Factors Governing the Individual Response of Humans to Ionising Radiation

Conclusions from the draft report of ICRP TG111

Consultation webinar
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ICRP

Main points - I

- There is robust evidence for the severity of normal tissue reactions to radiotherapy being influenced by genetic factors (inherited monogenic disorders), concurrent chemotherapy, comorbidies (cardiovascular disease, diabetes, inflammatory bowel disease and hypertension), and age; additionally, some evidence supports a role of smaller genetic changes (single nucleotide polymorphisms) in some genes. Prediction of normal tissue reactions using cellular and other assays has been reported, but it remains unclear if prediction is possible.

- For circulatory diseases, concurrent chemotherapy with anthracyclins may influence risk, convincing evidence in relation to other factors is lacking, although age and sex may influence the liklihood of certain circulatory disease outcomes; investigation of the prediction of individual response has not been conducted.

Main points - II

- Only limited evidence is available in relation to cataract risk, some evidence suggests that concurrent diabetes increases risk; investigation of the prediction of individual response has not been conducted.

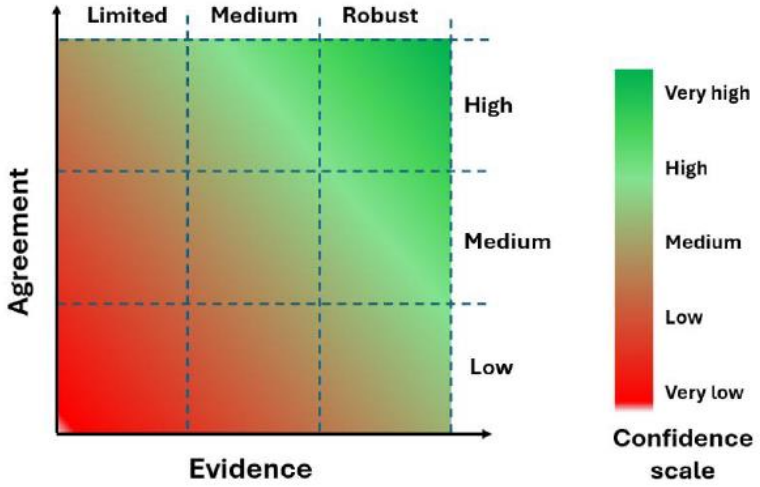
- For cognitive effects, there is robust evidence for age at exposure influencing risk, with those exposed at younger age being at greater risk; investigation of the prediction of individual response has not been conducted.

- In terms of radiogenic cancers, robust evidence indicates that risk is influenced by age-at-exposure (younger ages at elevated risk, but with variation between cancer sites), biological sex (in terms of excess relative risk females are at greater risk, but with variation between cancer sites), and smoking (notably radon lung cancer risk higher in smokers); some evidence exists for genetic factors and female sex hormones influencing risk; prediction of radiation cancer risk by means of simple tests has not been convincingly demonstrated.

Main points - III

Overall, only limited robust evidence is available on the influence of specific factors on responses to radiation exposure. The most secure evidence is in relation to age and biological sex, particularly with respect to radiation-related cancer. The ability to predict responses at the individual level remains a challenge.

Uncertainty & confidence assessment



Based in IPCC methodology
Intergovernmental Panel on Climate Change

Table 6.5. Factors modulating the risk of radiation-related cancer.

Factor	Evidence	Agreement	Confidence	Conclusion
Age at exposure	Robust	High	Very high	For all solid cancer sites combined, higher risk in for younger age at exposure but effects of age at exposure vary between individual sites.
Attained age	Robust	High	Very high	Attained age decreases ERR and increases EAR of all solid cancers. For all solid cancer sites combined, lower risk with increasing attained age, but effects of attained age vary between individual sites
Biological sex	Robust	High	Very high	For all solid cancer sites combined, higher ERR in women but variation between individual sites. EAR measures do not vary between sexes.
Comorbidities	Limited	High	Medium	No clear impact of comorbidities
Genetic factors	Medium	High	High	Impact of genetic factors on risk not clear
Smoking	Robust	High	Very high	Smoking potentiates the risk of lung cancer and possibly of other cancers
Alcohol	Limited	High	Medium	Impact of alcohol on risk not clear. Some animal data and limited data from Life Span Study
Obesity	Limited	High	Medium	Impact of obesity on risk not clear
Female sex hormones	Medium	Medium	Medium	Hormonal variability impacts risk at some sites. Animal data indicate that estrogen increases, and progesterone decreases risk. Emerging human data suggest increased susceptibility around the age of puberty to radiation cancers of the breast and uterine corpus.

Publications to date

- **Applegate et al (2020)** Individual response of humans to ionising radiation: governing factors and importance for radiological protection. Radiat Environ Biophys. 2020 May;59(2):185-209.
- **Wojcik & Pei (2021)** Individual Response to Ionising Radiation – Radiosensitivity of Children. In: Directorate-General for Energy (European Commission), EU Scientific Seminar 2020: "Radiosensitivity" of children – Health issues after radiation exposure at young age. Radiation Protection N° 196. Publications Office of the European Union, Luxembourg: 7–20
- **Abdelkarem et al (2022)** Effect of Race and Ethnicity on Risk of Radiotherapy Toxicity and Implications for Radiogenomics. Clin. Oncol 34(10):653-659.
- **Barnard & Hamada (2023)** Individual response of the ocular lens to ionizing radiation. Int J Radiat Biol, 99(2):138-154.
- **Rajaraman, et al (2025)**. Factors governing individual response to ionizing radiation and risk of diseases of the circulatory system: human epidemiological studies. Int J. Radiat. Biol. 101(11):1085-1097.

Task Group 128

Individualisation and Stratification in Radiological Protection: Implications and Areas of Application

- TG approved by the MC in March 2023
- A Task Group under Committee 1, 2, 3 and 4
- First meeting held on Monday 27th November 2023
- Open meeting planned as part of work, likely focus on medical sector

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