RESEARCH ARTICLE

Radiation awareness among dentists, radiographers and students

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Objectives: The aim of this study was to assess radiation awareness among dentists, radiographers, dentistry students and radiography students from the Medical University of Warsaw.

Methods: A questionnaire containing 13 multiple-choice questions was administered to 200 dentists, 200 radiographers, 100 dentistry students and 100 radiography students. Participants were asked about basic knowledge concerning dental radiological examinations.

Results: In total, 301 (50.2%) questionnaires were returned. The mean score of correct answers was 8.13 out of 13 for all responders; 8.36 for dentists, 8.11 for radiographers, 8.19 for dentistry students and 7.46 for radiography students. Range of correct answers varied from 3 to 12. Differences between the four main groups were not statistically significant. Dentists who had completed radiation protection training had significantly higher number of correct answers than untrained dentists. For radiographers, the level of education had no connection with the results. Correlation between year of the study and results was not visible in the dentistry student group. Within the radiography student group, students in the third year of the study had significantly higher number of correct answers than those in the first and second years of the study.

Conclusions: Our survey shows that radiation awareness among dentists, radiographers and students is inadequate, without significant differences in the main groups. Dentists who had completed radiation protection training had better awareness than those without such training. Greater emphasis should be put on the dental radiology course in both dentistry and radiography programmes at universities.

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Introduction

Many studies concerning radiation awareness among physicians of different specialties, interns, radiographers and medical students have been performed.^{1–5} However, according to our knowledge, no research has been conducted among healthcare professionals prescribing and performing dental radiological examinations.

According to the report of the Polish Sanitary Inspectorate, in 2012, over half of about 15,000 working

X-ray devices were dental ones.⁶ According to the European Commission, the number of dental examinations constitute nearly one-third of the radiological examinations in the European Union.⁷ These data show that collective doses from dental radiography have a significant share in the average annual dose from medical sources.

Average dose from intraoral radiography is lower or comparable with the daily background radiation dose.^{7–9} However, every exposure to ionizing radiation entails the possibility of inducing a stochastic effect (including leukaemia and certain tumours).¹⁰

Dentists should have adequate knowledge about radiation, as they prescribe the examinations. They decide

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if the value of information provided by radiographs outweighs the possible negative consequences for the patient health. Dentists as well as radiographers should be prepared to inform patients about the possible hazards involved with the use of X-rays.

The aim of this study was to assess general radiological knowledge among health professionals prescribing and performing dental radiological examinations, dentistry students and radiography students from the Medical University of Warsaw.

Methods and materials

The questionnaire was administered to randomly selected 200 dentists and 200 radiographers working in Mazovian Voivodeship and 100 dentistry students and 100 radiography students from the Medical University of Warsaw. As dental hygienists are not allowed to perform radiography in Poland, they were excluded from this study.¹¹ The authors were also excluded from the study. Data were collected anonymously.

The questionnaire was divided into two sections. The first section concerned the surveyed person (*e.g.* year of study, practice time, graduated university). The second one, containing 13 questions, assessed knowledge regarding basic radiological and some legal issues. The questions were designed in the form of affirmative sentences with “TRUE”, “FALSE” and “I DO NOT KNOW” answers. The questions together with answers and the relevant reference sources are presented in Appendix A.

The chosen metric of the level of knowledge was the number of correct answers. To compare the average number of correct answers in groups (dentists, radiographers etc.) and subgroups (qualifications, year of study), univariate ANOVA was used, calculated with SPSS® software v. 22 (IBM Corp., New York, NY; formerly SPSS Inc., Chicago, IL). The overall value for statistical significance was $p < 0.05$.

Results

A total number of 301 (50.2%) questionnaires were returned from the 600 questionnaires sent. Table 1 presents the mean number of correct answers in the groups together with corresponding standard deviations. The overall mean score of correct answers was 8.13 (63%) out of 13. The range of correct answers varied from 3 to 12.

Differences between the four main groups—dentists, radiographers, dentistry students and radiography students—were not statistically significant.

Comparison between certain subgroups of particular groups revealed statistically significant differences (Table 1). In the dentist group, the number of correct answers was related to the time of practice and the completion of radiation protection training ($F = 2.704$, $df = 4$; $p < 0.035$; $\eta^2 = 0.107$). Significant difference was observed only between dentists practising 1–5 years and those practising more than 15 years. Dentists who had completed radiation protection training had significantly higher number of correct answers ($F = 4.979$, $df = 1$; $p < 0.028$; $\eta^2 = 0.051$) than those without such training.

In the radiography student group, the number of correct answers was related to the year of the study ($F = 13.00$, $df = 2$; $p < 0.001$; $\eta^2 = 0.388$). Third-year students had significantly higher number of correct answers than first- and second-year students.

In the radiographer and dentistry student groups, differences between subgroups were not statistically significant.

Low-scoring questions

To explore how certain areas of radiological knowledge depend on the educational background and experience, the per-question analysis of the results was performed. In 5 out of 13 questions, <50% of responders marked correct answers in at least 1 group. These questions together with the percentage of correct answers across all groups are presented in Figure 1.

Table 1 The mean number of correct answers in the groups (mean $\pm$ standard deviation). In addition, pairs of subgroups with statistically significant differences are presented

Group	Subgroup	Number	Percentage	Number of correct answers
Dentists		95	32%	8.36 $\pm$ 1.76
	Time of practice			
	1–5 years	32		9.13 $\pm$ 1.93 ^a
	More than 15 years	23		7.78 $\pm$ 1.57 ^a
	Radiation protection training			
	Without training	33		7.82 $\pm$ 1.81 ^b
	With training	62		8.65 $\pm$ 1.67 ^b
Radiographers		89	30%	8.11 $\pm$ 1.67
Dentistry students		73	24%	8.19 $\pm$ 1.46
Radiography students		44	15%	7.46 $\pm$ 1.58
	Year of study			
	First	11		6.27 $\pm$ 0.38 ^c
	Second	18		7.33 $\pm$ 0.3 ^d
	Third	15		8.8 $\pm$ 0.32 ^{c,d}

^{a,b,c,d}Pairs of results are differing significantly; $p < 0.05$ vs control by ANOVA.

Question 4. Radiation dose associated with one periapical radiograph is absolutely safe and has no impact on health.

Question 7. Statistically, 1 in 1000 people, who have undergone 1 periapical examination, will die owing to cancer induced by radiation.

Question 9. Performing radiological examination in pregnant women is forbidden.

Question 10. Number of radiographs prescribed to patients in 1 year is not limited by law.

Question 11. A patient must have a prescription form to have a dentist perform periapical radiography

Figure 1 Low-scoring questions together with percentage of correct answers (<50% correct answers in any of the groups).

In Question 4, the majority of dentists, dentistry students and radiography students mistakenly claimed that one periapical radiation dose was absolutely safe and had no impact on health. Among dentists who had marked the correct answer, 81.5% of dentists had completed the radiation protection training. Awareness of the potential harmful effects was highest in the radiographer group, where the distribution of answers was not dependent on the level of education.

Question 7 concerning risks of inducing a fatal cancer from periapical radiograph was the most confusing for all responders—there was highest percentage of “I DO NOT KNOW” answers (30.9%).

In Question 9, most of the radiographers and radiography students found performing radiograph for patients who are pregnant forbidden, which was an incorrect answer. Dentists and dentistry students were better at answering this question.

Approximately half of the responders in each group falsely stated that the limit of radiographs for patients per year is determined by law (Question 10).

Almost half of the dentists and radiography students could not correctly indicate that periapical radiography can be performed upon patient request (Question 11).

Answers “TRUE” for both Questions 4 and 6 (Appendix A) were mutually exclusive. If radiation was absolutely safe (Question 4), then there would be no possibility of harmful effects such as leukaemia (Question 6). It is interesting that there were 30 (31.6%) dentists, 21 (23.6%) radiographers, 33 (45.2%) dentistry students and 18 (93%) radiography students who marked answers in such combination.

Discussion

Based on the results, we conclude that radiation awareness among dentists and radiographers is insufficient. The mean percentage of correct answers was 64% for dentists and 62% for radiographers. Only 46 (48%) dentists and 40 (45%) radiographers marked >8 correct answers. We set high expectations for the responder results, as the questions were simple and assessed more general rather than academic knowledge. None of the questions concerned precise numerical data and only few of them could be recognized as theoretical and irrelevant in everyday practice.

Data show that completion of radiation protection training increased dentist radiological knowledge—similar to another study.⁴ For radiographers, the level of education had no connection with the number of correct answers. The cross-group comparison tells that dentists achieved better results than radiographers, but the difference was not statistically significant. Our results are contrary to those of Ramanathan and Ryan,¹ who found significant knowledge deficiency among radiographers compared with other radiology department staff. Our responder knowledge was similar regardless of time of practice (significant difference was present only between two subgroups of the dentist group).

We expected students to perform better, as they are more up to date with knowledge, but only 36% of dentistry students and 18% of radiography students marked >8 correct answers. Radiography students achieved worse results. It may be because most of this group were first- and second-year students (first-year radiography students had completed only a general radiography course and had not started dental radiology course at the time they were questioned). For some questions (Questions 2, 3, 9 and 13), group-level distributions show similarities for students and their future counterparts—they may be explained by differences in the curriculum with regard to profession.

The majority of responders falsely claimed that one periapical radiation dose was absolutely safe and had no impact on health. Disregard for radiation risk may lead to excessive number of unnecessarily prescribed or repeated periapical radiographs. On the other hand, most of the responders overestimate the risk of radiological examination of patients who are pregnant. The possible negative consequences of this include abandoning radiological diagnostics for patients who are pregnant, even when the benefits outweigh the risk. Another much less likely but possible consequence is denial of performing prescribed examinations for patients who are pregnant by radiographers.

Our study has the following limitations: (1) the chosen metric does not distinguish between incorrect and “I DO NOT KNOW” answers—both were scored as 0 points; (2) the order of questions might have had influence on answers; (3) the responding group was small; (4) direct comparison between our results and results from past

studies is impossible (in other studies, responders were mostly asked to identify doses and radiation risk from examinations, while our study had comprehensive questions); (5) responders might have searched for answers in sources like books or the Internet; and (6) some questions (Questions 1–3, 4 and 6) were in some way related to each other.

The results indicate the need for improvement in dental radiology training at universities. Also, the Dentist Final Examination (Lekarsko Dentystyczny Egzamin Końcowy), which is obligatory to pass before starting dental practice, should include more questions from the dental radiology field, especially radiation safety topics.

Conclusions

Our survey shows that radiation awareness among dentists and radiographers as well as students is inadequate, without significant differences between main groups. Dentists who had completed radiation protection training had greater awareness than those without such training. Greater emphasis should be put on the dental radiology course in both dentistry and radiography programmes at universities.

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Appendix A

Questions along with correct answers and the relevant reference sources:

1. Background radiation comes from (among others) radioactive isotopes in the Earth crust, cosmic radiation emitted by the Sun and radioactive elements contained in materials used for building construction TRUE⁸
2. Ionizing radiation used in radiological diagnosis has similar properties to natural background radiation TRUE⁸
3. The average dose from periapical radiography is lower or comparable with daily background radiation dose TRUE⁷⁻⁹
4. Radiation dose associated with one periapical radiograph is absolutely safe and has no impact on health FALSE¹⁰
5. Risk involved with radiation should be lower than benefits from diagnostic information TRUE¹²
6. Every radiation exposure brings possibility of occurrence of the harmful effects, *e.g.* leukaemia TRUE¹⁰
7. Statistically, 1 in 1000 people, who have undergone 1 periapical examination, will die owing to cancer induced by radiation FALSE⁷
8. Children and foetuses are more vulnerable to radiation TRUE^{7,10}
9. Performing radiological examination in pregnant women is forbidden FALSE^{7,11}
10. Number of radiographs prescribed to patients in 1 year is not limited by law TRUE^{9,13,14}
11. A patient must have a prescription form to have a dentist perform periapical radiography FALSE¹¹
12. A patient must have a prescription form to have a dentist perform an orthopantomogram TRUE¹¹
13. In all X-ray devices, there is a radioactive source which emits X-rays FALSE¹⁵