Thoron: the unrecognized carcinogen in earthen dwellings typical to rural Africa and Asia

Margaret Chege and Catherine Nyambura
Kenyatta University, Kenya
Talk Structure

• Introduction
• Why the risk
• Conclusion
• Recommendation
Introduction

- Thoron half-life - 55.6 s
- In most cases, not considered a risk
  - in the perspective of modern houses
• However, may be elevated in ground floor, basement
• Enters from soil through cracks, crevices, joints

https://springfieldhealthyhomes.org/radon/

• Looked at for example from rural Africa and Asia perspective, may be misleading
• In some rural areas of Asia and Africa - soil is the main building material.
• In Kenya for example, soil makes wall, floor, e.g.

– Not necessarily out of poverty; rather way of life
• Source of thoron in contact with indoor air
Why the risk

(1) $^{232}$Th level in soil

- $^{232}$Th average in soil $45$ Bq/kg while $^{238}$U average $35$ Bq/kg
- Areas with elevated $^{232}$Th levels in soil reported, eg

<table>
<thead>
<tr>
<th>Country</th>
<th>Region</th>
<th>$^{232}$Th conc. (Bq/kg)</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya</td>
<td>Mrima Hill</td>
<td>500</td>
<td>Kebwaro et al 2011</td>
</tr>
<tr>
<td></td>
<td>Homa Mountain</td>
<td>410</td>
<td>Otwoma et al 2012</td>
</tr>
<tr>
<td></td>
<td>Lambwe East</td>
<td>1397</td>
<td>Achola et al 2012</td>
</tr>
</tbody>
</table>

- Same soil may be used for construction
(2) Thoron exhalation rate

• Thoron exhalation rate from surface soil often higher compared to radon; example

<table>
<thead>
<tr>
<th>Country</th>
<th>mBq/m²s</th>
<th>mBq/m²s</th>
<th>Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>2008</td>
<td>48.11</td>
<td>Syarbaini and Pudjadi et al 2015</td>
</tr>
<tr>
<td>Japan</td>
<td>1210</td>
<td>12</td>
<td>Hosoda et al, 2009</td>
</tr>
<tr>
<td>India</td>
<td>5402</td>
<td>73.6</td>
<td>Midhum et al 2017</td>
</tr>
</tbody>
</table>

– Thoron input in air higher
(3) Short half-life of thoron

- Curse in earthen dwellings
- Let number of airborne thoron atoms in unit time equals the number of radon atoms (N)

\[
Activity = \frac{0.693N}{T_{1/2}}
\]

\[
A_{\text{thoron}} = 5.936A_{\text{Radom}}
\]

- Significantly higher thoron progeny input rate
  - Progeny responsible for cancer
• Say 99.9% of thoron activity – progeny attach to surfaces, still;

\[ 0.1\% (A_{thoron}) \approx 6A_{Radom} \]

– High concentration - Increased risk

• NOTE: requires a steady state concentration of 17 thoron atoms to produce the same activity as 100,000 radon atoms.

– Thoron may be an issue even in modern dwellings if building material contains \(^{232}\text{Th}\)
(4) Thoron progeny airborne considerably longer
• Longer exposure time – increased risk
(5) Higher energy
• Higher probability of causing sufficient damage to cause cancer
Conclusion

• Have dwellings made of soil in parts of Africa and Asia.
• On average, $^{232}$Th (thoron source) in soil is higher than $^{238}$U (radon source).
• Thoron exhalation rate from surface soil is often higher than that of radon.
• For equal number of airborne radon, thoron atoms, thoron exhalation is considerably higher.
• Thoron progeny are airborne for longer period of time.
• Collectively, thoron progeny have more energy than radon progeny.
• Risk - function of concentration, exposure time, energy; hence thoron possible carcinogen in earthen dwellings.
Recommendation

• More research on the isotopes in earthen dwellings
• Epidemiological studies to investigate the link between living in earthen dwellings and risk of cancer.
Thank you for your attention