Physicians' Awareness on Biological Effects of Ionizing Radiation Applied in Radiological Imaging Procedures in Yazd Province

Ali Chaparian[*1], Hosain Hekmati Moghadam[2] and Mahsa Mansourian[1]

[1]. Department of Medical Physic, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

[2]. Department of Pathology, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

Received: 12/10/2013 **Accepted:** 3/2/2014

Abstract

Background: Ionizing radiation has long-term risks, including cancer in particular. Since physicians request radiological examinations for patients, they need to be aware of its benefits and also risks. The aim of this study was to assess the overall knowledge of physicians in Yazd province about the radiation risks associated with diagnostic imaging procedures.

Material and Methods: In this descriptive study, a questionnaire containing 25 questions was used to evaluate physicians' knowledge of radiation doses received from radiological procedures and risks of cancer from diagnostic imaging. Their demographic characteristics such as age, sex, specialty and experience (years of practice) was also asked. Normality of data distribution was assessed using the Shapiro–Wilks test and the Kolmogorov–Smirnov test. A t-test was used for continuous variables and comparison of mean differences in scores for dichotomous variables. Spearman's correlation coefficient was carried out to look for any relationship between variables of age and experience with the knowledge of the physicians.

Results: The overall mean knowledge score was 14 ± 3.15 out of 25 questions, or 56% ± 12.6%, and the scores ranged from 11.5% to 81%. The total mean score did not correlate with age and experience, but there was a significant difference (P value= 0.001) between men and women and also among the two main respondent groups, general practitioners and specialists (P value= 0.012). Physicians' knowledge about detrimental effects of radiation including both deterministic and stochastic effects was very weak.

Conclusion: The awareness of physicians about radiation is generally inadequate. Adequate training to practicing physicians about risks of radiological examinations seems necessary, and revision of the curriculum of medical students in this area is recommended.

Key words: Physicians; Awareness; Ionizing radiation; Imaging procedures; Cancer

[*] **Corresponding author: Tel:** +۰۹۱۳۱۰۹۱۷۳۵, **Email:** ali_chaparian@yahoo.com

[Downloaded from jhr.ssu.ac.ir on 2026-10-09]

Introduction

Radiological methods have been widely used for diagnosis of diseases and monitoring of management of patients. The number of these methods is rapidly increasing, particularly those involving ionizing radiation. For example, the use of computed tomography (CT) scanning has increased in the USA by a factor of 10 during 1980-2005[1]. While these technologies undoubtedly help accurately diagnose a wide range of diseases, ionizing radiation applied in them has an inherent potential to hurt. Previous investigations have proved that the most important long-term risk associated with ionizing radiation is cancer [2-3].

In the United Kingdom, about 100-250 deaths occur each year as a result of cancers directly related to medical exposure to ionizing radiation [4]. Therefore, limiting usage of radiation even for medical purposes is very important. Radiation dose should be enough to respond the clinical question, but as low as reasonably achievable (ALARA) to reduce the risk to the patient [5]. The ALARA concept is recommended by radiation protection organizations such as National Radiological Protection Board (NRPB) [6] and International Commission on Radiation Protection (ICRP) [7]. Justification is a basic principle of radiation protection [7-8]. For justification of a radiological procedure, it is necessary to weigh its risks against its benefits [7]. Since physicians request radiological examinations for patients, they have to be aware of its benefits and also risks of examinations involving radiation in order to justify a radiography request.

Awareness of physicians about risks of ionizing radiation is one of the main prequisites for decreasing unnecessary radiological tests and requesting the alternative procedures with low or zero radiation risk. In the recent years, many studies have investigated awareness of physicians from varying specialties about radiation dose and its associated risks. Results of these studies conducted in Australia[9], Norway [10], Germany [11], Pakistan [1] and Ireland [13] have indicated that physicians' knowledge about this topic is poor.

Literature review revealed that except for a study conducted by Chaparian et al [17] about awareness of radiographers about radiation protection, there is a lack of knowledge on level of awareness of radiation especially among physicians in Yazd province; therefore, the purpose of this study was to gain insight into the overall knowledge of Iranian physicians about the radiation risks associated with diagnostic imaging procedures.

[Downloaded from jhr.ssu.ac.ir on 2026-10-09]

Materials and Methods

A descriptive questionnaire-based study was performed to assess physicians' knowledge of radiation doses received from radiological procedures (Appendix A). The questionnaire consisted of 32 questions: five questions on the participant's demographics such as age, sex, specialty and experience (years of practice), 25 questions on their knowledge of radiation doses as well as risks of cancer from diagnostic imaging, and two questions on their education history and tendency for future education on the subject. All questions were in multiple choice formats with two to five choices, and the responders were asked to check the correct answer for each question. Unanswered questions were scored as incorrect. The validity of this questionnaire was verified by 3 medical physicists and 3 radiologists, and its reliability was determined by Cronbach alpha (0.9).

The questionnaire was distributed over an 8-week period to all physicians including general practitioners (GPs) and specialist physicians (SPs) working in Yazd province, Iran. Enrolment to the study was done by convenience sampling of them on a voluntary basis. There was no potential damage to participants, and the anonymity of responders was protected.

Data taken from completed questionnaires were transferred to the Statistical Package for the Social Sciences software (SPSS, version 19.0, USA) for statistical analysis.

Normality of data distribution was assessed using the Shapiro–Wilks test and the Kolmogorov–Smirnov test. A t-test was used for continuous variables and comparison of mean differences in scores for dichotomous variables. Statistical significance of all tests was set at a p value of $\leq 5\%$. Spearman's correlation coefficient was carried out to look for any relationship between variables of age and experience with the knowledge of the physicians.

Results

Totally 250 physicians were asked to answer the questionnaire, of whom 144 agreed to complete it (58% response rate). The participants included 45 general practitioners (GPs) and 99 specialist physicians (SPs) (including specialists in infectious diseases, internal medicine, surgeons, urologists, dermatologists, pediatricians, neurologists, orthopedists, gynecologists, cardiologists, ophthalmologists and ear, nose and throat specialists). The mean age of participants was 42.3 ± 8.9 years with a range of 29 - 74 years. Their mean experience was 12.8 ± 8.7 years with a range of 1–35 years.

A score (percentage of correctly answered questions) was given to each physician. The overall mean knowledge score was 14 ± 3.15 out of 25 questions, or 56% ± 12.6%, and the scores ranged from 11.5% to 81%.

[Downloaded from jhr.ssu.ac.ir on 2026-10-09]

The total mean score did not correlate with age and experience, but there was a significant difference (P value= 0.001) between men and women (Table 1) and also among the two main respondent groups, GPs and SPs (P value= 0.012) (Table 2).

Table1: Scores of male and female physicians who completed the questionnaire

Sex	Number	Mean	Std. Deviation
Male	89	59%	11.4%
Female	55	52%	13.3%

P. value: 0.001

Table 2: Scores of general and specialist physicians who completed the questionnaire

Specialty	**Number**	**Mean**	**Std. Deviation**
GPs	45	52%	12.5%
SPs	99	58%	12.3%

P. value: 0.012

Table 3 shows responses given to 25 questions by the physicians about different aspects of radiation and radiobiology related to radiological methods.

A statistically significant difference was found between the GPs and SPs in eight questions. Surprisingly, 60.5% of GPs did not know that an x- ray of abdomen produces the highest radiation exposure for the patient compared with ultrasound of abdomen, MRI of spine and chest x-ray. Also, only 21% of GPs and 37% of SPs knew that computed tomography is responsible for more radiation dose received by the people than ultrasound, chest x-ray, MRI, and lumbar spine x-ray. Physicians' knowledge about detrimental effects of radiation including both deterministic and stochastic effects was very weak.

Only 31.25% of physicians were aware of the fact that there is risk of carcinogenesis even if the number of x-ray examinations is little. Unfortunately, only 13.9% of physicians were familiar with the ALARA concept.

[Downloaded from jhr.ssu.ac.ir on 2026-10-09]

Table3: Percentages of correct answers of general and specialist physicians to 25 questions

Questions	Correct responses			Significance	Questions	Correct responses			Significance
	GPs (N=45)	SPs (N=99)	Total (N=144)			GPs (N=45)	SPs (N=99)	Total (N=144)	
1	83.72	83.84	83.33	NS*	14	86.05	87.88	87.50	NS
2	65.12	87.88	81.25	p< 0.001	15	53.49	50.51	50.69	NS
3	88.37	85.86	86.71	NS	16	20.93	20.20	20.14	NS
4	69.77	93.94	87.41	p<0.001	17	25.58	23.23	23.61	NS
5	58.14	93.94	83.33	p<0.001	18	11.63	12.12	11.81	NS
6	88.37	94.95	91.67	NS	19	30.23	26.26	27.08	NS
7	88.37	89.90	89.58	NS	20	9.30	19.19	15.97	NS
8	39.53	69.70	60.42	p<0.001	21	27.91	34.34	31.94	NS
9	81.40	75.76	77.78	NS	22	20.93	11.11	13.89	NS
10	20.93	37.37	33.33	p<0.041	23	34.88	30.30	31.25	NS
11	81.40	77.78	79.17	NS	24	34.88	38.38	36.81	NS
12	88.37	80.81	82.64	NS	25	25.58	59.60	50.00	p<0.0001
13	88.37	79.80	82.64	NS					

*NS = Not significant

As shown in Figure 1, only 2.4% of GPs and 14.4% of SPs had undergone formal training on risks of radiation. This figure also demonstrates that 83.3% of GPs and 66% of SPs were interested in being trained on this topic.

[Downloaded from jhr.ssu.ac.ir on 2026-10-09]

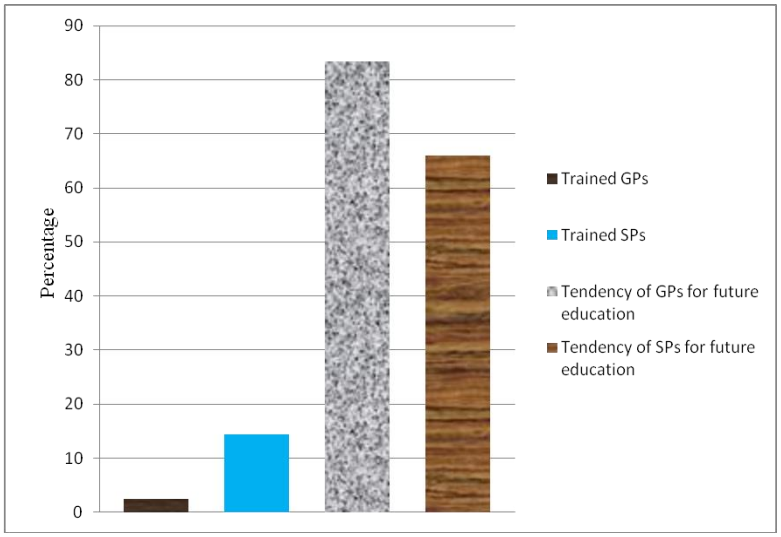

Figure 1: Status of education history and tendency of physicians for future education.

Discussion

The aim of this study was evaluation of physicians' knowledge about radiation hazards from medical imaging procedures. We found that the awareness of physicians on this topic is generally inadequate. This reflects a lack of knowledge regarding basic scientific principles of radiation, and an adequate training to physicians seems necessary.

The results of this study are somewhat more promising than the results of other studies. While the overall mean knowledge score in this investigation was 14 ± 3.15 of 25 questions (or 56 ± 12.6% as percentage of correct answers), it was 40, 43, and 39% in studies done by Keijzers et al. [9], Shiralkar et al[4], and Soye et al. [13], respectively. There was no statistically significant correlation between the overall mean score and the experience of physicians, which is similar to findings in some studies such as Heyer et al. [15] and Gumus et al. [16] studies. However, it was shown that the difference of knowledge between two sexes of physicians was statistically significant in our study (Table 1). This may probably be explained by the fact that usually men are more curious to know the technical aspects of radiation and imaging equipments. Furthermore, the overall mean score differed between the two main respondent groups, GPs and SPs (Table 2), which is consistent with Ghazikhanlou et al. study [14] and demonstrates tendency of specialists to care more about what they order for diagnostic maneuvers.

Physicians' knowledge about organs' sensitivities to ionizing radiation was better, with 77.8% correctly identifying the gonads as the most sensitive organ, whereas in the Ghazikhanlou et al. study[14], it was 81% and 92% for GPs and SPs, respectively. Interestingly, only 13.9% of physicians stated that they knew the ALARA principle; it was

[Downloaded from jhr.ssu.ac.ir on 2026-10-09]

almost similar with the obtained scores in the Heyer et al. study [11], which was 15%. About 51% of respondents stated that they were familiar with the terms of deterministic and stochastic effects, but only 11.8% - 31.9% of them were able to determine the type of different detrimental effects, which is consistent with the Borgen et al. study [10]. Nearly 63% of physicians wrongfully thought that after an X-ray examination, objects in the room emit radiation, which is almost similar with findings of the Mubeen et al. study [12], which was 58%. Only 25.6% of GPs and 59.6% of SPs knew that contrast substances used in some radiographies such as angiogram are not radioactive, whereas in the Mubeen et al. study [12], this was 20%. About 17% of physicians mistakenly thought that an MR study is associated with ionizing radiation, whereas in the Keijzers et al. study [9] and the Soye et al. study (13), this was 21% and 22%, respectively. Also, 13% of physicians were incorrect in their assumption that ultrasound examinations using ionizing radiation, whereas in the Keijzers et al. study [9] and the Soye et al.

study [13], this number was 5% and 10%, respectively. The reasons of discrepancies between different research works are not clear, but it may be attributed to differences in the curriculum, by which physicians have been trained in various countries.

Regarding the education history of physicians and their tendency for future education, only 2.4% of GPs and 14.4% of SPs had undergone formal training on risks of radiation, whereas in the Keijzers et al. study[9] and in the Soye et al. study[13], this was 24% and 34%, respectively. About 83% of GPs and 66% of SPs were interested in getting trained in this area. No significant differences were observed between the mean scores of trained physicians and untrained ones. The same finding was reported in the Keijzers et al. study [9].

The major limitation of the present study was reluctance of some physicians to complete the questionnaires. Some of them admitted that they have no knowledge about the issue, or did not have enough time to respond. Another limitation of this study was lack of distinction between different specialist physicians; therefore, it is recommended that a similar study is conducted to compare the awareness of physicians with different specialties.

Consequently, the results of this study obviously show lack of knowledge about the radiation risks from radiological procedures among physicians. An increase in awareness could ideally cause physicians to order less radiological examinations, ultimately minimizing unnecessary exposure of patients and its accompanying risk of cancer. Training courses on the risks of ionizing radiation are essential for practicing physicians. Also, revision of the curriculum of medical students in this area seems necessary.

[Downloaded from jhr.ssu.ac.ir on 2026-10-09]

References

1. McCusker MW, de Blacam C, Keogan M, et al. Survey of medical students and junior house doctors on the effects of medical radiation: is medical education deficient? Irish journal of medical science. 2009; 178(4): 479-83.

2. Beir V. Health risks from exposure to low levels of ionizing radiation. BEIR VII phase. 2006; 2.

3. Ron E. Cancer risks from medical radiation. Health Phys. 2003; 85(1): 47-59.

4. Shiralkar S, Rennie A, Snow M, et al. Doctors' knowledge of radiation exposure: questionnaire study. BMJ. 2003; 327(7411): 371-2.

5. Hertel NE. Introduction to Health Physics, 4th edition. Health Phys. 2009; 97(6): 639.

6. COR NI. National protocol for patient dose measurements in diagnostic radiology. Chilton, UK: NRPB. 1992.

7. ICRP Publication 105. Radiation protection in medicine. Annals of the ICRP. 2007; 37(6): 1-63.

8. The 2007 Recommendations of the International Commission on Radiological Protection. ICRP publication 103. Annals of the ICRP. 2007; 37(2-4): 1-332.

9. Keijzers GB, Britton CJ. Doctors' knowledge of patient radiation exposure from diagnostic imaging requested in the emergency department. The Medical journal of Australia. 2010; 193(8): 450-3.

10. Borgen L, Stranden E, Espeland A. Clinicians' justification of imaging: do radiation issues play a role? Insights into imaging. 2010; 1(3): 193-200.

11. Heyer CM, Hansmann J, Peters SA, et al. Paediatrician awareness of radiation dose and inherent risks in chest imaging studies- a questionnaire study. European journal of radiology. 2010; 76(2): 288-93.

12. Mubeen SM, Abbas Q, Nisar N. Knowledge about ionising and non-ionising radiation among medical students. J Ayub Med Coll Abbottabad. 2008; 20(1): 118-21.

13. Soye J, Paterson A. A survey of awareness of radiation dose among health professionals in Northern Ireland. British Journal of Radiology. 2008; 81(969): 725-9.

14. Ghazikhanlou Sani K, Jafari M, Mohammadi M, et al. Iranian physicians' knowledge about radiation dose, received by patients in diagnostic radiology. Iranian Journal of Radiation Research. 2009; 6(4): 207-12.

15. Heyer CM, Peters S, Lemburg S, et al. [Awareness of radiation exposure of thoracic CT scans and conventional radiographs: what do non-radiologists know?]. RoFo : Fortschritte auf dem Gebiete der Rontgenstrahlen und der Nuklearmedizin. 2007; 179(3): 261-7.

16. Gumus C, Cankorkmaz L, Erkoc MF, et al. Turkish pediatric surgeons knowledge on the radiation exposure of patients during diagnostic imaging. Türkiye Klinikleri Tıp Bilimleri Dergisi. 2008; 28(5): 623.

17. Chaparian A, Shamsi F, Heydari A. Assessment of awareness, attitude, and practice of radiographers about radiation protection in Yazd Province. tkj. 2013;5 (1):16-23

[Downloaded from jhr.ssu.ac.ir on 2026-10-09]