may be present even with a single exposure?

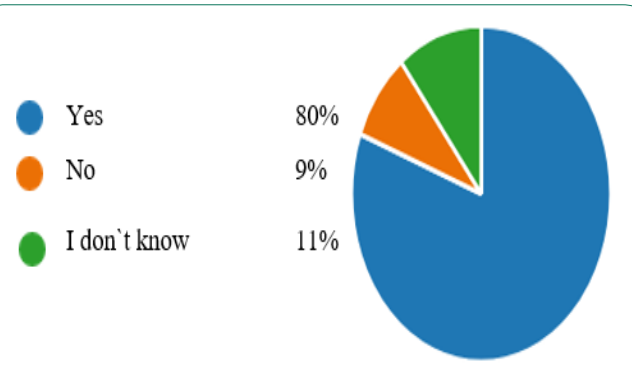

Figure 27: Should any procedure involving radiation be justified in relation to available alternatives?

Discussion

Radiation exposure is considered as a major concern in the medical community as having potential risks to both patients and healthcare professionals. Primary health care physicians play a crucial role in patient care, including diagnosing and treating a variety of medical conditions using radiation-based technologies. Therefore, it is critical that physicians have a well understanding of the risks accompanied with radiation exposure and do the necessary precautions that can reduce these risks to the minimum. On the other hand, the lack of radiation awareness among physicians can be a source of unnecessary patient radiation exposure thus will increase the risk of adverse outcomes.

Some previous studies [19] that investigated the awareness of doctors about diagnostic radiation exposure showed that over 80% of them had no formal training about ionizing radiation. Only minority (19%) of participant could identify the ALARA principle correctly. The current study shows different levels of radiation awareness among primary health care physicians with wide variation so some physicians have a well understanding of the radiation exposure risks and therefore taking the required precautions that can minimize these risks, others lack knowledge and awareness of radiation safety. Majority of participants could not identify correctly the patient absorbed dose from a chest X-ray as well as the approximate effective radiation dose from a chest X-ray compared to natural background radiation which should divert the attention of the need for more radiation safety education and training for primary health care physicians. On the other hand, majority of participants (87.5%) could identify lead as the correct material of radiation protection apron. While the majority could realize that children are the most sensitive to radiation, still a high percentage (41%) did not know this, similar result to identification of the most sensitive organs to radiation.

While majority (62%) thought that the risk for developing cancer increase with the dose value and may be present even with a single exposure, however those who could not identify this fact will be in need to more radiation education for awareness. Several studies [9-12] had recommended the radiation safety training programs as being able to significantly improve the awareness of physicians toward the radiation safety. These findings emphasizes the need for radiation safety education and training for primary health care physicians. These programs can include various topics such as the radiation safety principles, techniques of radiation protection, and the use of personal protective equipment. The application of such programs can also support the physicians to be up-to-date with the latest guidelines and regulations regarding radiation safety. 152 physicians shared in this survey, 59% were males and 49% were females. Majority of sharing physicians was family medicine (80%). Azmoonfar et al. [20] observed a poor awareness of most of the physicians about routine radiology examinations In our study, the study showed that 55% of participants had read a published articles on radiation protection, while 45% rarely or never did While more than 56% had rarely or never attended any course, workshop or lectureIn an earlier (21,22) majority of respondents had rightly indicated that the approximate effective dose that a patient receive in a two-view CXR is considered twice the single-view CXR. On the other hand, the study confirmed the high frequency of X-ray requests the PHCC physician needs in current daily work (94% are requesting sometimes, usually or always) while 5.5% rarely do. The study showed the importance of availability of previous studies as 97% of participants check it before requesting new studies (majority of participant, 89% are always or usually do this).

The study showed that about 53% of patients and/or their families are rarely or never asking about the radiation risks of their requested procedure while 92% of participants explain these risks versus benefits of X-Ray to their patients (65.5% are usually or always do). 81% of participants never requested X-Ray for pregnant ladies while 17%. Can request after observing the pros and cons of such an exam, notify the patient about the potential outcomes, and request a lead-vest to be worn by the patient. Majority of participants (85%) believe that both prescriber and practitioner share the professional responsibility for protecting patients from unnecessary radiation doses, and forbid unjustified exposure to ionizing radiation and place responsibility for protecting patients from unnecessary radiation which agrees with the recommendation of International Commission on Radiological Protection (ICRP). On the hand, only 19% of participant could recognize the ALARA (As Low A reasonably achievable) principle meaning correctly.

60.5% of participants could understand that pregnant women should not submitted to or screening mammography. Only 53% could identify CT as being the highest source of radiation dose among modalities used in medicine. Majority of participants (85%) could correctly identify US as being a non-ionizing radiation imaging modality and 35.5 could know that PET CT has a prolonged period of emitting radiation. Only 15% of participants could correctly identify the percentage (25-30%) of medical radiation from the total ionizing radiation the public is exposed to. 21% of participant could correctly estimate the approximate effective radiation dose from a chest X-ray compared to natural background radiation as being 10 days. This low frequency of respondents that demonstrated awareness of the approximate effective radiation dose from a chest X-ray compared to average natural background radiation affirmed an earlier report [20,23]. Furthermore, in earlier report [21] found that 20.61% of respondents had correct understanding in comparison of radiation exposure from one CXR as equivalent to the amount of radiation from the natural surroundings in 10 days. while only 10.5% could know that radiation dose from 1 lumbar spine examination is equal to radiation dose of 65 PA chest X-Ray and 16.5% of participant could estimate 0.02 mGy as the patient absorbed dose from a chest X-ray.

Only 32% could correctly choose kidneys as being less sensitive to radiation than thyroid, breast and gonads while 58.5% correctly identify gonads as being the most sensitive organs to radiation in pediatric population. Similar ratio (59%) of participant could understand that children are more sensitive to radiation than older. This matches with earlier studies [19,23] in which recorded the children as being the most sensitive category of age sensitive to radiation was indicated by more than 75% of respondents. Also, a nearly similar ratio (61%) of participants could know that fetal tissue is more susceptible to radiation. 54.5% of participants correctly thought that not every woman in childbearing age should be submitted to a pregnancy test before being submitted to radiography of the pelvis. 62% of participants only thought that the risk for developing cancer increase with the dose value and may be present even with a single exposure.

80% of participant believe that any procedure involving radiation should be justified in relation to available alternatives.

15% of participants had chosen 15-30% as a percentage of total ionizing radiation the public is exposed to from medical radiations. 80% of participant considered that any procedure involving radiation should be justified in relation to available alternatives?

Majority of participants (77.6%) are usually or sometimes requesting routine X- ray examinations for the diagnosis of their patients, most of participants (88.9%) check the patient`s file for any recent radiological study before they requesting new study. It was noticed that, minority of patients and/or their families are requesting information about the radiation risks ordered while the majority (35.5%) of participants of referring physician outline the attendant risks and benefits of X-ray examinations to their patients before prescribing these examinations? The International Commission on Radiological Protection (ICRP) recommendations defining professional responsibility for protecting patients from unnecessary radiation doses, and forbid unjustified exposure to ionizing radiation and place responsibility for protecting patients from unnecessary radiation on both prescriber and practitioner 85%. 87% of participants could correctly identified lead as the material used for radiation protection apron 53% of participants had identified CT as being the most radiation dose in medicine and 85% could correctly identified US as non-ionizing imaging modality, while only 35.5% could know that PET/CT has prolonged period of emitting radiation.

Conclusion

Radiation exposure is an important concern in the medical community. Collaboration among healthcare professionals is essential to ensure that radiation safety is of a high priority in patient care. This study highlighted the need for more radiation safety education and training program for primary health care physicians to improve the level of radiation awareness and safe practices. Implementing of radiation safety training can help to reduce the radiation exposure risk in primary health care.

Declarations

Competing interests: The authors declare that they have no competing interests.

Consent for publication: All authors read and approved the final manuscript.

Acknowledgement: Open access funding was provided by the Primary Health Care Corporation (Qatar).

Ethical considerations: The data in this study are selected fairly as this study will include all PHCC radiology staff and physicians. There is no direct contact with study participants. Therefore, no physical and mental discomfort, harm, and danger may arise from research procedures. In addition, the results of the study may help in addressing the need for radiation protection awareness. Collected data will be held in a password protected PHCC computer. The investigators will abide by the ethical rules and regulations of MOPH concerned with research. Among the important ethical issues is the confidentiality of the participants, they will be, they will be anonymized and de-identified. The investigators will abide by the ethical rules and regulations of MOPH concerned with research. Generic consent forms. The survey will be online and consent for participation will be digitally included in the questionnaire.

The study is approved by PHCC institutional review board research.

Conflict of interest statement: The authors declared no conflict of interest.

References

1. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008 report to the General Assembly, Annex on Medical Exposures, New York. 2010.

2. H. Alsleem, R. Davidson, B. Al-Dhafiri, R. Alsleem, H. Ameer, Evaluation of radiographers' knowledge and attitudes of image quality optimization in pediatric digital radiography in Saudi Arabia and Australia: a survey-based study, J. Med. Radiat. Sci. 2019. https://doi.org/10.1002/jmrs.366

3. Patient safety in medical imaging: a joint paper of the european society of radiology (ESR) and the European federation of radiographer societies (EFRS), Insights Imaging. 2019. https://doi.org/10.1186/s13244-019-0721-y.

4. E. Senemtas¸i Ünal, K. Gelis¸, P. Baykan, Investigation of awareness levels about the radiation safety of personnel working in the imaging units of the hospitals in Agri, Turkey, J. Radiat. Res. Appl. Sci. 2018. https://doi.org/10.1016/j. jrras.2017.10.009.

5. A Lara et al. Importance of patient radiation protection in computed tomography procedures. 2019. J. Phys.: Conf. Ser. 1221 012065IOP.

6. Panchbhai, Wilhelm Conrad Rontgen and the discovery of X-rays: revisited after centennial, J. Indian Acad. Oral Med. Radiol. 2015. https://doi.org/10.4103/ 0972-1363.167119.

7. D.J. Brenner, Richard Doll, Cancer risks attributable to low doses of ionizing radiation: assessing what we really know David, Adv. Exp. Med. Biol. 2016. https://doi.org/10.1007/978-3-319-39406-0_6.

8. M.P. Little, R. Wakeford, E.J. Tawn, S.D. Bouffler, A.B. De Gonzalez, Risks associated with low doses and low dose rates of ionizing radiation: why linearity may be (almost) the best we can do, Radiology. 2009. https://doi.org/10.1148/ radiol.2511081686.

9. Patient safety in medical imaging: a joint paper of the European society of radiology (ESR) and the European federation of radiographer societies (EFRS), Insights Imaging. 2019. https://doi.org/10.1186/s13244-019-0721-y.

10. A. Ribeiro, O. Husson, N. Drey, I. Murray, K. May, J. Thurston, W. Oyen, Ionising radiation exposure from medical imaging – a review of Patient's (un) awareness, Radiography. 2020. https://doi.org/10.1016/j.radi.2019.10.002.

11. Rawashdeh M, Saade C, Ibnian A, Bataineh Z, Al Mousa D, Brennan P, Al-Tamimi F, Al-Husari M, Taimai RA, McEntee M. Referral Physicians' Knowledge of Radiation Dose: A Cross-sectional Study Open Access Macedonian Journal of Medical Sciences. 2020; 8(E): 582-588. https://doi.org/10.3889/oamjms.2020.4727.

12. Kamble V, Mitra K, Ratnaparkhi C, Dhote S. Consultants knowledge and awareness about radiation exposure in diagnostic radiology in Central India. Int J Biomed Res. 2015;6(1):14-18.

13. Fong F, Schrader DC. Radiation disasters and emergency department preparedness. Emerg Med Clin North Am. 1996; 14(2): 349-370. https://doi.org/ 10.1016/S0733-8627 (05)70255-8

14. Awosan KJ, Ibrahim MTO, Saidu SA, et al. Knowledge of radiation hazards, radiation protection practices and clinical profile of health workers in a teaching hospital in northern Nigeria. J Clin Diagn Res. 2016; 10(8). https://doi.org/10.7860/JCDR/2016/20398.8394

15. Arslanog˘lu A, Bilgin S, Kubali Z, Ceyhan MN, Ilhan MN, Maral I. Doctors' and intern doctors' knowledge about patients' ionizing radiation exposure doses during common radiological examinations. Diagn Interv Radiol. 2007; 13(2): 53-55.

16. Wong CS, Huang B, Sin HK, Wong WL, Yiu KL, Chu Yiu Ching T. A questionnaire study assessing local physicians, radiologists and interns' knowledge and practice pertaining to radiation exposure related to radiological imaging. Eur J Radiol. 2012; 81(3): e264-e268. https://doi.org/10.1016/j.ejrad.2011.02.022

17. Soye JA, Paterson A. A survey of awareness of radiation dose among health professionals in Northern Ireland. Br J Radiol. 2008;81:725–729. https://doi. org/10.1259/bjr/94101717 12. Lee WJ, Woo SH, Seol DH, et al. Physician and nurse knowledge about patient radiation exposure in the emergency department. Niger J Clin Pract. 2016; 19(4): 502-507. https://doi.org/10.15441/ceem.14.019

18. Ahidjo A, Garba I, Mustapha Z, Abubakar AM, Usman UA. Referring doctors knowledge about radiation doses in patients undergoing common radiological examinations. J Med Med Sci. 2012; 3(4): 222-225

19. Dauda AM, Ozoh JO, Towobola OA. Medical doctors' awareness of radiation exposure in diagnostic radiology investigations in a South African academic institution. SA Journal of Radiology (Online). 2078-6778. South African Journal of Radiology (sajr.org.za).

20. Azmoonfar R, Faghirnavaz H, Younesi H, Morovati E, Ghorbani ZH, Tohidnia MR. Physicians' knowledge about radiation dose in radiological investigation in Iran. J Biomed Phys. 2016;6(4):285-288.

21. Mahesh M. Radiation dose in x-ray and CT exams: Computed Tomography dose (CT dose) [homepage on the Internet]. 2015. Radiological Society of North America, Inc. (RSNA). 2018 [cited 2018 Apr 11]. Available from: https://www. radiologyinfo.org/en/info.cfm?pg=safety-xray.

22. Smith-Bindman R, Lipson J, Marcus R, et al. Radiation dose associated with common computed tomography examinations and the associated lifetime attributable risk of cancer. Arch Intern Med. 2009; 169 (22): 2078-2086.

23. HPS Background Radiation. Fact sheet. Health Physics Society, Specialists in Radiation Safety [homepage on the Internet]. 2015 [cited 20. 18 Apr 12]. Available from: http://hps.org/documents/background_radiation_fact_sheet.pdf

24. Ramanathan S, Ryan J. Radiation awareness among radiology residents, technologists, fellows and staff: Where do we stand? Insights Imaging. 2015; 6(1): 133-139. https://doi.org/10.1007/s13244-014-0365-x