

RHRC
Rural Health Research
& Policy Centers
Funded by the Federal Office of Rural Health Policy
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Environmental Health for Rural Populations

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What makes our Center unique

- ◆ Environmental health focus
 - Agricultural
 - Industrial
 - Development
 - Social
 - Mining
- ◆ A public health or population focus

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Study 1:
**Development of an Environmental Hazards
Database and its Relationship to Mortality
Outcomes in Rural Areas**

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Objectives

- ◆ Describe number and type of point pollution sources in rural and urban locations nationwide
- ◆ Investigate associations between rural pollution sources and population mortality rates

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Methods - Design

- ◆ Retrospective secondary analysis of mortality rates in relation to exposure
- ◆ National, county-level ecological analysis

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Methods - Data

- ◆ Data gathered, cleaned, merged from:
 - ▣ EPA
 - ▣ CDC
 - ▣ EIA
 - ▣ USDA
 - ▣ NLCD
 - ▣ ARF
 - ▣ ARC
 - ▣ US Census

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Independent Variables

- ◆ EPA, 2008:
 - AIRS (Aerometric Information Retrieval System)
 - PCS (Permit Compliance System)
 - TRI (Toxics Release Inventory)
 - eGRID (Emissions and Generation Resource Integrated Database)
 - By facility type
 - Number of sites per square land mile

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Independent Variables (continued)


- ◆ USDA
 - National Agricultural Statistics Service, 2002
 - Percent of county in acres committed to harvested cropland
 - Number of animals per acre
- ◆ National Land Cover Dataset, 2001
 - Satellite imagery converted to percent developed land (not parks or agriculture)
- ◆ Energy Information Administration
 - Tons of coal mined 1996-2005

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MTM Explosion



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Well water impacted by mining



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Descriptive Variables and Covariates

- ◆ USDA rural-urban continuum codes for metro and non-metro areas
- ◆ ARF 2005 data on population characteristics: sex, poverty, education, race/ethnicity, supply of active primary care physicians
- ◆ ARC designation for Appalachian counties
- ◆ BRFSS smoking rates, 2003-2006

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Dependent Variables

- ◆ Age-adjusted CDC mortality rates per 100,000, years 1997-2005
 - ▣ All-cause
 - ▣ Cancer
 - ▣ Cardiovascular
 - ▣ Respiratory

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Results - Descriptive

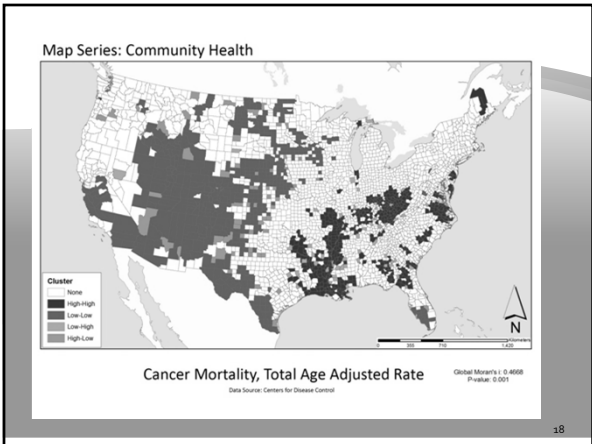
- ◆ Number and concentration of pollution sources is higher in metro areas, but...
- ◆ Rural areas contain:
 - 16,574 TRI sites
 - 14,276 AIRS sites
 - 34,214 PCS sites
 - 931 fossil-fuel power plants

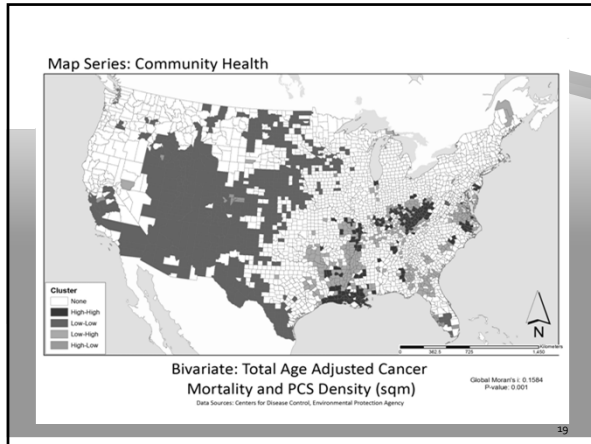
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Results - Descriptive

- ◆ Rural areas, compared to urban, have more
 - Agricultural cropland
 - Coal mining

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Rural Health Facts...

Pollution Sources and Cancer Mortality Rates across Rural-Urban Areas in the United States

Summary:
 Rural populations are potentially exposed to a variety of sources environmental risks from point and non-point pollution sources including industrial facilities, animal manure management facilities, mining operations, agricultural activities, and others. For this study, we focused on a variety of pollution sources and their relationship to CDC age-adjusted cancer mortality rates in rural and urban areas. We test the hypothesis that rural cancer mortality rates adjusted for other factors will be related to pollution sources in rural areas. We also created state-level and national maps of pollution sources and mortality rates. Controlling for covariates, greater density of air and water pollution sites was associated with higher cancer mortality. Examples of maps are shown here. The national map shows areas where high cancer mortality rates co-occur with higher concentrations of water pollution discharge sites.

Conclusions:

- Rural areas contain thousands of potential pollution sources
- Both urban and rural settings show significant association between air and water pollution sources and higher cancer mortality
- Rural counties with higher levels of human land development were associated with higher cancer mortality rates
- Rural coal mining areas have elevated cancer mortality rates
- Future research is needed to better understand the types of pollutants that enter unique rural population health

Maps & entire report will be available at <http://wvhrhrc.hsc.wvu.edu>

West Virginia University

Regression Results: Rural Counties

Mortality:	Total		Cancer		Cardiovascul
Model 1	Estimate (SE)	P<	Estimate (SE)	P<	Estimate (SE)
TCL-AIRS	6.51 (2.52)	.01	1.46 (.83)	.08	-.19 (1.65)
TCL-PCS	51.06 (14.53)	.0004	16.02 (4.80)	.0008	10.36 (9.55)
TCL-TRI	13.72 (9.00)	.13	-4.04 (2.97)	.18	-5.85 (5.91)
Model 2					
Low coal mining	6.97 (6.56)	.29	3.70 (2.16)	.09	2.39 (4.29)
High coal mining	20.16 (6.38)	.002	4.20 (2.10)	.05	4.79 (4.17)

Mortality:	Total		Cancer		Cardiovascula
	Estimate (SE)	P<	Estimate (SE)	P<	Estimate (SE)
Animals per acre	.05 (.06)	.40	-.02 (.02)	.22	.06 (.03)
Percent acres in crops	-73.71 (9.21)	.0001	-7.07 (2.51)	.005	-8.79 (4.83)

Mortality:	Total		Cancer		Cardiovasc
	Estimate (SE)	P<	Estimate (SE)	P<	Estimate (SE)
Percent Developed Land	120.6 (77.0)	.12	62.45 (20.63)	.003	13.18 (39.7)

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Limitations

- ◆ Simple counts only
 - Need to investigate discharge type and quantity
- ◆ Ecological, cross-sectional, county-level design
- ◆ Data collected at different times
- ◆ Gross diagnostic categories
- ◆ Some pollution sources not included (e.g., uranium or copper mining, timber, transportation)

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Discussion

- ◆ Rural areas have thousands (65,064) of potential point pollution sources.
- ◆ Concentration of water pollution sites is associated with total and cancer mortality
- ◆ Concentration of air pollution monitoring sites is associated with total and cancer mortality
- ◆ Coal mining is associated with total, cancer and respiratory mortality
 - Finer diagnostic findings for types of cancer, heart, kidney, respiratory disease, dental health, and birth outcomes

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Discussion (continued)

- ◆ An agricultural protective effect?
 - Lifestyle
 - Population
 - Environment

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Potential Policy Implications


- ◆ Environmental standards and monitoring for rural populations, for example,
 - Coal mining air and water quality
 - Well water testing
 - Rural public water systems
 - Increase rural provider awareness

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Publication

- ◆ Hendryx M, Fedorko E, Halverson J. Pollution sources and mortality rates across rural-urban areas of the United States. *Journal of Rural Health*, 2010, in press.

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**Study 2 (a,b,c):
Toxics Release Inventory Discharges and
Population Health Outcomes**

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Objectives

- ◆ Investigate associations between non-zero TRI discharges (1991-1998) and population health outcomes (1999-2006)
 - ◆ Total mortality
 - ◆ Lung cancer incidence and mortality
- ◆ Investigate distribution of release sites by race and socioeconomic status

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Methods - Design

- ◆ Retrospective secondary analysis
- ◆ National, county-level ecological analysis
- ◆ Design, variables and analysis similar to Year 1 study
- ◆ Amounts of on-site air and water releases at TRI sites (tons, log transformed)

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Results, Total Mortality (2a)

- The average rural county had
 - 105 tons of TRI releases to air
 - 23 tons of TRI releases to water
- The average urban county had
 - 222 tons of TRI releases to air
 - 32 tons of TRI releases to water

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Results (2a)

- ♦ Tons of discharges to air and water related to higher total mortality in both rural and urban areas
 - Adjusting for age, sex, poverty, education, race/ethnicity, supply of active primary care physicians, smoking, obesity
 - Effects strongest for air releases to rural areas

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Results, Race/ethnicity and SES (2a)

- ♦ Counties with higher African American populations had higher TRI discharges
- ♦ Higher TRI discharges associated with
 - *Smaller* Native American or Hispanic populations
 - *Higher* income, *higher* education, *lower* poverty
 - Exception: rural counties with higher rates of college education had lower TRI discharges

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Results, Lung Cancer (2b & 2c)
[Luo et al.]


- ◆ 2b: Tons of discharges to air and water related to higher lung cancer incidence *in rural areas only*
 - Adjusting for age, sex, poverty, education, race, supply of active primary care physicians, smoking, obesity
 - Discharges of chromium, formaldehyde, nickel (not arsenic, cadmium or butadiene)
- ◆ 2c: Findings for lung cancer mortality are also significant only in rural counties
 - Effects limited to areas with codes 3 - 5

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Publications in preparation for special section of JRH

- ◆ Total mortality
 - Lung cancer mortality
- ◆ Spatial methods
- ◆ Food quality and access
- ◆ Environmental competence

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Study 3:
Association of Mortality Rates with Food Access and Quality

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Data


- ◆ USDA Food Atlas data on supply of restaurants and food stores, direct farm sales, diabetes and obesity rates
- ◆ CDC mortality data, census data

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Results

- ◆ Total adjusted mortality is higher in association with:
 - More fast food restaurants and convenience stores
 - Fewer full service restaurants and grocery stores
 - Fewer direct farm sale dollars
- ◆ Effects for rural areas limited to measures of full service restaurants, grocery stores and farm sales.

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**Into the Future:
Childhood Asthma
Water Quality and Fluoridation
H1N1 Vaccinations in Rural Areas**

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