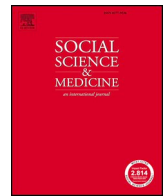




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The relationship between Jim Crow laws and social capital from 1997–2014: A 3-level multilevel hierarchical analysis across time, county and state

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ABSTRACT

Introduction: Jim Crow laws in the United States promoted racial prejudice, which may have reduced social capital. Our study tests the relationship between Jim Crow laws and social capital. **Methods:** We conducted 3-level multilevel hierarchical modeling to study differences in the stock of social capital for 1997, 2005, 2009 in Jim Crow states compared to states without Jim Crow laws. We examined the moderation effects of county level median income, percent Black and percent with high school education and Jim Crow laws on social capital. **Results:** Jim Crow laws significantly reduced stock of social capital across 1997, 2005, 2009. The model was robust to the inclusion of random county, states, time and fixed county and state level covariates for median income, percent Black and percent with high school education. The largest percent of between state variations explained for fixed variables was from the addition of Jim Crow laws with 2.86%. These results demonstrate that although Jim Crow laws were abolished in 1965, the effects of racial segregation appear to persist through lower social connectiveness, community and trust. A positive moderation effect was seen for median income and percent Black with Jim Crow laws on social capital. **Discussion:** Our study supports a negative association between Jim Crow laws and reduction in the stock of social capital. This may be attributed to the fracturing of trust, reciprocity and collective action produced by legal racial segregation. Findings from this study offer insight on the potential impacts of historical policies on the social structure of a community. Future research is necessary to further identify the mechanistic pathways and develop interventions to improve social capital.

1. Introduction

1.1. Jim Crow laws and racial inequities in health

“Racial segregation is the structural feature of American society responsible for the perpetuation of urban poverty and represents a primary cause of racial inequities in the United States” (Massey and Denton, 1993). Jim Crow laws were state and local laws that enforced racial discrimination by segregation across 21 states and the District of Columbia throughout the late 19th century until 1964 when the US Civil Rights Act made these laws illegal (Bailey et al., 2017; Krieger, 2011, 2014; Rothstein, 2017; Wilkerson, 2010). Jim Crow laws endorsed racial segregation through legislation making economic,

educational, and social segregation between people of color and Whites legal. For example, this systemic racism permitted redlining whereby banks could discriminate against Blacks by enforcing unusually severe terms for loans, and Blacks had worse access to quality education prohibiting them from earning a fair income or living in safe and good neighborhoods (Phelan and Link, 2015; Rothstein, 2017). To date, limited research has examined the impact of this type of unjust legislation on health disparities.

Recently, evidence has emerged about the negative impact of Jim Crow laws on the health of populations, both Blacks and Whites, living in Jim Crow states (i.e., states that implemented and enforced Jim Crow laws). Interestingly, a 2013 study by Krieger et al. showed higher infant mortality rates for Blacks and Whites living in Jim Crow states

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compared to non-Jim Crow states (Krieger et al., 2013). Following the elimination of legal racial discrimination, Black infant mortality rates within Jim Crow versus non-Jim Crow states declined, and became more similar to White infant mortality rates (Krieger et al., 2013). These temporal patterns of birth cohort effects is further seen with the outcome of premature mortality rates whereby the largest overall period-specific Jim Crow effect was found at the peak of enforcement of Jim Crow laws and a steep decline in these rates was subsequently observed after the abolition of Jim Crow laws (Krieger et al., 2014). In a 2017 study by Krieger et al., it was found that Jim Crow birthplace (i.e., being born in a Jim Crow state vs. non-Jim Crow state) was associated with an increase in odds of estrogen-receptor-negative (ER-negative) breast tumors among Black women with the effect strongest for women born before 1965 during the Jim Crow era (Bailey et al., 2017). A follow up study showed that the percentage of ER-positive cases rose among those diagnosed before the age of 55 with the greatest changes being among Black women in Jim Crow states (Krieger et al., 2017).

The temporal patterns observed in these studies provide strong evidence towards the detrimental effects of Jim Crow laws on the health of the US Black population and also the potential to have a cascading effect on the health of White populations. These results contrast notions that solely other causes, such as genetic predisposition or poor lifestyle, underlie racial disparities in cancer and add further evidence to the effect of macro-level political factors as contributors to specific disease outcomes (Bailey et al., 2017; Krieger et al., 2017). However, no study to date has investigated the social pathways that link the effects of Jim Crow laws and health outcomes. Understanding the effects of Jim Crow laws on preceding risk factors for health may help to explain the mechanisms that contribute to the impacts of Jim Crow laws on disparities in health.

1.2. Social capital

The conceptualization of social capital dates back to eighteenth and nineteenth century philosophers Tocqueville, J.S. Mill, Weber, Lock, and Rousseau who defined social capital as the bedrock of human relationships in a functional society (Adam and Rončević, 2003; Rodgers et al., 2019). A more recent definition by Putnam (1995) depicts social capital as features of social organizations such as trust, norms and networks that facilitate collective action for mutual benefit (R. D. Putnam, 1995). While Pierre Bourdieu described social capital as an aggregate of resources available from a social network (Bourdieu, 2011), Coleman (1988) considered social capital as an aspect of social structure that promotes actions that achieve certain ends (Coleman, 1988; Kawachi and Berkman, 2000). Sampson's view of social capital referred to the resource of collective efficacy, shared expectations and mutual engagement (Sampson et al., 1999). Fukuyama (2000) built on this idea, postulating trust and reciprocity within the community further drives collective action, and associative membership that builds public resources (Fukuyama, 2000; R. Putnam, 1993).

Social capital, as resource that resides in relationships between individuals within a social structure such as neighborhoods or counties or states that can generate programs of public interest has been most widely linked to population-level well-being (Y. Lee, Muennig, Kawachi and Hatzenbuehler, 2015; R. D. Putnam, 1995). This generation of public interest through social capital can lead to greater public investment in schools, healthcare, safer environments and community related activities, all of which have been associated with better health outcomes (Y. Lee et al., 2015; R. D. Putnam, 1995). For instance, higher levels of social capital defined by the level of community resources, has been correlated with reduced state level mortality rates across the US (Kawachi et al., 1997). Conversely, lower levels of social capital at the state level have been associated with higher rates of major causes of death including heart disease, infant mortality, and violent deaths including homicide (Kawachi et al., 1997). Other studies have also linked social capital to self-rated health status (Kawachi et al., 1999; Veenstra,

2000) and binge drinking (Weitzman and Kawachi, 2000). As well, most recently evidence has emerged that structural racism of residential segregation has led to unequal distribution of housing and health care which has increased the rates of chronic and infectious disease among Black communities in the US (Bailey et al., 2017). However, the relationship between racial segregation on social capital has not been studied extensively.

1.3. Jim Crow laws and social capital

Social capital represents the extent of bridges and bonds social networks within a community. Jim Crow laws sanctioned racial prejudice through the legalization of racial discriminatory practices that prevented Blacks from obtaining the same financial, economic, educational or health care resources as Whites. Evidence has shown racial prejudice leads to the disruption of social capital (Y. Lee et al., 2015) as it breeds a lack of trust and reciprocity amongst different groups. Trust is a key factor in social relationships and is a necessity in decisions that underlie the functioning of any society (Coleman and Coleman, 1994; Stanley et al., 2011). This disruption of trust even between different racial groups reduces social efficacy and can diminish the facilitation of collective actions that are mutually beneficial for all populations within a community (Coleman, 1988). Reduced social capital could result in the reduction of collective resources in society such as education, medical care, employment and other human capital investments of the entire community. Therefore, it is important to understand the relationship between Jim Crow laws and social capital because of its potential impact on the social structure of a society. Although previous studies have investigated the effect of Jim Crow laws on health outcomes, our study is the first to investigate the relationship of Jim Crow laws on social capital.

2. Methods

2.1. Dataset

2.1.1. Stock of social capital 1997–2014

We used an established objective indicator to measure social capital – the stock of social capital (Rupasingha et al., 2006). This measurement is based on Putnam's work (R. D. Putnam, 2001) and does not use self-reported questionnaires to measure social capital because previous studies have shown self-reported social capital measures to be biased by subjective perceptions (Kawachi and Subramanian, 2006; C.-J. Lee and Kim, 2013; Y. Lee et al., 2015; Sampson et al., 1997). This objective social capital index, combines a number of social capital measures. This social capital index estimates the number of each of the 11 social capital establishments per 10,000 people in a county. These include a variety of establishments and features within a community, including: bowling centers, public golf courses, physical fitness facilities, sports facilities, and recreational clubs. Organizations like civic and social, political, religious, labor, business, and professional organizations are also included. Finally, the index contains 3 additional social capital measures of percentage of residents voting in presidential election, county-level response rate to the Census Bureau's decennial census, and number of tax-exempt nonprofit organizations (derived from National Center for Charitable Statistic data). Previous studies have used principal component analysis (Rupasingha et al., 2006) to establish a combined social capital index, the stock of social capital. Our analysis was conducted using this overall measure of the stock of social capital. This objective measure of the stock of social capital by Rupasingha et al. (2006) was available for 1997, 2005, 2009 and 2014, and provides a range of 17 years. The relationship between Jim Crow laws and social capital was assessed at each of the time points of 1997, 2005, 2009 and 2014 to understand the changes in social capital over time between Jim Crow and non-Jim Crow states.

Table 1
Descriptive variables between non-Jim Crow (Non-JC) and Jim Crow (JC) states.

		Min	1st Qu	Median	Mean	3rd Qu	Max	Range	SD	P-value
Median household income	Non-JC	24388	40975.50	45181	47492.32	51553.00	100980	76592	10404.37	< 0.001
	JC	19351	34107.50	39239	41333.84	45705.25	115574	96223	11487.16	
%black	Non-JC	0	0.20	0.70	2.42	2.30	52.90	52.90	4.80	< 0.001
	JC	0	1.30	6.25	14.38	22.65	86.10	86.10	17.57	
high school graduate rate	Non-JC	11.10	30.85	36.10	35.64	40.80	54.40	43.30	7.40	0.643
	JC	8.20	31.70	36.20	35.76	40.30	74.40	66.20	6.55	
SC 97	Non-JC	-2.99	-0.18	0.45	0.69	1.39	8.24	11.23	1.33	< 0.001
	JC	-4.31	-1.34	-0.77	-0.57	-0.12	5.18	9.49	1.25	
SC 05	Non-JC	-3.07	-0.21	0.44	0.62	1.32	8.94	12.01	1.32	< 0.001
	JC	-3.91	-1.23	-0.71	-0.52	-0.08	8.86	12.76	1.18	
SC 09	Non-JC	-2.80	-0.36	0.20	0.46	1.09	7.07	9.87	1.34	< 0.001
	JC	-3.93	-1.07	-0.55	-0.38	0.05	7.45	11.37	1.41	
SC 14	Non-JC	-2.95	-0.43	0.19	0.40	0.97	9.15	12.10	1.23	< 0.001
	JC	-3.18	-0.92	-0.48	-0.33	0.02	7.74	10.92	1.07	

2.1.2. Predictor: Jim Crow laws across time

Jim Crow laws legalized racial discrimination and were enacted in 21 states and the District of Columbia. These states included: Alabama, Arizona, Arkansas, Delaware, Florida, Georgia, Kansas, Kentucky, Louisiana, Maryland, Mississippi, Missouri, New Mexico, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia, and Wyoming. Time was included as a fixed variable and a hierarchical level. The interaction between Jim Crow laws and time was also included in the model as a fixed variable.

2.1.3. Covariates

The covariates that we controlled for in our model include median income, percent Black and percent with high school education at the county and state level. These area level socioeconomic and demographic factors were chosen because of their association with social capital and potential association with Jim Crow laws. For instance, previous studies have documented that the distribution of income (Kawachi and Kennedy, 1997; Kawachi et al., 1999), racial makeup (Ayres, 2016; Orr, 1999) and educational attainment have been linked with social capital. As well, significant interactions between racial composition and social capital have been seen (Hutchinson et al., 2009). To account for these relationships between our covariates and our independent and dependent variables of Jim Crow laws and social capital, we added them as fixed effects in our models. For example, the racial composition of the percentage of the population that is Black is different between Jim Crow and non-Jim Crow states and also is associated with social capital. Thus, we included percent Black as a covariate in our model as to ensure this was not influencing the relationship between Jim Crow laws and the stock of social capital. Data on these covariates were collected from the United States Census Bureau's American Community Survey.

2.2. Statistical analysis

We conducted 3-level multilevel hierarchical modeling to predict the difference in the stock of social capital by county in Jim Crow states compared to states without Jim Crow laws (non-Jim Crow states). This allows us to account for state, county and time level differences by allowing the stock of social capital to vary for each state, county and across time. We removed outliers based on an outlier detection method that does not solely rely on visual inspection alone where an outlier is determined to be a point that is further than 1.5*IQR (IQR = Interquartile Range) (Dawson, 2011; Hubert and Van der Veen, 2008; Rousseeuw and Hubert, 2011). We identified one outlier in the dataset, which was the county of Edgefield, SC and was removed from our analyses.

We constructed a 3-level hierarchical model with the structure of the random effects linear regression model as time *i* (level-1) nested

within county *j* (level-2) and state *k* (level-3) as follows:

$$Y_{ijk} = \beta_0 + \beta X_{ijk}^1 + (e_{0ijk} + u_{jk} + v_{0k})$$

Y represents the outcome of the stock of social capital, X is a vector of explanatory variables; e_{0ijk} , u_{0jk} , and v_{0k} are residuals specific to each level (time, county, and state). We added random effect for each state, county and across time to control for unobserved heterogeneity in the outcome at the cluster state, county and across levels, conditional on the relationships between the stock of social capital and county level predictors and time as a fixed variable. This allowed us to evaluate the degree to which social capital varied across levels of time, county and state and to determine which fixed variables may have accounted for this variation.

2.2.1. Variance

The independently and identically distributed (iid) assumption states that each set of residuals follows a normal distribution with a mean of 0 and a variance of $e_{0ijk} \sim N(0, \sigma_{e_0}^2)$, $u_{0jk} \sim N(0, \sigma_{u_0}^2)$, and $v_{0k} \sim N(0, \sigma_{v_0}^2)$. The variance estimates for county, and states were summed for the between-population variation (i.e., $\sigma_{u_0}^2 + \sigma_{v_0}^2$). Hence, the proportion of variation in the outcome attributable to the between-population differences was calculated as $(\frac{\sigma_{u_0}^2 + \sigma_{v_0}^2}{\sigma_{e_0}^2 + \sigma_{u_0}^2 + \sigma_{v_0}^2}) \times 100$ and the proportion attributed to the within-population differences as $(\frac{\sigma_{e_0}^2}{\sigma_{e_0}^2 + \sigma_{u_0}^2 + \sigma_{v_0}^2}) \times 100$.

All analyses were performed using R software, Studio 3.3.3. P-values $\leq .05$ were considered statistically significant.

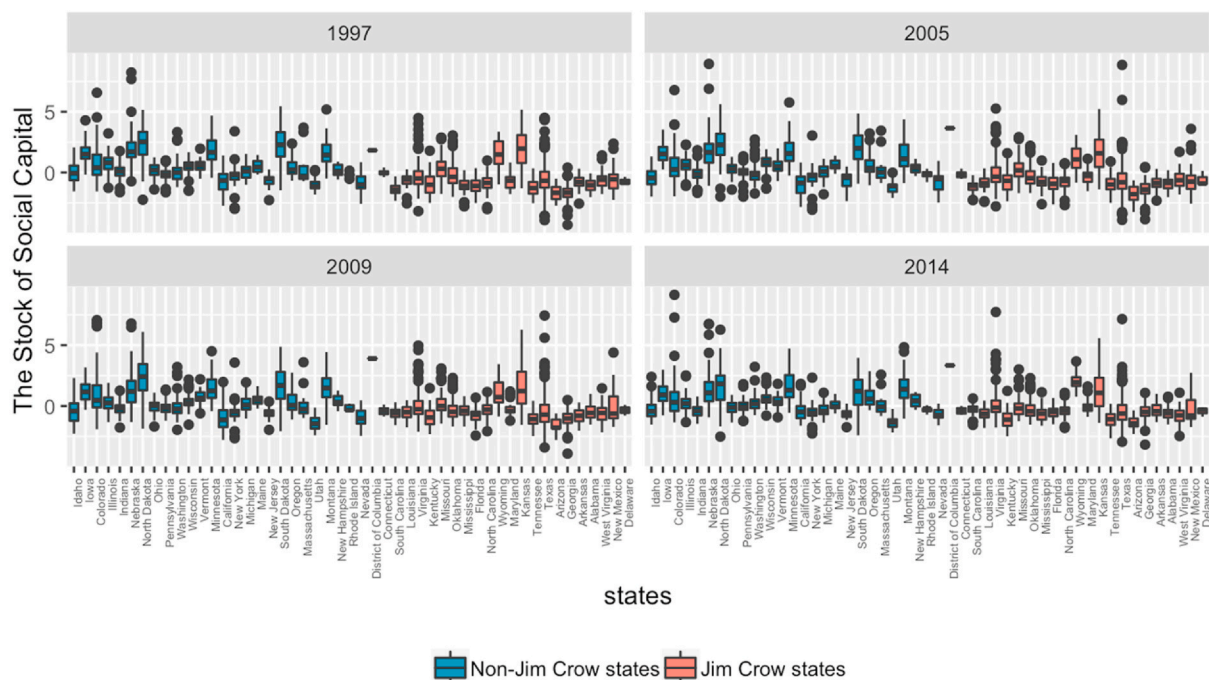
3. Results

Table 1 Describes the differences in descriptive variables between non-Jim Crow and Jim Crow states. The variables for median household income, and social capital for years 1997, 2005, 2009, and 2014 were significantly lower for Jim Crow compared to non-Jim Crow states. The percent of Blacks was higher in Jim Crow states compared to non-Jim Crow states and the percent of those who graduated from high school was not significantly different between Jim Crow and non-Jim Crow states. Fig. 1 displays the box plot of the average of the stock of social capital across all states for 1997, 2005, 2009, and 2014. Horizontal lines represent the median social capital by state, vertical lines are the IRQ range and the dots are outliers which are more than 3/2 times the upper quartile and 3/2 times the lower quartile. States were visually grouped according to whether they were a state with Jim Crow laws or without Jim Crow laws. States that had Jim Crow laws are represented in red and non-Jim Crow states are represented in green. For each of the years shown it is visually represented that states with Jim Crow laws have lower social capital compared to states without Jim Crow laws.

Table 2
Effect of Jim Crow laws on social capital for 1997, 2005, 2009, 2014.

Fixed effect	Model 1		Model 2		Model 3		Model 4	
	B	SE B	B	SE B	B	SE B	B	SE B
Intercept (Non-Jim Crow States)	-0.003	0.012	-0.011	0.028	0.013	0.135	0.375	0.161
Jim Crow States							-0.839***	0.244
Year 2005								
Year 2009								
Year 2014								
County Median Household Income								
County % Black								
County High School Graduate Rate								
State Median Household Income								
State % Black								
State High School Graduate Rate								
Year 2005*Jim Crow States								
Year 2009*Jim Crow States								
Year 2014*Jim Crow States								
Jim Crow States * County Median Household Income								
Year 2005* County Median Household Income								
Year 2009* County Median Household Income								
Year 2014* County Median Household Income								
Year 2005*Jim Crow States * County Median Household Income								
Year 2009*Jim Crow States * County Median Household Income								
Year 2014*Jim Crow States * County Median Household Income								
Random Effect								
County random effects term			-0.195		-0.07		-0.07	
County level variation			1.297		0.648		0.648	
State random effects term					-0.144		-0.138	
state level variation					0.857		0.696	
R-squared	0		0.602		0.764		0.765	
Average squared residual	1.762		0.7		0.415		0.415	
Residual variation	1.762		0.806		0.477		0.478	
Total Variation	1.762		2.103		1.982		1.822	
Within % Variation	100.00%		38.33%		24.07%		26.23%	
Between % Variation	0.00%		61.67%		75.93%		73.77%	
Change in Within % Variation	0.00%		61.67%		14.26%		-2.16%	
Change in Between % Variation	0.00%		-61.67%		-14.26%		2.16%	
	Model 5		Model 6		Model 7		Model 8	
Fixed effect	B	SE B	B	SE B	B	SE B	B	SE B
Intercept (Non-Jim Crow States)	0.376	0.162	0.042	0.174	0.849	1.168	0.993	1.168
Jim Crow States	-0.839***	0.244	-0.836***	0.243	-0.925**	0.317	-1.191***	0.318
Year 2005	-0.003	0.018	-0.003	0.018	-0.003	0.018	-0.071**	0.026
Year 2009	-0.002	0.018	-0.002	0.018	-0.002	0.018	-0.231***	0.026
Year 2014	0.002	0.018	0.002	0.018	0.002	0.018	-0.285***	0.026
County Median Household Income			0.012	0.013	0.013	0.013	0.013	0.013
County % Black			-0.001	0.001	-0.001	0.001	-0.001	0.001
County High School Graduate Rate			0.010***	0.002	0.010***	0.002	0.010***	0.002
State Median Household Income					-0.110	0.113	-0.110	0.113
State % Black					-0.001	0.013	-0.001	0.013
State High School Graduate Rate					-0.021	0.032	-0.020	0.032
Year 2005*Jim Crow States							0.123***	0.035
Year 2009*Jim Crow States							0.416***	0.035
Year 2014*Jim Crow States							0.522***	0.035
Jim Crow States * County Median Household Income								
Year 2005* County Median Household Income								
Year 2009* County Median Household Income								
Year 2014* County Median Household Income								
Year 2005*Jim Crow States * County Median Household Income								
Year 2009*Jim Crow States * County Median Household Income								
Year 2014*Jim Crow States * County Median Household Income								
Random Effect								
County random effects term	-0.07		-0.072		-0.073		-0.074	
County level variation	0.648		0.645		0.645		0.649	
State random effects term	-0.138		-0.11		-0.18		-0.183	
state level variation	0.696		0.691		0.725		0.726	
R-squared	0.765		0.765		0.765		0.772	
Average squared residual	0.415		0.414		0.414		0.402	
Residual variation	0.478		0.476		0.477		0.463	
Total Variation	1.822		1.812		1.847		1.838	
Within % Variation	26.23%		26.27%		25.83%		25.19%	
Between % Variation	73.77%		73.73%		74.17%		74.81%	
Change in Within % Variation	0.00%		-0.04%		0.44%		0.66%	
Change in Between % Variation	0.00%		0.04%		-0.44%		-0.66%	

Fixed effect	Model 9		Model 10		Model 11	
	B	SE B	B	SE B	B	SE B
Intercept (Non-Jim Crow States)	1.081	1.345	1.078	1.369	1.089	1.384
Jim Crow States	-1.232***	0.309	-1.227***	0.309	-1.232***	0.309
Year 2005	-0.070**	1.017	-0.088***	1.080	-0.097***	1.117
Year 2009	-0.231***	1.017	-0.217***	1.080	-0.232***	1.117
Year 2014	-0.286***	1.017	-0.271***	1.080	-0.293***	1.117
County Median Household Income	-0.106***	0.018	-0.097***	0.021	-0.136***	0.025
County % Black	0.000	0.001	0.000	0.001	0.000	0.001
County High School Graduate Rate	0.010***	0.002	0.010***	0.002	0.010***	0.002
State Median Household Income	-0.099	0.110	-0.099	0.110	-0.099	0.110
State % Black	-0.002	0.012	-0.002	0.012	-0.002	0.012
State High School Graduate Rate	-0.021	0.031	-0.021	0.031	-0.021	0.031
Year 2005*Jim Crow States	0.123***	0.035	0.156***	0.036	0.160***	0.036
Year 2009*Jim Crow States	0.416***	0.035	0.389***	0.036	0.396***	0.036
Year 2014*Jim Crow States	0.523***	0.035	0.497***	0.036	0.506***	0.036
Jim Crow States * County Median Household Income	0.212***	0.022	0.212***	0.022	0.277***	0.031
Year 2005* County Median Household Income			0.061***	0.018	0.091**	0.028
Year 2009* County Median Household Income			-0.049**	0.018	0.002	0.028
Year 2014* County Median Household Income			-0.049**	0.018	0.025	0.028
Year 2005*Jim Crow States * County Median Household Income					-0.050	0.036
Year 2009*Jim Crow States * County Median Household Income					-0.085**	0.036
Year 2014*Jim Crow States * County Median Household Income					-0.124***	0.036
Random Effect						
County random effects term	-0.065		-0.065		-0.065	
County level variation	0.656		0.657		0.657	
State random effects term	-0.150		-0.150		-0.150	
state level variation	0.685		0.685		0.685	
R-squared	0.774		0.775		0.775	
Average squared residual	0.399		0.397		0.397	
Residual variation	0.46		0.458		0.458	
Total variation	1.801		1.800		1.800	
Percentage within variation	25.54%		25.44%		25.44%	
Percentage between variation	74.46%		74.56%		74.56%	
Difference in within variation	7.98%		0.10%		0.00%	
Difference in between variation	-7.98%		-0.10%		0.00%	



Footnote: States that had Jim Crow laws are represented in red and non-Jim Crow states are represented in green. Box graphs show horizontal lines that represent the median social capital by state, vertical lines are the IQR range and the dots are outliers which are more than 3/2 times the upper quartile and 3/2 times of lower quartile.

Fig. 1. Average stock of social capital by state for 1997, 2005, 2009 and 2014. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

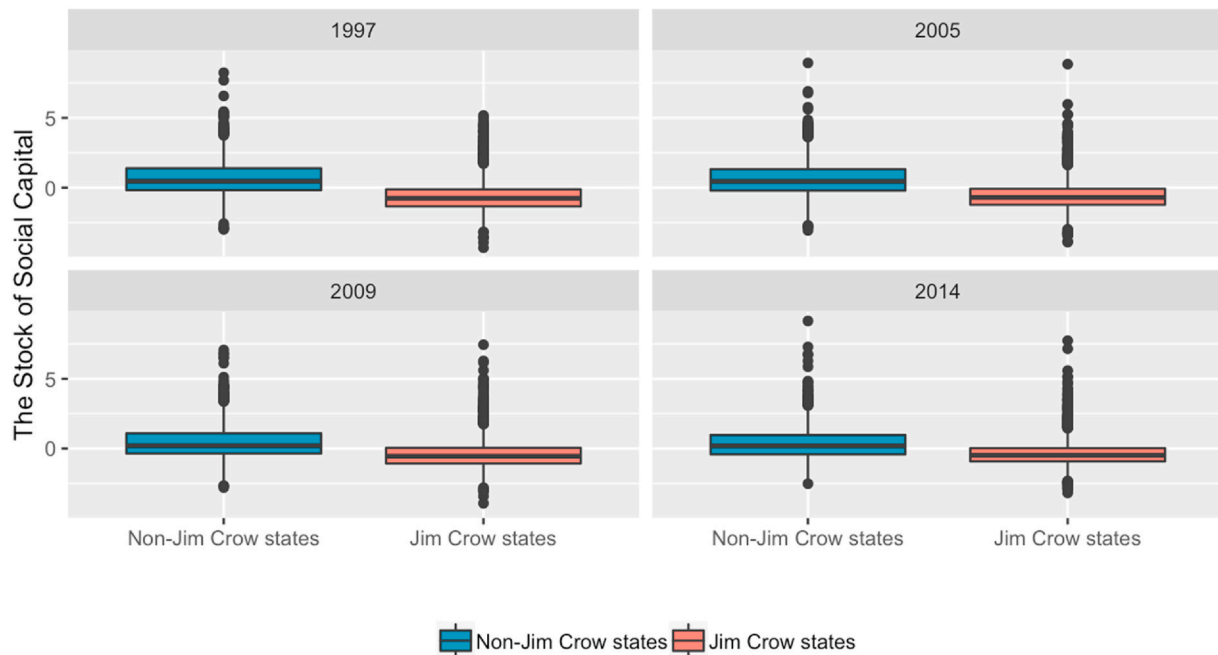


Fig. 2. Average stock of social capital for Jim Crow states and non-Jim Crow states for 1997, 2005, 2009, 2014.

Upon plotting an aggregated average of the stock of social capital of states with and without Jim Crow laws, which is shown in Fig. 2, we visually see lower social capital in Jim Crow states compared to non-Jim Crow states across all 4 time points.

Table 2 shows the regression models 1–11 for the effects of Jim Crow laws on the stock of social capital. The coefficient for Jim Crow is significantly negative across all models with the Jim Crow coefficient. Model 4, controlling for the fixed terms for year and county and state level variation, Jim Crow states on average had a 0.839 ($p < .001$) lower stock of social capital compared to states that did not have Jim Crow laws. The addition of the Jim Crow law, from Model 3 to 4, the between percent variation explained increased by 2.16%. The addition of the fixed variable for year in Model 5, the coefficient for Jim Crow remained significant. Upon the addition of the county level covariates in Model 6, for median income, percent Black and percent with high school education at the state levels, the Jim Crow coefficient increased to -0.836 ($p < .01$) and the only percent high school graduation rate at the county level was significant with a coefficient of 0.010 ($p < .001$). The addition of state level covariates in Model 7, the Jim Crow coefficient decreased to -0.925 ($p < .01$) and all covariates were not significant except for county level percent high school graduation rate with a coefficient of 0.010 ($p < .001$). In Model 8, the addition of the interaction term for Jim Crow and each of the years 2005, 2009, and 2014, Jim Crow states had an on average 1.191 lower stock of social capital compared to non-Jim Crow states. The coefficient of high school percent graduation rate at the state level was 0.010 ($p < .001$). The interaction terms for Jim Crow was significantly positive for all years with the coefficients for 2005, 2009, and 2014 prospectively 0.123 ($p < .001$), 0.416 ($p < .001$) and 0.522 ($p < .001$).

In Model 9 the Jim Crow coefficient was -1.232 ($p < .01$) and all covariates were not significant except for county level percent high school graduation rate with a coefficient of 0.010 ($p < .001$), and county median income with a coefficient of -0.106 ($p < .001$). The interaction terms for Jim Crow was significantly positive for all years with the coefficients for 2005, 2009, and 2014 prospectively 0.123 ($p < .001$), 0.416 ($p < .001$) and 0.523 ($p < .001$). The interaction term for Jim Crow and county median household income was 0.212 ($p < .001$). In Model 10 the Jim Crow coefficient was to -1.227 ($p < .01$) and all covariates were not significant except for county

level percent high school graduation rate with a coefficient of 0.010 ($p < .001$) county median income with a coefficient of -0.097 ($p < .001$). The interaction terms for Jim Crow was significantly positive for all years with the coefficients for 2005, 2009, and 2014 prospectively 0.156 ($p < .001$), 0.389 ($p < .001$) and 0.497 ($p < .001$). The interaction term for Jim Crow and county median household income was 0.212 ($p < .001$) and the interaction term between county median household income and 2005, 2009, and 2014 prospectively was 0.061 ($p < .001$), -0.049 ($p < .001$) and -0.049 ($p < .001$). In Model 11 the Jim Crow coefficient was to -1.232 ($p < .01$) and all covariates were not significant except for county level percent high school graduation rate with a coefficient of 0.010 ($p < .001$) and county median income with a coefficient of -0.136 ($p < .001$). The interaction terms for Jim Crow was significantly positive for all years with the coefficients for 2005, 2009, and 2014 prospectively 0.160 ($p < .001$), 0.396 ($p < .001$) and 0.506 ($p < .001$). The interaction term for Jim Crow and county median household income was 0.277 ($p < .001$) and the interaction term between county median household income and 2005, was 0.091 ($p < .001$). The three-way interaction term for Jim Crow X county median household income X year was significant for year 2009, and 2014 and the coefficient was prospectively -0.085 ($p < .001$) and -0.124 ($p < .001$).

4. Discussion

Jim Crow laws significantly reduced the stock of social capital and the statistical model in this analysis was robust to the inclusion of random county, states, time and fixed county and state level covariates for median income, percent Black and percent with high school education. The largest percent of between state variations explained for fixed variables was from the addition of Jim Crow laws with 2.86%. These results demonstrate that although Jim Crow laws were abolished in 1965, the apparent effects of racial segregation may have persisted and lowered social capital in Jim Crow states relative to non-Jim Crow states. Previous studies have demonstrated the negative impacts of anti-LGBTQ laws and neighborhoods on the health of LGBTQ persons and how the removal of these laws has partially alleviated these detrimental effects (Duncan and Hatzenbuehler, 2014; Hatzenbuehler et al., 2012). Although based in the 1960's, the Jim Crow laws may also have had a

lasting neighborhood effect on the entire communities and in particular persons of color who were targeted by these anti-Black laws.

Even though states with Jim Crow laws always had lower stock of social capital for each of the time periods of 1997, 2005, 2009, 2014, there was a positive interaction term with Jim Crow laws for every time period demonstrating that the stock of social capital within states with Jim Crow laws rose faster compared to states without Jim Crow laws. This result potentially shows that the association between Jim Crow and social capital could be attenuating over time. The steeper rise among Jim Crow states may be attributed to the rise in equality between Blacks and Whites after the Civil Rights Act, where improvements in equality may have been greater in states that had these legal discriminatory laws relative to those states without (i.e., non-Jim Crow states). For instance, a previous study demonstrated that racial prejudice is associated with lower amounts of social capital (Y. Lee et al., 2015). Therefore, elimination of racial segregation over time may have reduced racial prejudice, and may have led to greater cooperation and reciprocity in these communities, which further developed the stock of social capital. Similar temporal effects have also been observed in outcomes such as infant mortality (Krieger et al., 2013) and premature mortality (Krieger et al., 2014), whereby greater improvements in these outcomes were seen in states with Jim Crow laws in the periods after these laws were abolished. Our study did not test the potential mediator of social capital and Jim Crow laws and these specific health outcomes but should be tested in the future to better understand the potential mechanistic pathway of Jim Crow to social capital and infant mortality and premature mortality.

For the baseline year of 1997 in non-Jim Crow states, county median income had a negative association on social capital, and for the years 2009 and 2014 this association was more negative compared to 1997. However, the interaction term for Jim Crow X median income was significantly positive. This implies that for the year 1997, a crossover effect whereby the association of income and social capital was positive in Jim Crow states, which is the opposite to the association that was seen in non-Jim Crow states. Therefore, in Jim Crow states, areas that had lower income had worse social capital compared to areas with the same level of low income in non-Jim Crow states. These results may be related to the segregation of Blacks within Jim Crow states making these low-income areas more racially segregated and more socially fragmented.

The three-way interaction term for Jim Crow X county median income X time was significantly negative for 2009 and 2014, implying the positive association of median income and social capital in Jim Crow states diminished for these years compared to 1997, and the disparities in social capital between high- and low-income states also became smaller over time. Based on these findings, it shows that in Jim Crow states the difference between social capital of low-income areas vs. high-income areas was greater, but this gap decreased faster compared to non-Jim Crow states.

5. Limitations

Our findings of the relationship between Jim Crow laws and the lowering of the stock of social capital are associative and therefore cannot be deemed as causal. Ecological proxies for individual-level measures have been validated in previous studies and are often used in population health studies, especially in the context of evaluating the social environment (Mustard et al., 1999). As the stock of social capital is an ecological-level factor measured at the county level, analyses were conducted at the ecological-level. County and state level random effects were also included in the model and results should be interpreted at the ecological-level.

We used an established objective measure of the stock of social capital that combines a number of measures but may not have captured the subjective perceptions of trust and interpersonal reciprocity. Self-reported questionnaire measures were not included to avoid the

potential for social desirability bias, which has been shown to be more pronounced among more highly educated individuals (Y. Lee et al., 2015), and that may have led to a dampening of the results.

It has been postulated that Blacks may have created solidarity against White domination (Orr, 1999) with the possibility of generating stronger social capital among Blacks (Behtoui and Neergaard, 2016). Thus, it may be the case that the rise in the stock of social capital over time in Jim Crow states may be attributed to this unity amongst Blacks in these states. However, we measured the stock of social capital with an objective measure to remove response and recall, which could be correlated with racial prejudice to purposefully minimize this potential confounding (Y. Lee et al., 2015). The stock of social capital was not measured separately for Blacks thus we were not able to evaluate the differential effects of Jim Crow laws on the social capital of Blacks or whether there were larger disparities in social capital between Blacks and Whites in Jim Crow states compared to non-Jim Crow states. However, our findings do show Jim Crow laws significantly reduced the overall social capital of the community, generating state-level disparities that may have been detrimental for all racial groups living in areas with Jim Crow laws. The implications of social capital may also impact racial groups differently (Hutchinson et al., 2009; Lochner et al., 2003). Studies have shown the widening of racial disparities in health because of Jim Crow laws (Krieger et al., 2013, 2017). Therefore Jim Crow laws may be linked with the widening of racial disparities on health through the mechanism of social capital. While our study did not evaluate the effects of Jim Crow laws on racial disparities, further investigation should be taken to find the differential effects that Jim Crow laws have on social capital of Blacks and its consequences on racial disparities in health.

Although we did find a differential relationship between income and social capital in Jim Crow states compared to non-Jim Crow states, we did not conduct an analysis on the differential relationship between other variables such as percent Blacks and percent high-school education. Future studies should investigate the interaction between different area-level variables such as percent Black and social capital and Jim Crow laws to understand how the variable relationships may be impacted by legal segregation of Blacks and Whites. Additionally, it would be useful to understand the contribution of Jim Crow Laws on inequality especially because previous studies have documented the link between inequality and social capital. Therefore, Jim Crow laws may contribute to the upstream effects towards inequality and lower social capital in these areas.

Finally, our measure for social capital was not available before the passing of Jim Crow laws and it remains unclear if states with Jim Crow laws had lower social capital to begin with. Previous research has found that perceived scarcity can produce racial bias (Krosch and Amodio, 2014; Krosch et al., 2017). Hence it is possible that states with higher scarcity of social resources like social capital fostered racial discrimination and contributed to the passing of Jim Crow laws. Therefore, directionality of the effects cannot be confirmed by our study's findings.

6. Conclusion

Until the last quarter of the century, local governments systematically defined where Whites and Blacks lived, specifically restricting the choice of residence for Blacks, and the detrimental effects of these discriminatory practices persist to present day (Rothstein, 2017). Racism is adaptive over time and our study shows it is also pervasive over space and time (Williams et al., 2019). Our results offer novel evidence that Jim Crow laws reduce the stock of social capital, and may be the missing link in the pathway towards the poorer health outcomes seen in Jim Crow states by previous studies. This is the first study to investigate the mechanistic pathways between historical racist policies and the fracturing of trust, reciprocity and collective action, reflected as stock of social capital. Further research needs to be conducted to investigate the association between Jim Crow laws and human capital investment and

the potential mediation effect of social capital on higher rates of morbidity and mortality in these historically racially segregated states. Findings from this study offer insight on the effects of historical policies on the social structure of a community. Generating interventions to increase social capital in these areas may prove effective towards gaining greater human capital investment and improving health outcomes in these areas.

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Appendix A. Supplementary data

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Author statement

YH conceived of the study and design, acquired the data, interpreted the analyses and results, wrote the manuscript and revised the manuscript critically for important intellectual content.

QQ cleaned the data and conducted analyses.

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