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Analysis about radiation risk perception among university students from San Carlos de Bariloche and radiological protection experts from Argentina

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Abstract: Radiation risk perception must be studied by communication and radiological protection specialists, taking account of engineering, social and cultural variables. An anonymous and voluntary survey was peformed to enquire about the radiation risk perception among university students and radiological protection experts from Argentina, and to become aware of how it is perceived compared to other health risks. A fifteen-question dedicated questionnaire was designed including socio-demographic variables and questions about work environment, risk perception and risk communication. A five-point Likert-type scale was used for most of the questions. Surveyed people were asked to compare radiological risks in medicine with other risks (i.e.: smoking, sports, leisure activities, stress). The research involved 10 (38.5%) experts, 25 (45%) physics and engineering students and 40 (100%) bio-images production bachelor students. The results were analysed based on the professional or academic background. Although participants considered the radiation exposure in medicine as a low-risk activity, the results showed a disagreement about the radiation risk perception in particular situations (i.e.: living near a nuclear power plant, training in radiological protection while at college) and about radiation risk communication strategies. There is neither right nor wrong risk perception; however, a lot of work must be done to build an agreement between radiological risk perception and risk assessment due to radiation exposure in medicine. It should include working on the design of public policies focused on radiological protection training for health staff and clinical research training for medical physicists and radiological protection specialists, while strengthening communication skills and channels.

Keywords: radiation, medicine, health, communication.

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Análisis sobre la percepción del riesgo radiológico entre estudiantes universitarios de San Carlos de Bariloche y expertos en protección radiológica de Argentina

Resumen: La percepción del riesgo radiológico debe ser estudiada por especialistas en comunicación y protección radiológica, teniendo en cuenta variables sociales, culturales y de ingeniería. Se realizó una encuesta anónima y voluntaria para indagar sobre la percepción del riesgo radiológico entre estudiantes universitarios y expertos en protección radiológica de Argentina, y conocer cómo se percibe en comparación con otros riesgos para la salud. Se diseñó un cuestionario específico de quince preguntas que incluía variables sociodemográficas y preguntas sobre clima laboral, percepción y comunicación de riesgos. Para la mayoría de las preguntas se utilizó una escala tipo Likert de cinco puntos. Se pidió a los encuestados que compararan los riesgos radiológicos en medicina con otros riesgos (ej.: fumar, deportes, actividades de ocio, estrés). En la investigación participaron 10 (38.5%) expertos, 25 (45%) estudiantes de física e ingeniería y 40 (100%) estudiantes de licenciatura en producción de bioimágenes. Los resultados se analizaron en función de la trayectoria profesional o académica. Aunque los participantes consideraron la exposición a la radiación em medicina como una actividad de bajo riesgo, los resultados mostraron un desacuerdo sobre la percepción del riesgo de radiación en situaciones particulares (ej.: vivir cerca de una central nuclear, capacitación en protección radiológica en la universidad) y sobre el riesgo radiológico y estrategias de comunicación. No existe una percepción del riesgo correcta o incorrecta; sin embargo, queda mucho trabajo por hacer para lograr un acuerdo entre la percepción del riesgo radiológico y la evaluación del mismo debido a la exposición a la radiación en medicina. Debería incluir el trabajo sobre el diseño de políticas públicas enfocadas a la formación en protección radiológica del personal de salud y en investigación clínica de físicos médicos y especialistas en protección radiológica, fortaleciendo las capacidades y canales de comunicación.

Palabras-clave: radiación, medicina, salud, comunicación.

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1. INTRODUCTION

Ionising radiation plays an important role in modern world. The use of X-rays brought about a revolution in medical diagnosis because, for the very first time, the human body could be studied and explored without opening it up. Nowadays, medical care is unimaginable without X-ray imaging, including computed tomography (CT) scans and nuclear medicine. In addition, radiation therapy units have become very popular in hospitals all around the world, especially in the developed countries providing treatments to many patients with cancer [1].

In spite of that, the perception that medical imaging radiation can be harmful has been present from the discovery of X-rays soon after they started to be applied in medical procedures; concerns about radiation exposure have intensified lately due to an increased amount of radiation use in medicine, both for medical diagnosis and disease treatment. Therefore, ionizing radiation must be used cautiously [2].

Radiation exposure and risk from medical imaging examinations is a leading safety issue in radiological protection. When discussing radiation risk, it must be considered that X-ray imaging and CT procedures are an invaluable tool for diagnosis, and that the benefit from a properly medically justified exam far exceeds the potential risk. Thus, assuming the LNT (Linear Non-Threshold) model as valid, the main question is what the detrimental health effects of low-dose radiation exposure are (if any), such as those found in medical diagnostics or experienced by radiation workers and the general public, and how the radiological risk linked to them is perceived by individuals [3-5]. The question above has no unique answer; quite the contrary, answers differ widely depending on who is interviewed and where and when the survey is performed. It means, the context plays an importante role, e.g., aversion against radioacctive waste depends on the activity generating it [6-9].

Several theoretical methods about how people behave when facing health-related risks acknowledge risk perception as a key component and a required precedent for individuals to change their mind and behaviour. However, it is not always enough [10-12]. Moreover, according to the psychometric paradigm, affective responses condition risk perception in the healthcare environment as well. Based on this paradigm when feelings towards such an activity are positive, individuals usually judge the related risks as negligible and the benefits as high; the opposite happens when people have negative feelings or emotions towards an activity [7,13].

Health-related risk perception can be classified in two categories: first, risk perception and decision making are linked to risky habits carried out by people, such as smoking, drinking, driving drunk, sunbathing, addictive behaviour, etc. Secondly, risk perception related to things and events that cannot be controlled by individuals, e.g., natural disasters [14]. When health-related risks are a consequence of radiation exposure, they might be linked to both groups. When people decide to undergo a properly justified radiation medical exam, they accept the risk because there is a certain kind of voluntarism and even certain imaginary control over the radioactive source, that is, the X-ray machine. On the other hand, health-related risk could be associated with the second classification when they come from nuclear or radiological accidents [15-17].

Ionising radiation is a broad, complicated and often misunderstood topic by the general public. Exposure to ionising radiation is usually associated with danger and harm, especially as the radiation dose increases [5]. However, individuals are all the time exposed to ionising radiation from different sources: naturally occurring, medical imaging and other human-made. Some studies point out a difference in both risk perception and knowledge o factual sources of ionising radiation between laypeople and radiation experts. Reasons for this difference can be found in how mass media portrays radiation-related health risks, which may exaggerate some of them and minimize others; the technical language used by experts is often misunderstood by the general public, given educational discrepancies in the

population at large. According to some research studies, perception of radiological and nuclear risks is often emotional and unlikely to be altered; this often feeling-centered perception usually explains why nuclear power is perceived as extremely risky in opposition as how radiological risks in medicine are discerned [18,19].

When radiological risks in medicine are more deeply enquired into, some studies suggest that laypeople are not concerned about the radiation-related health effects from medical exams because of a widespread notion that healthcare professionals have received proper training and are competent in minimizing risks. However, healthcare professionals may not be as informed as the public believes [20]. Physicians tend to underestimate the dose of ionising radiation from medical sources, and some are even unaware of which medical tests are sources of ionising radiation [21,22]. There exists a great need to give proper goal-oriented information. That is, information focused on the characteristics of the population groups receiving it. Despite a vast radiation and nuclear-related history in Argentina, the studies assessing radiological risk perception cannot be easily found nationwide. The same happens at a local level in San Carlos de Bariloche, the bigggest city in Argentina north-western Patagonia. This location is famous worldwide because of the scientific activities carried out down there, most of them related to nuclear and radiation technologies. The city has grown around an atomic centre, where a research reactor has safely operated for the last forty years, and an internationally well-known nuclear company and several hospitals and healthcare centres have settled down nearby. In addition, in the last few years, a high technology nuclear medicine centre has started up giving assistance to local patients and those from the nearby cities through diagnosis and treatment exams and procedures. However, there are no local records about radiological risk perception among the population. Taking this into account, a survey was conducted to find out what university students from different academic backgrounds and radiological protection experts think of and how they perceive radiological risks.

2. MATERIALS AND METHODS

A fifteen-question dedicated questionnaire was design including socio-demographic variables (such as gender, age, university background) and questions about work environment, risk perception and risk communication were asked. A five-point Likert type scale (from strongly agree to strongly disagree) was used for most of the questions. In addition, surveyed people were asked to compare radiological risks in medicine with other dailiy and familiar risks such as those related to smoking, extreme sports, leisure activities and stress.

The Likert-type scale was given the following values: 1. Strongly disagree; 2. Disagree; 3. Neither agree nor disagree; 4. Agree; 5. Strongly agree. In order to analyse the radiological risk perception compared to other risks, participants could choose one of the following risk level options for each activity: very low; moderately low; low; neither low nor high; high; moderately high; very high. The correlation between replies was computed by the Pearson correlation coefficient. The descriptive statistics (such as mean and percentage) were used to present the distribution of the socio-demographics and the respondents' risk perceptions.

The participants pool consisted of: twenty-six radiological protection experts from Argentina: thirteen men and thirteen women were chosen based on their professional background (more than 20 years of national and international recognized expertise in different fields: nuclear, medicine, industry, regulatory authority, etc.); engineering and physics undergraduate students; bio-images production bachelor students. A web-based version of the questionnaire was sent by email to the experts and engineering and physics students, including a short explanation about the survey's goal. The same questionnaire on a paper-based mode was distributed among the rest of the participants during a radiation protection of patient's seminar carried out in the local hospital.

This research study was carried out in San Carlos de Bariloche in November 2019.

3. RESULTS AND DISCUSSIONS

Ten out of the 26 radiological protection national experts replied the survey, which represents only 38.5% of the experts reached. In addition, 40 (100%) out the bio-images production bachelor students and 25 (45%) out of the engineering (nuclear, mechanics, telecommunications) and physics students replied the survey. The results were analysed based on the academic background.

The radiological protection experts were sent an email with the survey's web link and a short explanation about the framework and objective of this research. The web link was available during one month and no reminder was sent during this period of time. The small percentage of participation (38.5%) of this group of people surveyed drives to think about the role experts and professional societies play in radiation risk communication and how they interact with other social and laypeople groups. Further research must be done in order to find out the reasons and responses for this behaviour, that is, such a little participation in the survey. Moreover, a joint effort should be done to work together (experts and healthcare professionals) and to agree common communication strategies.

Firstly, participants were presented eight different activities or sources of risk. They were asked to put them into perspective and to rank them form the riskiest to the least risky activity. The results are shown in Table 1. Afterwards, these sources of risk were grouped into categories: radiation-related risks (undergoing a CT exam); smoking-related risks (smoking); job-related risks (job stress or stress during the exam periods); leisure-related risks (sunbathing at noon, doing extreme sports); other non-nuclear-related risks (travelling by bus as a passenger, driving a car, riding a bicycle in a busy street).

Table 1 : Comparsion between radiation risk perception and other familiar activities. They are ordered from the riskiest to the least risky activity according to participants.

Order	Engineering and physics students	Bio-images production students	Radiological protection experts
1	Smoking	Exam or job stress	Smoking
2	Doing extreme sports	Smoking	Biking in a busy street
3	Biking in a busy street	Doing extreme sports	Doing extreme sports
4	Sunbathing at noon	Sunbathing at noon	Exam or job stress
5	Exam or job stress	Biking in a busy street	Sunbathing at noon
6	Driving a car	Undergoing a CT exam	Travelling by bus
7	Undergoing a CT exam	Driving a car	Undergoing a CT exam
8	Travelling by bus	Travelling by bus	Driving a car

Risk is usually defined in the literature as a multiplicative combination of the probability of a hazardous event occurring and the severity of the resulting negative consequences [9]. From this point of view, risk itself is understood as an approach to risk assessment, which often considers two key components: how severe the negative consequences are and the likelihood of the occurrence of a malignant event. Nevertheless, risk perception is much more complex since it is influenced by other characteristics besides probability and severity. Risk perception is shaped by the knowledge people have about the existence of a health risk and by the feeling of being themselves at risk [23]. The three groups of participants think the radiation-related health risks associated with CT exams are low (sixth and seventh positions in the table), which is quite close to reality. A CT exam in a young child results in an increase of risk of fatal cancer later in life of about 0.03%-0.05%, meaning, the risk to the individual is small, and, when properly justified by the prescribing physician, balanced by the medical benefits.

However, it becomes a significant public health problem when the small individual risk is multiplied by the millions of such procedures performed annually [1].

Radiation risk perception is a social constructionism. Both emotions, risks and value judgements are configured by social and cultural processes while interacting with human beings, material objects, space and location. Furthermore, emotions and feelings are dynamic, shared and collective, as well as risk understanding and assessment. Risk perception is influenced by both fashion and trends among different social groups and the willingness of taking a risk. Risks appraisal related to smoking, doing extreme sports, sunbathing at noon, riding a bike or driving a car in a busy street in rush hour, is part of the contemporary understanding people have about the relationship between risk and feelings, not only as individuals, but also as members of a social group. These activities just mentioned are linked to a risk. Taking that risk is often the main motivation to carry out the action, not only to reach a goal (a tanned skin, going from a place to another, etc.), but also to reaffirm the group membership. This behaviour should be taken into account when planning and developing risk communication strategies and health-related public policies [7,8,24].

The second half of the questionnaire was evaluated by applying a five-point Likert scale (from strongly agree to strongly disagree) and included the following topics: (a) information and knowledge about radiation-related health effects and radiation protection; (b) perception of increase of cases of cancer; (c) communication in social networks; (d) knowledge about overexposure situations and likelihood of radiological accidents. The results are summarized from Table 2 to Table 5.

Table 2 : Information and knowledge about radiation-related health effects and radiological protection. References: RPE: radiation protection experts; EPS: engineering and physics students; RXS: bio-images production students. *The percentage missing to reach 100% corresponds to the number of people who did not answer the question.

	Level of agreement	RPE [%]	EPS [%]	RXS* [%]
When a radiation medical procedure must be performed, information given to the patient is sufficient and reliable. Correlation coefficient (RPE vs. EPS) : 0.41 Correlation coefficient (RPE vs. RXS) : 0.15 Correlation coefficient (EPS vs. RXS) : 0.29	Strongly agree	0.0	16.0	27.5
	Agree	20.0	8.0	32.5
	Neither agree nor disagree	0.0	36.0	17.5
	Disagreee	70.0	32.0	17.5
	Strongly disagree	10.0	8.0	5.0
Health personnel recieve enoufh training on radiological protection while at university. Correlation coefficient (RPE vs. EPS) : -0.12 Correlation coefficient (RPE vs. RXS) : 0.10 Correlation coefficient (EPS vs. RXS) : 0.62	Strongly agree	0.0	4.0	15.0
	Agree	0.0	12.0	25.0
	Neither agree nor disagree	10.0	68.0	30.0
	Disagree	60.0	4.0	22.5
	Strongly disagree	30.0	12.0	5.0
Radiation-related risks can be under control regarding current scientific knowledge. Correlation coefficient (RPE vs. EPS) : 0.98 Correlation coefficient (RPE vs. RXS) : 0.94 Correlation coefficient (EPS vs. RXS) : 0.97	Strongly agree	30.0	28.0	20.0
	Agree	50.0	52.0	70.0
	Neither agree nor disagree	10.0	12.0	5.0
	Disagree	10.0	4.0	0.0
	Strongly disagree	0.0	4.0	0.0

Determining what information is important to patients undergoing a radiation medical exam and how satisfied they are with the information provided by healthcare staff is critical.

Patients should know what the potential adverse or side effects might be in order to face them more appropriately, especially when they undergo radiation therapy for cancer treatment. According to the results obtained in this survey, more than one half of bio-images production students think the information given to patients is sufficient and covers the patient's needs. The opposite happens within the group of experts. International literature suggests that there is a lot to do in this field: on the one hand, patients are satisfied with the information received [25,26]. On the other hand, some reports state that at least one third of patients wish they had known more about the risk of potential adverse effects from their treatment before they were exposed to it [27]. Since there are no national studies about this subject, the remaining questions is whether these international findings can be extrapolated to the results observed in this survey, keeping in mind socio-demographic and cultural differences among populations. In order to solve this out, new research works will be carried through soon on this topic.

Regarding training of health personnel, a clear disagreement was observed between radiological protection experts and university students. The first group considers radiation protection training at college is insufficient, while students surveyed think it is enough, and even an important percentage of them have not a clear opinion about it. This could be understood as a need for improvement in training opportunities related to radiological protection. The question here is where healthcare personnel should obtain that training (college, at work, both, etc.). Furthermore, high levels of confidence in their professional skills and in their self-esteem is characteristic of healthcare personnel, which sometimes might be counter-productive for both patients and healthcare staff [28].

Table 3 : Perception of increase of cases of cancer. References: RPE: radiation protection experts; EPS: engineering and physics students; RXS: bio-images production students. *The percentage missing to reach 100% corresponds to the number of people who did not answer the question.

	Level of agreement	RPE [%]	EPS [%]	RXS [%]
Being exposed to ionising radiation at work increases the likelihood of future undesirable health effects. Correlation coefficient (RPE vs. EPS) : 0.19 Correlation coefficient (RPE vs. RXS) : 0.75 Correlation coefficient (EPS vs. RXS) : 0.41	Strongly agree	50.0	12.0	27.5
	Agree	20.0	16.0	35.0
	Neither agree nor disagree	20.0	32.0	20.0
	Disagreee	10.0	36.0	15.0
	Strongly disagree	0.0	4.0	2.5
Living near a nuclear power plant increases the incidence of cancer in the population. Correlation coefficient (RPE vs. EPS) : 0.86 Correlation coefficient (RPE vs. RXS) : -0.33 Correlation coefficient (EPS vs. RXS) : -0.50	Strongly agree	10.0	0.0	17.5
	Agree	10.0	0.0	30.0
	Neither agree nor disagree	10.0	8.0	42.5
	Disagree	40.0	36.0	7.5
	Strongly disagree	30.0	56.0	0.0
Using ionising radiation in medical procedures results in more benefit than harm to the patient. Correlation coefficient (RPE vs. EPS) : 0.91 Correlation coefficient (RPE vs. RXS) : 0.84 Correlation coefficient (EPS vs. RXS) : 0.62	Strongly agree	40.0	48.0	25.0
	Agree	50.0	36.0	35.0
	Neither agree nor disagree	10.0	4.0	27.5
	Disagree	0.0	0.0	7.5
	Strongly disagree	0.0	12.0	0.0
Radiation received when undergoing an X-ray exam as a patient increases the likelihood of cancer in the future. Correlation coefficient (RPE vs. EPS) : 0.78 Correlation coefficient (RPE vs. RXS) : 0.37 Correlation coefficient (EPS vs. RXS) : 0.79	Agree	90.0	48.0	35.0
	Neither agree nor disagree	0.0	16.0	5.0
	Disagree	10.0	36.0	55.0

Increased cancer risk near nuclear power plants remains in fact an open question: answers will come from larger and deeper radiation epidemiology studies. In the meantime, some papers state this open question feature, where the need for more research is highlighted [29,30], and some other reports show negative results when correlating increase of cancer risk and the radiation doses received by people living in the neighbourhood of a nuclear power plant [29,31]. The probabilistic nature of the stochastic effects and the properties of the LNT model state that the absence of evidence of risk is not evidence of absence of risk, which means, some finite risk, however small, must be assumed and a level of protection established based on what is deemed acceptable [32].

More than one half of the respondents agreed that the exposure to ionising radiation in a work environment and that living near a nuclear power plant increase the cancer risk in the population. However, a similar percentage of individuals believe that undergoing an X-ray medical exam does not contribute to the increase of stochastic effects in patients. Reasons for this argument could be found in the perception of an individual net benefit when the decision of undergoing themselves to an X-ray medical exam is made. That is, individuals are looking for information to confirm or reject a diagnosis or the exposure to radiation is part of a medical treatment. In addition, several anti-nuclear NGOs (non-governmental organisations) have been publishing information against nuclear energy in the neighbourhood of San Carlos de Bariloche during the last years. Moreover, setting up a nuclear power plant in Río Negro province, the state where the city is located, is prohibited by law, which was born as a consequence of this anti-nuclear social pressure.

Table 4 : Radiation risk communication in social networks. References: RPE: radiation protection experts; EPS: engineering and physics students; RXS: bio-images production students. *The percentage missing to reach 100% corresponds to the number of people who did not answer the question.

	Level of agreement	**RPE [%]**	**EPS [%]**	**RXS [%]**
Short messages in social networks have enough and reliable information. Correlation coefficient (RPE vs. EPS) : 0.64 Correlation coefficient (RPE vs. RXS) : 0.81 Correlation coefficient (EPS vs. RXS) : 0.95	Strongly agree	0.0	0.0	2.5
	Agree	10.0	0.0	7.5
	Neither agree nor disagree	40.0	16.0	20.0
	Disagreee	40.0	48.0	45.0
	Strongly disagree	10.0	36.0	22.5

Although short messages in social networks have become an important and frequent channel of communication utilized both by different public and governmental organisations and private companies, at least one half of individuals surveyed do not trust them and in their opinion the information provided is not enough. In addition, a high percentage of participants showed what might be considered as a neutral opinion about this way of communication. One reason for these responses could be linked to the phenomenon of fake news, which plays an important negative role in science communication, as well as the hunger for first news and a tendency for misleading and attracting attention. Moreover, these short messages are usually spread by "influencers" regardless of accuracy and no official references at all [33]. This biased and often shocking information make people believe it despite a lack of a proven scientific source. Another reason for this atmosphere of mistrut could be that scientific knowledge regarding radiation risks still has not reached the general public in Argentina and related organisations are not known nationwide [34,35]. In addition, recent research performed in this country found that one half of the information spread by the media is incorrect or erroneous from the scientific or technical point of view. Moreover, it usually prompts the reader to a line of thought that could be assumed to be biased [36].

Although the headlines can be changed and corrected later, the question is whether it can really take it back and the possible potential harm repaired.

Table 5 : Knowledge and perception of occurrence of overexposure situations. References: RPE: radiation protection experts; EPS: engineering and physics students; RXS: bio-images production students. *The percentage missing to reach 100% corresponds to the number of people who did not answer the question.

	Level of agreement	**RPE [%]**	**EPS [%]**	**RXS [%]**
Overexposure of patients when undergoing radiation medical exams has happened in Argentina. Correlation coefficient (RPE vs. EPS) : -0.07 Correlation coefficient (RPE vs. RXS) : -0.09 Correlation coefficient (EPS vs. RXS) : 0.99	Yes, it has	90.0	16.0	15.0
	I don't know	10.0	76.0	75.0
	No, it hasn't	0.0	8.0	7.5
The likelihood of radiological accidents at nuclear power plants is higher than that related to radiation medical exams. Correlation coefficient (RPE vs. EPS) : 0.99 Correlation coefficient (RPE vs. RXS) : 0.41 Correlation coefficient (EPS vs. RXS) : 0.45	Yes, it is	0.0	4.0	35.0
	I don't know	20.0	20.0	30.0
	No, it isn't	80.0	76.0	32.5

Accidents and risks from medical radiation exposure have been widely described and studied for the last few decades [37]. Several millions of medical diagnostic and therapeutic radiation exams are performed annually worldwide, so medical radiation incidents can be expected (actually, they happen), some of them recognized some time after their occurrence. If properly and timely identified, most radiological incidents are easy to manage and do not usually cause casualties. In Argentina, almost 300 radiological incidents (patients overexposed to radiation due to medical exams) have been recorded until 2016 [38]. However, most of the individuals surveyed ignore the facts. This could be a consequence of inappropriate communication strategies carried out at a national level.

4. CONCLUSIONS

Perception of radiological and nuclear risks has often an emotional component among laypeople, which is conditioned sometimes by a communication bias coming from the media, unlikely to be altered. In addition, experts are influenced by their environment and reality. This often feeling-centered perception usually explains why nuclear power is perceived as extremely risky in opposition as how radiological risks in medicine are discerned, stressed sometimes by the way the media tell the news. Moreover, there are usually differences between the perceptions different groups of individuals have about it. The bigger the differences, the more difficult the possibility to build bridges of communication.

By carrying out this research, several topics could be pointed out: the authors could draw a picture of how university students from different academic backgrounds and radiological protection experts perceive radiation risks, in particular those associated with medical procedures. Furthermore, a comparison between these groups of people could be made, and the findings should be used to improve communication strategies, training programmes and regulations currently valid in the country. Last, based on the findings of this research, the authors remark the need to go one step further considering the bias among the different groups studied and the impact of radiation comprehension and communication. Furthermore, the authors emphasise the need to work on radiation risk perception in San Carlos de Bariloche, based on its demographic characteristics: small population and high density of scientists and technologists per inhabitant.

Although there is neither right nor wrong risk perception, a lot of work must be done in order to build an agreement between radiological risk perception and risk assessment due to radiation medical exposures. It should involve working on the design of public policies focused on radiological protection training for health staff and clinical research in humans for medical physicists, strengthening communication skills and channels.

Finally, and most important, the following questions should be answered: is radiological risk properly understood? What kind of tools is needed to guarantee that a stochastic phenomenon involving a population group is not understood as something individual and deterministic?

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CONFLICT OF INTEREST

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