Sex-specific lung cancer risk following fractionated low-dose radiation in occupational cohorts: An update from the Million Person Study

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S13: The epidemiology of lung cancer following radiation exposure
MPS Study Team

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Lung Cancer

- Evidence of association of lung cancer with low-LET radiation comes mainly from acute high-dose rate exposures and at moderate radiation doses (UNSCEAR 2008)

- Japanese Atomic Bomb Survivors – elevated risk, with nearly 3-fold risk for women

- Few occupational studies include large numbers of women

<table>
<thead>
<tr>
<th>Atomic Bomb Survivors</th>
<th>Female ERR</th>
<th>Male ERR</th>
<th>Ratio F:M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung cancer risk</td>
<td>0.12</td>
<td>0.08</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>[0.07, 0.18]</td>
<td>[0.02, 0.08]</td>
<td></td>
</tr>
</tbody>
</table>
Sex-Specific Lung Cancer ERR -Other

- Atomic Bomb Survivors
- Hodgkin Lymphoma
- Indoor Radon
- Mayak
- TB Fluroscopy
- Techa River

ERR (95% Confidence Interval)
# Lung Cancer Deaths - MPS

<table>
<thead>
<tr>
<th>MPS Cohort</th>
<th># Male Workers</th>
<th># Male lung cancers</th>
<th># Females Workers</th>
<th># Female lung cancers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomic Veterans</td>
<td>113,806</td>
<td>8,037</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Mallinckrodt</td>
<td>2,514</td>
<td>157</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Mound</td>
<td>3,983</td>
<td>303</td>
<td>971</td>
<td>63</td>
</tr>
<tr>
<td>Nuclear Power Plant*</td>
<td>140,234</td>
<td>3,633</td>
<td>4,975</td>
<td>57</td>
</tr>
<tr>
<td>Industrial Radiographers*</td>
<td>110,580</td>
<td>2,061</td>
<td>12,934</td>
<td>55</td>
</tr>
<tr>
<td>Combined NPP &amp; IR*</td>
<td>250,814</td>
<td>5,694</td>
<td>17,909</td>
<td>112</td>
</tr>
<tr>
<td>Medical Workers*</td>
<td>55,218</td>
<td>480</td>
<td>53,801</td>
<td>370</td>
</tr>
<tr>
<td>Los Alamos &amp; Zia**</td>
<td>19,808</td>
<td>653</td>
<td>6,520</td>
<td>186</td>
</tr>
<tr>
<td>TEC**</td>
<td>18,789</td>
<td>1,002</td>
<td>13,951</td>
<td>641</td>
</tr>
<tr>
<td>Rocky Flats**</td>
<td>7,977</td>
<td>395</td>
<td>1,558</td>
<td>35</td>
</tr>
<tr>
<td><strong>Provisional total</strong></td>
<td><strong>478,359^</strong></td>
<td><strong>17,512^</strong></td>
<td><strong>95,663^</strong></td>
<td><strong>1,398^</strong></td>
</tr>
</tbody>
</table>

^Totals are preliminary and do not include the Combined NPP/IR pooled cohort  
*Manuscript under review; **Analytic results are preliminary
Sex-Specific Mean Lung Dose: mGy
Sex-specific Lung Cancer ERR - MPS
Sex-specific Lung Cancer ERR - MPS

*ERR/100 weighted mGy
Adjustment for SES

• All MPS models adjust for socioeconomic status
  • Education level: Mound, LANL, Rocky Flats
  • Pay Category: Atomic Veterans, MCW, IR, NPP, TEC
• Reasonable surrogates for smoking/tobacco use?
  • Likely cohort and time/era dependent
• TEC – opportunity to obtain medical records
  • n=641 female lung cancers; n=707 matched comparisons
  • n=1,235 records found; n=598 with tobacco use (yes/no)
• Tobacco use results:
  • Higher among cases (49.7%) compared to controls (25.7%)
  • Higher among hourly compared to salary, but not significant
• ERR per 100 weighted mGy
  • Adjusted for paycat = 0.003 (-0.01, 0.01)
  • Adjusted for tobacco = 0.001 (-0.01, 0.001)
Preliminary Observations in MPS

• Little evidence for lung cancer risk at fractionated low dose, low dose rates
  • Some cohorts have larger CIs, but include null value
  • No consistent evidence of sex-specific differences

• Strengths of MPS
  • US working cohorts, some more contemporary
  • Variety of exposure scenarios
  • Large number of women
  • All MPS cohorts adjust for SES (surrogate for smoking)
    • Sensitivity analyses for tobacco use

• Limitations
  • Individual cohort power - # cases, narrow dose distribution
  • Adjustment for co-exposures
  • Lung cancer incidence
More to come

- Additional cohorts
- Pooling of MPS cohorts
  - ~20K male lung cancer deaths
  - ~2K female lung cancer deaths
- Tobacco use/smoking
  - TEC men
  - Hanford

### Cohort Details

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fernald</td>
<td>390</td>
<td>33</td>
</tr>
<tr>
<td>Hanford*</td>
<td>1662</td>
<td>274</td>
</tr>
<tr>
<td>K-25*</td>
<td>702</td>
<td>82</td>
</tr>
<tr>
<td>Linde</td>
<td>82</td>
<td>13</td>
</tr>
<tr>
<td>Middlesex</td>
<td>39</td>
<td>2</td>
</tr>
<tr>
<td>Paducah</td>
<td>201</td>
<td>29</td>
</tr>
<tr>
<td>Pantex*</td>
<td>204</td>
<td>30</td>
</tr>
<tr>
<td>Portsmouth</td>
<td>371</td>
<td>40</td>
</tr>
<tr>
<td>Savannah River*</td>
<td>790</td>
<td>26</td>
</tr>
<tr>
<td>Radium Dial</td>
<td>9</td>
<td>102</td>
</tr>
<tr>
<td>Rocketdyne**</td>
<td>251</td>
<td>14</td>
</tr>
<tr>
<td>X-10*</td>
<td>677</td>
<td>143</td>
</tr>
<tr>
<td>Y12*</td>
<td>987</td>
<td>98</td>
</tr>
<tr>
<td><strong>Total additional</strong></td>
<td>3,529</td>
<td>484</td>
</tr>
</tbody>
</table>

*Lung cancer cases are preliminary, NDI processing in progress; **Update to original study
References


References


Thank You