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Research Article

Measurement of Radiation Dose on Medical Workers in Selected Hospitals in Dhaka Bangladesh

Ashiru Garba Abdullahi[1], Fazlul Haque, A. K. M.[1], Musa Garba Abdullahi[2*], Mutari Ali hajara[3] & Saratu Garba Abdullahi[4]

[1]*Department of Electronics and Telecommunication Engineering, Daffodil International University of Dhaka Bangladesh*

[2]*Department of Physics, Faculty of Science, Yusuf Maitama Sule University Kano, Nigeria*

[3]*Department Physics, Faculty of Science, Bayero University Kano, Nigeria*

[4]*Nursing Department Bayero University Kano, Nigeria*

[*]**Correspondence to:** Musa Garba Abdullahi, Department of Physics, Faculty of Science, Yusuf Maitama Sule University Kano, Nigeria.

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Abstract

Radiation exposure poses hazards for health-care workers, patients and health-care facilities (HCFs). Radiographic imaging is among the diagnostic tools in medicine that has an extremely valuable and accuracy, hence, ionizing radiation and computed tomography (CT) scan has potential risks. Hospital workers in the x-ray machine rooms are likely to get exposed to the excess of radiations. Therefore, Personnel and radiation safety monitoring is a necessary safety precaution in the radiography. The aimed of this study is to assess the occupational radiation exposure and safety protection among medical staff in HCFs in hospitals In Dhaka Bangladesh. Total of five (5) HCFs with radiological services was selected during the data collection in the period from April to

September 2015. The radiation assessment survey was carried out by the measurement of radiation in the CT-scan room and x-ray at different points of the imaging, diagnostics, and waiting rooms of the five hospitals. The radiation safety was assessed by monitoring the eighty (80) occupational workers from five hospitals In Dhaka Bangladesh for six months to quantify their exposure to excess radiation doses using a stance potable radiation dosimeter. Data revealed that the average estimated dose for all subjects ranged from 0.01 to 2.42mSv. Among these workers, workers in radiology department received the most substantial estimated dose, which is below recommended dose for the international dose limit (20mSv). It is significant to comment that workers were wearing protective lead aprons and thyroid shields when performing examinations, in agreeing to the radiation protection policy.

Introduction

Recently, radioactive sources are using in most of the applications, such as medicine, industry, research, agriculture, and education, for a wide variety of beneficial purposes. The purposes of improved health services and an aging population have resulted in a combination of high application to increase the use of radiation and radionuclides in diagnosis and treatment [1]. All medical workers and occupational exposure to ionizing radiation represent the significant part of exposure to low radiation doses. The researchers estimated that cancer risk incidence directly increases with the increases in the absorbed dose. It is essential to establish a model to examine the carcinogenic impacts forth slow radiation dose [2]. The aims of the International Commission on Radiological Protection (ICRP) is to come off with a system, and useful standards for radiation protection consist of medical, environmental, occupational, and exposure controls against radiological misfortunes without excessively limiting the valuable Practices giving rise to radiation exposure [3,4]. The term "occupational exposures" means the exposure of environmental, as well as the exposure controls against radiological accidents without excessively limiting Practices produces to the radiation exposure [3,4]. The term "occupational exposures" defined as the exposure of people at work to ionizing radiation from natural and human-made sources as a result of operations within a place of work, except for exposures excluded from the standards and exposures from practices or sources exempted by measures [5-12].

Therefore, we considered exposure to radiation as one of the hazards of working in a department of diagnostic radiology (DR) or radiography due to the possibility of long-term exposure to low-level radiation. And any associated biological effects. Evidence of reversible and irreversible genotoxic impacts during periods of Radiation exposure has been reported [14]. Even though biological effects caused by moderate and high-level doses (>100mGy) are evident; hence, there is still considerable debate regarding this biological effects due to low-dose exposures (<100mGy) [14-17]. During the last decade, the number of Peoples who work in departments of radiography and DR has increased [15,18]. Due to the introduction of advanced imaging technologies, such as multislice computed tomography (MSCT), tomography, and positron emission (PET), the number of workers in the departments of radiography and Diagnostic Radiation, as well as the different types of imaging examinations performed. Also, the relative number of patients undergoing imaging procedure and hence the amount of radiation used have all increased [15,19]. Nonetheless, historical evidence of the radiation exposure of workers indicates that the doses have decreased with time due to improved radiation protection practices since the discovery of X-rays [17].

Many kinds of literature estimated the radiation dose of workers in these departments as mentioned earlier in which they had been reported the radiation doses vary between 1 and 50mSv/year in many parts of the world [20-26]. The United Nations Scientific Committee on the Effects of Atomic Radiations (UNSCEAR) has reported that the worldwide mean annual occupational dose in NM and DR is below 2mSv [27]. The substantial variation in exposure among staff working with radiation in departments of radiography and DR has attributed to the nature of the work that individual carries out.

This research deals with the analysis of Radiation level in occupational workers and effects that might cause when exposes to high doses. The point in this research work are essentially based on the data analysis and the research findings we recommended for workers exposed to medical radiation sources to follow and apply all the Safety rules established in the International Basic Safety Standards to Protect themselves against Ionizing Radiation and the Safety of Radiation Sources. Dose estimation for radiation workers is an essential factor for government and organizations to evaluate radiation risks and establish protective measures as recommended by [6,7,10,13].

Materials and Methods

The research used thermo luminescent dosimeters (TLD) and questionnaires in collecting the data. The TLDs comprise the cards with holders containing a Harshaw detector crystal of LiF: Ti, Mg (TLD-100) to give measurements of both skin and deep doses. The data was collected from five departments in different hospital in Dhaka city Bangladesh which includes Radiology department, CT scan department, Cardiology department, Radiotherapy department, and Nuclear medicine department. All workers are advised to wear the badge in proper position throughout their work. We recommended the upper-left side of the chest because is the most essential area to wear the dosimeter outside the lead apron as the maximum radiation exposure is anticipated in this part of the body. The target people for this investigation is all of the diagnostic medical radiation workers who carry out or assist in interventional radiation procedures and are presently registered in the five selected hospitals in Dhaka Bangladesh which works as a lifetime management system of occupational radiation doses.

We developed a questionnaire by reviewing previous studies among radiation workers and adjusting the questionnaire items used of earlier studies of diagnostic radiological medical workers we also conducted a pilot study between interventional medical radiation workers [28]. The enrolment questionnaire contains items on work practices, demographics, work history, the experience of high-dose exposure, and radiation exposure by personal medical examination, health-related behaviors and medical history. The demographic data comprise the date of birth, gender, name and workplace address.

The data where cumulatively collected and analyzed using charts and graphs to determine the absorb dose from each afore-mentioned categories that deal with radiation in the above departments where the equipment and the questionnaires was used. This study tried to entails the details of the distribution and trends of doses from occupational radiation exposure among radiation workers from these five selected hospitals in Dhaka Bangladesh. We used two-month dose measurements collected for a period of six months (April to

September 2015); using a transportable environment radiation monitor (thermo luminescent dosimeters) to compute the total radiation in places of work in the mentioned departments. A total of 80 medical occupational workers were monitored, comprising 48 persons Diagnostics radiology department, 12 persons CT scan department, 5 people's cardiologist, 10 personnel Radiologist and 5 people's Nuclear medicine department.

Table 1: *Number of Radiation Workers Monitored for both the occupational Categories of Medical Departments*

Occupational Categories	Radiation Workers	Number of Monitored Workers	Total
Diagnostics Radiology Dept.	Medical Physicist	2	48
	Radiologist	18	
	Radiology Nurse	6	
	Chief Technician	1	
	Technical Director	1	
	General Technician	14	
	Supervisor	2	
	Mammo Technician	2	
	Ango. Technician	2	
CT scan	Technician	6	12
Laboratory	Nurse	3	
Catheterization	Consultant	3	

Nuclear Medicine Dept.	Technician	3	5
	Supervisor	1	
	RSO	1	
Radiotherapy Dept.	Medical Physicist	1	10
	Medical Dosimetrist	1	
	Nurse and Assistants	8	
Cardiology Dept.	Technician	2	5
	Consultant	1	
	Cleaners	2	
Total Number of Workers			80

Results and Discussion

The study used the introduction stage of more comprehensive and regular monitoring of occupational radiation exposures and compared the long-term investigations into its accumulation patterns. Hence, this could form the basis of future records on the detrimental effects of the radiation characteristic of workers in the medical field, because the ionizing radiation has dangerous health effects upon human exposure.

The dose dissemination of radiation workers is used to evaluate the minimum level of exposure in the medical field given by ALARA principles. In the Dhaka hospital, we monitored approximately 80 occupational radiation workers. Their percentage is as follows: nuclear medicine 4%, general radiography 38.4%, CT scan, and catheterization laboratory 9.6%, radiotherapy 8%, and Cardiology 4%. However, this percentage is part of 80. Table 1 explained the total number of radiation workers monitored for all the occupational categories of medical departments as well as their position during 2017 exercise. Also, Fig. 1 gives the percentage contribution yields for each type of medical radiation worker to the total monitored worker.

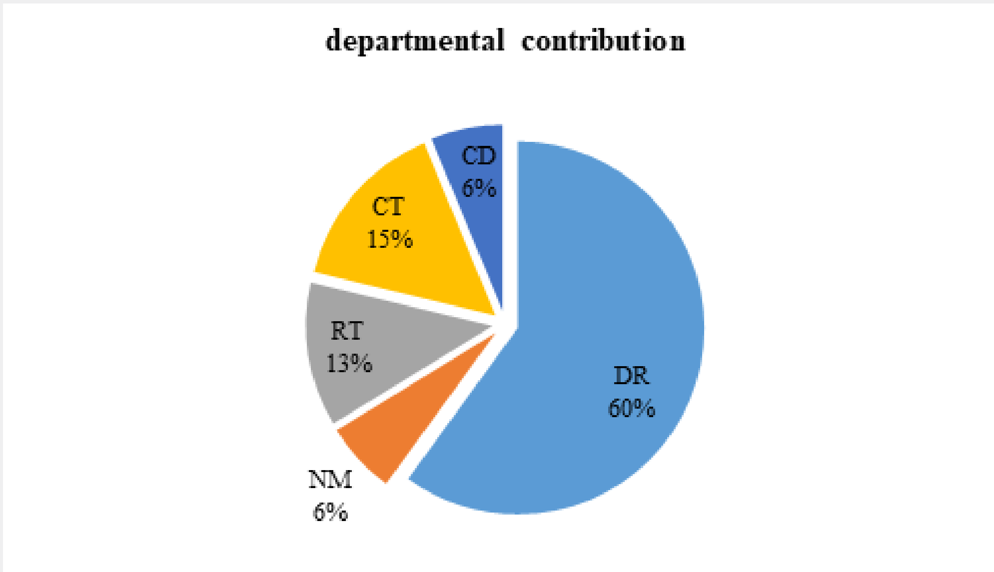

Fig.1 *percentage (%) contribution yields for the entire medical radiation worker monitored.*

Where DR is the Diagnostics Radiation, RT is the Radiotherapy Dept. CD stand for Cardiology Department, NM is the Nuclear Medicine and CT is CT scan department.

The study obtained the average of the estimated dose for all departments ranged from 0.01 to 2.42mSv. Among these workers, workers in radiology department received the largest estimated dose. It was obtained by the use of a simple equation to compute the estimated dose received per person per year as:

$$X = \frac{365\,\text{days} \times \text{dose received}}{\text{total days}\,(\textit{period})}$$

In this regards we used the equation 1 and obtained the results in Table 2 as:

$$X = \frac{365\,\text{days} \times 0.94}{180\ \text{days}} \times 1.91\,mSv$$

WhereX stand for estimated dose per year in a unit mSv.

Table 2: *Described the amount of dose by radiology department worker and the estimated dose per year been calculated*

Total days	D1	D2	D3	Total dose mSV	Estimate dose per year mSV
	Dose mSV	Dose mSV	Dose mSV		
180	0.26	0.26	0.42	0.94	1.91
180	0.22	0.21	0.28	0.71	1.44
180	0.39	0.40	0.40	1.19	2.42
180	0.23	0.29	0.32	0.84	1.71
180	0.18	0.37	0.41	0.96	1.95
180	0.25	0.27	0.32	0.84	1.71
180	0.22	0.29	0.38	0.89	1.81
180	0.47	0.38	0.49	2.34	4.74
180	0.12	0.17	0.23	0.52	1.06
180	0.16	0.19	0.22	0.57	1.16
180	0.17	0.22	0.24	0.63	1.28
180	0.29	0.34	0.39	1.02	2.07
180	0.85	0.24	0.31	1.40	2.84
180	0.25	0.19	0.33	0.76	1.55
180	0.34	0.44	0.26	1.04	2.11
180	0.19	0.19	0.23	0.61	1.24
180	0.69	0.81	1.08	2.58	5.23
180	0.30	0.31	0.38	0.99	2.00
180	0.26	0.36	0.46	1.08	2.19

This method was applied to all the remaining departments. As for purpose of an article, due to the limitation we cannot present all the tables as it might sound boring and bulky. We summarized the results as in the Table 3.

Table 3: *Summary of the annual doses received by all the medical workers monitored*

Departments	Radiation Workers	Estimate dose per year mSV
Diagnostics Radiology Dept.	Medical Physicist	0.31-1.91
	Radiologist	0.39-2.19
	Radiology Nurse	0.84-2.42
	Chief Technician	0.29-1.06
	Technical Director	0.29-1.16
	General Technician	0.36-2.19
	Supervisor	0.33-1.55
	Mammo Technician	0.29-1.71
	Ango. Technician	0.37-2.00
CT scan	Technician	0.32
Laboratory	Nurse	1.25
Catheterization	Consultant	0.94
Nuclear Medicine Dept.	Technician	1.65
	Supervisor	0.99
	RSO	0.48

Radiotherapy Dept.	Medical Physicist	0.28
	Medical Dosim-etrist	0.34
	Nurse and Assis-tants	0.30
Cardiology Dept.	Technician	0.20
	Consultant	0.08
	Cleaners	0.01
Total Number of Workers		

All the results obtained are well below recommended dose for the international dose limit which is 20 mSv. It is significant to comment that completely radiation workers were wearing a protective lead aprons and thyroid shields throughout when performing examinations, in agreeing to the radiation protection policy at the country hospitals. The annual estimated dose distribution for the entire radiation workers in the medical department is shown in Table 3 and Fig. 2. The highest recorded is far below the recommended dose limit 20 mSv as adopted from the ICRP. As seen in Table 3, the highest annual dose obtained as recorded was 2.42 mSv, recorded by the chest TLD that worn by one of the Nurse radiologists in the department, which represents 12.1% of the annual recommended dose limit.

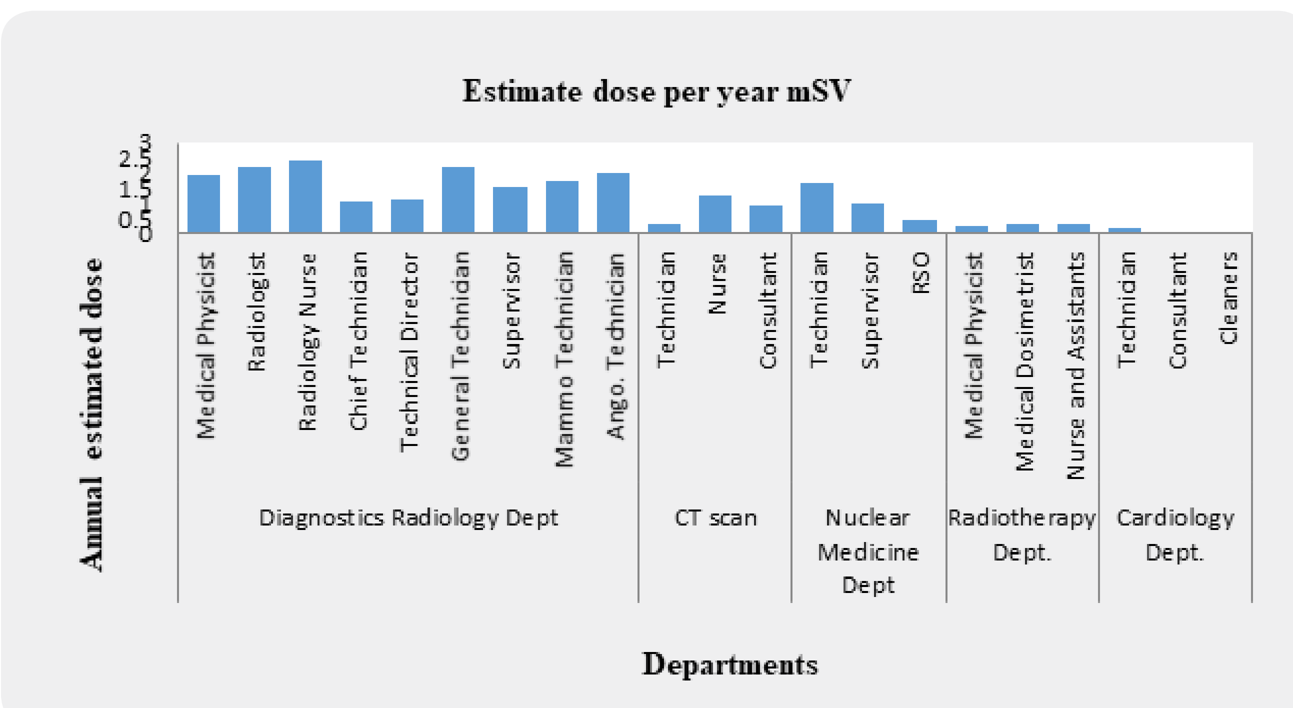

Fig. 2 *Annual estimated dose for the entire medical workers monitored*

This percentage was obtained using the relation given by the international commission for radiation protection (ICRP). Hence, the maximum permissible exposure limit for occupational workers by the international commission for radiation protection (ICRP) allowed standard maximum exposure is 20mSv for workers in radiation environment. From the estimated dose of exposure per year shows in this study, the maximum estimated dose exposure per year among all the workers in all departments is 2.42mSv, and minimum is 0.01. Their percentage is given as:

$$Max = \frac{2.42mSv}{20mSv} \times 100\% = 12.1\%$$

Then the minimum estimated dose exposure per year is 0.01mSv. The percentage is given as:

$$Min = \frac{0.01mSv}{20mSv} \times 100\% = 0.05\%$$

So, the average estimated dose exposure per year is

$$Average = \frac{(2.42 + 0.01)\,mSv}{2} = 1.23mSv$$

This yields the percentage average of

$$Ave = \frac{1.23mSv}{20mSv} \times 100\% = 6.15\%$$

The percentage as calculated above for the occupational workers that work with radiation in selected hospitals in the hospital in Dhaka city will not exceed the estimated dose for the international commission on radiological protection (ICRP). It implies that the workers under these departments based on this research can maintain the daily continue record by keeping safety measures and rules.

Conclusion

The measured annual effective doses for diagnostic radiology, nuclear medicine radiotherapy, Cardiology and CT scan workers at Dhaka Bangladesh hospital were found to range from, 0.01 and 2.42mSv, respectively. The radiation protection program carried out at Dhaka Bangladesh hospital was effective due to correctly uses the international recommended rules and regulations. However, we found the occupational radiation to workers at five different medical departments received well below the recommended dose limit as compared it with the accepted international or global occupation radiation exposure level is 20mvs.

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Bibliography

1. Balwinder, S., Jaspreet, S. & Amritpa, K. (2013). Applications of Radioisotopes in Agriculture. *Int J Biotechnolog and Bioengineering Research, 4*(3), 167-174.

2. United Nations, New York. (2006). Effect of ionizing radiation. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), United Nations, New York, *1*.

3. International Commission on Radiological Protection. (1990). Report 60 Recommendations of the International Commission on Radiological Protection. International Commission on Radiological Protection (ICRP), Publ 60, *Ann ICRP., 21*(1-3).

4. Dariusz, L. (2014). The Grand Challenge: use of a new approach in developing policies in the area of radiation and health. *Frontiers in Public Health: Radiation & Health Jouranal, 2*(50), 1-4.

5. Weizhang, W., Zhang, W., Cheng, R. & Zhang, L. (2005). Occupational Exposures of Chinese Medical Radiation Workers in 1986-2000. *Radiation Protection Dosimetry, 117*(4), 440-443.

6. Yuan, T., Liang, Z. & Yongjian, J. (2008). Dose level of occupational exposure in China. *Radiation Protection Dosimetry, 128*(4), 491-495.

7. Chales, M. (2001). Sources and effects of ionizing radiation. *J. Radiol. Prot., 21*(1), 83-86.

8. International Atomic Energy Agency. (1996). International basic safety standards for protection against ionizing radiation and for the safety of radiation source, International Atomic Energy Agency (IAEA), 1996, Safety Series No 115.

9. United Nations Scientific Committee on the Effect of Atomic Radiation. (2000). *Radiation, sources and effects of ionizing.* United Nations Scientific Committee on the Effect of Atomic Radiation (UNSCEAR), Volume I, United Nations Sales Publication, New York.

10. Khalid, M., Munir, A., Junaid, Z., Mumtaz, H., Afshan, A. & Haroon, Z. (2012). Assessment of Occupational Exposure Among Pakistani Medical Staff During 2007-2011. *Australas Phys. Eng. Sci. Med., 35*(3), 297-300.

11. Jabeen, A., Munir, M., Khalil, A., Masood, M. & Akhter, P. (2010). Occupational Exposure from External Radiation used in Medical Practices in Pakistan by Film Badge Dosimetry. *Radiation Protection Dosimetry, 140*(4), 396-401.

12. International Atomic Energy Agency. (2002). Occupational radiation protection: protecting workers against exposure to ionizing radiation. International Atomic Energy Agency (IAEA), in: Proceedings of an International Conference, Geneva, and 26-30 August, 2002.

13. Mora, P. & Acuna, M. (2011). Assessment of Medical Occupational Radiation Doses in Costa Rica. *Radiation Protection Dosimetry, 147*(1-2), 230-232.

14. Shain A., Tatar, A., Oztas, S., *et al.* (2009). Evaluation of genotoxic effects of chronic low-dose ionizing radiation exposure on nuclear medicine workers. *Nucl Med Biol., 36*(5), 575-578.

15.Pauwels, E. K. J. & Bourguignon, M. H. (2012). Radiation dose features and solid cancer induction in pediatric computed tomography. *Med Princ Pract., 21*(6), 508-515.

16. Covens, P., Berus, D. & de Mey, J., *et al.* (2010). Mapping very low level occupational exposure in medical imaging: a useful tool in risk communication and decision making. *Eur J Radiol., 81*(9), e962-e966. 16.

17. Linet, M. S., Kim, K. P. & Miller, D. L., *et al.* (2010). Historical review of occupational exposures and cancer risks in medical radiation workers. *Radiat Res., 174*(6), 793-808.

18. Smith-Bindman, R., Miglioretti, D. L. & Johnson, E., *et al.* (2012). Use of diagnostic studies and associated radiation exposure for patients enrolled in large integrated health care systems: 1996-2010. *JAMA., 307*(22), 2400-2409.

19. Smith-Bindman, R., Miglioretti, D. L. & Larson, E. B. (2008). Rising use of diagnostic medical imaging in a large integrated health care system. *Health Aff (Millwood)., 27*(6), 1491-1502.

20. Al Haj, A. N. & Lagarde, C. S. (2002). Statistical analysis of historical occupational dose records a large medical centre. *Health Phys., 83*(6), 854-860.

21. Martins, M. B., Alves, J. N. & Abrantes, J. N., *et al.* (2007). Occupational exposure in nuclear medicine in Portugal in the 1999–2003 period. *Radiat Prot Dosimetry., 125*(1-4), 130-134.

22. Mettler, F. A., Jr, Bhargavan, M., Thomadsen, B. R., *et al.* (2008). Nuclear medicine exposure in the United States, 2005–2007: preliminary results. *Semin Nucl Med., 38*(5), 384-391.

23. Shrimpton, P. C., Wall, B. F. & Hart, D. (1999). Diagnostic medical exposures in the UK. *Appl Radiat Isot., 50*(1), 261-269.

24. Wu, W., Zhang, W., Chen, R., *et al.* (2005). Occupational exposure of Chinese medical radiation workers in 1986–2000. *Radiat Prot Dosimetry., 117*(4), 440-443.

25. Jabeen, A., Munir, M., Khalil, A., *et al.* (2010). Occupational exposure from external radiation used in medical practices in Pakistan by film badge dosimetry. *Radiat Prot Dosimetry., 140*(4), 396-401.

26. Abdullahi, M. G. & Toriman, M. E. (2015). The Effects of X-rays (Radiation) on Embryonic and Fetal during Developmental Pregnancy Stages. *J Nucl Med Radiat Ther., 6*, 231.

27. United Nations Scientific Committee on the Effects of Atomic Radiations. (2010). Summary of low-dose radiation effects on health. UNSCEAR report. New York, UN Press, 2010, (pp 1–14).

28. Lee, W. J., Ha, M., Hwang, S. S., *et al.* (2015). The radiologic technologists' health study in South Korea: study design and baseline results. *Int Arch Occup Environ Health., 88*(6), 759-68.