## Public Health and Coal Mining

Michael Hendryx, PhD
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## 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

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## 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.

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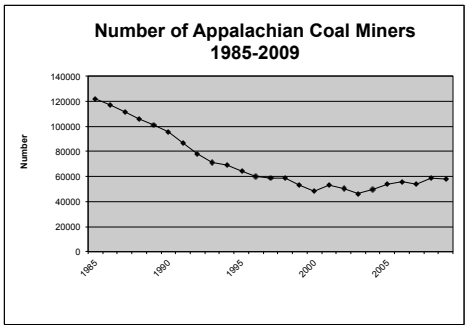


Source: Annual Coal Reports, Energy Information Administration (*figures for 1986-1989 imputed)

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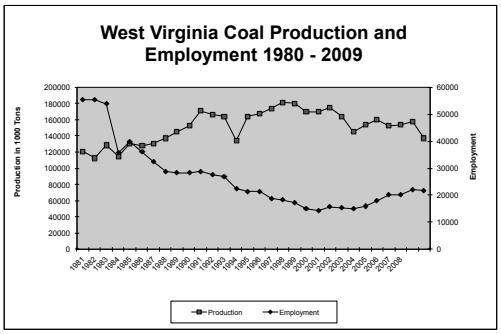


Sources: Energy Information Administration and West Virginia Coal Association

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## 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

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# Disparities in Mining Areas

| | Appalachian Coal Mining | Other Appalachian | Rest of Nation |
|---|---|---|---|
| % college education* | 11.7 | 13.8 | 17.1 |
| Median household income * | $28,054 | $32,596 | $36,753 |
| Unemployment rate* | 7.4 | 6.2 | 5.2 |
| Poverty rate* | 19.6 | 15.6 | 13.1 |

* Group differences significant at p<.0001

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

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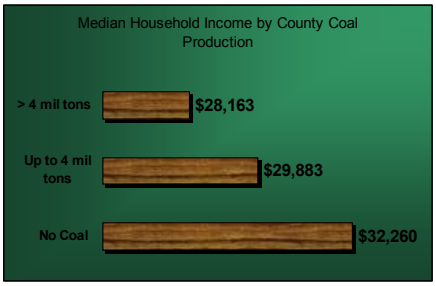


Sources: Area Resource File and WV Geological and Economic Survey

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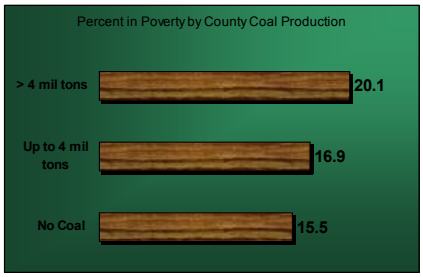


Sources: Area Resource File and WV Geological and Economic Survey

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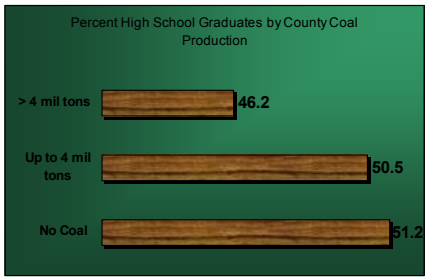


Sources: Area Resource File and WV Geological and Economic Survey

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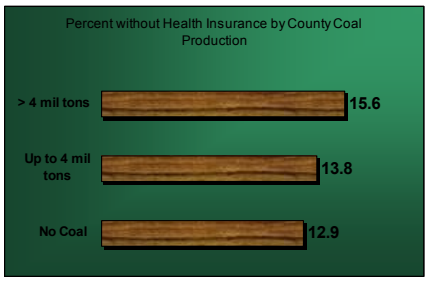


Sources: Area Resource File and WV Geological and Economic Survey

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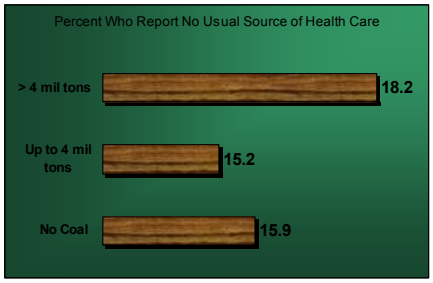


Sources: West Virginia IHPR Survey and WV Geological and Economic Survey

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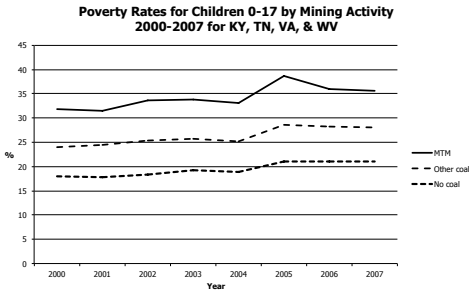


Source: Area Resource File 2008 and EIA

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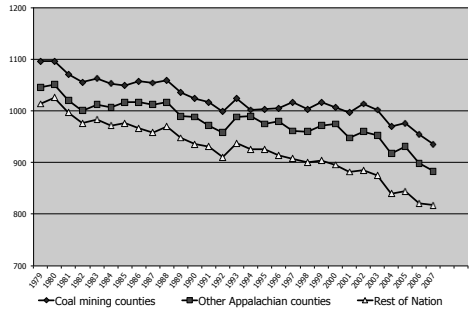
## Total Age-Adjusted Mortality per 100,000 for the Years 1979-2007 by County Group

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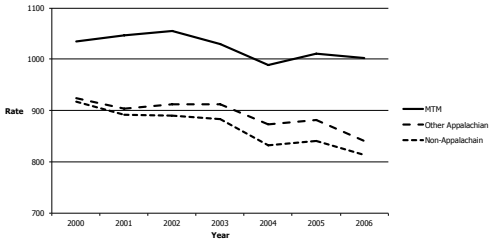
## Age-adjusted mortality per 100,000 by MTM status

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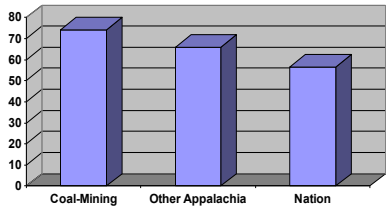
Age-Adjusted Lung Cancer Mortality per 100,000, years 2000-2004




Hendryx, O'Donnell & Horn, Lung Cancer, 2008

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## 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

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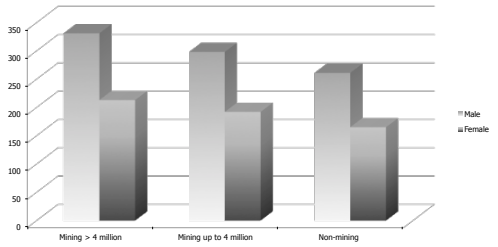
## 2000-2004 Total Heart Disease Mortality per 100,000

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## 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

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## 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

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## 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.

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## 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

- Ahern, Hendryx, Conley, Fedorko, Ducatman, Zullig, Environmental Research 2011, 111, 838-846

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## 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
- 

| | MTM | Other Mining |
|---|---|---|
| Age-adjusted only | 1.63 (1.54, 1.72) | 1.27 (1.20, 1.35) |
| Adjusted | 1.26 (1.21, 1.32) | 1.10 (1.05, 1.16) |

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## Birth Defects in MTM Areas: Results

- Adjusted PRRs by organ system:

| | MTM | Other Mining |
|---|---|---|
| Circulatory/respiratory* | 1.93 (1.73, 2.15) | 1.08 (0.94, 1.24) |
| CNS* | 1.36 (1.11, 1.67) | 1.18 (0.95, 1.46) |
| Gastrointestinal* | 1.41 (1.17, 1.71) | 1.02 (0.82, 1.28) |
| Urogenital** | 1.35 (1.19, 1.54) | 1.32 (1.15, 1.51) |
| Musculoskeletal* | 1.30 (1.20, 1.41) | 1.08 (0.99, 1.18) |
| Chromosomal | 0.92 (0.72, 1.18) | 0.85 (0.66, 1.09) |
| Other** | 1.13 (1.04, 1.23) | 1.12 (1.03, 1.22) |

* Higher only in MTM group; ** higher in both groups

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## Birth Defects in MTM Areas: Results

- Adjusted MTM PRRs by early versus late period:

| | 1996-1999 | 2000-2003 |
|---|---|---|
| Circulatory/respiratory* | 1.20 (1.03, 1.41) | 2.81 (2.43, 3.25) |
| CNS | 1.42 (1.06, 1.91) | 1.30 (0.95, 1.76) |
| Gastrointestinal* | 1.30 (0.94, 1.80) | 1.53 (1.18, 1.96) |
| Urogenital* | 1.16 (0.94, 1.42) | 1.62 (1.38, 1.93) |
| Musculoskeletal | 1.31 (1.17, 1.46) | 1.30 (1.15, 1.46) |
| Chromosomal | 1.21 (0.89, 1.64) | 0.68 (0.46, 1.03) |
| Other* | 0.99 (0.88, 1.12) | 1.29 (1.15, 1.45) |
| Any* | 1.13 (1.06, 1.21) | 1.42 (1.33, 1.52) |

* Higher in later period

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## 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

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## 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

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## 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

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## Explosion over the town of Dorothy

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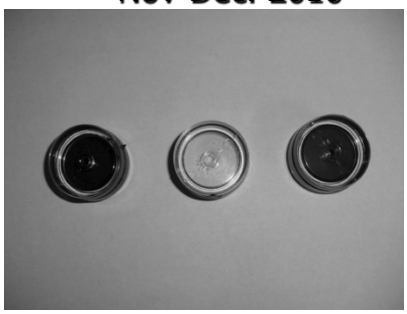
## MTM and Control Air Samples, Nov-Dec. 2010



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## 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

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Well water in the town of Rawl, West Virginia

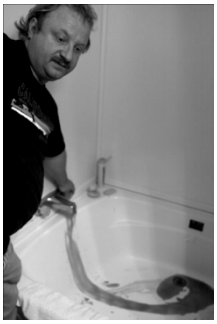

Photo: Antrim Casky, 2008

Photo: Nat Geographic, 2006

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## Tests of Well and Groundwater

- Arsenic in ~ ½ 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)

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## Tests of Well and Groundwater

- Tests of 15 wells exceeded standards for 9 metals including lead, arsenic, manganese, barium, beryllium, selenium
- Our preliminary studies see elevated conductivity in surface, ground and drinking water

© Damon Winter/The New York Times

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## 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

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## 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

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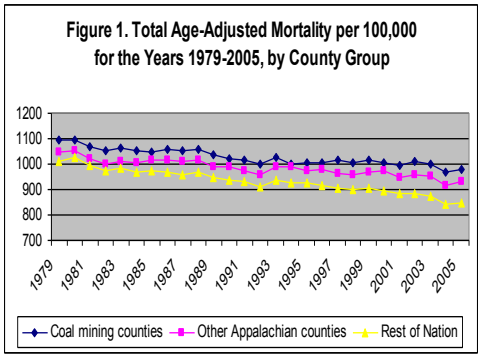


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## The Human Cost of Coal Mining

| | Cost estimate in billions compared to: | | | |
|---|---|---|---|---|
| VSL in millions: | Appalachia 1979-2005 | Appalachia 1999-2005 | Nation 1979-2005 | Nation 1999-2005 |
| $4.67 | ***$18.563*** | ***$20.697*** | ***$41.283*** | ***$51.010*** |
| $7.74 | ***$30.766*** | ***$34.304*** | ***$68.422*** | ***$84.544*** |
| Excess annual deaths: | 3,975 | 4,432 | 8,840 | 10,923 |

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## 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

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