Public Health and Coal Mining

Michael Hendryx, PhD
November, 2011

Mountaintop Mining

- Removes the entire tops of mountains and ridges
- Explosives and draglines reach coal seams hundreds of feet deep
- Spoil is deposited into adjacent valleys
- Has permanently buried over 1,200 miles of streams
- Will impact >1.4 million acres

Industry Statements

- "Within a few years, 10,000 replacement miners will be needed...For every miner, 8 other workers are needed for support jobs. That’s 90,000 good paying jobs with good benefits."
  - 2007 Charleston Gazette newspaper article
- "Every coal mining job generates between 5 and 6 other jobs somewhere in the local economy."
  - West Virginia Coal Association website, accessed 08-24-08
- "It’s frequently noted that "every coal mining job creates another 5 to 8 jobs somewhere in the economy. Anyone who has ever visited a coal oriented community in West Virginia would have no hesitation in believing that statistic."
  - Friends of Coal, West Virginia Coal Association “Coal Facts 2007” report.

Number of Appalachian Coal Miners 1985-2009

Source: Annual Coal Reports, Energy Information Administration (*figures for 1986-1989 imputed)

Independent Assessment of Coal Economy

- For every mining job, 2.38 other jobs are created (not 5-8)
- Direct, indirect and induced benefits: $8.08 billion in 2005 dollars

Source: University of Kentucky report, 2001, funded by ARC
**Disparities in Mining Areas**

<table>
<thead>
<tr>
<th></th>
<th>Appalachian Coal Mining</th>
<th>Other Appalachian</th>
<th>Rest of Nation</th>
</tr>
</thead>
<tbody>
<tr>
<td>% college education*</td>
<td>11.7</td>
<td>13.8</td>
<td>17.1</td>
</tr>
<tr>
<td>Median household income*</td>
<td>$28,054</td>
<td>$32,596</td>
<td>$36,753</td>
</tr>
<tr>
<td>Unemployment rate*</td>
<td>7.4</td>
<td>6.2</td>
<td>5.2</td>
</tr>
<tr>
<td>Poverty rate*</td>
<td>19.6</td>
<td>15.6</td>
<td>13.1</td>
</tr>
</tbody>
</table>

* Group differences significant at p<.0001

Area Resource File 2006 adjusted for age, race/ethnicity and sex

---

**Median Household Income by County Coal Production**

- > 4 mil tons: $28,163
- Up to 4 mil tons: $29,883
- No Coal: $32,260

Sources: Area Resource File and WV Geological and Economic Survey

---

**Percent in Poverty by County Coal Production**

- > 4 mil tons: 20.1%
- Up to 4 mil tons: 16.9%
- No Coal: 15.5%

Sources: Area Resource File and WV Geological and Economic Survey

---

**Percent High School Graduates by County Coal Production**

- > 4 mil tons: 46.2%
- Up to 4 mil tons: 50.5%
- No Coal: 51.2%

Sources: Area Resource File and WV Geological and Economic Survey

---

**Percent without Health Insurance by County Coal Production**

- > 4 mil tons: 15.6%
- Up to 4 mil tons: 13.8%
- No Coal: 12.9%

Sources: Area Resource File and WV Geological and Economic Survey

---

**Percent Who Report No Usual Source of Health Care**

- > 4 mil tons: 18.2%
- Up to 4 mil tons: 15.2%
- No Coal: 15.9%

Sources: West Virginia IMPR Survey and WV Geological and Economic Survey
Cardiopulmonary and kidney disease mortality

- Chronic heart, lung, & kidney disease mortality rates are higher in coal mining areas than the rest of Appalachia or the nation
- CDC mortality data 2000-2004
- Adjustments for smoking, age, sex, race, poverty, education, rural-urban setting, insurance rates, physician supply, region
- Results are concentrated in MTM areas
Self-Reported Health
- Greater coal mining is associated with higher rates of:
  - Chronic cardiovascular, respiratory, and kidney disease
  - National 2006 BRFSS data show higher rates of heart attack and coronary heart disease
- People in Appalachian mining areas report more days of poor health and activity limitations
  - Men and women, young and old
  - Controlling for smoking, alcohol use, BMI, age, gender, race/ethnicity, marital status, income, education, rural/urban setting, doctor supply
- Effects are concentrated in MTM areas

Low Birth Weight
- Low birth rate 16% in heavy mining areas; 14% in moderate areas of WV
- Control for mother’s age, smoking, drinking, education, prenatal care
- Higher LBW risk concentrated in MTM areas

Academic Performance
- Students in mining counties of WV are significantly more likely to fail standardized tests
  - Grades 3,4,5,6,7,8,10
  - Controlling for low income, county high school education rate, class size, teacher quality, school size
  - Approximately 1,600 excess fails per year.

Birth Defects in MTM Areas
- Analyzed all live births 1996-2003 in KY, TN, VA, and WV
- Data from National Center for Health Statistics natality files
  - Data use agreement to access county of residence
  - Live singleton births, N=1,889,071

Birth Defects in MTM Areas: Results
- Unadjusted prevalence of any defect:
  - MTM: 235 per 10,000 live births
  - Other mining: 183 per 10,000
  - No mining: 144 per 10,000

<table>
<thead>
<tr>
<th></th>
<th>MTM</th>
<th>Other Mining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age-adjusted only</td>
<td>1.63 (1.54, 1.72)</td>
<td>1.27 (1.20, 1.35)</td>
</tr>
<tr>
<td>Adjusted*</td>
<td>1.36 (1.23, 1.32)</td>
<td>1.10 (1.05, 1.16)</td>
</tr>
</tbody>
</table>

Adjusted PRRs by organ system:

<table>
<thead>
<tr>
<th>Organ System</th>
<th>MTM PRR</th>
<th>Other Mining PRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circulatory/respiratory*</td>
<td>1.93 (1.73, 2.15)</td>
<td>1.08 (0.94, 1.24)</td>
</tr>
<tr>
<td>CNS*</td>
<td>1.36 (1.11, 1.67)</td>
<td>1.18 (0.95, 1.46)</td>
</tr>
<tr>
<td>Gastrointestinal*</td>
<td>1.41 (1.17, 1.71)</td>
<td>1.02 (0.82, 1.28)</td>
</tr>
<tr>
<td>Urogenital**</td>
<td>1.35 (1.19, 1.54)</td>
<td>1.32 (1.13, 1.51)</td>
</tr>
<tr>
<td>Musculoskeletal*</td>
<td>1.30 (1.20, 1.41)</td>
<td>1.08 (0.99, 1.18)</td>
</tr>
<tr>
<td>Chromosomal</td>
<td>0.92 (0.72, 1.18)</td>
<td>0.85 (0.66, 1.09)</td>
</tr>
<tr>
<td>Other**</td>
<td>1.13 (1.04, 1.23)</td>
<td>1.12 (1.03, 1.22)</td>
</tr>
</tbody>
</table>

* Higher only in MTM group; ** higher in both groups
Birth Defects in MTM Areas: Results

Adjusted MTM PRRs by early versus late period:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Circulatory/respiratory*</td>
<td>1.20 (1.03, 1.41)</td>
<td>2.81 (2.43, 3.25)</td>
</tr>
<tr>
<td>CNS</td>
<td>1.42 (1.06, 1.91)</td>
<td>1.30 (0.95, 1.76)</td>
</tr>
<tr>
<td>Gastrointestinal*</td>
<td>1.30 (0.94, 1.80)</td>
<td>1.53 (1.18, 1.96)</td>
</tr>
<tr>
<td>Urogenital*</td>
<td>1.16 (0.94, 1.42)</td>
<td>1.62 (1.38, 1.93)</td>
</tr>
<tr>
<td>Musculoskeletal</td>
<td>1.31 (1.17, 1.46)</td>
<td>1.30 (1.15, 1.46)</td>
</tr>
<tr>
<td>Chromosomal</td>
<td>1.21 (0.89, 1.64)</td>
<td>0.68 (0.46, 1.03)</td>
</tr>
<tr>
<td>Other*</td>
<td>0.99 (0.88, 1.12)</td>
<td>1.29 (1.15, 1.45)</td>
</tr>
<tr>
<td>Any*</td>
<td>1.13 (1.06, 1.21)</td>
<td>1.42 (1.33, 1.52)</td>
</tr>
</tbody>
</table>

* Higher in later period

Results: Summary

- Birth defects are significantly higher in MTM areas versus either other mining areas or no mining, controlling for other risks
- Effects are present across many organ systems
- Effects for some systems are stronger in more recent times
- Some suggestion of spatial effects
- Clearest results (significant overall, stronger in recent times, and possible spatial effects) for:
  - Circulatory respiratory, urogenital, other, and any

Results (continued)

- No difference in supply of OB/GYNs or primary care docs between groups
- Smoking increased risk by about 18% (MTM circ/resp in 2000-2003 higher by 181%; overall was 26% higher in MTM)
- Results are partially attributable to other behavioral or demographic risks, but a MTM effect remains

Appalachian Coal Mining Correlates to Public Health:

- Become stronger as mining levels increase
- Present for women, men, and children
- Present across multiple data sources and health outcomes
- Become stronger in closer proximity to mining activity
- Concentrated in MTM areas

Explosion over the town of Dorothy
MTM and Control Air Samples,
Nov-Dec. 2010

MTM Dust
- Primarily silicon and sulfur by weight
- Contains many other elements, including Be, Fe, Mn, Cd, Co, Pb, U, Al, Ti, and others
- In animal studies:
  - MTM dust kills heart cells
  - MTM dust impairs vascular function

Tests of Well and Groundwater
- Arsenic in ~ 1/2 of 179 wells in central Appalachia, most at levels known to increase cancer risk (Shiber)
- Ground water in mined areas of Appalachia have higher sulfate, iron, manganese, aluminum, calcium, magnesium, zinc, pH, and turbidity (McAuley & Kozar, USGS report)

Public Water Uncertainties
- From 2001 through 2009, there were 17,362 water quality violations reported to the EPA from West Virginia:
  - 86 per facility in MTM areas
  - 15 per facility in rest of the state
  - Most violations were failures to sample for organics as required
  - Estimated health violations about 5 times higher
**What is the Value of a Life (statistically speaking)?**

- VSL research
- EPA and FDA studies place VSL at $4.67 to $7.74 million, in 2005 dollars

---

**The Human Cost of Coal Mining**

<table>
<thead>
<tr>
<th>VSL in millions:</th>
<th>Cost estimate in billions compared to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$18.563</td>
</tr>
<tr>
<td>$7.74</td>
<td>$30.766</td>
</tr>
<tr>
<td>Excess annual deaths:</td>
<td>3,975</td>
</tr>
</tbody>
</table>

---

**The Precautionary Principle**

- We know that MTM environments are not healthy environments, *regardless* of specific causes
- Lack of knowledge regarding exact causal relationships should not preclude action
- MTM areas are where health problems are most severe, regardless of cause, and should be the focus of interventions