Executive Summary

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May 6, 2010

We reviewed 8 peer-reviewed journal articles, authored by Dr. Michael Hendryx, on the health of coal mining communities in Appalachia. We found a number of factual discrepancies and methodological flaws in those articles. Those discrepancies and flaws fall into three primary categories of concern: (1) inconsistencies in the definitions and numbers of "high" and "low" coal-producing counties in Appalachia; (2) failure to consider some important covariates and limited or missing data for others; and, (3) inability of the study design and findings to support some of the authors' conclusions.

(1) The total number of counties considered and the ways that they were divided into high vs. low coal-producing counties varied across studies. Two studies counted 413 total Appalachia counties, whereas two other studies counted 417 total counties. Three different criteria were used in different studies to characterize "high" vs. "low" coal-producing counties. No explanation or justification for these varying criteria was provided.

(2) Key factors expected to directly influence study outcomes, obesity, diabetes and alcohol consumption, were omitted from the analyses. The significance of such deficiencies is emphasized by Hendryx' published observation that diabetes causes greater morbidity and mortality in Appalachia than in the rest of the country. The Hendryx studies attempt to control for smoking, but there is a lack of county-specific smoking data for some of the Appalachian states. In those cases, his analyses use data for the state or for country aggregates, which almost certainly misclassify risks. This is of particular concern because Hendryx has reported that smoking rates are higher in Appalachian coal mining counties vs. non-coal mining counties.

(3) The Hendryx studies employ an ecological study design, i.e., "exposure" is determined by group location, not by individual exposures, but the study conclusions presume that group differences are attributable to individual exposures, e.g., to the effects of coal mining. One study found excess mortality rates in Appalachian coal mining communities, but not in coal mining communities in other areas of the country. Likewise, he attributes increased mortality to proximity to coal mining, but not to being a coal miner.

Our review illuminates a number of methodological concerns in the Hendryx research, but is not able to determine the magnitude of the resulting study bias. Further analysis, including data excluded in the Hendryx studies, would be necessary to estimate the actual magnitude and direction of such bias and to determine whether his findings are replicable.

Table 1 lists the Hendryx studies reviewed and the acronym by which each is described in the following text and discussion:

TABLE 1. Reviewed Hendryx Studies with Associated Acronyms	
Acronym	**Study**
EH	Hitt NP, Hendryx M. Ecological integrity of streams related to human cancer mortality rates. *EcoHealth*. **2010**.
PHR	Hendryx M, Ahern MH. Mortality in Appalachian coal mining regions: the value of statistical life lost. *Public Health Reports.* **2009**; 124: 541-550.
JRH	Pollard C, et al. Electronic patient registries improve diabetes care and clinical outcomes in rural community health centers. *The Journal of Rural Health.* **2009**; 25(1): 77-84.
EJ	Hendryx M. Mortality rates in Appalachia coal mining counties: 24 years behind the nation. *Environmental Justice*. **2008**; 1(1): 5-11.
IA	Hendryx M. Mortality from heart, respiratory, and kidney disease in coal mining areas of Appalachia. *Int Arch Occup Environ Health.* **2008**; 82: 243-249.
LC	Hendryx M, O'Donnell K, Horn K. Lung cancer mortality is elevated in coal-mining areas of Appalachia. *Lung Cancer.* **2008**; 62: 1-7.
AJPH	Hendryx M, Ahern MH. Relations between health indicators and residential proximity to coal mining in West Virginia. *American Journal of Public Health*. **2008**; 98(4): 669-671.
JTEH	Hendryx M, Ahern MH, Nurkiewicz TR. Hospitalization patterns associated with Appalachian coal mining. *J of Toxicology and Environ Health.* **2007**; 70: 2064-2070.

1. Number of Appalachia Counties: The number of counties in Appalachia differs among Hendyrx's studies and the Appalachian Regional Commission.
    - In the *PHR* and *LC* studies, Hendryx states that there are **413** counties in Appalachia.
    - In the *EJ* and *IA* studies he states that there are **417** counties as defined by the Appalachian Regional Commission.
    - Currently, however, the Appalachian Regional Commission states that **420** counties are part of Appalachia.

2. Definition of "High" v. "Low" Coal Producing Counties: The definition of "high" v. "low" coal producing counties differs between Hendryx's studies.
    - Coal production is a categorical variable in Hendryx's studies. However, the delineation between "high" and "low" coal production is different in each study. He does not explain why he uses different definitions.
    - The comparison counties and the total number of counties are different in each study. The US Census Bureau lists 3,140 total counties or county-equivalent administrative units in the United States.
    - The *EJ* study used two different methods to estimate exposure to coal mining. The first method divided counties based on the sum of coal production during 1999-2004. The

cutoff was 4 million tons. The second method divided counties based on coal production per capita, found by dividing county tons mined by the county population. The cutoff was 200 tons per person. This study only reported the number of counties in the "high" and "low" coal production categories as divided by 4 million tons. It does not report how many counties are in each of the other categories.

- The *EJ* study excluded from the analysis 104 non-Appalachian counties where coal mining took place but no explanation is given for why they were excluded (p. 6).
- The *AJPH* study was conducted at the individual level, as opposed to the county-level, using data from a telephone survey of 16,493 adults. This study also uses 4 million tons as the cutoff between "high" and "low" coal producing counties.
- The *JTEH* study was conducted at the individual level, as opposed to the county-level, using data from 2001 adult hospitalizations (*n* = 93,952) for West Virginia, Kentucky, and Pennsylvania. "The coal production variable was transformed by taking the square root of tons of coal measured in thousands. The coal production variable was linked to the hospital records at the county-level" (p. 2066). No division of "high" v "low" counties was used.
- The geographic area of counties varies. Coal production values were adjusted to area only in the *EH* study.
- Table 2 below demonstrates these differences:

TABLE 2. Definition and Numbers of "High" v "Low" Coal Producing Counties in Hendryx's Studies

Study	High/Low Cutoff	Data Years	Number of Appalachian Counties in "High" Group	Number of Appalachian Counties in "Low" Group	Total Appalachian Coal Producing Counties	Comparison Counties 1	Comparison Counties 2	Total Counties
IA	4 million tons	2000-2004	66	63	129	97 "Non-Appalachian mining"	2,914 "No Mining"	3,140
EJ Method 1	4 million tons	1999-2004	67	65	132	Not reported "Non-mining Appalachia"	Not reported "	3,141
EJ Method 2	200 tons per person	1999-2004	Not reported	Not reported	-----	Not reported "Non-mining Appalachia"	Not reported "Non-mining Rest of Nation"	3,141
LC	3 million tons	2000-2004	66	Not reported	-----	347 "Other Appalachian"	2,615 "Rest of Nation"	3,028
PHR	median	1994-2005	70	69	139	274 "Non-mining Appalachia"	2,728 "Rest of Nation"	3,141

Table 3 presents the number of counties in the "high" and "low" coal production counties using the raw data that we gathered for the years 2000-2004:

TABLE 3. Number of Counties in "High" and "Low" Coal Producing Counties Using the Data We Collected

	Number of Counties in "High" Group	Number of Counties in "Low" Group
4 million tons	66	63
3 million tons	67	62
Median	65	64

3. Obesity, Diabetes and Alcohol Consumption: Hendryx excluded potentially important covariates. Because both obesity and diabetes are such important risk factors for mortality, we were surprised that neither had been explicitly included in the analyses. Such problems are likely to impact most of the Appalachian coal mining counties.
    - The CDC has said that Appalachia has one of the highest rates of obesity and diabetes in the country.
    - The *JRH* study noted that the prevalence of diabetes in West Virginia was nearly twice the national average.
    - The *JRH* study also noted that: "West Virginia's diabetes problem is impacted through its rural geography, which limits access to health care" (p. 77).
    - The *EJ* study stated that "other behavioral contributions to mortality such as diet or alcohol consumption were not included, although these behavioral variables are known to correlate with other measures that were included such as education and poverty" (p. 9).

4. Missing or Limited Data on Important Covariates:
    - The *PHR* and *EJ* studies perform the same basic analysis of mortality rates compared to the level of coal production. In the *EJ* study, Hendryx excluded 61 counties from the regression analysis due to missing data on covariates (p. 5). However, the missing data were not mentioned and the specific counties were not excluded in the *PHR* study.
    - The *PHR* and *EJ* studies use coal production data from 1994-2005 as a proxy for coal production in counties during the entire analysis period (1979-2005). This assumes that county coal production rates have remained relatively constant during this entire period.
    - Hendryx admits in his *EJ* study that the data are limited: "coal production figures for years prior to 1999 are not readily available for all counties." (p. 6).
    - Data for many covariates were not available for the same year: median household income (mean from 2000-2003), poverty rate (mean from 2000-2002), high school education (2000), unemployment rates (2000) coal production data (1997-2005).
    - In all but one of the studies, only data on coal production (not the locations of coal processing facilities, coal slurry impoundments or permitted slurry injection sites) were considered; the *EH* study considered all three.

5. Imprecise Estimate of Smoking Rates: Since smoking rates are often higher in coal producing counties, imprecise measurements for smoking could lead to an inability to adequately control for smoking-related health effects and mortality in the regression analyses.
    - Hendryx himself explains in the *EJ* study that smoking rates were "imprecisely estimated" (p. 9).
    - The methodology for gathering smoking data that was used the *PHR, IA, LC, EJ, EH* studies are as follows: Smoking rates were obtained from the CDC's Behavioral Risk Factor Surveillance System (BRFSS). Data are only available at the county-level for some metropolitan areas. Additional BRFSS data are available from each state's public health website at the level of the county or groups of counties. State averages are used when county-level data were not available.
    - The counties grouped together for smoking rate data often have varying rates of coal production. The tables in Appendix A demonstrate this for West Virginia and Kentucky data.
    - The use of grouped county data is especially relevant because Hendryx's studies reported that smoking rates were significantly increased in counties with high levels of coal production. For example, in the *IA* study, Table 1 (see Appendix B) indicates apparently significant differences between counties with >4 million tons vs. non-mining counties (29.2 vs. 23). In the *LC* study, Table 1 (see Appendix C) indicates a significantly higher smoking rate in the Appalachian counties with "High coal mining" vs. "Other Appalachian" counties and Table 2 (see Appendix D) indicates a highly significant relationship between smoking rate and coal production.
    - The available smoking data are often not directly comparable. In some cases, data are only available for different years (e.g., Alabama currently makes available data for 2007, while Kentucky presents only 2000-2003 data).
    - Some states provide data for two smoking categories (smoking: yes/no) while others present data for 4 categories (smoking: current everyday; current/occasional; former smoker; never smoker).

6. Mortality Cause:
    - In the *EJ* study, Hendryx excluded deaths caused by external factors, including homicide, suicide, motor vehicle accidents and other accidents. In the *PHR* study, these deaths were included in the analysis. He states only that "we examined total mortality rates for all causes, and included all ages" (p. 542).

7. Ecological Study Design: The conclusions that he makes in the discussion section of his paper are not necessarily supported by the study.
    - Hendryx admits the limitations of his methodology in the *EJ* study: "Limitations of the study include the ecological design, the imprecision of covariates, and the limited availability of coal mining data. Individual causes of mortality and their relationship to mining or other variables may be suggested but cannot be proven with a county-level analysis." (p. 9)
    - He can conclude from the *PHR* and *EH* studies that higher mortality rates were found in areas with higher levels of coal mining, but he cannot conclude that environmental pollution from coal mining is what caused these deaths.

- He also cannot conclude from his studies that coal mining is the cause of the poverty and poor education rates in the coal mining areas of Appalachia.
- By their nature, the Hendryx studies are ecological, i.e., the study design is unable to assess individual exposure to the potential environmental contaminants from coal mining, but the studies presume that differences between groups are due to coal mining.

8. Employment data:
   - The *PHR* study states: "Comparing the economic report [Thompson] with EIA figures indicated an 11% decrease in employment in Appalachian coal mining from 1997 to 2005" (p. 546). The numbers of counties were not the same in those two reports (EIA: 126 Appalachian coal producing counties for 2004; Thompson: 118 coal producing counties for 1997). Considering the differences between the two databases, it is possible that the employment difference was an artifact of the different numbers of counties in the two reports.
   - Review of the employment data from the EIA files indicates that the number of Appalachian coal miners decreased from 1998 to 1999, but that employment has increased since then. It is possible that there was a one-time drop in employment and the employment rates will continue to rise.

9. Attributing Excess Deaths to Coal Mining:
   - In both the *EJ* and *PHR* studies Hendryx, found that higher rates of mortality existed for Appalachian coal mining areas but not coal mining areas elsewhere: "Coal mining effects were significant for Appalachia and the combined analysis for both underground and surface mining, but not for coal-mining limited to areas outside of Appalachia (the analysis of non-Appalachian coal mining effects deleted Appalachian coal mining counties.)" (*EJ*, p. 7-8) See figure 1 below for a summary of Hendryx results.
   - However, he concluded the following: "That effects were found for Appalachia coal mining areas but not coal mining areas elsewhere may reflect the unique relationship of mining activity to topography and population centers characteristic of Appalachia" (p. 8).
   - These results also suggest that coal mining is not the reason for the excess deaths.

FIGURE 1.

TABLE 3. ADJUSTED REGRESSION COEFFICIENT FOR THE HIGH COAL MINING VARIABLE (≥4 MILLION TONS), BY MINING TYPE (SURFACE, UNDERGROUND, AND COMBINED), AND BY INCLUSION OR EXCLUSION OF NON-APPALACHIAN COAL MINING AREAS

	Surface mining	*Underground mining*	*Combined*
Coal mining in Appalachia only	43.25 ($p < 0.001$)	42.08 ($p < 0.001$)	41.39 ($p < 0.0004$)
Coal mining outside of Appalachia	−2.71 ($p < 0.84$)	15.84 ($p < 0.38$)	5.14 ($p < 0.65$)
Coal mining nationwide	17.21 ($p < 0.06$)	31.56 ($p < 0.002$)	21.50 ($p < 0.006$)

Source: *EJ*

10. Data Redundancy:

- Population Sizes & Rural-Urban Variable: Areas with coal mining have much smaller population sizes— it is not evident that this is fully controlled for by the rural-urban continuum code. Are data as reliable in rural areas compared to urban areas?
- Median Household Income, Poverty Rates & Unemployment Rates: All are measures of wealth; should they be counted 3 times?
- Spatial Autocorrelation: The *EH* study indicates a high degree of spatial data clustering. How does this impact the analyses?

APPENDIX A. Counties in Kentucky and West Virginia that were grouped together by smoking rates but have wide ranging levels of coal production.

KENTUCKY: BIG SANDY DEVELOPMENT DISTRICT								
COUNTIES	***COAL*** *(Thousand Short Tons)*					***SMOKING*** *(% Current)*		
	2004	**2003**	**2002**	**2001**	**2000**	**2004**	**2003**	**2002**
Floyd	2,990	3,193	2,870	3,365	2,678	31.1	37.0	37.6
Johnson	308	475	513	543	491			
Magofin	748	67	20	0	0			
Martin	6,229	8,900	9,508	9,822	11,138			
Pike	28,113	27,547	30,001	34,049	34,009			

KENTUCKY: CUMBERLAND VALLEY DEVELOPMENT DISTRICT								
COUNTIES	***COAL*** *(Thousand Short Tons)*					***SMOKING*** *(% Current)*		
	2004	**2003**	**2002**	**2001**	**2000**	**2004**	**2003**	**2002**
Bell	1,372	2,081	2,519	2,582	0	29.9	38.9	39.5
Clay	56	318	103	67	9			
Harlan	11,928	10,548	10,784	12,410	10,125			
Jackson	47	31	23	0	0			
Knox	758	519	417	425	389			
Laurel	81	53	34	28	29			
Rockcastle	0	0	0	0	0			
Whitley	309	196	204	118	176			

KENTUCKY: KENTUCKY RIVER DEVELOPMENT DISTRICT								
COUNTIES	***COAL*** *(Thousand Short Tons)*					***SMOKING*** *(% Current)*		
	2004	**2003**	**2002**	**2001**	**2000**	**2004**	**2003**	**2002**
Breathitt	925	1,751	1,435	1,303	1,026	31.8	35.5	40.6
Knott	11,091	10,201	10,784	12,894	12,633			
Lee	18	18	49	3	0			
Leslie	4,462	5,220	6,099	6,460	7,286			
Letcher	7,506	6,449	8,951	10,649	9,479			
Owsley	74	105	48	37	22			
Perry	12,081	12,045	13,522	13,672	12,301			
Wolfe	0	0	0	0	0			

Kentucky Smoking Data Source: (Kentucky Cabinet for Health and Family Services, BRFSS)
http://chfs.ky.gov/NR/rdonlyres/8A61BC13-336E-4DFA-A540-4FD8DBE3ACD4/0/_smoker2a.pdf

WEST VIRGINIA: *Boone/Lincoln*						
COUNTIES	***COAL*** *(Thousand Short Tons)*					***SMOKING*** *(% Current)*
	2004	**2003**	**2002**	**2001**	**2000**	**2001-2005**
Boone	31,270	30,308	31,932	31,677	31,922	30.2
Lincoln	777	235	327	1766	734	

WEST VIRGINIA: *Greenbrier/Summers/Monroe*						
COUNTIES	***COAL*** *(Thousand Short Tons)*					***SMOKING*** *(% Current)*
	2004	**2003**	**2002**	**2001**	**2000**	**2001-2005**
Greenbrier	606	576	757	779	563	21.7
Summers	0	0	0	0	0	
Monroe	0	0	0	0	0	

WEST VIRGINIA: *Braxton/Nicholas/Webster*						
COUNTIES	***COAL*** *(Thousand Short Tons)*					***SMOKING*** *(% Current)*
	2004	**2003**	**2002**	**2001**	**2000**	**2001-2005**
Braxton	0	0	0	0	0	26.1
Nicholas	4,875	5,298	4,969	5,610	4,826	
Webster	4,706	4,915	5,661	5,832	5,595	

WEST VIRGINIA: *Calhoun/Clay/Gilmer/Roane*						
COUNTIES	***COAL*** *(Thousand Short Tons)*					***SMOKING*** *(% Current)*
	2004	**2003**	**2002**	**2001**	**2000**	**2001-2005**
Calhoun	0	0	0	0	0	34.5
Clay	4,158	3,879	4,215	4,570	5,128	
Gilmer	0	0	0	0	0	
Roane	0	0	0	0	0	

WEST VIRGINIA: *Barbour/Taylor*						
COUNTIES	***COAL*** *(Thousand Short Tons)*					***SMOKING*** *(% Current)*
	2004	**2003**	**2002**	**2001**	**2000**	**2001-2005**
Barbour	968	989	916	568	659	21.6
Taylor	0	0	0	0	0	

WEST VIRGINIA: *Preston/Tucker*						
COUNTIES	***COAL*** *(Thousand Short Tons)*					***SMOKING*** *(% Current)*
	2004	**2003**	**2002**	**2001**	**2000**	**2001-2005**
Preston	1,858	2,406	2,464	2,465	1,232	25.7

Tucker	0	67	131	277	202	

WEST VIRGINIA: *Grant/Mineral*						
COUNTIES	***COAL*** *(Thousand Short Tons)*					***SMOKING*** *(% Current)*
	2004	**2003**	**2002**	**2001**	**2000**	**2001-2005**
Grant	1,181	1,364	1,437	774	652	27.7
Mineral	88	70	69	90	45	

West Virginia Smoking Data Source: (West Virginia Department of Health and Human Resources, BRFSS) http://www.wvdhhr.org/bph/hsc/pubs/BRFSS/2004_2005/default.htm

APPENDIX B. Table from the *IA* study showing a statistically significant difference in smoking rate between counties that produce coal and those that do not.

Table 1 Descriptive summary of study variables by county category

	County category			
	No mining	Non-Appalachian mining	Appalachian mining ≤ 4 million tons	Appalachian mining > 4 million tons
Number of counties	2,914	97	66	63
Total population	274,502,126	4,234,505	5,287,206	3,762,685
Age-adjusted annual number of deaths				
Chronic heart disease[a]	303,319	9,948	7,421	8,550
Acute heart disease[b]	302,316	11,028	8,313	8,117
Chronic respiratory disease[c]	138,777	4,921	3,601	3,871
Acute respiratory disease[d]	67,513	2,423	1,726	1,639
Chronic kidney disease[e]	44,418	1,526	1,252	1,284
Acute kidney disease[f]	171	3	5	4
Covariates				
Smoking rate	23.0	24.0	27.7	29.2
Percent male	49.9	50.0	49.5	49.1
Percent African American	9.3	4.9	2.6	3.2
Percent Native American	1.9	4.9	0.2	0.2
Percent Hispanic	6.7	6.7	0.9	0.7
Percent Asian American	1.0	0.5	0.4	0.4
Percent with high school education	77.7	77.9	71.4	70.2
Percent with college education	16.8	14.8	12.3	11.5
Physicians per 1,000	1.3	1.2	1.3	1.5
Poverty rate	13.4	14.0	16.3	18.2
Percent Southern county	25.4	1.0	45.5	31.7
Mean urban–rural code	5.1	5.1	5.2	5.3

[a] Includes hypertensive heart disease (ICD-10 code I11), atherosclerotic cardiovascular disease so described (I25), all other forms of chronic, ischemic heart disease (I25.8), and essential (primary) hypertension and hypertensive renal disease (I10, I12)

[b] Includes acute myocardial infarction (I21), other acute ischemic heart diseases (I24), acute and sub-acute endocarditis (I33), diseases of pericardium and acute myocarditis (I31, I40), and heart failure (I50)

[c] Includes chronic and unspecified bronchitis (J40-J42), emphysema (J43), asthma (J45), and other chronic lower respiratory diseases (J44)

[d] Includes pneumonia (J12–J18), acute bronchitis and bronchiolitis (J20–J21), and unspecified acute lower respiratory infection (J22)

[e] Includes chronic glomerulonephritis, nephritis and nephropathy not specified as acute or chronic, and renal sclerosis unspecified (N03–N05), and renal failure (N17–N19)

[f] Includes acute and rapidly progressive nephritic and nephrotic syndrome (N00, N01)

Source: *IA*

APPENDIX C. Table from the *LC* study demonstrating significantly higher smoking rates for "Heavy Appalachian coal mining" areas versus "Other Appalachian" areas.

Table 1 Summary of study independent variables by geographic location

	Heavy Appalachian coal mining ($N = 66$)	Other Appalachian ($N = 347$)	Rest of Nation ($N = 2615$)	F or χ^2, p
Smoking rate [a]	27.7	25.2	21.7	<.0001
Percent male [b]	49.1	49.5	49.9	<.0001
Percent African-American [c]	3.1	7.3	9.5	<.0002
Percent Native American [d]	0.2	0.4	2.1	<.0001
Percent Hispanic [b]	0.7	1.8	7.3	<.0001
Percent Asian American [b]	0.4	0.5	1.0	<.0001
High school education [b]	70.0	71.4	78.3	<.0001
College education [a]	11.4	13.5	17.1	<.0001
Poverty rate [a]	18.2	14.9	13.3	<.0001
Percent metropolitan counties	27.3	34.0	35.4	<.36
Percent micropolitan counties	21.2	24.2	21.8	<.58
Percent counties in the South [a]	33.3	68.6	20.0	<.0001
Percent without health insurance [d]	14.3	13.7	14.8	<.0005
Mean physicians per 1000	1.49	1.31	1.32	<.62

[a] Post hoc tests significantly different between all three means.
[b] Coal mining and Appalachian areas significantly different from the nation.
[c] Coal-mining areas significantly different from Appalachia and the nation.
[d] Post hoc differences between means not significant.

Source: *LC*

APPENDIX D. Table from the *LC* study demonstrating a significant association between coal mining and smoking rate.

Table 2 Ordinary least squares regression model, age-adjusted lung cancer mortality rate

	Coal exposure measured in tons[a]				Coal exposure measured per capita[b]			
	Coefficient	S.E.	*p*	*B*	Coefficient	S.E.	*p*	*B*
Intercept	58.60	8.45	<.0001		58.66	8.44	<.0001	
Coal mining up to 3 million tons	−0.15	1.77	<.93	−0.001	–	–	–	–
Coal mining ≥3 million tons	3.72	1.77	<.036	.034	–	–	–	–
Coal mining up to 100 tons per person	–	–	–	–	−0.46	1.71	<.79	−0.004
Coal mining ≥100 tons per person	–	–	–	–	4.49	1.84	<.015	.039
Appalachia	−2.96	0.90	<.002	−0.63	−2.93	0.90	<.0002	−0.063
Smoking rate	0.94	0.08	<.0001	.210	0.94	0.08	<.0001	.209
Percent male	0.25	0.13	<.06	.028	0.25	0.13	<.06	.028
Percent African-American	−0.07	0.02	<.002	−0.067	−0.07	0.02	<.003	−0.066
Percent Native American	−0.04	0.04	<.21	.020	−0.04	0.03	<.22	−0.020
Percent Hispanic	−0.45	0.03	<.0001	−0.344	−0.45	0.03	<.0001	−0.343
Percent Asian American	0.15	0.11	<.20	.021	0.14	0.11	<.21	.021
High school education	−0.49	0.06	<.0001	−0.269	−0.50	0.06	<.0001	−0.268
College education	−0.30	0.05	<.0001	−0.146	−0.30	0.05	<.0001	−0.146
Poverty rate	0.52	0.08	<.0001	.195	0.52	0.08	<.0001	.184
Metropolitan	9.11	0.63	<.0001	.271	9.13	0.63	<.0001	.271
Micropolitan	4.03	0.62	<.0001	.104	4.07	0.62	<.0001	.105
South	2.16	0.76	<.004	.059	2.15	0.76	<.005	.059
Primary care physicians per 1000	0.85	0.22	<.0001	.074	0.86	0.21	<.0001	.075

[a] $F = 122.6$ (16, 3010), $p < .0001$; adjusted $R^2 = .39$.
[b] $F = 122.8$ (16, 3010), $p < .0001$, adjusted $R^2 = .39$.

Source: *LC*