

### Public Health and Coal Mining



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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

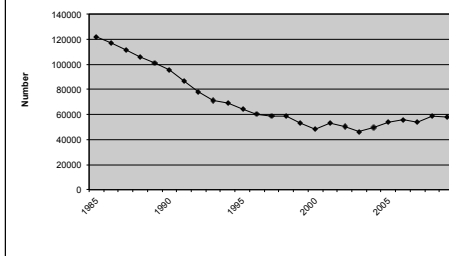
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### Industry Statements

- "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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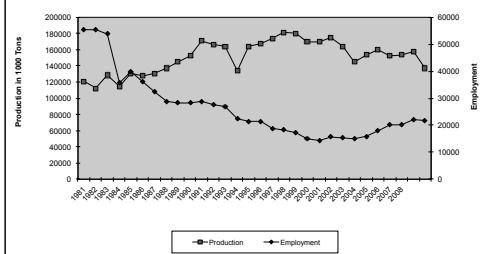
### Number of Appalachian Coal Miners 1985-2009



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

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### West Virginia Coal Production and Employment 1980 - 2009



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

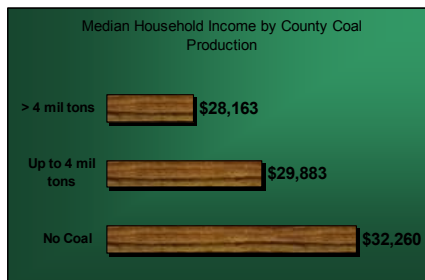
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### Disparities in Mining Areas

|                           | 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           |

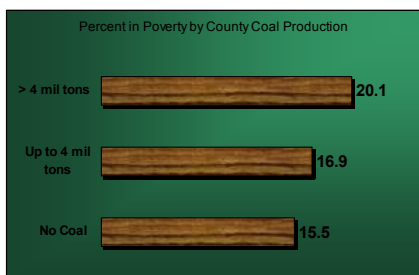
\* Group differences significant at p<.0001  
 Area Resource File 2006 adjusted for age, race/ethnicity and sex

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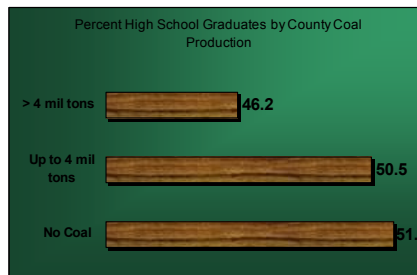
Sources: Area Resource File and WV Geological and Economic Survey

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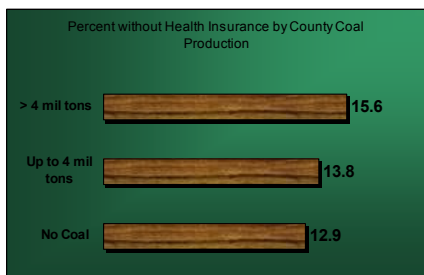
Sources: Area Resource File and WV Geological and Economic Survey

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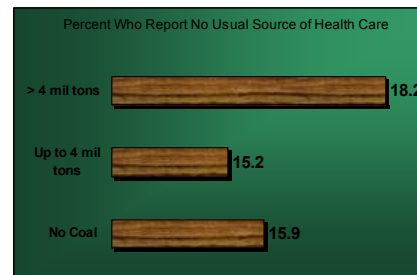
Sources: Area Resource File and WV Geological and Economic Survey

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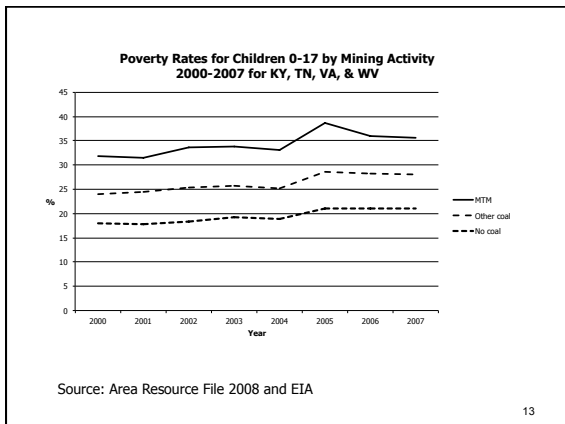
Sources: Area Resource File and WV Geological and Economic Survey

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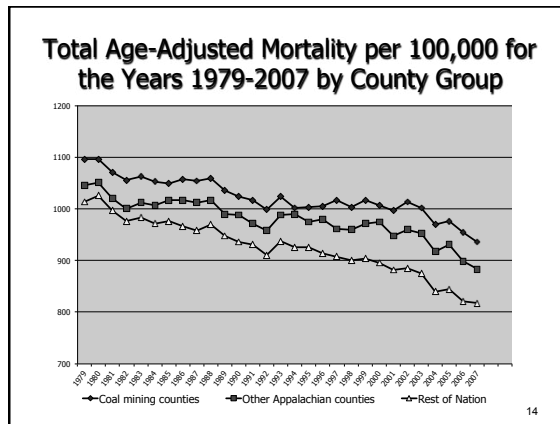


Sources: West Virginia IHPR Survey and WV Geological and Economic Survey

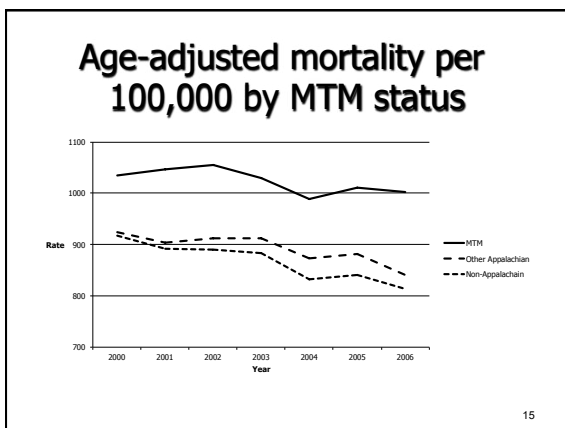
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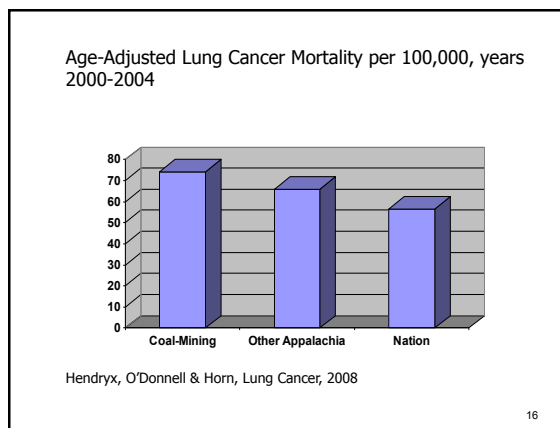
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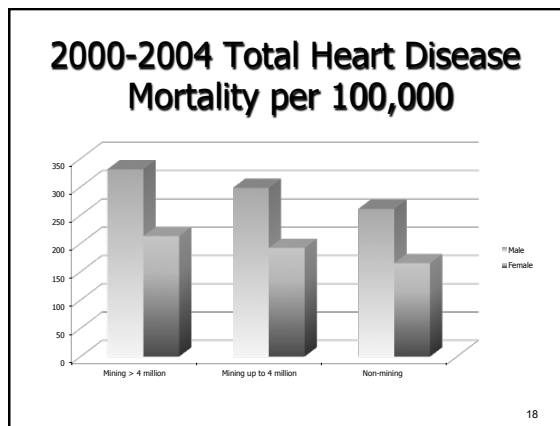


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### Cardiopulmonary and kidney disease mortality

- 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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### 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
- Clearer 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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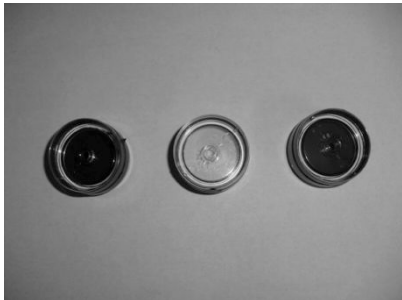
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### Explosion over the town of Dorothy



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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

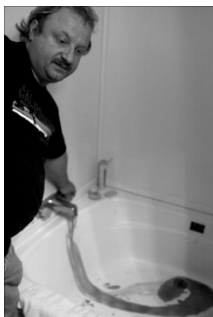


Photo: Antrim Casky, 2008



Photo: Nat Geographic, 2006

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### Tests of Well and Groundwater

- Arsenic in ~ 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)



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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

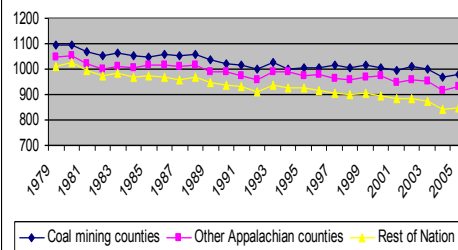
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### What is the Value of a Life (statistically speaking)?

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

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Figure 1. Total Age-Adjusted Mortality per 100,000 for the Years 1979-2005, by County Group



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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                | <b>\$18.563</b>                        | <b>\$20.697</b>      | <b>\$41.283</b>  | <b>\$51.010</b>  |
| \$7.74                | <b>\$30.766</b>                        | <b>\$34.304</b>      | <b>\$68.422</b>  | <b>\$84.544</b>  |
| 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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