

# Effects of radiation exposure on offspring and next generations

## Effects consequent to intrauterine exposure to ionising radiation

Richard WAKEFORD, Christelle ADAM-GUILLERMIN, Aidana AMRENOVA, Sisko SALOMAA, Dominique LAURIER  
on behalf of ICRP Task Group 121



**Richard WAKEFORD**  
**ICRP Committee 1**

# Intrauterine Exposure

- Considers exposure
  - From the point of conception
  - To the time of birth
  - So, for humans, about 40 weeks
- Encompasses effects
  - On the conceptus, embryo and through to
  - The late fetus

# Effects of Exposure *in utero*

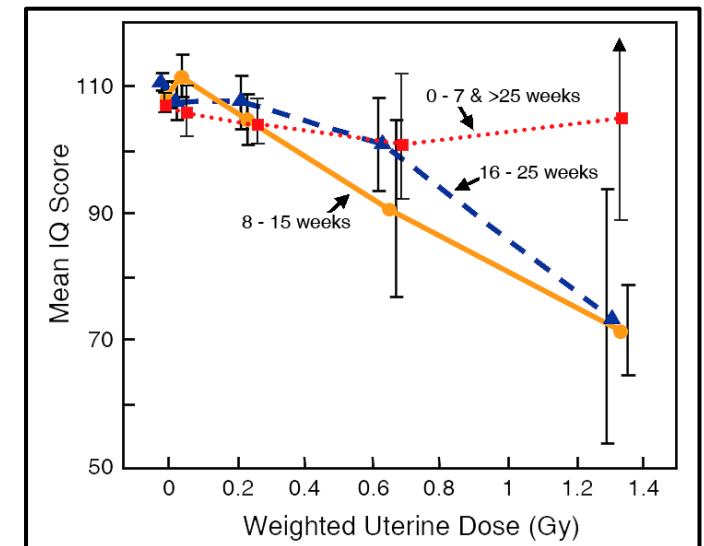
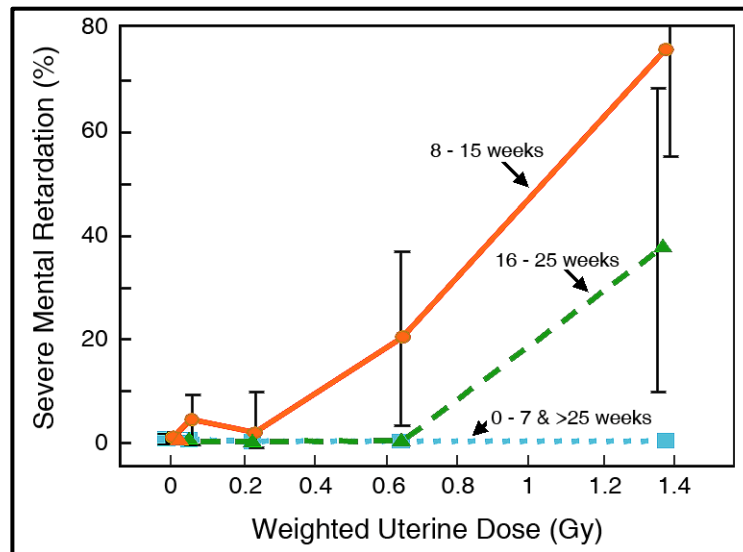
- For antenatal exposure
  - The risks of cancer and hereditary effects must be considered, as for postnatal exposure
  - But the magnitude of these risks may well vary with gestational age
- But also
  - Teratogenic (developmental) effects must be considered, such as congenital malformations
  - The risk of teratogenic effects will vary with gestational age

# Teratogenic Effects

- Effects of exposure *in utero* include
  - Lethality (spontaneous abortion, miscarriage, stillbirth), congenital malformations and growth retardation
  - Level of effect varies with gestational age
- Mental retardation (Japanese atomic bomb survivors - epidemiology)

Variation of severe mental retardation and IQ score with respect to uterine dose received during the bombings and weeks since conception at the time of exposure

ICRP Publication 90, 2003  
NCRP Report No. 174, 2013



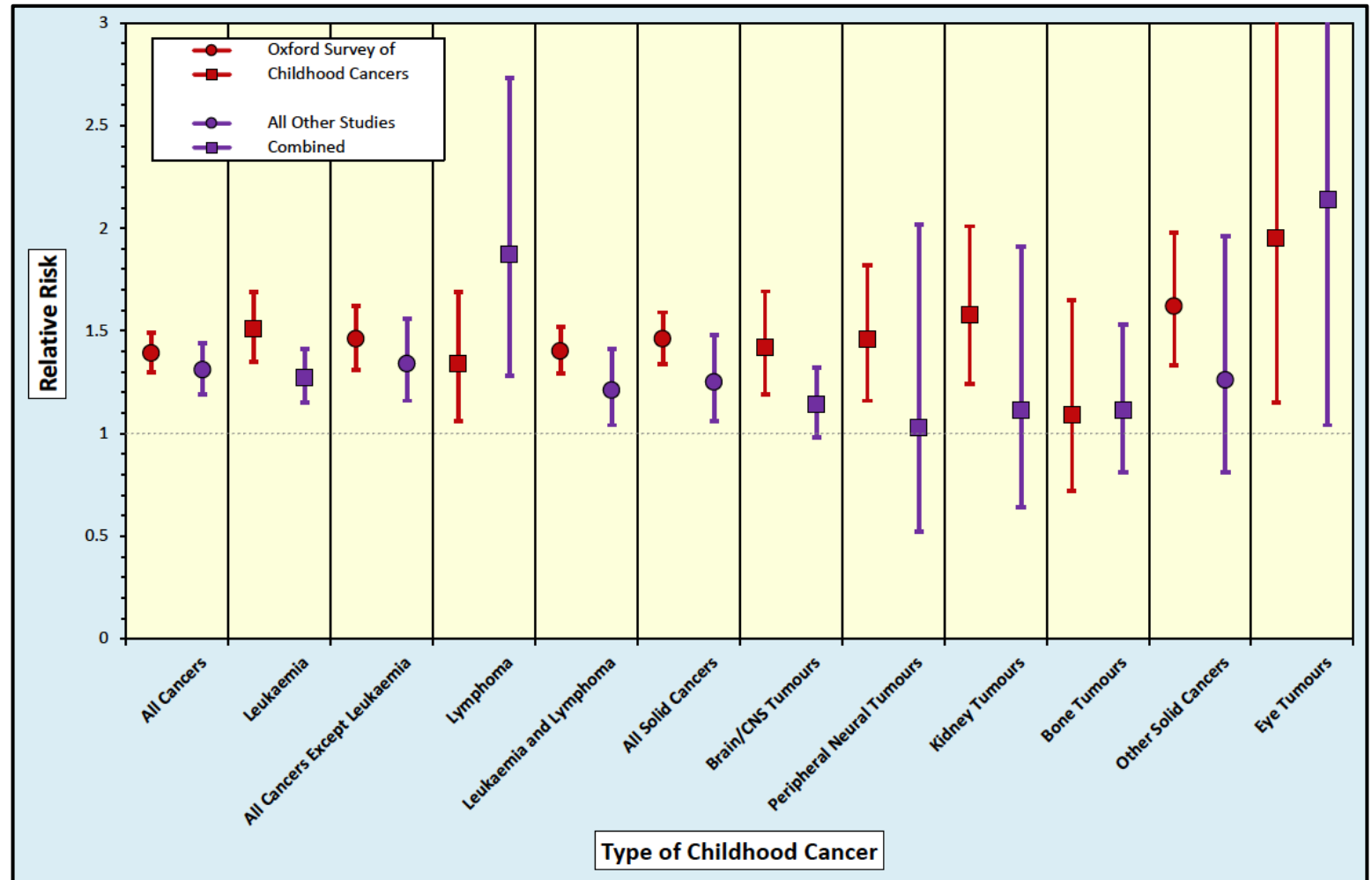
# Cancer and Hereditary Disease

- Stochastic health effects
  - Radiation exposure *in utero* is assumed to increase the risks of cancer and hereditary disease
  - Degree of risk is likely to vary with gestational age
- Cancer risk
  - Human epidemiological findings available
    - Case-control studies of childhood cancer and antenatal X-rays
    - Cohort study of Japanese atomic bomb survivors exposed *in utero*
  - Oxford Survey of Childhood Cancers (OSCC) gives, for all childhood cancers combined (Doll & Wakeford, *Br J Radiol* 1997; **70**: 130-9)
    - ERR = 0.5 (95% CI: 0.3, 0.8) at 10 mGy (X-rays)
    - Little variation of ERR between the typical childhood cancer types

# Childhood Cancer

Comparison of relative risks  
(RR = ERR + 1)  
of antenatal exposure to X-rays:  
Oxford Survey of Childhood Cancers  
and all other case-control studies  
appropriately combined  
in a meta-analysis

Wakeford & Bithell,  
*Int J Radiat Biol* 2021; **97**: 571-92



# Bomb Survivors Exposed *in utero*

- Cohort study of survivors irradiated *in utero* (average dose, 0.25 Gy)
  - Solid cancer mortality to end-2012 (66-67 years of age)
    - Females: ERR/Gy = 2.10 (95% CI: 0.26, 5.61) (21 deaths)
    - Males: ERR/Gy = -0.08 (95% CI: <-0.82, 1.36) (24 deaths)
  - Sugiyama *et al.*, *Eur J Epidemiol* 2021; **36**: 415-28
- Childhood cancers (Wakeford & Little, *Int J Radiat Biol* 2003; **79**: 293-309)
  - 2 cases of childhood cancer against 0.42 expected
  - 0 case of childhood leukaemia (but only 0.18 case expected)
    - Absence of childhood leukaemia surprising given the excess among those irradiated as young children





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