Using the School Quality Indicators Database to Examine the Relationship between County-Level School Segregation and Population Health

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Abstract

In the United States, stark health inequalities exist across counties. Schools are a key feature of counties and residents often make decisions about where to live based on the local schools. Such decisions may lead to greater school segregation, as privileged White residents look to secure educational advantages for their children. Thus, school segregation may reflect one way that health becomes embedded in geographic places. We constructed county-level data on school segregation using administrative data from all U.S. public schools and linked these to *County Health Rankings* data. We examined if county-level school segregation relates to two key population health indicators – premature mortality and infant mortality – after adjusting for county-level demographic and socioeconomic characteristics. State-fixed effects models revealed a positive association between county-level school segregation – as measured by Black isolation and Theil's entropy – and infant mortality. A similar association was found between Theil's entropy and premature mortality.

Background

In the United States, stark and persistent health inequalities exist by geography.[1] For example, in 2014, U.S. life expectancy at birth ranged from a low of 67 to a high of 87 years depending on where in the country one was born – a gap of 20 years. Infant mortality, a key indicator of population, also varies significantly across U.S. counties. From 2007-2013 in counties that reported an infant death, infant mortality rate ranged from a low of 3 to a high of 20. According to Entwisle (2007), the relationship between place and health is often conceptualized as unidirectional – residents are passively exposed to features of an area and these features affect their health – rather than as bi-directional.[2] Thus, county-level disparities in mortality are thought to be due in part to county-level differences in poverty, employment, and educational attainment.

Yet, counties are important for local governance and play an important role in the delivery of social services, taxation, and economic development.[3] And, residents actively shape their counties; they elect county officials who implement federal and state mandates, distribute funds, and invest in the local economy. Schools are a key feature of communities; residents often make decisions about where to live based on the local schools.[4] Such decisions may lead to racial segregation within and across schools as well as differential access to educational opportunities, as privileged White residents look to secure the most educational advantages for their children.[5] As a result, county-level school segregation may reflect one way that health-relevant opportunities or constraints become embedded in geographic places.[6]

In our paper, we consider how county-level school segregation relates to two key population health indicators – premature mortality and infant mortality. We explore how other aspects of the educational system – school achievement and school discipline – within a county relate to these two population health outcomes and whether they attenuate the relationship between county-level school segregation and health. We use county-level data on schools available from the School Quality Indicators Database (SQID) that our study team constructed. We link our data to data available from the *County Health Rankings and Roadmaps Program* (hereafter referred to as *Rankings*). To our knowledge, ours is the first ecological study to investigate how the educational system within a county is associated with that county's health.

Data and Methods

In this ecological study, we analyze county-level data. Mortality, socio-economic, and demographic data on U.S. counties come from the *County Health Rankings & Roadmaps Program.* We used data from the 2016 and 2017 *Rankings* in our analysis to most closely align the temporal assessment of school segregation, achievement, and discipline with health and demographic data.

County-level data on school segregation, achievement, and discipline come from the School Quality Indicators Database (SQID), which we constructed by aggregating publicly-available administrative data on all public elementary and secondary schools in the United States for the 2004/5 – 2013/14 academic school years. For this analysis, we use data from the 2013/14 academic school year. School-level administrative data come from the National Center for Education Statistics (The Common Core of Data; CCD)[7] and the Civil Rights Data Collection (CRDC).[8] To create the county-level school indicators, we used a school's physical address to identify the county where the school was located. In cases where county FIPS codes were missing, we used the school's address and U.S. Census TIGER files to match schools to counties.

About 91% of schools were ultimately matched. We excluded alternative schools or schools in correctional facilities as well as non-operational schools or schools with no enrollment prior to aggregation to the county-level. Per NCES recommendations, counties where fewer than 85% of schools reported data on an indicator were excluded from analyses.[7] Aggregated county-level data on indicators where 85-94% of schools reported data are flagged.

We constructed two samples for our analysis. Our first sample included U.S. counties with data on age-adjusted premature mortality and school segregation (n=1,880). Our second sample was a subset of the first and included U.S. counties with data on infant mortality and school segregation (n=1,275).

Measures

Dependent Variables. For each county, *Rankings* extracted the age-adjusted *premature mortality* rate using pooled National Center for Health Statistics data from 2013-2015. Premature mortality is defined as the number of deaths among county residents under the age of 75 per 100,000 population. The *infant mortality rate* for each county was based on pooled 2007-2013 estimates from the National Center for Health Statistics. Infant mortality is defined as the number of deaths among children less than one year of age per 1,000 live births in the county.

School Segregation. We used school enrollment data available from the CCD to calculate two county-level school segregation indices for the 2013/14 academic school year, which are commonly used in school segregation research: entropy and isolation.[9, 10] These two indices capture two important dimensions of segregation – evenness and exposure. "Evenness" refers to how evenly racial/ethnic groups are distributed across schools within a county,[11] which we measured using Theil's entropy index.[11, 12] The *Theil's entropy index* calculates the weighted average deviation of each school from the county's racial/ethnic diversity. It ranges from 0 (when all schools have the same racial/ethnic composition as the county) to 1 (when all schools contain one racial/ethnic group only). "Exposure" is the extent to which a student from group *r* will come into contact with a student from group *t*, which we measured with the isolation index.[11] Exposure is distinct from evenness in that it captures the degree to which a student from group *r* experiences segregation. In our study, we examined Black isolation; the *isolation index* measures the extent to which Black students are exposed only to one another, rather than to students from another group. The index ranges from 0 to 1, indicating the probability that a Black student will attend school with another Black student.

School segregation measures were not calculated for counties with fewer than 100 students, fewer than *n*-1 schools (where *n* is the number of racial/ethnic groups used to calculate the segregation measure), or where only 1 racial/ethnic group resided. We only calculated Theil's entropy if the county included at least 25 students for two or more racial/groups. Similarly, we only calculated isolation if the county included at least 25 White and 25 Black students. For state-level fixed effect models, we multiplied each school segregation index by 10 so that a 1-unit increase in school segregation represented a 10-point change in segregation.

School Achievement. County-level high school graduation rate comes from *Rankings* and is defined as the percentage of 9th grade students in public schools that graduated within four years. We also include a county-level indicator of the percentage of *high school students enrolled in Advanced Placement or International Baccalaureate (AP/IB)* coursework for the 2013/14 academic school year. School-level data on AP/IB coursework comes from CRDC.

School Discipline. County-level school discipline indicators included the percentage of students who received an *in-school suspension* and the percentage of students who received an *out-of-school suspension* for the 2013/14 academic school year. We restricted our calculations to schools offering 12th grade, given the low levels of suspensions at primary grade levels.[13] School-level data on disciplinary action come from the CRDC.

Covariates. Because place can be associated with population health via the characteristics of its residents, we included a set of demographic and socio-economic county-level characteristics, which we downloaded from *Rankings*, in all models. The following demographic characteristics were derived from the Census Bureau's Population Estimates Program (PEP) for the 2013 year: population size of the county (divided by 10,000), percent under age 18, percent 65 years or older, percent who self-identified as non-Hispanic White, percent who were not proficient in English, and percent of the county that was rural. Socio-economic characteristics included percent food insecure (Map the Meal Gap, 2013), percent of ≥ 16 year-olds who were unemployed (Local Area Unemployment Statistics (LAUS) program of the Bureau of Labor Statistics, 2013), percent of 25-44 year-olds who completed some college (5-year estimates from the American Community Survey, 2010-2014), percent of children under 18 years-old living in poverty (Small Area Income and Poverty Estimates (SAIPE), 2013), and percent of children residing in a single-parent household (5-year estimates from the American Community Survey, 2009-2013).

Preliminary Results

County Characteristics

Table 1 presents demographic, socioeconomic, and school characteristics for the 1,880 counties in our full sample. The average U.S. county in our sample had a mean age-adjusted premature mortality rate of 392.9 per 100,000 residents and a mean infant mortality rate of 7 per 1,000 live births. The Black isolation in schools in the average county was 0.2 (range 0 – 1), indicating that the average Black student attended a school where 20% of the student population was Black. The average Theil's entropy index for U.S. counties included in our sample was 0.11, meaning that schools in the average U.S. county were 11% less diverse than the county as a whole. In the average county, about 84% of 9th grade students graduated from high school within four years and 9.2% of public high school students were enrolled in AP/IB courses. County-level in-school suspensions averaged 10.2%, whereas county-level out-of-school suspensions averaged 4.4%. Other county characteristics are described in Table 1.

Table 1: Sample Demographics for Counties (N=1,880)

	Mean(SE)	Range
Premature Mortality Rate per 100,000	392.9 (2.3)	156-840
Infant Mortality Rate per 1,000 live births [a]	7.0 (0.1)	3-17
County-Level School Characteristics		
Black Isolation	0.2 (0.01)	0 – 0.96
Theil's Entropy	0.1 (0.00)	0 – 0.61
Graduation Rate, %	84.0 (0.19)	42 – 100
AP/IB Courses, %	9.2 (0.17)	0 – 57.9
In-School Suspensions, %	10.2 (0.18)	0 – 77.5
Out-of-School Suspensions, %	4.4 (0.07)	0 – 44.4
County-Level Socioeconomic Characteristics		
Some College, %	57.3 (0.26)	20.2 – 88.3
Children in Poverty, %	24.2 (0.21)	4.0 – 56.0
Single Parent Household, %	33.6 (0.21)	11.0 – 72.0
Unemployed, %	7.5 (0.05)	0.9 – 27.7
Food Insecure, %	15.4 (0.09)	5.0 – 32.0
County-Level Demographic Characteristics		
Total Population Size [b]	16.0 (0.94)	0.3 – 1001.7
Less than 18 Years Old, %	22.9 (0.07)	7.7-35
More than 65 Years Old, %	15.9 (0.09)	6-51.6
Female, %	50.3 (0.04)	34.3-55.1
Rural, %	44.5 (0.62)	0-100
White, %	75.5 (0.43)	3.7-97.9
non-English Language Proficient, %	2.0 (0.06)	0-24.9

[a] Infant mortality rate available for 1,275 counties; [b] Total Population Size divided by 10,000

Table 2 presents the 10 counties with the highest and lowest levels of school segregation – as measured by Black isolation and Theil's Entropy Index – among those counties with data on premature and infant mortality (n=1,275). The counties with the lowest school segregation also appear, on average, to have higher high school graduation rates (82.8% vs 67.5%) and AP/IB course taking (11% vs. 7%), and lower rates of in-school (4.5% vs. 15.8%) and out-of-school suspensions (2.1% vs. 8.1%), child poverty (16.3% vs. 39.5%), and single-headed households (24.3% vs. 58.7%). These counties have a greater percentage of White residents and are more rural than the most segregated counties. Importantly, the counties with the lowest levels of school segregation also reported lower premature mortality (337.7 vs. 508.8) and infant mortality (6.2 vs 9.4).

Table 2: Descriptive Statistics for Most and Least Segregated Counties [a]

	Rank	County Name	Premature Mortality Rate	IMR	Black Isolation	Theil's Entropy	% AP/IB	High school Graduation Rate	% In-School Suspensions	% Out-of-School Suspensions	% Some College	% <18 in Poverty	% Single Parent HH	% Rural	% White
Least Segregated Counties	1	Churchill, NV	395	9	0.015	0.007	10.9	72.0	6.2	0.9	56.7	21.0	34.0	34.7	74.6
	2	Jasper, IN	392	8	0.008	0.021	9.6	89.0	5.1	4.6	55.4	15.0	25.0	68.0	92.0
	3	Box Elder, UT	309	6	0.009	0.027	12.2	85.0	0.7	0.2	58.2	13.0	19.0	31.1	87.5
	4	Chicago, MN	262	5	0.010	0.027	2.8	85.0	2.0	1.5	66.4	8.0	24.0	55.6	94.2
	5	DeKalb, IN	410	7	0.010	0.030	11.9	92.0	8.0	1.5	55.1	19.0	28.0	42.3	95.3
	6	Matanuska-Susitna, AK	339	4	0.026	0.015	5.8	74.0	2.3	3.4	61.1	12.0	24.0	50.3	81.1
	7	Morgan, IN	393	7	0.010	0.032	11.4	86.0	6.2	1.9	54.3	19.0	28.0	49.1	96.3
	8	Barry, MI	292	5	0.009	0.034	11.7	86.0	6.6	2.0	59.3	16.0	21.0	77.1	94.9
	9	Iron, UT	330	7	0.006	0.036	5.9	81.0	1.2	1.1	72.4	24.0	17.0	22.6	86.6
	10	Garfield, CO	255	4	0.007	0.037	27.7	78.0	7.0	3.3	57.2	16.0	23.0	24.1	68.8
Least Segregated Counties Mean			338	6	0.110	0.266	11.0	82.8	4.5	2.1	59.6	16.3	24.3	45.5	87.1
Most Segregated Counties	1	Washington, MS	632	12	0.948	0.477	1.9	56.0	17.7	10.3	52.0	51.0	68.0	17.5	26.4
	2	Dallas, AL	607	8	0.923	0.440	0.3	70.0	41.9	14.7	42.9	50.0	69.0	45.6	28.5
	3	Orleans, LA	458	8	0.898	0.440	10.6	74.0	3.0	9.6	67.3	39.0	61.0	0.6	31.0
	4	Wayne, MI	478	10	0.807	0.496	6.4	75.0	5.5	8.5	59.8	37.0	47.0	0.7	50.0
	5	Yazoo, MS	633	9	0.882	0.390	2.6	65.0	46.0	3.1	42.6	51.0	64.0	44.6	36.5
	6	District of Colombia	399	9	0.857	0.403	13.6	62.0	3.6	8.7	79.1	29.0	59.0	0.0	35.8
	7	DeKalb, GA	325	7	0.838	0.411	16.1	60.0	17.9	8.2	69.6	30.0	44.0	0.3	30.0
	8	Baltimore, MD	608	11	0.897	0.325	5.2	69.0	0.7	3.7	59.9	33.0	66.0	0.0	28.3
	9	Hinds, MS	481	11	0.916	0.307	6.8	70.0	12.1	8.7	65.3	40.0	59.0	15.3	26.7
	10	Ouachita, LA	467	9	0.776	0.432	7.0	74.0	9.2	6.0	52.7	35.0	50.0	24.2	58.7
Most Segregated Counties Mean			509	9	8.74	4.12	7.0	67.5	15.8	8.1	59.1	39.5	58.7	14.9	35.2

[a] Highest and lowest counties based on both isolation and entropy index scores. Counties ranked from all counties in sample with both premature mortality and infant mortality data (N=1,275).

State-Fixed Effects Linear Models

Prior to estimating state-fixed effects linear regression models, we visually inspected our indicators for their distribution and graphed correlational plots to identify non-linear relationships between school segregation and the mortality indicators. We found a non-linear relationship between Black isolation and both mortality indicators, so we included a quadratic term in our models to account for non-linearity. Next, we estimated two models. Model 1 included the school segregation index, adjusting for county-level demographic and socio-economic characteristics. Model 2 added county-level measures of school achievement and school discipline. We compared model fit statistics and regression coefficients from Model 2 to Model 1 to determine which county-level school achievement indicators were significantly associated with county-level mortality and attenuated the relationship between school segregation and county-level mortality. All regression models included an indicator variable for U.S. state (Texas is the referent state) to account for observed and unobserved state-level differences.

Table 3 presents estimates from state-fixed effects models predicting county-level premature mortality. For Black isolation, the association was non-linear (Model 1A). The relationship between county-level Black isolation in schools and premature mortality was fairly flat until Black isolation reached 0.6, after which point greater Black isolation was associated with lower premature mortality (Figure 1). Conversely, the relationship between Theil's entropy and premature mortality was positive and linear. In counties where the public schools were less diverse than the county, premature mortality was higher (b=4.85, SE=1.65; Model 1B). Inclusion of county-level school achievement and school discipline improved model fit (Models 2A and 2B), and slightly attenuated the relationship between Theil's entropy and premature mortality. We also found that county-level school achievement was inversely associated with premature mortality, but county-level out-of-school suspensions was positively associated with premature mortality.

Table 3: State-Fixed Effects Linear Regression Models predicting County-Level Premature Age-Adjusted Mortality Rate, N=1,880

	Black Isolation		Theil's Entropy	
	Model 1A	Model 2A	Model 1B	Model 2B
	b (se)	b (se)	b (se)	b (se)
Segregation Index	2.74 (1.80)	2.96 (1.80)*	4.84 (1.65)***	4.35 (1.64)***
Segregation Index (squared)	-0.46 (0.22)**	-0.54 (0.22)**		
High school students in AP/IB, %		-0.93 (0.19)***		-0.93 (0.19)***
High school graduation rate		-0.38 (0.20)*		-0.37 (0.20)*
High school students w/ in-school suspension, %		-0.41 (0.17)**		-0.32 (0.16)**
High school students w/ out-school suspension, %		0.89 (0.39)**		0.75 (0.39)*
Total county population	0.04 (0.03)	0.05 (0.03)	0.03 (0.03)	0.03 (0.03)
Residents under 18 years of age, %	3.21 (0.67)***	3.44 (0.67)***	2.99 (0.66)***	3.19 (0.66)***
Residents 65 and older, %	-1.27 (0.54)**	-1.24 (0.54)**	-1.50 (0.52)***	-1.51 (0.52)***
Female residents, %	1.15 (0.82)	1.25 (0.81)	1.13 (0.82)	1.22 (0.81)
Rural, %	-0.13 (0.06)**	-0.17 (0.06)***	-0.14 (0.06)**	-0.17 (0.06)***
Non-Hispanic White residents, %	1.12 (0.18)***	1.13 (0.18)***	1.27 (0.14)***	1.31 (0.14)***
Residents not proficient in English, %	-8.46 (0.76)***	-8.28 (0.75)***	-8.43 (0.73)***	-8.17 (0.73)***
Adults 25-44 w/some College, %	-2.11 (0.20)***	-1.90 (0.20)***	-2.17 (0.20)***	-1.96 (0.20)***
Unemployed ≥ 16 years old, %	4.11 (0.90)***	4.31 (0.90)***	4.37 (0.87)***	4.60 (0.87)***
Children under 18 in poverty, %	4.74 (0.31)***	4.61 (0.31)***	4.72 (0.30)***	4.61 (0.30)***
Children in single parent households, %	1.70 (0.25)***	1.58 (0.25)***	1.66 (0.25)***	1.54 (0.25)***
Food Insecure, %	1.74 (0.99)*	1.53 (0.99)	1.24 (0.88)	0.94 (0.87)
Constant	142.82 (38.2)**	177.88 (41.5)**	154.56 (38.1)**	188.30 (41.5)**
R-squared	0.83	0.83	0.83	0.83
Wald Test		9.01***		9.06***

Notes: Total county population is divided by 10,000; Segregation indicator multiplied by 10; F-test for inclusion of county-level school achievement and school discipline

* p<0.1, ** p<0.05, *** p<0.01

Figure 1: Predicted County-Level Age-Adjusted Premature Mortality Rate per 100,000 Residents by Black Isolation

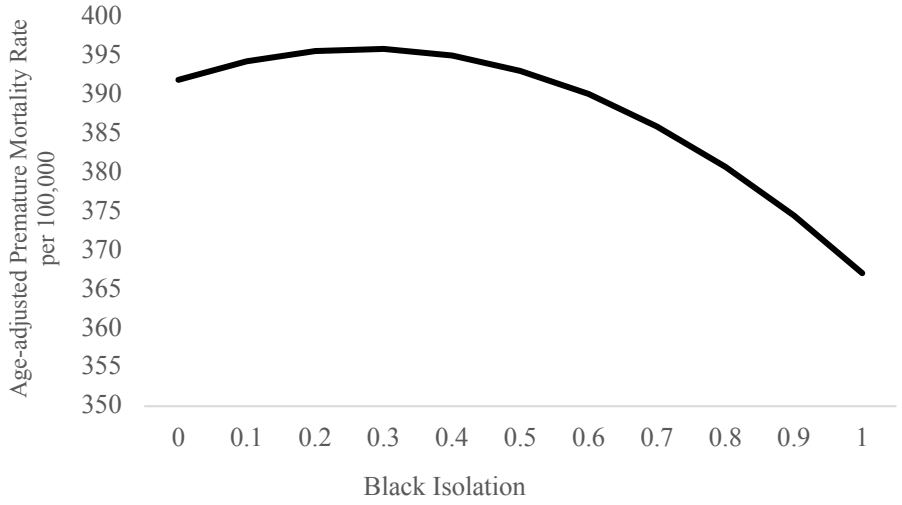

Table 4 presents estimates from state-fixed effects models predicting county-level infant mortality. For both measures of county-level school segregation, greater school segregation was associated with higher rates of infant mortality (Models 1A and 1B). Inclusion of county-level school achievement and school discipline measures did not improve model fit, and, only the percent of county public high school students taking AP/IB classes was associated with infant mortality (b=-0.02, SE=0.01).

Table 4: State-Fixed Effects Linear Regression Models predicting County-Level Infant Mortality Rate, N=1,275

	Black Isolation		Theil's Entropy	
	Model 1A	Model 2A	Model 1B	Model 2B
	b (se)	b (se)	b (se)	b (se)
Segregation Index	0.13 (0.07)*	0.13 (0.07)*	0.12 (0.07)*	0.12 (0.07)*
Segregation Index (squared)	0.02 (0.01)*	0.01 (0.01)		
High school students in AP/IB, %		-0.02 (0.01)**		-0.02 (0.01)**
High school graduation rate		0.01 (0.01)		0.01 (0.01)
High school students w/ in-school suspension, %		-0.01 (0.01)		-0.01 (0.01)
High school students w/ out-school suspension, %		0.01 (0.02)		0.02 (0.02)
Total county population	-0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Residents under 18 years of age, %	0.05 (0.03)*	0.05 (0.03)*	0.07 (0.03)**	0.07 (0.03)**
Residents 65 and older, %	0.03 (0.02)	0.02 (0.02)	0.05 (0.02)**	0.05 (0.02)**
Female residents, %	-0.03 (0.04)	-0.03 (0.04)	-0.03 (0.04)	-0.03 (0.04)
Rural, %	0.01 (0.00)***	0.01 (0.00)***	0.01 (0.00)***	0.01 (0.00)***
Non-Hispanic White residents, %	-0.01 (0.01)	-0.01 (0.01)	-0.03 (0.01)***	-0.03 (0.01)***
Residents not proficient in English, %	-0.12 (0.03)***	-0.12 (0.03)***	-0.16 (0.03)***	-0.16 (0.03)***
Adults 25-44 w/some College, %	-0.04 (0.01)***	-0.04 (0.01)***	-0.04 (0.01)***	-0.04 (0.01)***
Unemployed ≥ 16 years old, %	-0.07 (0.04)*	-0.06 (0.04)*	-0.11 (0.04)***	-0.10 (0.04)***
Children under 18 in poverty, %	0.03 (0.01)**	0.04 (0.01)**	0.02 (0.01)	0.02 (0.01)
Children in single parent households, %	0.03 (0.01)**	0.03 (0.01)**	0.03 (0.01)***	0.03 (0.01)***
Food Insecure, %	0.07 (0.04)	0.06 (0.04)	0.15 (0.04)***	0.14 (0.04)***
Constant	6.66 (1.95)**	6.03 (2.10)**	6.33 (1.98)	5.86 (2.12)
R-squared	0.57	0.58	0.57	0.57
Wald Test		1.6		1.5

Notes: Total county population is divided by 10,000; Segregation indicator multiplied by 10; F-test for inclusion of county-level school achievement and school discipline

* p<0.1, ** p<0.05, *** p<0.01

Next Steps

Our results are preliminary and will be extended as follows. First, we plan to add county-level school expenditures data (e.g., per-pupil funding) and replace our current measure of educational attainment with a county-level indicator of the percent of adults 25-44 with a college degree or higher. We also plan to examine race-specific mortality (i.e., Black premature mortality, Black infant mortality) and racial disparities in our two health indicators (i.e., Black-White disparity in premature and infant mortality). Finally, it is possible that spatial clustering of county-level school segregation and school quality is occurring in our sample, which would lead to biased regression estimates.[14] We plan to calculate Moran's I statistics to determine if the residuals from our original regression models were spatially autocorrelated. If Moran's I statistics indicate autocorrelation, we will estimate spatial error or spatial lag econometric models.

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