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United Nations Scientific Committee
on the Effects of Atomic Radiation

# Panel discussion
# Future of Radiation Protection

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Hans Vanmarcke, Chair

*ICRP-ICRU 90 Year Jubilee Colloquium*
*Thursday 18 October 2018*

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# Mandate


Scientific Committee of UN General Assembly

Assesses

- levels and exposure,
- biological mechanisms and health effects

of ionizing radiation for Member States, scientific community and public

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# Science underpins radiation protection

## Reflections on low-dose risks

- Unhelpful controversy about low-dose risks
- Lifetime exposure in Belgium tripled since 1895
- Limited power of low-dose epidemiological studies
- Gap between transient short term effects and disease
- Progress in life science will lead to unanticipated insights

# Controversy about low-dose risks

## Unhelpful approaches of dealing with low-dose risks

- Alarming message: **collective dose** as indicator of health risk
  - Translation of individual risk, with low individual probability, into collective risk with a theoretical number of victims
  - Based on simplistic and unproven assumptions *(dose as surrogate for risk, LNT hypothesis…)*

- Reassuring message: **"no discernable increase in risk to be expected"** from epidemiological studies
  - Based on intrinsic limitations of epidemiological studies and not on scientific evidence of absence of health effects at low doses
  - Radiation epidemiology is a blunt instrument: *even the billion dollar study of the atomic bomb survivors is not statistically significant below about 100 mSv*

# Annual exposure doubled since the discovery and use of ionizing radiation



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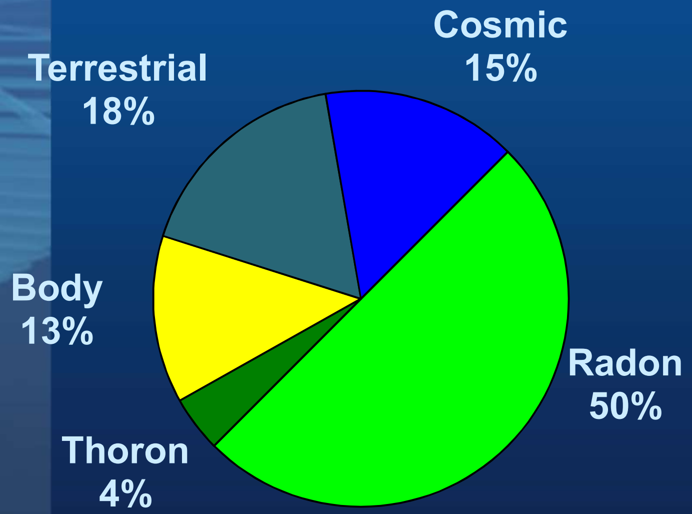
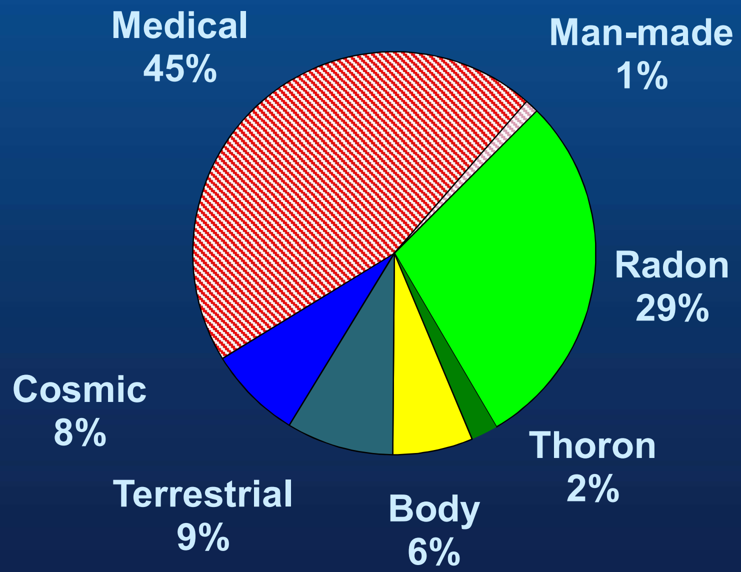
## 1895 Average dose in Belgium 2006

**2.3 mSv/y** from natural sources

**4.6 mSv/y** - 2.5 mSv/y from natural sources
- 2.1 mSv/y from medical exposure

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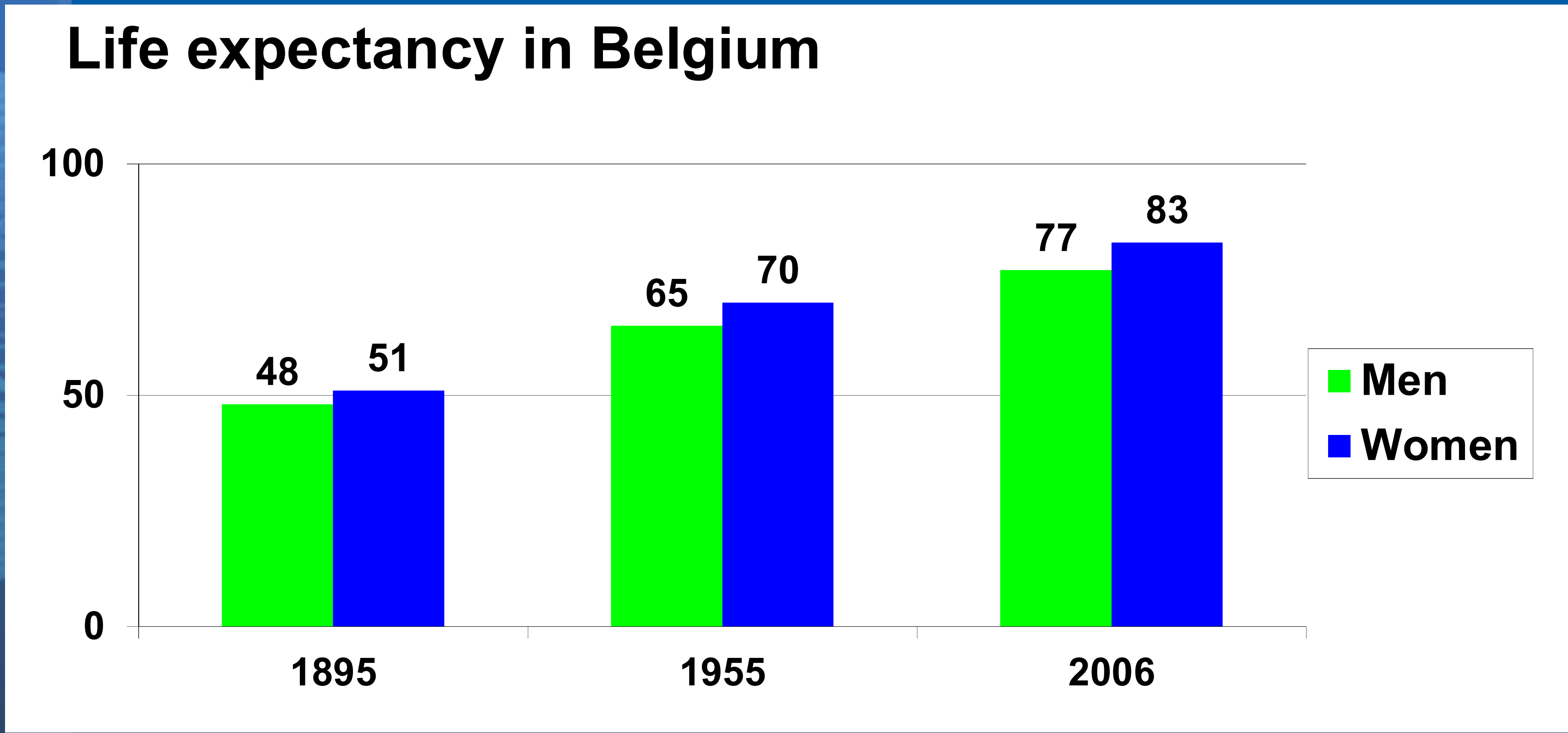
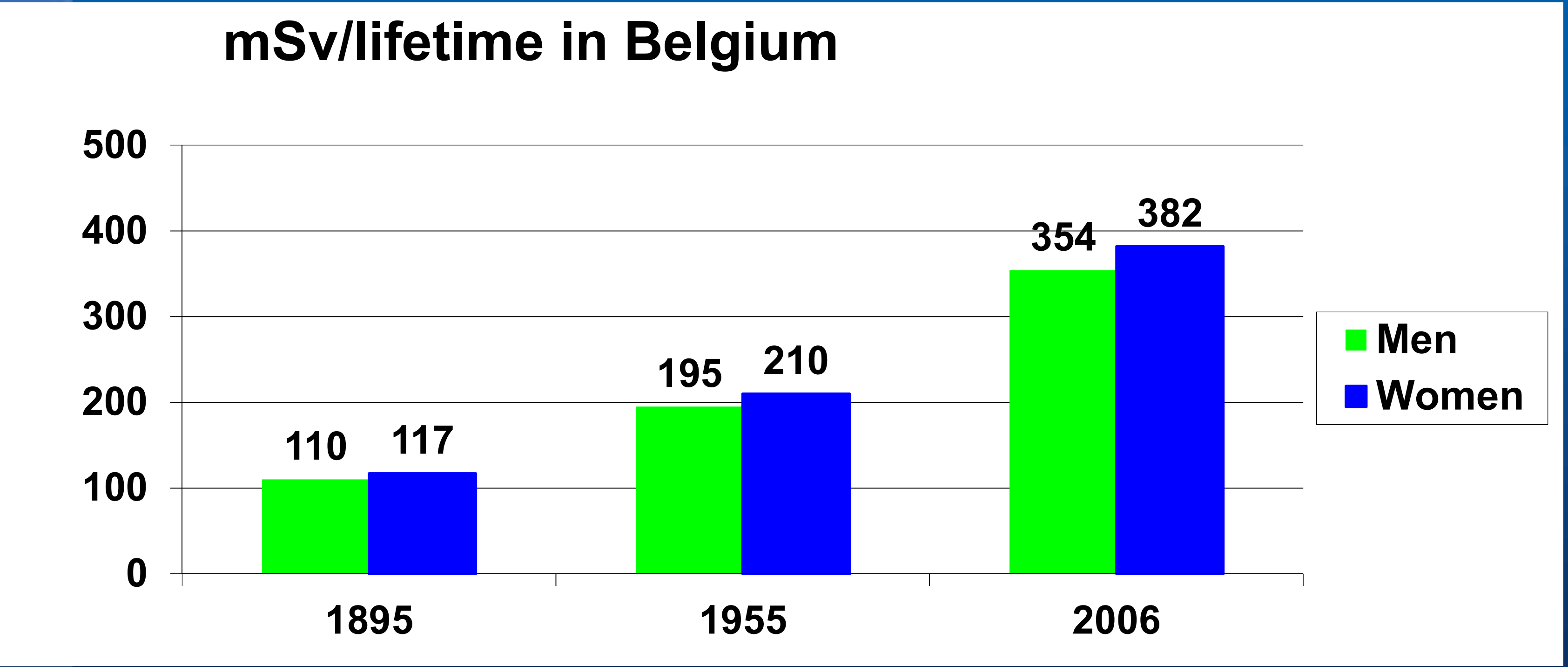
# Causes for doubling average exposure

- Slow increase of indoor radon concentration
  - From 1.15 mSv in 1895 to 1.35 mSv in 2006
  - Reduced ventilation and use of building materials, such as phosphogypsum and fly ash
- Small increase in cosmic radiation
  - Air travel and winter sports
- Strong increase in medical use of ionizing radiation
  - **From 0 mSv in 1895 to 2.1 mSv in 2006**
- Small contribution from other man-made sources
  - From 0 mSv in 1895 to 0.05 mSv in 2006

# Life expectancy increased by 30 years since 1895

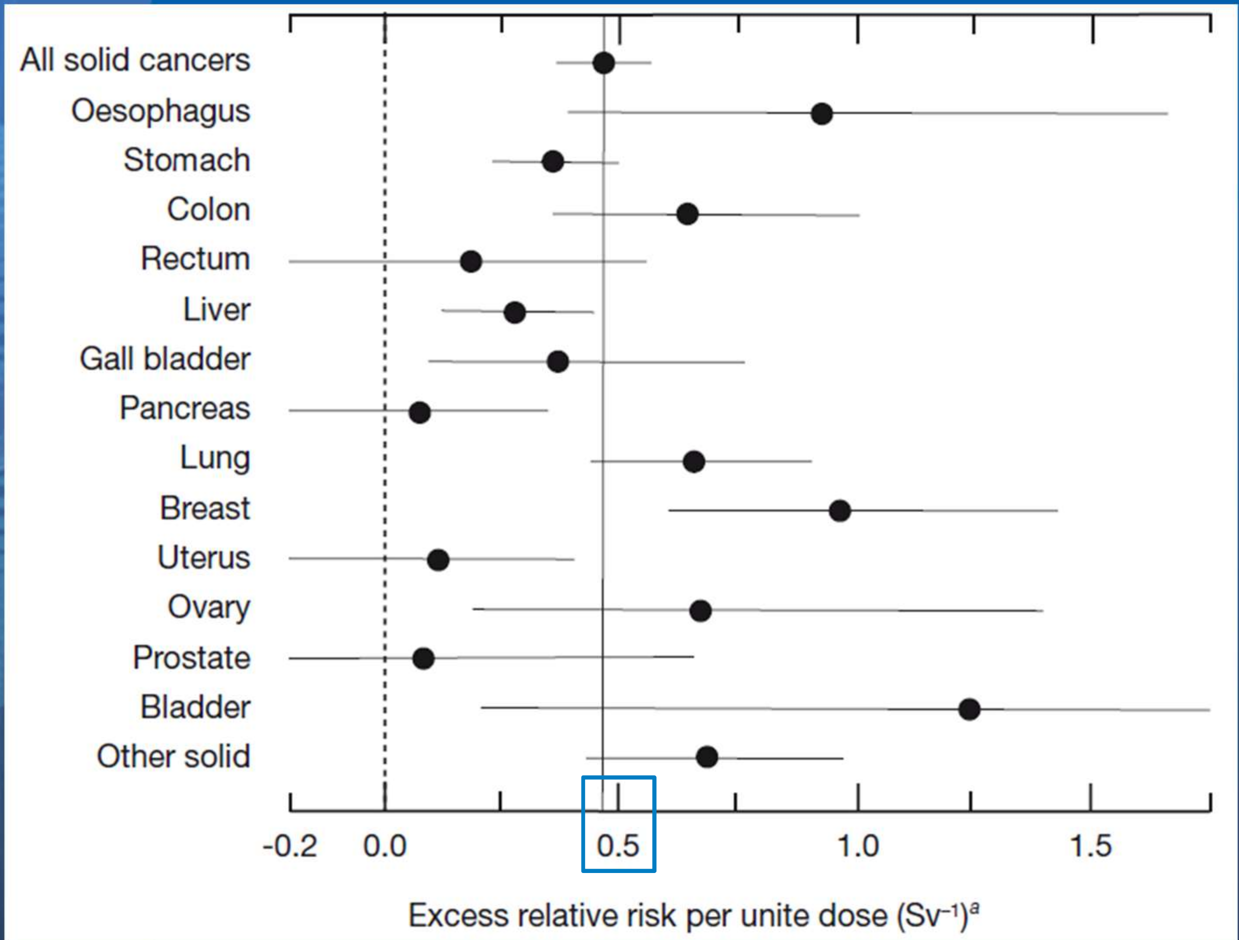


# 3-fold increase in lifetime exposure since 1895




- The high and increasing lifetime exposure and the wide range of exposures **limits the power of low-dose epidemiological studies**

# Organ-specific solid cancer mortality among survivors of atomic bombings in Japan



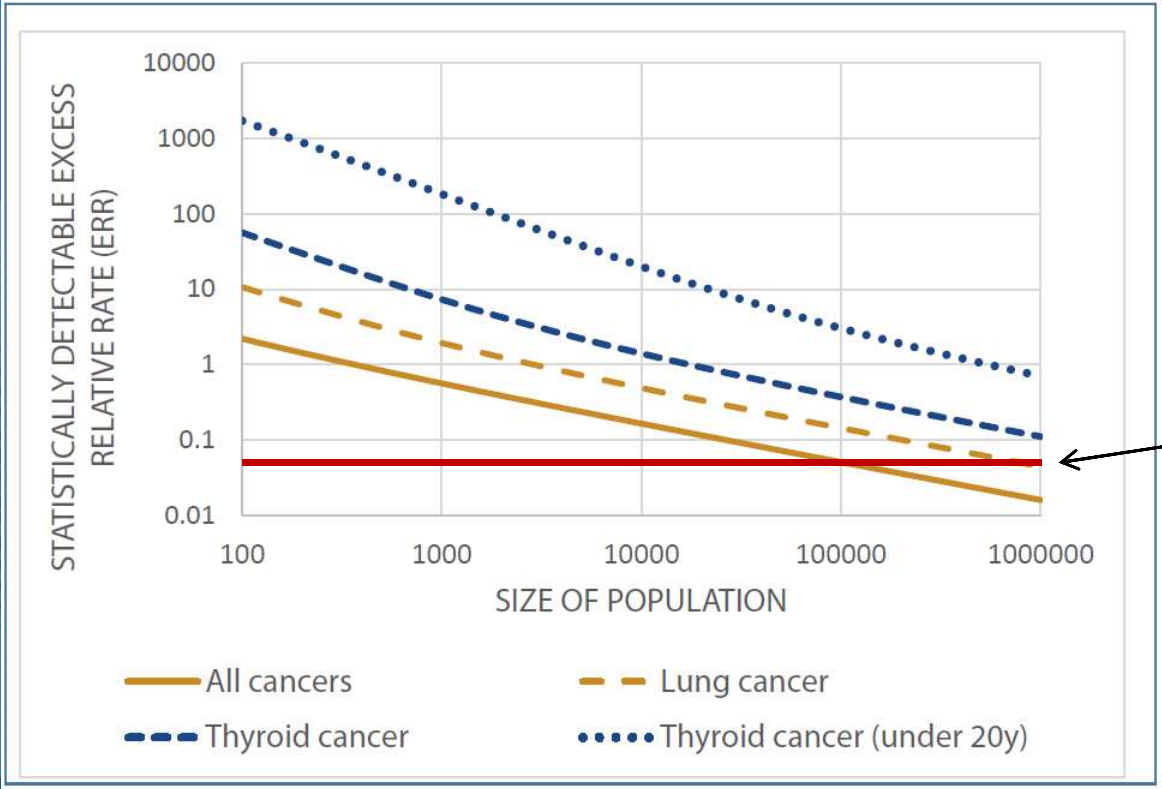

Substantial differences in cancer mortality for various organs

≈ 0.5 per Sv for solid cancers or an **ERR of 5% per 100 mSv** (assuming LNT)

UNSCEAR, 2006

# What cohort size is needed to detect an excess relative rate of 5%?

UNSCEAR, 2012




**ERR of 5%**

*(100 mSv in the Hiroshima-Nagasaki study)*

- For **all cancers** and an ERR of 5%, **two perfectly matched populations of 100,000 people are needed**
- For **specific cancers** much larger cohorts are needed
- In practice, due to **bias and confounding factors** lager cohorts are needed

➡ **Sets an effective limit** on the power of low-dose epidemiological studies

# Difficulties to attribute specific cancer cases to low-dose exposure

- No biomarkers that are specific to radiation exposure are presently available
- Long latency period between exposure and disease presentation (years or decades)
  - *45% of the atomic bomb survivors in Japan were still alive in December 2000*
- High spontaneous incidence of diseases associated with radiation in the general population
  - *Lifetime baseline cancer risk is about 35%*

➡ Same difficulties exist for heritable effects, congenital malformations, cardio-vascular diseases, cataracts, …

# How to bridge gap between transient short term effects and disease?

- Current molecular techniques are very sensitive: we see all kinds of biological responses at very low doses of a few mSv
  - *Radiobiology is almost as sensitive as dosimetry in detecting effects (double strand breaks, activation and deactivation of gene networks…)*
- As these effects are transient, their significance for late health effects (disease) is still unclear
- Radiobiology research and animal studies can help to clarify the significance of these short term responses for human health in the long term
  - *In the absence of clear biomarkers and firm epidemiological data*

# Keep an eye on progress in life science

- Life changes its environment to suit its needs
  - The way nature works is full of surprises
  - The challenge is to unravel underlying mechanisms
- Progress in life science will lead to unanticipated insights
  - Radiobiology: Bridge gap between transient short term effects and disease
  - Radioecology: From more descriptive research to understanding basic processes