Perception of Risks from Radiation by Faculty and Students of Nagasaki University

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Although a variety of radiation-related education courses are provided in universities, information on faculty and student perceptions of radiation risk is limited. To obtain quantitative data on this issue, we conducted a written questionnaire survey at Nagasaki University on the perceived risks of 13 health hazards, of which six related to radiation exposure. The respondents were asked to estimate the risk of the various items to health on a rating scale of 1 to 5. ‘Living near a nuclear plant’ received the highest rating of 4, followed by ‘not using solar UV protection in midsummer’. ‘X-ray diagnostic tests’ were rated at only 2, which was lower than the rating for ‘air travel’. Among the respondents, undergraduate students showed the highest average risk rating across all items followed by nurses, and staff and graduate students, with doctors and dentists producing the lowest scores. These results suggest that level of specialist knowledge is associated with risk perception, and therefore that radiation education should be carefully planned to improve levels of understanding.

Key words: radiation risk, education, surveys, risk perception, Nagasaki

1. Introduction

Approximately 45,000 survivors of the 1945 atomic bombing of Nagasaki, Japan, are still living in the city in 2008, making up 10% of the total population. One would expect the perception of the risks of radiation exposure by the Nagasaki population, who are exposed to atomic bomb-related stories in the media almost every day, to be higher than that in places without such history. However, quantitative data on the perception of radiation risks in Nagasaki has not yet been gathered.

Nagasaki University has the largest number of students engaged in the fields of research and education in the Nagasaki district; however, many of these students, as well as staff, are not native residents of the area. As some of them, mainly those engaged in the life sciences, material technology and medical radiology, are exposed to radiation or handle radioisotopes, a variety of radiation education courses are compulsory not only to undergraduate students but also to registered radiation workers, including graduate students, research scientists, nurses and medical doctors, in accordance with Japanese laws and regulations regarding radiation safety.

The prior perceptions of radiation risk of people in different occupations can be expected to be non-uniform\(^1,2\); therefore, radiation risk perception, as well as contents and scientific levels of information appropriate to the target audience, should be taken into account when educational courses are designed. In this paper, we report the results of a simple written questionnaire survey of the perceived risks of 13 potential hazards to health, six of which related to radiation exposure, which was administered to 790 students and staff of Nagasaki University during the years 2004 to 2007.

2. Methods

2.1 Respondents

The 790 survey respondents were classified into four target groups: 231 undergraduate students, 185 graduate students/staff, 111 nurses, and 163 medical doctors (MD) and dentists (DDS). The undergraduate students were members of a class on basic knowledge of radiation. Most of them were freshmen belonging...
to a variety of faculties including technology, fisheries, economics, education, pharmaceutical sciences, dentistry and medicine. Graduate students and staff attended a radiation safety beginners’ course, which is a prerequisite for registration as a radiation worker in Japan. Their major areas of research were life sciences and technology. Nurses employed in the university hospital also attended beginners’ course for radiation safety specially adapted to use of radiology in patient care. Medical doctors and dentists were required to attend a post-graduate training orientation class for radiation safety immediately after qualifying in their national examinations. The questionnaires were distributed on campus in advance of class time. Each respondent returned the completed form directly to the instructor just before the class began.

2.2 Questionnaire

Respondents were asked to express their estimation of the risk of 13 potential hazards on a scale of 1 to 5, where 1 = ‘no risk’, 2 = ‘negligible risk’, 3 = ‘acceptable risk’, 4 = ‘tolerable risk’, and 5 = ‘intolerable risk’. Six of them involved radiation exposure as follows: ‘receive diagnostic X-rays’, ‘operate radiological treatment equipment’, ‘work as a nurse in the vicinity of radiological treatment’, ‘work with radiation in research or education’, ‘work in nuclear power generation’, ‘living near a nuclear plant’. Four were food and environment-related risks: ‘sea bathing in midsummer’, ‘not using solar UV protection in midsummer’, ‘genetically modified food’, and ‘American beef’. Although no case of variant Creutzfeldt-Jakob disease (vCJD) has been found in Japan, people have been anxious about the relationship between bovine spongiform encephalopathy (BSE) and American beef. Another three questions addressed the technology-associated risks ‘air travel’, ‘Mitsubishi motor vehicles’ and ‘Schindler elevators’. Both Mitsubishi and Schindler caused serious accidents resulting in Japanese victims, which were attributed to a lack of safety management. All calculations for statistical differences were performed by analysis of variance (ANOVA).

3. Results

3.1 Patterns of perceived risk

The average score for all respondents for all risk items was 2.84. The range was from 3.89 (tolerable risk) for ‘living near a nuclear plant’ to 1.97 (negligible risk) for ‘X-ray diagnosis’ (Fig. 1a). While nuclear power-related risks showed the scores higher than the average, risks for medical radiation were evaluated less than the average score. This is in good accord with previous studies conducted inside and outside Japan3-5). It is possible that the markedly high risk attributed to ‘living near a nuclear plant’ was the result of recent accidents at nuclear power plants, such as Tokai Village in 19999). ‘Not using solar UV protection in midsummer’ had the second-highest risk, which was considerably lower than ‘living near a nuclear plant’.

The rating of ‘X-ray diagnosis’ as a negligible risk was somewhat unexpected, in that the safety of medical radiation has been a controversial issue since the publication of data indicating that Japan has the world’s highest estimated risk of cancer caused by medical radiation, due to the high frequency of X-ray for diagnosis7). This may mean that the general public, including the respondents in this study, has paid little attention to these reports or considers the level of risk to be acceptable. The risks relating to ‘genetically modified food’ and ‘American beef’ were still judged ‘acceptable’, and, as noted, the environmental risk of ‘not using solar UV protection in midsummer’ was scored second highest. These levels of perceived risk may be greatly affected by mass media, as the threat from genetically modified foods is uncertain, and no incidents of vCJD have been reported in Japan. The effect of solar UV light on the skin as sunburn and sun tanning is immediately observable, and longer-term effects, such as skin cancer and melanoma, are well known. It is also possible that the well-publicized relationship between UV radiation and depletion of the ozone layer has raised the perception of this particular risk.

Figure 1b shows the unbiased estimates of population variance for each risk factor. The risk items were divided into two groups at the point separating ‘not using solar UV protection in midsummer’ and ‘living near a nuclear plant’, and a statistically significant difference between the group variances was obtained. All six radiation-related risks were among the eight items that showed lower variances, indicating a greater population similarity in the perception of radiation-related risks than for health risks in general. The large variance of responses for ‘Mitsubishi motor vehicles’ and ‘Schindler elevators’ could be attributable to differences in the time periods between when the accidents occurred and when the surveys were undertaken. In fact, decreased risk score for Mitsubishi was observed as a matter of time (see 3.3).

It was expected that risk perception for ‘no solar UV protection in midsummer’ would differ between the sexes. Gender was not identified on the questionnaires, but the nurse group, which was close to 100% female, evaluated the risk at 3.85, whereas the average rating of the graduate students and staff group with a smaller female representation was 2.94, showing statistical
Fig. 1  Average risk ratings for 790 respondents. (a) Risk ratings on a five-point scale (1 to 5). (b) An unbiased estimate of population variance for each risk item. Closed bars indicate radiation-associated risks. Statistically significant differences are indicated by *p<0.05 or **p<0.01.

3.2 Inter-group analysis

The average score for all risk items was highest in the undergraduate students and nurses groups, and lowest in the MD/DDS group; differences between groups were, in part, statistically significant (Fig. 2a). This result agrees with earlier findings of a relationship between hazard perception and educational status\(^2\). The highest ratings for ‘living near a nuclear plant’ and ‘X-ray diagnosis’ were also given by undergraduate students and nurses; in each of these cases, ratings were significantly different from those of the MD/DDS group (data for the four groups is shown in Fig. 2b-c). This suggests that the inter-group differences in risk ratings for radiation were not particular to radiation as a health hazard, but rather were part of an overall characteristic of higher risk perception. Among all risk items, ‘Living near a nuclear plant’ had the highest perceived risk in every group. ‘X-ray diagnosis’ was given the lowest rating by

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Fig. 2  Average risk ratings in four target groups (undergraduates, postgraduates/staff, nurses, MD/DDS) for (a) all risk items combined, (b) living near a nuclear plant, and (c) diagnostic X-rays. Statistically significant differences are indicated by *p<0.05 or **p<0.01.
3.3 Trend analysis

The chronological changes in risk ratings, as the surveys were taken at six-month intervals between 2004 and 2007, are shown in Fig. 3a-b. Not all groups were involved on each occasion, and so the group contribution to the rating scores is not identical for each six-month survey. Nevertheless, the ratings for ‘living near a nuclear plant’ and ‘work in nuclear power generation’ were fairly stable throughout the four-year period. This may have been assisted by the absence of nuclear accidents in Japan in this period, in which the INES (International Nuclear Event Scale) score was higher than 1. The score for ‘American beef’ appeared to rise until a sudden drop in 2007 while genetically modified food fell, apart from a rise in 2006. Risk ratings for ‘X-ray diagnosis’ decreased slightly, possibly due to the nation-wide expansion of CT-PET technology and perceptions of its benefit. The risk ratings for ‘Mitsubishi motor vehicles’ decreased dramatically as time elapsed from the period of repeated traffic accidents in 2004, due to lack of quality control.

4. Discussion

The inter-group analysis indicated no significant differences in their relative perception patterns between radiation risks and other risks. Instead, the general level of education seemed to be the differential factor of most importance. In the context of radiation and risk, the major purpose of radiation education in the university is not simply to reduce levels of risk perception for radiation, but to provide those engaged as workers and consumers of radiation with the best available information on its benefits and risks, so that they can personally make rational and correct judgments appropriate to their situation. The scientific level and content of the syllabus should be carefully chosen and organized towards this end. Reiteration of introductory and basic material might be most effective for undergraduate students and nurses who are neither radiation professionals nor radiation operators. For graduate students and staff, practical knowledge of the fundamentals of risk reduction through safe handling and protection from radiation is absolutely necessary because they can be exposed to radiation in their work. Doctors and dentists, with more advanced knowledge in the area, possibly judge risks from a scientific bias, and need to be reminded that they should be concerned about radiation hazards to the human body. The most up-to-date information on radiation safety management, especially radiation pathologies and the effectiveness of protection evidenced in examples of nuclear accidents, would be beneficial in their case.
Here, we report the results of a simple questionnaire answered by respondents confined to a university context in Nagasaki. Apart from their classification into four target groups, demographic data was not collected from the respondents, and so no analysis of the results could be made using background factors such as sex, age, and, particularly, home town and presence of atomic-bomb survivors among relatives. For the latter reasons, the results cannot address the influence of Nagasaki’s history on radiation risk perception by its citizens. A comparative study using matched respondents in another district of Japan is now in preparation.

5. Conclusion

A questionnaire requiring the rating of six possible radiation hazards revealed that the respondents, who were attending radiation education classes at Nagasaki University, perceived the risk from living near a nuclear power station as high while that from medical radiation as negligible. The responses to questions on other types of risks showed that perceptions of radiation risks were much less varied than for other risk types, such as food and environmental hazards. The average risk rating for all risk factors was highest among undergraduate students and nurses, and lowest among doctors and dentists. This difference was also occurred in ratings for radiation risks. All respondents had already attended classes on radiation safety, but it is thought that careful planning of a syllabus appropriate to each educational group would improve their understanding of radiation and promote their ability to evaluate radiation risks rationally.

6. Acknowledgements

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References

APPENDIX: Questionnaire

Please range the following activities in a 1 to 5 scale, where 1 is ‘no risk’, 2 = ‘negligible risk’, 3 = ‘acceptable risk’, 4 = ‘tolerable risk’, and 5 = ‘intolerable risk’:

- receive diagnostic X-rays
- operate radiological treatment equipment
- work as a nurse in the vicinity of radiological treatment
- work with radiation in research or education
- generate electricity by nuclear reactions
- live near a nuclear plant
- play sea bathing in midsummer
- live in midsummer without solar UV protection
- eat genetically modified food
- eat American beef
- travel by airplane
- ride Mitsubishi motor vehicles
- use Schindler elevators