Separate and unequal: Structural racism and infant mortality in the US

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ABSTRACT

We examined associations between state-level measures of structural racism and infant mortality among black and white populations across the US. Overall and race-specific infant mortality rates in each state were calculated from national linked birth and infant death records from 2010 to 2013. Structural racism in each state was characterized by racial inequity (ratio of black to white population estimates) in educational attainment, median household income, employment, imprisonment, and juvenile custody. Poisson regression with robust standard errors estimated infant mortality rate ratios (RR) and 95% confidence intervals (CI) associated with an IQR increase in indicators of structural racism overall and separately within black and white populations. Across all states, increasing racial inequity in unemployment was associated with a 5% increase in black infant mortality (RR=1.05, 95% CI=1.01, 1.10). Decreasing racial inequity in education was associated with an almost 10% reduction in the black infant mortality rate (RR=0.92, 95% CI=0.85, 0.99). None of the structural racism measures were significantly associated with infant mortality among whites. Structural racism may contribute to the persisting racial inequity in infant mortality.

1. Introduction

In the US, the black infant mortality rate is more than double the white infant mortality rate (Matthews et al., 2015). This profoundly disturbing racialized patterning of infant mortality has existed for as long as data have been available (MacDorman, 2011), and research has largely centered around individual-level determinants, highlighting differences in the lived experiences and socioeconomic circumstances between black and white women (Geronimus, 1992; Lu et al., 2010). Increasingly, however, efforts aimed at eliminating social inequalities in health have begun to focus on macro-level conditions and societal contexts as explanations behind the persistent difference in rates at the population level (Siddiqi et al., 2016).

Understanding the development of racial inequities in health – including infant mortality – requires historical contextual framing and the identification of the contemporary US as an unequal society (Siddiqi et al., 2016). For centuries, whites in the US have and continue to unfairly benefit from generations of socioeconomic advantage and with it greater opportunities in education and employment, healthier

neighborhood environments, higher quality health care and greater political power (Feagin and Bennefield, 2014). The creation and perpetuation of this inequitable system of opportunity and privilege constitutes structural racism (Aspen Institute, 2013).

A growing body of research is beginning to reveal how structural racism divides the health of the nation along racial lines (Feagin and Bennefield, 2014; Jee-Lyn Garcia and Sharif, 2015; Krieger, 2008; Lukachko et al., 2014; Williams and Collins, 2001). Structural racism restricts access for people of color to health-promoting factors (i.e. wealth, income, safe housing, quality education and health care). The result is a health disadvantage among socially-marginalized groups who lack resources to prevent and treat disease (Link and Phelan, 1995). For pregnant women, the consequences of structural racism may be transgenerational, increasing their own risk during pregnancy and the likelihood of their infant's morbidity and mortality.

Socioeconomic gradients in health, irrespective of race, have been well documented (Adler and Ostrove, 1999). Infant mortality risk decreases as income and educational levels increase *within* black and white women, (Goza et al., 2007) although the effects of socioeconomic

measures on black women's risk are generally smaller and more variable than among white women (Goza et al., 2007; Messer et al., 2008). Previous research has not examined the health impact of relative measures on infant mortality, i.e., the unequal distribution of income, employment, education, and the denial of opportunities (incarceration) *between* black and white populations. These relative measures represent novel metrics of structural racism for exploration of its impact on black infant mortality.

The present study seeks to explore the extent to which state-level racial inequities in societal conditions – proxy for social policies that dictate distribution and redistribution of resources and opportunities – are associated with state-level racial inequities in infant mortality (Siddiqi et al., 2016). We focus on the state level as many social policies are legislated and implemented by the state governments with substantial variation across the country. We hypothesize that states with a high degree of structural racism (i.e. large racial inequalities in income, employment, education and judicial treatment) have larger racial inequities in infant mortality. First we examine how these factors impact infant mortality overall, and separately within white and black women. Second, we examine how inequities in these factors (black relative to white population measures) are associated with infant mortality and whether they differentially predict infant mortality separately within black and white populations. Following theories and earlier research on structural racism (Feagin and Bennefield, 2014; Lukachko et al., 2014; Schnittker et al., 2011; Subramanian et al., 2009; Uggen and Manza, 2002), we hypothesize that inequities in these factors will be associated with higher infant mortality rates among blacks but not whites. It may be that whites in fact experience a health benefit (lower infant mortality rates) associated with greater racial inequity that results from the privilege of greater individual and societal resources (money, knowledge, political and commercial power) (Phelan and Link, 2015). Our large dataset of national vital records provides geographic representation across all 50 states for a comprehensive examination of contextual variation.

2. Methods

2.1. Outcome

The National Center for Health Statistics (NCHS) provided annual linked birth/infant death files from 2010 to 2013, inclusive, including geographic identifiers for maternal state of residence for all 50 states and the District of Columbia. The linked birth/infant death data sets consists of a numerator file containing death records for all infant deaths occurring in a given calendar year linked to their corresponding birth certificates, whether the birth occurred in the same or previous year, for all instances where both the birth and the death occurred in the 50 states and the District of Columbia. The denominator file contains all birth certificates for infants born in the given calendar year, for the purposes of computing infant mortality ratios per 100,000 live births. In some states, incomplete linkage of all infant deaths to their corresponding birth record results in a small number of unlinked infant deaths. Therefore a weight is added to the linked numerator file to correct in part for biases in the percent of records linked by major characteristic. Accounting for weighted data, we computed the 4-year infant mortality rate (deaths per 1000 live births) for the total population (n=95,554 deaths), and separately for infants born to self-reported non-Hispanic (NH) black and NH white women in each state.

2.2. Exposures

Structural racism in each state was characterized as the degree of racial inequality across socioeconomic and judicial domains. State-level indicators included prison incarceration and juvenile custody rates; educational attainment (proportion of the population age 25 and older with a Bachelor's degree or higher); unemployment (proportion of the

civilian labor force not currently employed); professional occupation status (proportion of the civilian employed population in management, business, science, and arts occupations); and median household income (2013 inflation-adjusted dollars). Structural racism was operationalized as the ratio of black to white population values for each indicator.

Data on the indicators came from several sources and were linked to vital records by state Federal Information Processing Standard code. The Sentencing Project (Sentencing Project, 2016) provided 2013 estimates of prison incarceration and juvenile custody rates by race and state, based on data reported by the US Bureau of Justice Statistics and the US Office of Juvenile Justice and Delinquency Prevention. Data on the remaining indicators came from the US Census Bureau's American Community Survey 3-year estimates 2011–2013 for each state, within the total population and separately among black and white populations. All indicators were scaled to their interquartile range (IQR). IQR scaling enables interpretation of the resulting regression coefficients as a comparison of infant mortality rates in state with typically high values of the indicator variable to rates in states with typically low values.

2.3. Statistical analysis

Descriptive statistics characterized infant mortality rates and all contextual indicators across jurisdictions for the total population and separately among NH black and NH white populations, where sample size permitted (the ACS suppresses population counts where there are no or too few observations to compute a reliable estimate). Poisson regression with robust standard errors first estimated associations for an IQR increase in the absolute level of each indicator (i.e. incarceration rate, unemployment rate, educational attainment, etc.) and infant mortality rates for the total state population. In order to control for differences in states' racial compositions and economic conditions, rate ratios (RR) and 95% confidence intervals (CI) associated with an IQR increase were adjusted for the proportion of births that were among black women and the state poverty level (American Community Survey 2011–2013 3-year estimate of the percent of state population living below the Federal Poverty Level). Second, we estimated the same associations among black and white populations separately, adjusting only for the state poverty level. Third, we estimated RRs and 95% CI associated with an IQR increase in relative levels of each indicator (i.e. the ratio of black to white incarceration rates, unemployment rates, etc.) for the total population infant mortality rate adjusting for the state poverty level and proportion of births to black women, and again separately among black and white women adjusting for the state poverty level only. In order to isolate the effect of *racial inequity* in socioeconomic and criminal justice conditions independent of the state's overall level of socioeconomic and criminal justice conditions, we additionally adjusted the relative measures for the absolute level within the state. For example, RR associated with racial inequity in unemployment was adjusted for the state's overall unemployment rate.

3. Results

From 2010–2013, overall infant mortality averaged approximately 6 deaths per 1000 live births across all 50 states and DC ranging from a low of 4.26 in Massachusetts to a high of 9.37 in Mississippi (Table 1). Nationally, black infant mortality averaged 7.57 per 1000 live births and exceeded the estimate among whites in every state.

The rate of imprisonment among black residents was on average 6.2 times higher than the white imprisonment rate, and the custody rate among black juveniles was more than 7 times the white juvenile custody rate. Unemployment rates were double, and median household incomes only two-thirds on average among black residents compared to whites. The proportion of black residents with a Bachelor's degree or higher and the proportion employed in professional or managerial

Table 1

Mean and distribution of infant mortality rates and state-level structural racism indicators.

	Mean (STD)	Min	Max	IQR
Infant mortality rate (deaths per 1000 live births)	6.19 (1.18)	4.26	9.37	2.05
Black infant mortality rate	7.57 (1.42)	5.26	11.77	2.27
White infant mortality rate	3.31 (0.56)	1.78	4.31	0.82
Births to black women (% of the population of live births)	0.13 (0.12)	0.01	0.52	0.16
Prison incarceration rate (per 100,000 population)	391.96 (142.90)	153.00	816.00	167.00
Black imprisonment rate[a]	1470.53 (480.23)	585.00	2625.00	676.00
White imprisonment rate[a]	274.92 (118.31)	56.00	580.00	165.00
Ratio of black to white imprisonment rate	6.21 (3.08)	2.38	19.00	3.68
Juvenile custody rate (per 100,000 population)	178.08 (86.89)	46.00	560.00	88.00
Black juvenile custody rate	565.8 (338.55)	77.00	2162.00	377.00
White juvenile custody rate	103.2 (58.92)	12.00	255.00	70.00
Ratio of black to white juvenile custody rate	7.15 (6.44)	1.23	36.45	3.18
Educational attainment (% of population age 25 and older with a Bachelor's degree or higher)	28.91 (5.96)	18.84	53.49	6.38
Black educational attainment	20.09 (5.01)	12.60	36.58	6.40
White educational attainment	32.57 (10.11)	18.67	90.13	8.77
Ratio of black to white educational attainment	0.64 (0.15)	0.26	1.12	0.13
Unemployment (% of civilian labor force who are unemployed)	8.56 (1.97)	3.00	12.00	3.20
Black unemployment[b]	15.7 (3.07)	7.30	23.20	3.90
White unemployment	7.06 (1.73)	2.50	10.80	2.10
Ratio of black to whites unemployment	2.33 (0.7)	1.56	5.88	0.56
Managerial positions (% of civilian employed population in management, business, science, and arts occupations)	36.07 (4.83)	27.50	60.70	4.00
Black managerial employment[c]	28.05 (4.3)	21.64	40.69	5.31
White managerial employment	40.02 (7.34)	31.67	81.00	5.97
Ratio of black to white in managerial employment	0.70 (0.08)	0.47	0.88	0.09
Median Household Income (2013 inflation-adjusted dollars)	52905.78 (8774.63)	38087.00	72345.00	12641.00
Black median household income	35679.78 (8514.47)	24505.00	61265.00	12392.00
White median household income	58427.96 (12343.14)	41241.00	113910.00	12354.00
Ratio of black to white median household income	0.61 (0.11)	0.34	0.92	0.10
Poverty (% of population below the Federal Poverty Level)	15.22 (3.23)	9.10	23.30	6.00

[a] DC excluded because data not reported.

[b] MT excluded because data from this geographical area are not reported as number of sample cases is too small.

[c] ID, ME, MT, ND, SD, VT, WY excluded because data from these geographical areas are not reported as number of sample cases is too small.

occupations were 0.64 and 0.70 times lower, respectively, than the proportions among white residents.

States with lower imprisonment rates, and higher levels of education, professional employment, and median household incomes had lower infant mortality rates overall (Table 2). These patterns of association were similar within whites. Black infant mortality rates were significantly associated with total population median household income. For every $12,641 (IQR) increase in state's median household income, the black infant mortality rate was decreased by 17% (RR=0.83, 95% CI=0.72, 0.95).

Race-stratified results are shown in Table 3. Within both the black and white populations, states with higher levels of managerial employment, educational attainment, and income had lower infant mortality rates. Unemployment within the state's black population was additionally associated with black infant mortality such that increasing unemployment was associated with higher infant mortality rates. Criminal justice indicators within the state's black population (imprisonment and juvenile custody rates) were not significantly asso-

ciated with black infant mortality rates. Unemployment was not associated with infant mortality among whites; however, there was a positive association between juvenile custody among whites and infant mortality with rates increased by 7% among states in the lowest quartile of white juvenile custody rates compared to states in the highest quartile.

Finally, Table 4 contains estimates associated with measures of structural racism, or the black to white ratio of each indicator. As hypothesized, the analysis revealed harmful effects of structural racism on black – but not white – infant mortality. Across all states, increasing racial inequity in unemployment was associated with a 5% increase in black infant mortality (RR=1.05, 95% CI=1.01, 1.10). Decreasing racial inequality in education by just 13% was associated with an almost 10% reduction in the black infant mortality rate (RR=0.92, 95% CI=0.85, 0.99), independent of the educational level of the state's residents overall. None of the structural racism measures were significantly associated with infant mortality among whites.

Table 2

Overall and race-specific infant mortality rate ratios (RR) and 95% confidence intervals (CI) for associations with contextual indicators among the total state population.

	Overall Infant Mortality[a]		Black Infant Mortality[b]		White Infant Mortality[b]	
	RR	95% CI	RR	95% CI	RR	95% CI
Prison incarceration rate	**1.09**	**(1.02, 1.17)**	1.06	(0.96,1.16)	1.06	(0.99,1.13)
Juvenile custody rate	1.00	(0.99, 1.00)	1.00	(1.00,1.00)	**1.00**	**(1.00,1.00)**
Unemployment	**0.88**	**(0.81, 0.97)**	0.99	(0.88, 1.12)	0.91	(0.83, 1.00)
Managerial positions	**0.89**	**(0.83, 0.96)**	0.97	(0.91, 1.05)	**0.88**	**(0.82, 0.94)**
Educational attainment	**0.84**	**(0.78, 0.90)**	0.91	(0.80, 1.05)	**0.83**	**(0.78, 0.89)**
Median household income	**0.78**	**(0.73, 0.84)**	**0.83**	**(0.72, 0.95)**	**0.76**	**(0.70, 0.82)**

[a] Model controlled for % of state population in poverty and % of 2010–2013 births that were among black women.

[b] Model controlled for % of state population in poverty only.

Table 3

Infant mortality rate ratios (RR) and 95% confidence intervals (CI) for associations with contextual indicators within the state's Black and White populations separately.[a]

Race-stratified indicators	Black Infant Mortality [b]		White Infant Mortality [b]	
	RR	95% CI	RR	95% CI
Black imprisonment rate	1.02	(0.96,1.08)		
Black juvenile custody rate	1.00	(0.89,1.13)		
Black unemployment	**1.06**	**(1.00,1.12)**		
Black managerial employment	**0.91**	**(0.85, 0.99)**		
Black educational attainment	**0.85**	**(0.78, 0.93)**		
Black median household income	**0.86**	**(0.77, 0.98)**		
White imprisonment rate			1.06	(0.99, 1.14)
White juvenile custody rate			**1.07**	**(1.01, 1.13)**
White unemployment			0.96	(0.89, 1.03)
White managerial employment			**0.87**	**(0.85, 0.91)**
White educational attainment			**0.85**	**(0.81, 0.89)**
White median household income			**0.85**	**(0.81, 0.89)**

[a] Models controlled for % of state population in poverty.

4. Discussion

A large body of previous work has demonstrated that individual-level differences between women in the US do not entirely explain the persistence of a racial inequities in infant mortality at the population level. Doing so requires a movement away from analysis of individual-level factors towards broader explanations that consider the structure of the society into which women are born, live, work and grow (Marmot, 2007). Our analysis contributes to a small but growing body of work aimed at exploring societal conditions – shaped by historical and contemporary social policies – as determinants of racial inequities in health (Do et al., 2008; Lukachko et al., 2014; Siddiqi et al., 2016; Subramanian et al., 2009).

First, we find that associations between state-level socioeconomic conditions and infant mortality mirror those at the individual level: mortality rates were lower in states with higher median household incomes, and larger populations of college-educated and professionally employed individuals. Because they are measured across the state's total population, however, these factors are largely dictated by white population estimates given its significantly larger size relative to black populations and therefore not surprisingly have total population patterns of association mirrored within the white-specific infant mortality rates. The counterintuitive negative association suggesting higher unemployment correlates to lower infant mortality corroborates previous findings (Orsini and Avendano, 2015; Ruhm, 2009; Tapia Granados, 2005). But race-specific infant mortality rates were not significantly associated with total population unemployment, underscoring the heterogeneous impact of economic instability (Couch and Fairlie, 2010).

Second, within-race comparisons revealed similar patterns: black infant mortality was lower in states where a greater proportion of the

black population had a college education, were employed in a professional or managerial position, and had a higher median household income and the same was true within the white population. Of these contextual predictors, median household income was the strongest for both blacks and whites, a finding in line with similar work by Siddiqi et al. who also found that state-level median household income was inversely associated with both white and black infant mortality rates. Our work further compliments their exploration of state-level income inequality – an increasing problematic feature of contemporary society – in association with infant mortality (Siddiqi et al., 2016). Unexpectedly, they report a negative association between income inequality and two-year lagged black infant mortality, which they suggest may be reflective of increases in black income with simultaneous but more rapid increases in white income driving income inequality overall (Siddiqi et al., 2016). This finding implicates the importance of examining race-specific and between-race measures, including additional societal conditions related to resource and opportunity deprivation as we have done in the current analysis.

Racial inequity was apparent across all measures of socioeconomic and judicial treatment indicators we examined, evidence of entrenched racial hierarchy and structural racism. The largest inequity between races was in judicial treatment where rates of imprisonment and juvenile custody were 6 and 7 times higher on average among blacks compared to whites and still 3 and 6 times higher, respectively, in states with the smallest inequities. In relation to infant mortality rates, however, we found inequities in socioeconomic indicators to be more strongly associated. In a previous exploration of structural racisms effect on population health, we found that racial inequity in incarceration was strongly associated with increased risk of small-for-gestational age birth – a potentially serious infant morbidity – only when co-occurring with high levels of income inequality (Author 2015, [details

Table 4

Overall and race-specific infant mortality rate ratios (RR) and 95% confidence intervals (CI) for associations with measures of structural racism.

Structural racism measures[a]	Overall Infant Mortality[b]		Black Infant Mortality[c]		White Infant Mortality[c]	
	RR	95% CI	RR	95% CI	RR	95% CI
Ratio of black to white imprisonment rate	0.95	(0.87, 1.03)	0.97	(0.87, 1.07)	0.96	(0.87, 1.04)
Ratio of black to white juvenile custody rate	0.98	(0.95, 1.01)	0.99	(0.96, 1.02)	0.99	(0.96, 1.02)
Ratio of black to white unemployment	1.02	(0.97, 1.07)	**1.05**	**(1.01, 1.10)**	1.04	(0.99, 1.09)
Ratio of black to white educational attainment	1.01	(0.97, 1.05)	**0.92**	**(0.85, 0.99)**	0.99	(0.96, 1.02)
Ratio of black to white in managerial positions	**1.07**	**(1.00, 1.14)**	0.99	(0.90, 1.09)	1.04	(0.98, 1.10)
Ratio of black to white median household income	0.98	(0.93, 1.03)	0.95	(0.87, 1.03)	0.96	(0.92, 1.01)

[a] All models including ratio measures controlled for the corresponding absolute measure in the total population. For example, the ratio of black to white imprisonment rate is controlled for the total state-level prison incarceration rate.

[b] Models additionally controlled for % of state population in poverty and % of 2010–2013 births to black women.

[c] Model additionally controlled for % of state population in poverty only.

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As hypothesized, socioeconomic indicators of structural racism – racial inequity in educational attainment and employment – were negatively associated with black infant mortality only, and these relationships persisted above and beyond the absolute levels of poverty, education, and unemployment within the state's population. Structural racism measures were not associated with white infant mortality. Greater racial inequity did not increase white infant mortality rates, nor did whites experience a health benefit (reduced infant mortality rates) relative to their increasingly advantaged status, contrary to findings demonstrated previously in a similar analysis of structural racism and cardiac health (Lukachko et al., 2014).

While the use of national linked live birth and infant death records provides comprehensive geographic coverage, we are limited to ecologic analyses of state-level mortality rates. Future explorations of social contexts may consider multi-level analysis to identify the variance in mortality attributable to differences in state-level indicators partitioned from individual-level risk factors known to increase risk of infant mortality. Second, as a cross-sectional examination, our state-level indicators were measured at approximately the same range of years as our estimates of infant mortality. However, the deleterious effects of racial inequity may be chronic or cumulative across the life-course and likely even generations. Longitudinal examinations that consider length of contextual exposure to structural racism may provide further insight. Additionally, we examined a limited number of indicators of structural racism and may not have fully captured the degree to which social context within a state systematically disadvantages the black population leading to racialized disparities in health. Relatedly, we chose to focus on the state-level as state-level policies such as investments in education and employment dictate the structure of opportunities available to all residents. However, structural racism may act on various levels within the state which we did not examine, including more proximal neighborhood or city- or county-level characteristics such as racial residential segregation, or concentrated disadvantage. Finally, due to the small black population in some states, data on employment and particularly employment in professional or managerial positions was not available. As a result, the models estimating associations between racial inequity in these indicators and infant mortality may have been underpowered.

Despite these limitations, the implications of this study are significant. They underscore the importance of future research that considers not only absolute measures of resources and opportunities within a population subgroup but also their distribution relative to other groups in order to understand the harmful health effects of social hierarchy. Moreover, they suggest that addressing the entrenched racialized disparity in infant mortality requires policy initiatives that target greater racial equity in education and employment.

Funding

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