Domestic radon exposure and the risk of childhood cancer

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Radon

- originates from uranium = naturally occurring element in granitic and metamorphic rocks


- emanates from soils and concentrates inside of buildings

Radon doses

Irradiation due to radon inhalation
• respiratory tract
  ➜ evidence for association between radon exposure and lung cancer in adults e.g. Darby et. al. (2005)

• other organs
  ➜ irradiation by radon and its decay products as well (Kendall 2002, 2005)
**Radon doses**
Radon: responsible for 60% (3.6 mSV) of total ionizing radiation dose of Swiss population (6 mSV)

**Annual doses to different organs at 100 Bq/m³**
adults (based on Kendall et al. 2002, 2005):

radon gas and decay products (mSv):
- lung: 18.6
- red bone marrow: 0.47
- brain: 0.11

Background

so far:
• ecological studies
  - most ecologic studies found increased risk

• case-control studies: inconsistent results:
  - no association between residential radon and leukaemias

  - association between residential radon and leukaemias
    (eg. Raaschou-Nielsen et al., 2008, Maged et al., 2000)

• no cohort studies so far
Aims

• census based cohort study on national level

Assessment of association between residential radon concentration and childhood cancer:
  - childhood cancer in general

  in particular:
  - leukaemia
    - acute lymphoblastic leukaemia (ALL)
  - central nervous system tumour (CNS-tumour)
Study design

• census based cohort study on national level

period of observation


→ time of diagnosis

→ time of death

→ child becoming 16 years old

→ time of emigration

no event until end of year 2008

31.12.2008
Study design

Inclusion criteria
• children between 0 to 15 years of age at date of census 2000
• cancer cases, diagnosed between the date of census 2000 and end of year 2008

→ databases:
• Swiss National Cohort (SNC): data on mortality, emigration
• Swiss Childhood Cancer Registry (SCCR): data on cancer outcomes, time of diagnosis
Statistical analysis

Cox regression model for time-to-event analysis

Considered predictors:
• residential radon concentration
• period effects
• environmental radiation exposure from external sources
• gender
• birth order within each household
• socio-economic status of the parents
Exposure assessment: residential radon concentration

- based on radon prediction model ($R^2$: 20%)
  (cf. Hauri et al. (2012))
- predictions for each household, each individual
Number of children considered for the analysis

Total number of children: 1,279,435

<table>
<thead>
<tr>
<th>Cancer cases</th>
<th>All cancers</th>
<th>Leukaemia</th>
<th>Acute lymphoblastic leukaemia (ALL)</th>
<th>CNS tumours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>866</td>
<td>257</td>
<td>205</td>
<td>223</td>
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</tbody>
</table>

Radon concentration: all children
μ: 86.0 Bq/m³
min: 1 Bq/m³  max: 490 Bq/m³
Results:
Main analysis

- **ALL CANCERS**
  - Hazard Ratio
  - 1-78 Bq/m³ (Ref.)
  - 78-140 Bq/m³
  - 140-490 Bq/m³

- **LEUKAEMIA**
  - Hazard Ratio
  - 1-78 Bq/m³ (Ref.)
  - 78-140 Bq/m³
  - 140-490 Bq/m³

- **ALL-LEUKAEMIA**
  - Hazard Ratio
  - 1-78 Bq/m³ (Ref.)
  - 78-140 Bq/m³
  - 140-490 Bq/m³

- **CNS-TUMOURS**
  - Hazard Ratio
  - 1-78 Bq/m³ (Ref.)
  - 78-140 Bq/m³
  - 140-490 Bq/m³
Results: infants (0-4 years old)
Results:
Boys

ALL CANCERS

- Hazard Ratio
- 1-78 Bq/m³ (Ref.)
- 78-140 Bq/m³
- 140-490 Bq/m³

LEUKAEMIA

- Hazard Ratio
- 1-78 Bq/m³ (Ref.)
- 78-140 Bq/m³
- 140-490 Bq/m³

ALL-LEUKAEMIA

- Hazard Ratio
- 1-78 Bq/m³ (Ref.)
- 78-140 Bq/m³
- 140-490 Bq/m³

CNS-TUMOURS

- Hazard Ratio
- 1-78 Bq/m³ (Ref.)
- 78-140 Bq/m³
- 140-490 Bq/m³
Discussion

strengths
• population-wide cohort study
• consideration of confounding factors
• assessment of association on individual level

limitations
• uncertainties in exposure estimation
Conclusion

• no evidence for an association between residential radon and different childhood cancer outcomes

⇒ in line with current organ specific dose estimation
(Kendall 2002, 2005)
Thank you for your attention!