



ELSEVIER



Research

What information did pregnant women want related to risks and benefits attending X-ray examinations?

Anita F. Reitan^a and Audun Sanderud^{ab*}

^a Department of Life Sciences and Health, Oslo Metropolitan University, Faculty of Health Sciences, Radiography, Oslo, Norway

^b Department of Radiology, Akershus University Hospital, Oslo, Norway

ABSTRACT

Background: In connection with X-ray examinations of pregnant patients, good communication of benefit and risk is important to provide adequate patient care. Pregnant women often become concerned about the foetus and are unsure of the risk of malformations and the development of cancer. Health professionals who are involved in imaging pregnant women require specific knowledge about risks and benefits so they can convey information without creating unnecessary fear.

Purpose: This study identifies the information needs of pregnant women in connection with X-ray examinations and how they prefer to have the information communicated.

Method: A qualitative study using semi-structured interviews of seven pregnant women aged 28–36 in weeks 16–33 of their pregnancy. The interviews were analysed using interpretive phenomenological analysis.

Results: The participants had expectations regarding the information provided about X-ray examinations during pregnancy. They needed concrete information on radiation doses, risks and any effects on the foetus. The risk was thought to be low, but several of the participants would still have been concerned when undergoing an X-ray examination.

Conclusion: To provide adequate care of pregnant women in connection with X-ray examinations, healthcare professionals must have knowledge of pregnancy and radiation and have expertise in risk communication. This will prevent unnecessary concern in the pregnant woman, ensure that justified necessary examinations are carried out, and avoid adverse decisions such as termination of pregnancy based on erroneous grounds.

RÉSUMÉ

Contexte : En ce qui concerne les examens radiologiques des patientes enceintes, une bonne communication des avantages et des risques est importante pour fournir des soins adéquats aux patients. Les femmes enceintes sont souvent inquiètes pour le fœtus et sont incertaines du risque de malformations et de développement d'un cancer. Les professionnels de la santé qui participent à l'imagerie des femmes enceintes ont besoin de connaissances spécifiques sur les risques et les avantages afin de pouvoir transmettre l'information sans créer de peur inutile.

But : Cette étude identifie les besoins d'information des femmes enceintes en rapport avec les examens radiologiques et la manière dont elles préfèrent que l'information leur soit communiquée.

Méthodologie : Une étude qualitative utilisant des entretiens semi-structurés de sept femmes enceintes âgées de 28 à 36 ans au cours des semaines 16 à 33 de leur grossesse. Les entretiens ont été analysés à l'aide d'une analyse phénoménologique interprétative.

Résultats : Les participantes avaient des attentes concernant l'information fournie sur les examens radiologiques pendant la grossesse. Elles avaient besoin de renseignements concrets sur les doses de radiation, les risques et les effets éventuels sur le fœtus. Le risque était considéré comme faible, mais plusieurs des participants auraient quand même été inquiets en subissant un examen radiologique.

Conclusion : Afin de fournir des soins adéquats aux femmes enceintes dans le cadre des examens radiologiques, les professionnels de la santé doivent avoir des connaissances sur la grossesse et les rayonnements et posséder une expertise en matière de communication des risques. Cela permettra d'éviter toute inquiétude inutile chez la femme enceinte, de garantir que les examens nécessaires justifiés sont effectués et d'éviter des décisions défavorables telles que l'interruption de grossesse fondée sur des motifs erronés.

Contributors: All authors contributed to the conception or design of the work, the acquisition, analysis, or interpretation of the data. All authors were involved in drafting and commenting on the paper and have approved the final version.

Funding: This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing interests: All authors declare no competing interests.

Ethical Approval: The Norwegian Centre for Research Data (NSD) found the study to satisfy data protection requirements (NSD Ref. 495113).

* Corresponding author. Oslo Metropolitan University, P.O. Box 4, St. Olavs Plass NO-0130, Oslo, Norway.

E-mail address: asande@oslomet.no (A. Sanderud).

Introduction

In connection with X-ray examinations of pregnant women, it is important to properly communicate the benefits and risks to the patient. Women who undergo an X-ray examination during pregnancy often have concerns about the foetus and are unsure of the risk of malformations and the development of cancer.¹ To allay such concerns and ensure that necessary examinations are performed, it is important that healthcare professionals have knowledge about pregnancy and X-rays and that they can convey this information to pregnant women without creating unnecessary fear.

Over the past few decades, there has been increasing focus on risk communication in the field of medical radiation.^{2–8} Risk communication in this context can be defined as information about the recommended examinations, benefits and risks, alternative imaging diagnostic modalities as well as the risks of not conducting examinations.² Informing patients about risks is important for enabling them to make informed decisions about their medical care, in this case imaging.⁴ Who performs this communication may vary, but referring doctors, radiologists and radiographers should be in a position to do so.^{3,4} Patients want to receive information about radiation doses and risks related to their X-ray examination,^{4–7} but according to Ukkola⁸ there is a mismatch between patients' expectations of information and the information they actually receive. According to Norwegian legislation, patients should be informed about both risks and potential harm, including risks related to medical imaging. This information must be adapted to the examination or treatment and be provided as needed.⁹

Healthcare professionals must be able to inform patients about the benefits and risks associated with diagnostic imaging examinations, and must therefore have knowledge of medical radiation, dose levels and radiation effects.¹ Several studies show that there is insufficient competence in these areas.^{10–12} Studies on pregnancy and X-rays show that doctors lack knowledge about radiation doses for foetuses and that some would have recommended abortion on erroneous grounds.^{13,14}

This study investigates pregnant women's information needs related to potential X-ray examinations during pregnancy. The purpose of the study is to identify the information needs of pregnant women in order to give informed consent to X-ray examinations, how they want to have this information communicated, and their reflections and thoughts on the subject.

Material and method

This was a qualitative study and analysis of interviews with pregnant women, conducted between August 2019 and

January 2020. The inclusion criteria were pregnant women during weeks 13–38 of their pregnancy. The participants were recruited via inquiries to radiographers who suggested relevant individuals within their acquaintance circuit. This approach was based on practical considerations, because it was difficult to get access to pregnant women through other health professionals. The advantage of this approach is quick access to participants, but a disadvantage may be that the sample becomes too uniform and that they feel obligated to participate. The participants came from the Oslo metropolitan area, and none of them had undergone an X-ray examination during this pregnancy prior to the interview.

At the start of the interview, the participants were informed that participation was voluntary, that they would be anonymized in the results and they signed a consent form. In depth interviews were conducted based on an interview guide that had been prepared in advance. The in-depth interview is a suitable method when the topic is to be understood from the interviewee's perspective and when the purpose is to explore their opinions on, attitudes towards and experiences of a phenomenon.¹⁵ The interview must have a clear purpose and an overall interview guide as a starting point.¹⁵ In this study, an interview guide was prepared on the topics of pregnant women and X-ray examinations, risks and concerns about harm to the foetus, the need for information, and how information is sought. The questions in the interview guide were prepared to answer the research question and were based on topics from previous studies^{13,14} The interview guide contained various questions about risk, information, thoughts and knowledge relating to the topic of pregnancy and X-ray examinations:

“What would you think about if you were referred for an X-ray examination now while you are pregnant?”

“To what extent / at what level would you be concerned about the foetus [...]” and

“How would you like to receive information [...]?”

Seven pregnant women were interviewed individually. Their mean age was 33 (28–36), and they were in weeks 16–33 of their pregnancy when the interviews were conducted (see Table 1). Each interview lasted from 25 to 40 min. The participants received an information letter prior to the interview and gave their written consent to participate. The interviews were audio-recorded and then transcribed verbatim. All personal data was removed in the transcript, each transcript was given a code that linked back to the participant and the audio recording was deleted as soon as the transcription was

Table 1
Participants in the study.

	Age (year)	Week of the pregnancy
Participant 1	36	26
Participant 2	30	33
Participant 3	34	17
Participant 4	28	33
Participant 5	35	32
Participant 6	34	24
Participant 7	32	16
Summary	33	26

quality assured. The transcripts were stored on a password-protected computer, while the code key was written on paper and stored in a locked cabinet in the first author's office. Personal data was treated confidentially, and the participants were anonymized. The results of this study cannot be generalised to all pregnant women because of the small sample, but they can be transferable, as the results may provide answers to the needs of pregnant women connection with X-ray examinations.

The article's first author conducted the interviews, transcription, and analysis, while both authors interpreted the results and prepared the manuscript.

Analysis

The data analysis was thematised and was conducted in four phases: content of meaning, coding, condensation, and summary.¹⁵ Phase 1 focused on overall impressions, and the content was condensed so that the meaning content was highlighted. In phase 2, meaningful elements were encoded and labelled. Phase 3 involved coding, extracting essential elements, and categorising the codes in themes and main themes. In the final phase, the material was summarised and recontextualised. The data was categorised into four main topics derived from the experiences, opinions, and knowledge of pregnant women: risk communication, risk and concern for the foetus, accidental radiation exposure of the foetus, and the role of the healthcare professional (see Table 2).

Ethical considerations

The Norwegian Centre for Research Data (NSD) found the study to satisfy data protection requirements (NSD Ref. 495113). Pregnancy and X-rays can be a sensitive topic, and by interviewing pregnant women about this, we may create concerns they did not have prior to the interviews. We therefore chose to inform the participants about the facts of pregnancy and X-rays after each interview. Written information and reports published by the Directorate for Radiation Protection and Nuclear Safety (DSA) and the International Commission on Radiological Protection (ICRP) were added to the information.^{1,16} After the interviews, none of the participants expressed that the interview itself had caused concern about conducting an X-ray examination during pregnancy.

In this study we decided not to interview pregnant women who had been referred for X-ray examinations out of ethical considerations. We did not want to cause them unnecessary worry or influence their decision to undergo necessary examinations. In addition, it would be difficult to reach them in the short time between the referral and the examination. Instead, we interviewed pregnant women who had not been referred for X-ray examination and asked them about their thoughts and views about the prospect of undergoing an X-ray examination while pregnant. This may provide insight into the thoughts and information needs of pregnant women who are referred for medical imaging during pregnancy.

Results

In this study, four main themes derived from the systematic data analysis: risk communication, risk and concern for the foetus, accidental radiation exposure of the foetus, and the role of the healthcare professional.

Risk communication

The participants in this study expressed a need for specific information about the examination. This would have given them the opportunity to obtain information about the examination, the necessity for it and the related risks. Several of them wanted this information to be provided by their GP, verbally or in brochures published by health authorities or health professionals in the field of medical radiation. Immediately prior to the examination, the participants needed further information from those who would conduct the examination. Again, they expressed a need for information about the necessity for the examination and about the risk to the foetus. After the examination, some of the participants would have asked for written material.

The participants in this study had varying levels of knowledge about pregnancy and X-rays, and relied on healthcare providers to communicate risk in an understandable manner. Providing a dose or risk number would not provide them with significant information. To understand dose and risk, they would have asked for something to compare them with. They wanted honest information and would rather know the risk than not. One of the participants pointed out that it was more important that the person who provided the information seemed honest and trustworthy than which profession the person represented.

"I would have felt safe if the people who informed me took me seriously." Participant 4.

The participants had diverse needs for information. Some only needed to hear that it was safe, while others wanted more factual knowledge about dose and related risks.

Risk and concern for the foetus

The participants in this study assumed that the risk to the foetus from X-ray examination was low, but they also expressed that they would have felt uneasy about undergoing

Table 2
Main themes derived from the analysis.

Risk communication
Risk and concern for the foetus
Effects of accidental radiation exposure on the foetus
Role of healthcare professionals

an X-ray examination during pregnancy. Several of them would have asked health professionals about the risks prior to the X-ray examination.

“Would have asked if there was a risk, but I’d probably be told that it was low.” Participant 5

The participants expressed different views on whether a foetus was more radiation-sensitive in the first trimester and on whether the risk depended on which anatomical area was irradiated. Some participants believed that the risk was highest when the foetus was included in the X-ray examination, while others felt that this had no bearing since radiation would be scattered around the room anyway. If some modalities resulted in a higher radiation dose and thereby increased risk, some participants believed that computer tomography (CT) produced the highest radiation dose, while others believed that the examination time was the key factor in terms of risk. Repeated examinations were mentioned as a factor that would increase the risk of negative effects on the foetus.

Several of the participants believed that X-ray radiation had to carry some risk, since healthcare professionals left the room during radiation exposure:

“They usually leave the room, and I think that says something.” Participant 2

Several participants pointed out that if radiation was harmful to adults – and the fact that healthcare professionals leave the room during exposure suggest that this is the case – then it would also have an effect on the foetus. They regarded the foetus as more radiation-sensitive, which they supported by the fact that pregnant relatives are not allowed to accompany patients who undergo X-rays examinations.

“And if it’s dangerous for fully developed humans, what about those who are not fully developed?” Participant 4

None of the participants believed that X-ray examinations during pregnancy were risk-free, but they believed the risk to be low since they were referred. The participants who were most concerned throughout pregnancy were also more concerned about radiation. Their concerns related to the level of risk involved in an X-ray examination and the type of effects radiation had on the foetus. Developmental or growth disorders were mentioned as possible effects, along with malformations and cancer.

Several participants raised the question of who should weigh the risk against the need for the examination. While the examination may be necessary for the mother, it may pose a risk for the foetus. The participants found this dilemma challenging, especially because they lacked sufficient knowledge about the subject. One of the participants described it as follows:

“I would have to make an assessment myself in a way, assess how much pain I was in and how necessary it was.” Participant 1

Effects of accidental radiation exposure on the foetus

Accidental radiation exposure occurs when a foetus has been irradiated before pregnancy is known.⁹ This may occur when a woman discovers her pregnancy after completing her X-ray examination. Two of the participants in this study would be genuinely concerned in such a situation. One of them would consider abortion as a possible consequence.

“Would have thought about abortion if I had discovered something, but not at once.” Participant 6

All the participants who would have experienced this situation would feel a lack of control, and would seek information from health professionals or via the internet. They would seek information about the risk after such an incident, whether there was anything they could have done to influence the situation, whether there was anything special they should monitor or examinations they should undergo.

“Without information, the level of fear would be high.” Participant 6

Role of healthcare professionals

The participants in this study had high confidence in healthcare professionals. They trusted that they would not have been referred for an X-ray examination unless it was necessary. They highlighted that if they were referred for an X-ray or CT examination during pregnancy, they believed that health professionals would assess the risk of the examination before considering it safe.

“When a pregnant woman is referred for CT or X-ray, someone has assessed the risk and concluded that it is safe.” Participant 5

The participants differed in their views of which health professionals were considered safe and credible to receive information from. All seven participants trusted doctors, though this varied somewhat depending on their specialty and role. Some participants wanted information from their GP, while others were sceptical about their GP’s knowledge in this area. They would have preferred to receive information from a specialist, such as a gynaecologist or radiologist. Some of the participants wanted information from the midwife, but the majority believed that the midwife would not have enough knowledge of medical radiation and thus could not inform them about doses and risks. Some considered obstetric nurses to be relevant healthcare professionals who could provide information. All the participants relied on health professionals who were medical radiation practitioners, such as radiologists and radiographers, and they expected these professions to have a high level of knowledge on the subject.

Discussion

Patients who undergo diagnostic examinations while pregnant are often alarmed and feel insecure, because of the emotional perceptions of radiation.^{17,18} The participants in this study confirmed that pregnant women who are referred for X-ray examinations during pregnancy have a strong need for information. It showed that the information needs of pregnant women vary, and that they have different levels of knowledge about pregnancy and X-rays. These differences between needs and knowledge will create challenges for healthcare professionals in communicating risk. Nurses, nursing assistants and receptionists who interact with pregnant women will also be asked questions.⁵

To be able to provide satisfactory information to pregnant patients, it is important that healthcare professionals have the necessary interpersonal skills to listen, read body language, and adapt information to individual patients.¹² Each situation must be considered in relation to how much information is necessary and appropriate to provide, in accordance with regulations.⁹ Providing too much information may prove overwhelming and create fear, while insufficient information may create insecurity. The information given must be simple and understandable, and respect must be shown for the patient's concerns.⁴ Patients do not need to have a detailed understanding of the benefits and harms, but they must have enough information to be able to make an informed decision.¹² The pregnant patient should be informed and involved before decisions are taken. This applies to decisions on examinations and their timing and, in rare cases, on termination of a pregnancy after high radiation exposure.¹⁹ This study shows that the participants had different needs for information. Some of them wanted detailed information, while others only needed to hear that undergoing an X-ray examination during pregnancy was safe. If a pregnant patient must conduct an X-ray/CT examination involving direct radiation to the pelvis or abdomen, it is important that she be informed of the benefits and risks, and the low incidence of complications must be highlighted.²⁰ The clinical risk of not performing the examination must be assessed and communicated to the patient.¹⁸

The word 'radiation' can arouse fear in patients, and media focus on radiation-related events confounds public perceptions of radiation as dangerous. Moreover, that fact that radiation is often associated with cancer reinforces public fear of radiation.¹² It is therefore only natural that some pregnant women worry about the foetus when they are referred for an X-ray examination. The interviews revealed inadequate knowledge and some erroneous perceptions among pregnant women regarding pregnancy and X-rays. Some of the participants were unsure when a foetus was most radiation-sensitive and whether the foetal dose depended on anatomical area or modality. This variation in knowledge levels shows how important it is that healthcare professionals provide information that is informed by research-based knowledge.^{5,21}

Several of the participants in this study highlighted the challenges of weighing the risk against the need for X-ray

examinations. Since they lacked knowledge about the subject, they found making such a decision challenging. This challenge relates to justification, one of three fundamental principles of radiological protection.²² Related to pregnancy, justification is based on the benefits and risks for both the mother and the child. The stronger the necessity for one of them, the stronger the justification,¹⁹ but for a pregnant woman it is difficult to assess this balance between benefit and risk. It is particularly challenging to weigh their own medical health against the risk to the foetus, and they need help to make an informed decision. It is also important that healthcare professionals demonstrate their knowledge and skills, both professionally and compassionately. Only when the women are free from pressure and are provided with information that is understandable and transparent will the informed decision-making process be valid.⁵

The participants highlighted how they experienced the situation where healthcare professionals leave the room during exposure. This was perceived to mean that radiation was harmful. The fact that healthcare professionals left the room underscored that a foetus should not be irradiated. These situations pose a communication challenge for healthcare professionals in explaining radiation protection. Leaving the room during exposure or wearing protective equipment may give patients the impression that the real risk from radiation is higher than what they were told. This aspect is important to focus on, and through risk communication, healthcare professionals can help give patients a realistic view of the risk.

This study showed that some of the participants would be genuinely concerned about the foetus being accidentally exposed to radiation. In these cases, it is particularly important that healthcare professionals have up-to-date and sufficient knowledge, and it is important to suggest that such exposure does not imply a need to terminate a pregnancy.¹⁶ Inadequate knowledge about the risk to the foetus of accidental exposure may result in unwanted abortions. Since pregnant women have high confidence in health professionals, they are likely to listen to their advice in such situations. If a healthcare professional incorrectly recommends considering an abortion after accidental exposure, it may cause the pregnancy to be terminated. Previous research shows that abortion has been recommended after accidental exposure.^{13,14} This is a highly unfortunate consequence that should not occur. Health professionals working with pregnant patients should therefore have knowledge about the threshold dose for deterministic effects on the foetus, which is 100 mGy,¹ and be able to compare it to foetal doses from different modalities and examinations. Healthcare professionals must have precise knowledge and understanding of radiation risks and be able to explain the types and ranges of risk on a level the pregnant patient understands.⁴

All seven participants in the study highlighted the role of the healthcare professional. They had high confidence in health professionals and would have relied on their information and advice. This places high demands on healthcare professionals who refer, inform about or perform X-ray

examinations on pregnant women. The participants expected an X-ray examination to be justified if they were referred for one. In a justified examination, the overall advantages are greater than the disadvantages caused by radiation.¹ To conduct such an assessment, knowledge of radiation doses and risks is needed, as well as the risks and benefits of conducting the examination during pregnancy.

The participants' expectations of health professionals contrast with the results of previous research. Previous studies^{13,14} show that there is a lack of knowledge on the topic of pregnancy and X-ray examinations among healthcare professionals. In addition, there is a lack of risk communication in the field of medical radiation. A recent study conducted by Ukkola⁸ looked at reasons why adequate information is not given to patients about radiation doses and risks.⁸ One reason was the fear of causing unnecessary concern among patients, which in turn can contribute to the failure to carry out justified examinations. Another reason was that health professionals assumed that information had already been provided and that further information was therefore unnecessary.⁸

The limitations and strengths of the study

The findings of the interviews cannot be generalised to apply to all pregnant women but may shed light on how pregnant women view X-ray examinations. The method in this study was suitable for exploring the topic and using in-depth interviews, and the participants were given the opportunity to illuminate the topic with their own thoughts and reflections. The small number of participants may influence the results, but our experience was that we reached a saturation point where no new information was provided. We wanted to recruit participants via health centres and midwives, but we received minimal interest in recruiting participants for this study. Therefore, we contacted radiographers to help with recruitment. The participants had no relation to the authors. The authors of the study have extensive experience in the subject of pregnancy and medical imaging, as well as scientific expertise that can strengthen the study's validity.

Since the results of this study are not generalisable, we are considering further work to investigate a larger sample on the same topic. We are considering developing a quantitative survey based on these results.

Conclusion

Pregnant women have expectations concerning information related to X-ray examinations during pregnancy, and have confidence in health professionals. The challenge is whether healthcare professionals can meet such expectations. If healthcare professionals lack sufficient knowledge of pregnancy and X-rays, or lack risk communication skills, they will be unable to satisfy the needs for information about risks and benefits of pregnant women. It is therefore important that healthcare professionals who care pregnant women have sufficient knowledge and expertise to inform them about this topic and that this information is quality secured. This may prevent

unnecessary concerns among pregnant woman, ensure that justified examinations are carried out, and avoid adverse decisions such as termination of pregnancy based on erroneous grounds.

References

1. ICRP. Pregnancy and medical radiation. *Ann ICRP*. 2000;30(1):iii–viii, 1–43. [https://doi.org/10.1016/s0146-6453\(00\)00037-3](https://doi.org/10.1016/s0146-6453(00)00037-3).
2. Ukkola L, Oikarinen H, Henner A, et al. Patient information regarding medical radiation exposure is inadequate: patients' experience in a university hospital. *Radiography*. 2017;23(4):e114–e119. <https://doi.org/10.1016/j.radi.2017.04.001>.
3. Lam L Diana, Larson B David, Eisenberg D Jonathan, et al. Communicating potential radiation-induced cancer risks from medical imaging directly to patients. *AJR Am J Roentgenol*. 2015;205(5):962–970. <https://doi.org/10.2214/AJR.15.15057>.
4. Broder S Joshua, Frush P Donald. Content and style of radiation risk communication for pediatric patients. *J Am Coll Radiol*. 2014;11(3):238–242. <https://doi.org/10.1016/j.jacr.2013.10.003>.
5. WHO. *Communicating Radiation Risks in Paediatric Imaging: Information to Support Health Care Discussions about Benefit and Risk*. World Health Organization; 2016. Available from: http://www.who.int/ionizing_radiation/pub_meet/radiation-risks-paediatric-imaging/en/.
6. Ribeiro A, Husson O, Drey N, et al. Ionising radiation exposure from medical imaging - a review of Patient's (un) awareness. *Radiography*. 2020;26(2):e25–e30. <https://doi.org/10.1016/j.radi.2019.10.002>.
7. Ukkola L, Oikarinen H, Henner A, et al. Information about radiation dose and risks in connection with radiological examinations: what patients would like to know. *Eur Radiol*. 2016;26(2):436–443. <https://doi.org/10.1007/s00330-015-3838-5>.
8. Ukkola L, Kyngas H, Henner A, et al. Barriers to not informing patients about radiation in connection with radiological examinations: radiographers' opinion. *Radiography (Lond)*. 2020;26(2):e114–e119. <https://doi.org/10.1016/j.radi.2019.12.005>.
9. DSA. *Regulations on Radiation Protection and Use of Radiation*. Norwegian Radiation and Nuclear Safety Authority; 2016. Pub. L. No. FOR-2016-12-16-1659 Stat. FOR-2016-12-16-1659 https://dsa.no/en/legislation/_attachment/download/8ce9925b-5cbf-4c77-9d4f-811210609905:45c0ca4fde3c31e5a2c5f880c11c1ad007745c27/Regulations%20on%20Radiation%20Protection%20and%20Use%20of%20Radiation%20-%202020.pdf.
10. Borgen L, Stranden E, Espeland A. Clinicians' justification of imaging: do radiation issues play a role? *Insights Imaging*. 2010;1(3):193–200. <https://doi.org/10.1007/s13244-010-0029-4>.
11. Kada S. A study of general practitioners' knowledge of ionizing radiation from diagnostic imaging examinations. *Qual Prim Care*. 2010;18 6:391–397.
12. Dauer LT, Thornton RH, Hay JL, et al. Fears, feelings, and facts: inter-actively communicating benefits and risks of medical radiation with patients. *AJR Am J Roentgenol*. 2011;196(4):756–761. <https://doi.org/10.2214/AJR.10.5956>.
13. Ratnapalan S, Bona N, Chandra K, et al. Physicians' perceptions of teratogenic risk associated with radiography and CT during early pregnancy. *AJR Am J Roentgenol*. 2004;182(5):1107–1109. <https://doi.org/10.2214/ajr.182.5.1821107>.
14. Rehani MM. *Radiation Exposure in Pregnancy: International Guidelines and Experiences from Developing Countries*. Crete: Concert Project; 2015.
15. Bowling A. *Research Methods in Health: Investigating Health and Health Services*. fourth ed. Maidenhead: Open University Press, McGraw-Hill; 2014.
16. Friberg EG, Olerud HM. *Graviditet Og Røntgenstråling. StrålevernInfo 15:2005*. Østerås: Statens strålevern; 2005.

17. IAEA. *Radiation Protection of Pregnant Women in Radiology: IAEA*; 2020. Available from: <https://www.iaea.org/resources/rpop/health-professionals/radiology/pregnant-women>.
18. Toma P, Bartoloni A, Salerno S, et al. Protecting sensitive patient groups from imaging using ionizing radiation: effects during pregnancy, in fetal life and childhood. *Radiol Med*. 2019;124(8):736–744. <https://doi.org/10.1007/s11547-019-01034-8>.
19. Vock P. Clinical perspective on diagnostic X-ray examinations of pregnant patients – what to take into account. *Phys Med*. 2017;43:165–171. <https://doi.org/10.1016/j.ejmp.2017.05.004>.
20. Lowe S. Diagnostic imaging in pregnancy: making informed decisions. *Obstet Med*. 2019;12(3):116–122. Diagnostic imaging in pregnancy: making informed decisions.
21. Barbic D, Barbic S, Dankoff J. An exploration of Canadian emergency physicians' and residents' knowledge of computed tomography radiation dosing and risk. *CJEM*. 2015;17(2):131–139. <https://doi.org/10.2310/8000.2014.141355>.
22. ICRP. The 2007 Recommendations of the international commission on radiological protection. ICRP publication 103. *Ann ICRP*. 2007;37(2–4):1–332. <https://doi.org/10.1016/j.icrp.2007.10.003>. PMID: 18082557.