Effects of radiation exposure on offspring and next generations

Current Issues and Potential Impact for Radiological Protection

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ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

MELODI Multidisciplinary European Low Dose Initiative

EUROPEAN RADIOECOLOGY ALLIANCE

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ICRP Committee 1
and MC

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

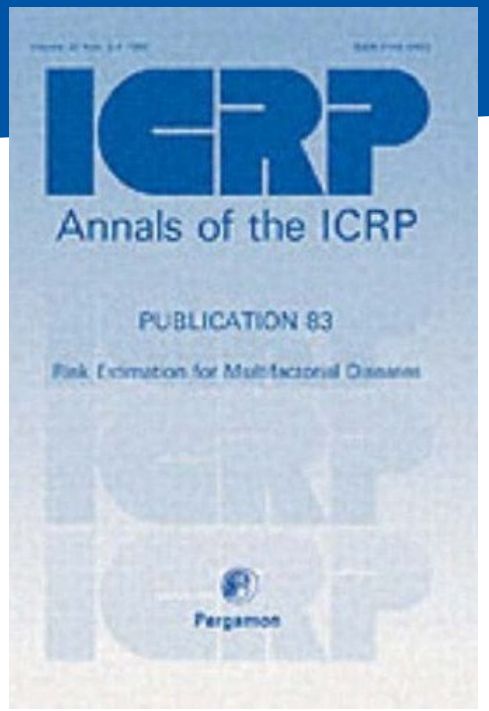
➡ **A revised assessment of the effects of ionising radiation in offspring and next generations is needed to inform future global revisions of the system of radiological protection**

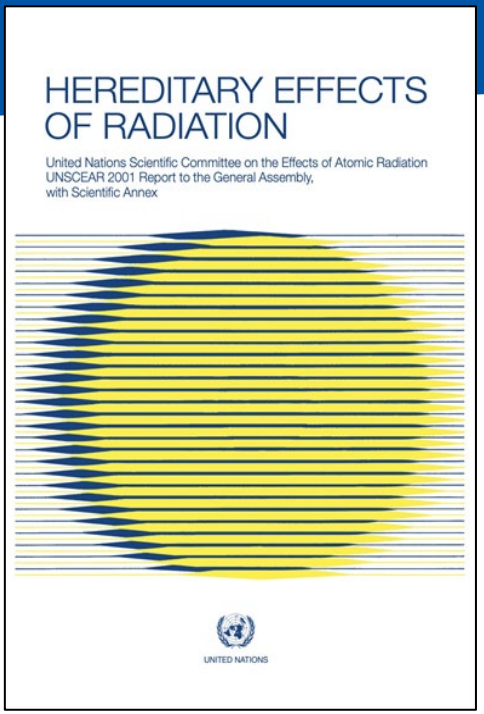
➡ **ICRP TG121 was launched at the end of 2021**

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

Baseline frequency P
(in humans)

Mutation component MC
(relative change in disease frequency vs mutation rate)

$$\text{Risk per unit dose} = \sum_{D} P_D \times \left[\frac{1}{DD_D}\right] \times MC_D \times PRCF_D$$

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

→ **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

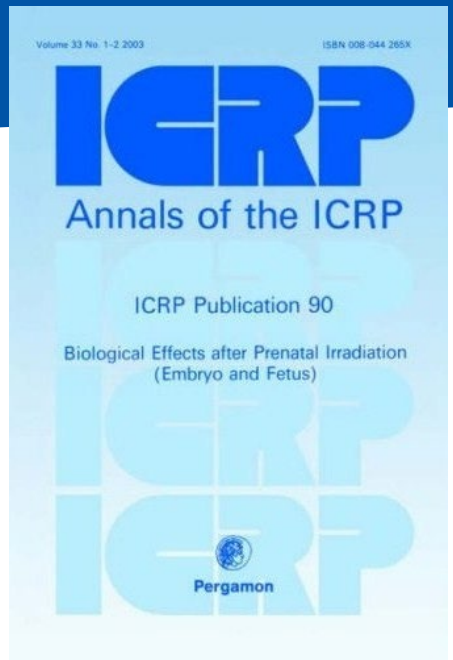
Exposed population	Cancer	Heritable effects	Total
Whole population	5.5	0.2	**5.7**
Adult workers	4.1	0.1	**4.2**

(ICRP Publication 103, 2007)

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
  - ICRP Publication 90 (2003)

- 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

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

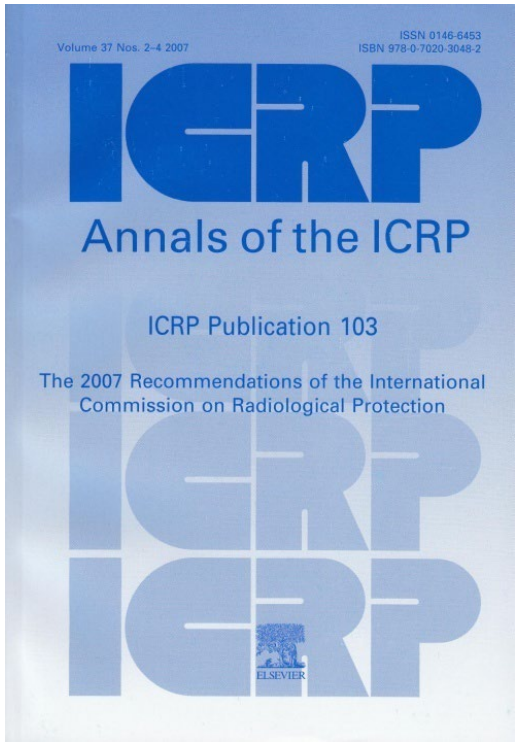
- Impact on the calculation of radiation detriment
- Impact on the characterization of tissue reactions associated with in utero exposure

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

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