Effects of radiation exposure on offspring and next generations

Current Issues and Potential Impact for Radiological Protection

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Effects of radiation exposure on offspring and next generations

- **Recurrent issue** for the general public and major concern for parents exposed to ionising radiation from occupational, medical or environmental sources

- **Lack of knowledge** about the fundamental mechanisms underlying potential radiation-induced genetic diseases, the contribution of epigenetic processes to adverse outcomes if any, and the potential contributory role of lifestyle, physiological, and maternal vs paternal factors

- Uncertainty reinforced by a **number of studies at variance** either in the laboratory and/or in the field on various fauna and flora species, and between humans and non-human species

- Last recommendations in 2007 (ICRP Publication 103), heritable **effects on non-human biota** not considered in the current Radiation Protection system

  ➡️ **A revised assessment of the effects of ionising radiation in offspring and next generations is needed to inform future global revisions of the system of radiological protection**

  ➡️ **ICRP TG121 was launched at the end of 2021**
ICRP TG121 objectives

• To **update the review of the scientific literature** related to radiation-induced effects for the offspring of individuals exposed to ionising radiation, for both human and non-human species. The review will have two major parts:
  • **preconceptional effects due to the exposure of parents**: hereditary and transgenerational effects and effects on fertility and fecundity
  • **postconceptional effects of radiation due to the exposure of the embryo and fetus** addressing developmental effects and carcinogenesis

• To provide advice about the **level of evidence** and consideration of these effects in the **system of radiological protection for humans and non-human biota**
Heritable effects

- Last update
  - ICRP Pub 83 (1999)
  - UNSCEAR 2001 report

- In the current system of radiological protection, heritable effects
  - Include risks of Mendelian diseases, chromosomal diseases, chronic diseases and congenital abnormalities
  - Are considered as stochastic effects
  - Are integrated as an add-in risk in the radiation detriment calculation process
Heritable effects: quantification

Risk per unit dose = \sum_{D} P_{D} \times \left[ \frac{1}{D_{D}} \right] \times M_{D} \times P_{RCF_{D}}

- **Baseline frequency** $P$ (in humans)
- **Mutation component** $MC$ (relative change in disease frequency vs mutation rate)
- **Doubling Dose** $DD$ (mutation rates in mice)
- **Potential recoverability correction factor** $PRCF$ (transfer from mice to humans)

Risk assessment approach considers genetic damages on 2 generations

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**Are these risk estimates still fit for purpose today?**
Heritable effects: contribution to radiation detriment

Detriment-adjusted nominal risk coefficients (per 100 per Sv) for stochastic effects after exposure to radiation at low dose rate

<table>
<thead>
<tr>
<th>Exposed population</th>
<th>Cancer</th>
<th>Heritable effects</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole population</td>
<td>5.5</td>
<td>0.2</td>
<td>5.7</td>
</tr>
<tr>
<td>Adult workers</td>
<td>4.1</td>
<td>0.1</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Limited contribution of heritable effects (about 2 to 4%) to radiation detriment

Are these risk estimates still fit for purpose today?
Effects of in utero exposures

- Last update

- In the current system of radiological protection, effects of in utero exposures on humans includes both tissue reactions (teratogenic effects) and stochastic effects (cancers)

Are these risk estimates still fit for purpose today?
**Workshop**

**Workshop**

**Effects of Ionising Radiation Exposure in Offspring and Next Generations**

31st May – 2nd June 2022

Budapest, Hungary

In parallel with the 6th European IRPA Congress

Jointly organized by ICRP Task Group 121 under Committee I and European Radiation Protection Research Platforms MELODI and ALLIANCE

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**A** Hereditary and epigenetic effects due to exposure of germ cell line (pre-conceptional exposure)

**B** Effects arising from exposure of the embryo and fetus (post-conceptional exposure)

**C** Transgenerational effects in biota

**D** Potential impact on the System of Radiological Protection
Implications for the RP system

Impact on the assessment of harmful radiation-induced effects on human health
- Impact on the calculation of radiation detriment
- Impact on the characterization of tissue reactions associated with in utero exposure

Impact on operational radiological protection
- Concerns about potential effects from public, workers and patients
- Operational issues in medical radiological protection, but also for example in post-accidental situations
- Ethical aspects

Consideration of effects on non-human biota in the system of radiological protection
System Review: The Next Decade

- Recognise gaps
- Consider needed updates
- Identify **building blocks**: essential work required for the next general recommendations

Keep the System fit for purpose