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Title of the paper: **Radiation awareness among dentists, radiographers and students**

A shortened version of the title: Radiation awareness

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Abstract

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

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

Results. In total, 301 questionnaires were returned (50.2%). 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, 7.46 for radiography students. Range of correct answers varied from 3 to 12. Differences between four main groups were not statically significant. Dentists who had completed radiation protection training had significantly higher number of correct answers in comparison with 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 dentistry students group. Within the radiography students group, students in third year of the study had significantly higher number of correct answers in comparison with first and second year.

Conclusions. Our survey shows that radiation awareness among dentists, radiographers and students was inadequate, without significant differences in main groups. Dentists, who had radiation protection training completed, had a better awareness, compared with dentists without such training. Greater emphases should be put on dental radiology course in both dentistry and radiography programs at the universities.

Key words. survey; dental radiography; medical staff; dentists; students

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 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 significant share in average annual dose from medical sources.

Average dose from intraoral radiography is lower or comparable with the daily background radiation dose.^{7,8,10} However every exposure to ionizing radiation entails the possibility of inducing a stochastic effect (including leukemia and certain tumors).⁹

Dentists should have adequate knowledge about radiation, as they prescribe the examinations. They decide if the value of information provided by radiographs outweighs the possible negative consequences for the patients' health. Dentists as well as radiographers should be prepared to inform patients about the possible hazards involved with the use of x rays.

Objectives

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 Medical University of Warsaw.

Material and methods

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 Medical University of Warsaw. As dental hygienists are not allowed to perform radiographs 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 in two sections. The first one concerned 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.

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 analysis of variance (ANOVA) was used, calculated with IBM SPSS software version 22. The overall value for statistical significance was $p < 0.05$.

Results

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

Differences between four main groups – dentists, radiographers, dentistry students and radiography students – were not statically significant.

Comparison between certain subgroups of particular groups revealed statistically significant differences (Table 1). In the dentists group the number of correct answers was related with 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 practicing 1-5 years and more than 15 years. Dentists with radiation protection training completed had significantly higher number of correct answers ($F=4.979$; $df=1$; $p<0.028$; $\eta^2=0.051$) in comparison with dentists without such training.

In radiography students group the number of correct answers was related with 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 in comparison with first and second year.

In radiographers group and dentistry students group differences between subgroups were not statically 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 less than 50% of responders marked correct answers in at least one group. These questions together with percentage of correct answers across all groups are presented in Figure 1.

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 marked correct answer 81.5% had the radiation protection training completed. Awareness of potentially harmful effects was the highest in radiographers' 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 radiographers and radiography students found performing radiograph for pregnant patient forbidden which was an incorrect answer. Dentists and dentistry students were better at answering this question.

Approximately half of responders in each group falsely stated that the limit of radiographs for patient 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 on patient's request (Question 11).

Answers “TRUE” for both Question 4 and Question 6 (Appendix) were mutually exclusive. If radiation was absolutely safe (Q4) then there would be no possibility of such harmful effects as leukemia (Q6). It is interesting that there were 30 dentists (31.6%), 21 radiographers (23.6%), 33 dentistry students (45.2%) and 18 radiography students (93%), who marked answers in such combination.

Discussion

Based on results we conclude that radiation awareness among dentists and radiographers was insufficient. The mean percentage of correct answers was 64% for dentists and 62% for radiographers. Only 46 of dentists (48%) and 40 of radiographers (45%) marked more than 8 correct answers. We set the high expectations for the responders’ 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 every day practice.

Data show that completion of radiation protection training increased dentists’ radiological knowledge – similarly like in other 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 result than radiographers, but the difference was not statistically significant. Our results are contrary to Ramanathan et al results, who found significant knowledge deficiency among radiographers compared to other radiology department staff.¹ Our responders’ knowledge was similar regardless of time of the practice (significant difference was only between two subgroups of dentists 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 more than 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 were after general radiography course and had not started dental radiology course at the time they were being questioned). For some questions (questions no: 2, 3, 9, and 13) the group-level distributions shows similarities for students and their future counterparts – that may be explained by differences in curriculum with regards to profession.

The majority of responders falsely claimed that one periapical radiation dose was absolutely safe and had no impact on health. Disregard of radiation risk may lead to excessive number of unnecessarily prescribed or repeated periapical radiographs. On the other hand, most of responders overestimate risk of radiological examination of pregnant patients. The possible negative consequences of this include abandoning radiological diagnostics for pregnant patients even when the benefits outweigh the risk. Other much less likely but possible consequence is denial of performing prescribed examinations for pregnant patient 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) 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, (6) some questions (no: 1-3, 4,6) were in some way related with each other.

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

Conclusions

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

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Tables and Figures:

1. Table 1. The mean number of correct answers in the groups, means \pm SD. Additionally pairs of subgroups with statistically significant differences are presented.
2. Figure 1. Low-scoring questions together with percentage of correct answers (less than 50% correct answers in any of the groups).

Table 1

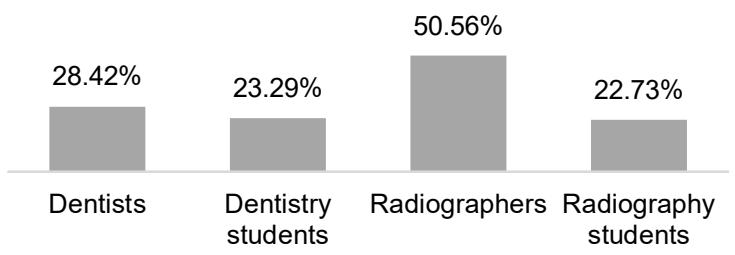
Table 1. The mean number of correct answers in the groups, means \pm SD. Additionally pairs of subgroups with statistically significant differences are presented.

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:			
	• I year	11		6.27 \pm 0.38 ^c
	• II year	18		7.33 \pm 0.3 ^d
	• III year	15		8.8 \pm 0.32 ^{c, d}

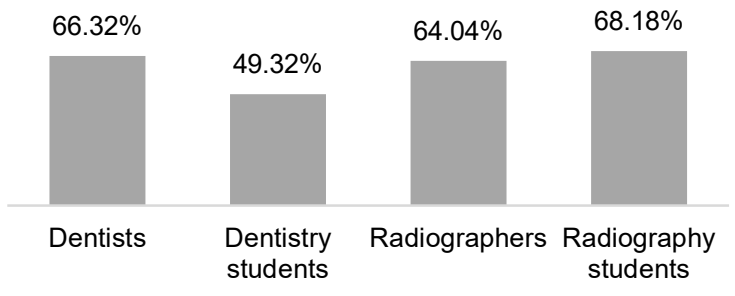
^{a, b, c, d} pairs of results differing significantly, $p < 0.05$ vs. control by ANOVA

Figure 1

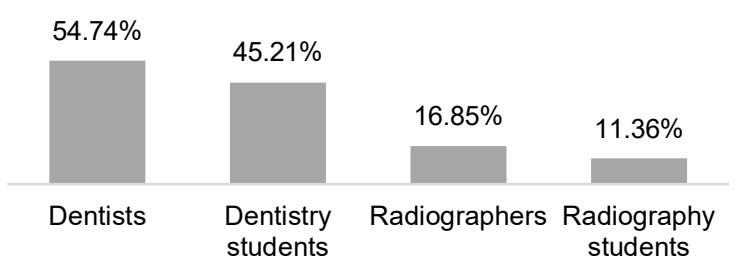
Question 4. Radiation dose associated with one periapical radiograph is absolutely safe and has no impact on health.



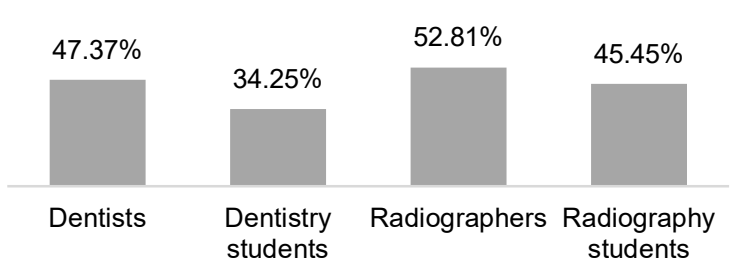
Question 7. Statistically, one of a thousand people, who have had one periapical examination performed, will die due to cancer induced by radiation.



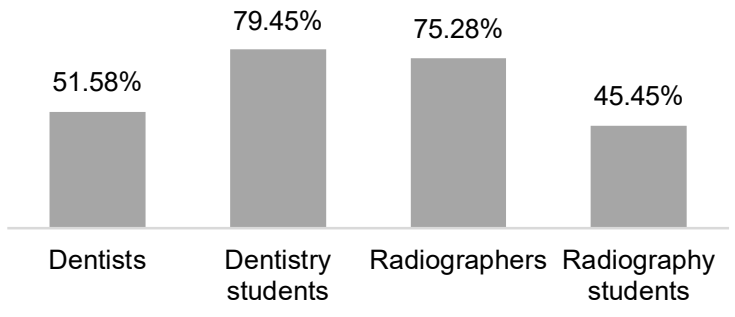
Question 9. Performing radiological examination to pregnant female patient is forbidden.



Question 10. Number of radiographs prescribed to patient in one year is not limited by law.



Question 11. To perform periapical radiograph patient has to have prescription from dentist.



Appendix

Questions along with correct answers and the relevant reference sources.

1. Background radiation comes from (among others) radioactive isotopes in the Earth's crust, cosmic radiation emitted by the Sun, radioactive elements contained in materials used for buildings' construction. TRUE ⁸
2. Ionizing radiation used in radiological diagnosis has similar properties to natural background radiation. TRUE ⁸
3. The average dose from periapical radiography is lower or comparable with daily background radiation dose. TRUE ^{7,8,10}
4. Radiation dose associated with one periapical radiograph is absolutely safe and has no impact on health. FALSE ⁹
5. Risk involved with radiation should be lower than benefits from diagnostic information. TRUE ¹²
6. Every radiation exposure brings possibility of occurrence of the harmful effects, e.g. leukemia TRUE ⁹
7. Statistically, one of a thousand people, who have had one periapical examination performed, will die due to cancer induced by radiation. FALSE ⁷
8. Children and fetuses are more vulnerable to radiation. TRUE ^{7,9}
9. Performing radiological examination in pregnant women is forbidden. FALSE ^{7,11}
10. Number of radiographs prescribed to patient in one year is not limited by law. TRUE ^{10,13,14}
11. A patient must have a prescription form a dentist to have a periapical radiograph performed. FALSE ¹¹
12. A patient must have a prescription form a dentist to have an orthopantomogram performed. TRUE ¹¹
13. In all X-ray devices there is a radioactive stone which emits X-rays. FALSE ¹⁵