Joint Effects of Structural Racism and Income Inequality on Small-for-Gestational-Age Birth

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Objectives. We examined potential synergistic effects of racial and socioeconomic inequality associated with small-for-gestational-age (SGA) birth.

Methods. Electronic medical records from singleton births to White and Black women in 10 US states and the District of Columbia (n = 121 758) were linked to state-level indicators of structural racism, including the ratios of Blacks to Whites who were employed, were incarcerated, and had a bachelor's or higher degree. We used state-level Gini coefficients to assess income inequality. Generalized estimating equations models were used to quantify the adjusted odds of SGA birth associated with each indicator and the joint effects of structural racism and income inequality.

Results. Structural racism indicators were associated with higher odds of SGA birth, and similar effects were observed for both races. The joint effects of racial and income inequality were significantly associated with SGA birth only when levels of both were high; in areas with high inequality levels, adjusted odds ratios ranged from 1.81 to 2.11 for the 3 structural racism indicators.

Conclusions. High levels of racial inequality and socioeconomic inequality appear to increase the risk of SGA birth, particularly when they co-occur. (*Am J Public Health.* 2015;105:1681–1688. doi:10.2105/AJPH.2015.302613)

In the United States, Black women are more than 1.5 times as likely as White women to give birth to a small-for-gestational-age (SGA) infant, typically defined as an infant with a birth weight below the 10th percentile for a given gestational age; such births increase the risk of neonatal morbidity and long-term deficits in growth and development.[1] This disparity has persisted for decades and is not fully explained by differences in health behaviors or access to prenatal care.[2–4] Although individual socioeconomic status attenuates some of the increase in risk experienced by Black women, residual disparities remain.[5]

Racial discrimination may be a distinct and critical source of chronic stress among women of color, both during pregnancy and across the life course.[6] Disparities in perinatal outcomes, including SGA birth, are of particular interest to researchers concerned with the potential health effects of discrimination. A growing body of research has identified the harmful effects of racial discrimination on the health of Blacks in the United States.[7] Evidence suggests that discrimination may be at least partially responsible for the large and persistent disparities in morbidity and mortality that exist between Whites and Americans of color.[8] Much of this research has focused on individual experiences of discrimination, but a relatively recent paradigm shift has begun to identify such experiences as part of a larger system of policies and practices that reinforce racial inequity.[9]

This system refers to the concept of structural racism, defined as the exclusion of racial minorities from resources and opportunities (e.g., wealth, housing, education), effectively creating a health disadvantage.[10] The historical legacy of racial oppression experienced by Black Americans[9,11] and persistent differences in access to resources have resulted in a system of strong links between race and social class at the population level. Inequalities in health therefore are not driven by race or class alone,[12] and disentangling the health effects of both racial and socioeconomic disadvantage continues to present conceptual and methodological difficulties.[13]

Previous work highlighting the detrimental effects of structural racism on pregnancy outcomes, including infant size and gestational age at delivery, has been largely limited to analyses of neighborhood or metropolitan area contexts such as segregation patterns,[14–19] deprivation,[20–23] and crime,[24] which may stem from, for example, discriminatory mortgage lending, population differences in buying power, and federal housing policies.[25] Furthermore, studies that have considered contextual socioeconomic characteristics have produced inconsistent results in terms of the degree to which these factors explain racial disparities in adverse birth outcomes between neighborhoods.[15,19,21]

It remains unknown whether structural racism measured at the state level is associated with SGA birth. In a recent investigation of structural racism and myocardial infarction, Lukachko et al. developed a series of state-level indicators intended to represent the systematic exclusion of people of color from access to resources, opportunities, and social mobility.[26] Using similar indicators, we investigated the potential synergistic effects of state-level structural racism and socioeconomic inequality on the risk of SGA birth among White and Black women in a large US obstetrical cohort study. We aimed to describe the degree of structural racism across the study states, determine whether the effects of structural racism differed according to maternal race and across levels of income inequality, and quantify the risk of SGA birth associated with high levels of both racial and socioeconomic inequality.

METHODS

The Consortium on Safe Labor study (CSL) was an electronic medical record–based cohort investigation conducted from 2002 to 2008 at hospitals in California, Delaware, the District of Columbia, Florida, Illinois, Indiana, Maryland, Massachusetts, New York, Ohio, Texas, and Utah (we refer to contextual variables describing the District of Columbia as state-level

variables for ease of presentation). Hospitals were chosen on the basis of availability of electronic medical records and geographical diversity.[27] Data were extracted from medical records for births at 23 weeks of gestation or later on such variables as maternal demographic characteristics; medical, reproductive, and prenatal histories; labor and delivery; and postpartum and newborn characteristics. In addition, electronic discharge summaries for mothers and infants were linked to medical records.

For the purposes of this analysis, we restricted our sample to White and Black women because, consistent with previous research, we were interested in describing the population health effects of structural racism indicators representing systematic disenfranchisement unique to Black Americans.[9] Given that the size of the Black population in Utah (1.3% of the state population according to the 2012 US Census Bureau estimate and accounting for 0.6% of the Utah births in the CSL) did not meet the US Bureau of Labor Statistics publication standard of reliability, data for this group were unavailable.[28] We therefore excluded births in Utah from this analysis. We further limited the sample to singleton births, and the final sample included 121 758 births to 110 353 women (59% White, 41% Black) that occurred in 14 hospitals located in 10 states and the District of Columbia.

Ten percent (n = 11 405) of the women in the CSL contributed more than one birth over the study period, and these repeated births occurred in every state. It is important to note that CSL data on maternal race were extracted from medical records. As such, given the lack of detailed ethnicity data, we cannot assume that the women in our sample were explicitly non-Hispanic Black and non-Hispanic White.

Outcome

Our outcome of interest was SGA birth, defined as an infant with birth weight below the 10th percentile for their gestational age and gender according to the distributions in the full CSL sample.[29]

Income Inequality

The Gini coefficient is a measure of statistical dispersion that is frequently used to describe the distribution of resources in a population.[30] It ranges from 0 to 1, and the lower the value, the more equitable the distribution of income across the population. Annual estimates of state-level Gini coefficients are available from the US Census Bureau's American Community Survey.[31] We used the Gini coefficient to measure the degree of income inequality during the birth year in CSL participating states and linked this information to CSL data via Federal Information Processing Standards codes (numeric codes issued to ensure uniform identification of geographic entities across all federal government agencies). We categorized the Gini coefficient into tertiles defining low, medium, and high levels of inequality according to the distributions in our data. Our medical record data were anonymous, with no information on maternal address; we therefore assigned an inequality level to each birth according to the state in which the delivery hospital was located.

Structural Racism Indicators

We obtained data on indicators of structural racism (as proposed by Lukachko et al.[26]) representing Black–White racial disparities in access to resources and social mobility from various publicly available resources, as follows. Inequality in educational attainment was determined according to the ratio of Blacks to Whites with a bachelor's degree or higher within each state. Data for this indicator were derived from the American Community Survey, which provides annual estimates beginning in 2005.[31] In the case of births that occurred from 2002 to 2004, we derived data from 2000 US census estimates.

The employment disparity indicator was determined according to the relative proportions of Blacks to Whites in each state who were employed during the birth year. Race-specific annual estimates of civilian labor force employment are available from the Bureau of Labor Statistics.[28] Finally, the disparity in incarceration indicator represents the relative proportions of each state's Black and White populations who were incarcerated. These estimates were compiled by Maur and King, who used 2005 data from the Bureau of Justice Statistics.[32]

As with the Gini coefficient, we assigned each birth a value for state-level educational attainment, employment, and incarceration on the basis of the state (and year where available) in which it occurred. We dichotomized each indicator at the median to define a high or low level of structural racism; values above the median for incarceration represent a high level of inequality, whereas values below the median represent a high level of inequality in education and employment.

Covariates

Adjusted models controlled for a number of covariates available in the CSL medical record data related to individual-level differences in maternal characteristics: maternal age in 5-year categories, parity (no births, more than one birth), marital status (married, single, divorced or widowed), insurance status (private, public, self-pay or other), tobacco use and alcohol consumption during pregnancy (yes or no), prepregnancy body mass index (underweight, <18.5 kg/m^2; normal weight, 18.5 kg/m^2–24 kg/m^2; overweight, 25 kg/m^2–29 kg/m^2; obese, ≥ 30 kg/m^2), chronic medical conditions (chronic hypertension, pregestational diabetes, asthma, heart disease, thyroid disease, history of depression, all yes or no), and year of birth. For each of these covariates, we coded missing values into a separate category so that we could retain all observations in our multivariate models.

In addition, the models included a measure of the absolute level of poverty in each state during the birth year (i.e., the percentage of the population below the federal poverty level, derived from American Community Survey data) to isolate the independent effect of relative income distribution represented by the Gini coefficient.

Statistical Analysis

We conducted descriptive analyses focusing on maternal sociodemographic characteristics, structural racism indicators, and rates of SGA birth to characterize the population and the degree of structural racism across study states. Subsequently, we used generalized estimating equations models to examine each structural racism indicator separately as a means of evaluating the relationships between income inequality, structural racism, and odds of SGA birth. We tested for interactions between structural racism indicators and race to determine whether the association between race and SGA birth was more pronounced in areas with high levels of structural racism.

Finally, to quantify the joint and separate effects of racial and socioeconomic inequality, we grouped women by exposure as follows: high racial and income inequality, high racial inequality and low or medium income inequality, and low racial inequality and high income inequality. Each of these categories was compared with the referent category, low racial inequality and low or medium income inequality. In our joint effects analysis, we combined the low and medium income inequality groups because there were no significant differences in risk of SGA birth between women in these categories.

Three of the CSL study areas (Maryland, Ohio, and the District of Columbia) each had 2 participating hospitals; the remaining 8 states each had only 1 hospital. We specified our generalized estimating equations models to account for clustering of women within hospitals as well as births clustered among women. We conducted a sensitivity analysis by restricting the sample to term births (those occurring at > 37 weeks of gestation) to assess the impact of structural racism on infant size independent of preterm delivery, which occurs with greater frequency among Black women than White women.[33] Repeating our analysis among term births only allowed us to evaluate the robustness of the association between SGA birth and racism and income inequality that remains after elimination of any possible confounding effects attributable to preterm delivery.

We conducted a second sensitivity analysis to test the robustness of our results under a more extreme definition of a high degree of structural racism. We dichotomized the education and employment ratio variables at the 25th percentile and defined values below this cut point as extreme (Black to White ratios below 0.86 for employment and below 0.56 for education) and values above as the reference group. We dichotomized the incarceration ratio variable at the 75th percentile and defined values above this cut point as extreme and values below as the reference group.

RESULTS

Almost 60% of the 121 758 births included in this analysis were to White women, whereas the remaining 41% were among Black women (Table 1). Most women were in the 20- to 24-year age range, nulliparous, and private insurance holders, although almost 40% had public insurance coverage. Births were relatively evenly distributed across study jurisdictions, with the most (12.6%) occurring in Texas and the fewest (5.0%) in Florida. Relative to non-SGA births, proportions of SGA births were higher among Black women, adolescent mothers, nulliparous women, single women, private insurance holders, women who smoked or used alcohol during pregnancy, and women who had a diagnosis of chronic hypertension or asthma before their pregnancy.

Blacks were underrepresented in educational attainment in every state, and, on average, they were underrepresented in employment across states (Table 2). The mean ratio of Blacks to

TABLE 1—Selected Characteristics of the Study Population: Consortium on Safe Labor Study, United States, 2002–2008

Characteristic	Total Sample, No. (%)	Non-SGA Births, No. (%)	SGA Births, No. (%)
Race			
Black	49 970 (41.0)	42 182 (39.4)	7 788 (53.1)
White	71 788 (59.0)	64 900 (60.6)	6 888 (46.9)
Age, y			
< 20	12 734 (10.5)	10 544 (9.9)	2 190 (14.9)
20–24	30 950 (25.4)	26 400 (34.7)	4 550 (31.0)
25–29	27 516 (22.6)	24 990 (23.3)	2 526 (17.2)
30–34	20 606 (16.9)	18 622 (17.4)	1 984 (13.5)
≥ 35	29 952 (24.6)	26 526 (24.8)	3 423 (23.3)
Parity			
0	49 699 (40.8)	42 502 (39.7)	7 197 (49.0)
≥ 1	72 059 (59.2)	64 580 (60.3)	7 479 (51.0)
Insurance coverage			
Private	66 778 (61.1)	59 892 (62.4)	6 886 (51.9)
Public	40 768 (37.3)	34 631 (36.1)	6 137 (46.2)
Self-pay or other	1 755 (1.6)	1 505 (1.6)	250 (1.8)
Marital status			
Single	53 036 (43.6)	44 970 (42.0)	5 997 (40.9)
Divorced	1 905 (1.6)	1 640 (1.5)	265 (1.8)
Married	63 748 (52.4)	57 751 (53.9)	8 066 (55.0)
Alcohol use during pregnancy	2 260 (1.9)	1 915 (1.8)	345 (2.4)
Tobacco use during pregnancy	10 713 (8.8)	8 842 (8.3)	1 871 (12.8)
Prepregnancy BMI category			
Underweight (<18.5 kg/m^2)	56 873 (46.7)	49 693 (46.4)	7 180 (48.9)
Normal weight (18.5 kg/m^2–24 kg/m^2)	35 023 (28.8)	30 750 (28.7)	4 273 (29.1)
Overweight (25 kg/m^2–29 kg/m^2)	15 219 (12.5)	13 585 (12.7)	1 634 (11.1)
Obese (≥ 30 kg/m^2)	14 643 (12.0)	13 054 (12.2)	1 589 (10.8)
Maternal chronic disease			
Asthma	10 711 (8.8)	9 280 (8.7)	1 431 (9.8)
Depression	5 514 (4.5)	4 853 (4.5)	661 (4.5)
Chronic hypertension	3 147 (2.6)	2 742 (2.6)	405 (2.8)
Kidney disease	1 292 (1.1)	1 156 (1.1)	136 (0.9)
Heart disease	2 348 (1.9)	2 104 (2.0)	244 (1.7)
Diabetes	1 895 (1.6)	1 702 (1.6)	193 (1.3)
Thyroid disease	1 977 (1.6)	1 765 (1.7)	212 (1.4)

Continued

TABLE 1—*Continued*

Birth location			
California	12 356 (10.2)	11 307 (10.6)	1 049 (7.1)
Delaware	11 666 (9.6)	10 438 (9.8)	1 228 (8.4)
District of Columbia	11 186 (9.2)	9 545 (8.9)	1 641 (11.2)
Florida	6 086 (5.0)	5 180 (4.8)	906 (6.2)
Illinois	7 607 (6.3)	6 374 (6.0)	1 233 (8.4)
Indiana	6 538 (5.4)	5 760 (5.4)	778 (5.3)
Maryland	10 703 (8.8)	9 631 (9.0)	1 072 (7.3)
Massachusetts	13 177 (10.8)	11 968 (11.2)	1 209 (8.2)
New York	14 744 (12.1)	12 497 (11.7)	2 247 (15.3)
Ohio	12 311 (10.1)	10 842 (10.1)	1 469 (10.0)
Texas	15 384 (12.6)	13 540 (12.6)	1 844 (12.6)

Note. BMI = body mass index; SGA = small for gestational age. The sample size was n = 121 758.

Whites for both of these indicators was less than 1. On average, the proportion of Blacks who had attained a bachelor's degree or higher was 0.57 times lower than the proportion among Whites; this disparity was greatest in the District of Columbia, where the proportion of Blacks with a bachelor's degree or higher was only one quarter the proportion among Whites. The average incarceration rate among Blacks was 6.4-fold greater than the rate among Whites. This indicator was lowest in Florida, where the relative rate of incarceration was still 4.4 times greater among Blacks than among Whites, and highest in the District of Columbia, where the incarceration rate among Blacks was 19 times higher than that among Whites.

The unadjusted rate of SGA birth among women was higher in areas with high levels of racial inequality in education, employment, and incarceration than in areas with less inequality (Table 3). This was true among all women and among Black and White women separately. However, regardless of the magnitude of structural racism in each state, Black women were at significantly greater risk for SGA birth than were White women.

Gini coefficient (income inequality) values ranged from 0.429 in Delaware and Indiana to a high of 0.545 in the District of Columbia. The rate of SGA birth increased as income inequality increased, from 11.1% in the lowest inequality tertile to 13.4% in the highest tertile (Table 3). At every level of income inequality, Black women were significantly more likely than were White women to have an SGA birth, although racial disparities in SGA tended to be greater in states where the income distribution was more equitable.

TABLE 2—Distributions of Income Inequality and State-Level Structural Racism Indicators: Consortium on Safe Labor Study (CSL) States, United States, 2002–2008

Variable	CSL States (n = 11)
Income inequality (Gini coefficient), mean (SD; range)	0.47 (0.03; 0.43–0.55)
Structural racism indicator, mean ratio[a] (SD; range)	
Employed	0.91 (0.09; 0.67–1.05)
≥ bachelor's degree	0.57 (0.11; 0.23–0.70)
Incarcerated	6.40 (3.88; 4.40–19.00)

Note. Data were derived from the Bureau of Labor Statistics, the Bureau of Justice Statistics, and the US Census Bureau. CSL states included in analysis were California, Delaware, the District of Columbia, Florida, Illinois, Indiana, Maryland, Massachusetts, New York, Ohio, and Texas.
[a]Relative proportion of Blacks to Whites within each state.

Table 4 presents adjusted odds ratios (AORs) and 95% confidence intervals (CIs) for SGA birth among Blacks and Whites from a model without any racial or income inequality measures and from subsequent models that included inequality measures. In each of these models, racial disparities in SGA birth were significant and relatively intractable in magnitude, with adjusted odds ratios for Blacks (relative to Whites) ranging from 1.53 to 1.61. The results of the test assessing the interaction between race and each structural racism measure were nonsignificant, indicating that degree of structural racism did not modify the effect of race on SGA birth (Table A, available as a supplement to the online version of this article at http://www.ajph.org). Contrary to our hypothesis, racial disparities in SGA birth were not significantly greater in areas with high rates of racial inequality in education, employment, and incarceration than in areas with low rates.

The results of a test assessing the interaction between each racial inequality measure and income inequality were significant, indicating that the effects of structural racism differed across levels of income inequality (Table A). When considered jointly, levels of income inequality and racial inequality in education, incarceration, or employment were associated with an increased risk of SGA birth only when both were high (Table 5). Compared with women in areas where levels of both racial and income inequality were classified as low, women in areas with high inequality levels were 1.81 to 2.11 times more likely (depending on the structural racism indicator) to have an SGA birth (Table 5). Risk of SGA birth was not significantly greater among women in areas where levels of either racial or income inequality (but not both) were high than among women in areas where both were low. Joint effects did not differ by maternal race.

The results of analyses limited to term births (n = 106 190) were consistent with the findings of the primary analyses. The results of the second sensitivity analysis (which defined extreme inequality in education and employment as ratios below the 25th percentile and extreme inequality in incarceration as ratios above the 75th percentile) were fairly consistent with the findings of the primary analysis; the combination of high income inequality and

TABLE 3—Percentages of Small-for-Gestational-Age (SGA) Births, by Race and State-Level Indicators of Racial and Socioeconomic Inequality: Consortium on Safe Labor (CSL) Study, United States, 2002–2008

Variable	SGA Births Among All Women, %	SGA Births Among Black Women, %	SGA Births Among White Women, %
Race			
Black	15.6	. . .	. . .
White	9.6	. . .	. . .
Structural racism (state level)			
High educational inequality[a]	13.4	16.1	11.1
Low educational inequality	11.0	15.1	8.6
High employment inequality[b]	12.7	15.9	10.5
Low employment inequality	11.4	15.3	8.6
High incarceration inequality	12.4	15.7	10.7
Low incarceration inequality[c]	11.3	15.5	8.3
Income inequality (state level)			
Low	11.1	16.1	8.5
Medium	11.7	15.3	8.4
High	13.4	15.4	12.0
Low income inequality			
High educational inequality	12.1	16.9	8.9
Low educational inequality	10.8	15.9	8.5
High employment inequality	12.5	16.5	9.5
Low employment inequality	10.4	15.9	8.2
High incarceration inequality	11.3	16.5	8.0
Low incarceration inequality	11.0	16.1	8.6
Medium income inequality			
High educational inequality	12.4	15.6	8.9
Low educational inequality	10.8	14.8	7.7
High employment inequality	11.1	15.3	8.2
Low employment inequality	12.6	15.3	8.6
High incarceration inequality	10.8	15.3	8.4
Low incarceration inequality	13.9	15.4	8.5
High income inequality			
High educational inequality	15.0	16.3	13.9
Low educational inequality	11.7	14.2	9.7
High employment inequality	14.0	16.0	12.7
Low employment inequality	12.4	14.5	10.1
High incarceration inequality	14.1	16.0	13.0
Low incarceration inequality	11.7	14.5	6.1

Note. All differences in rates of SGA birth (among all women) across the race and income inequality predictors were significant at $P < .001$. CSL states were California, Delaware, the District of Columbia, Florida, Illinois, Indiana, Maryland, Massachusetts, New York, Ohio, Texas, and Utah. The sample size was n = 121 758.

[a]High educational inequality refers to values below the median ratio across CSL Study states of Blacks to Whites who attained a bachelor's degree or higher.

[b]High employment inequality refers to values below the median ratio across CSL Study states of Blacks to Whites who were employed.

[c]High incarceration inequality refers to values above the median ratio across CSL states of Blacks to Whites who were incarcerated.

extreme racial inequality was associated with an increased risk of SGA birth relative to low income inequality and low (less than extreme) racial inequality (data not shown). The magnitudes of the joint effects estimates were higher than in the primary analyses, but the confidence intervals overlapped. As with the primary analyses, there was no difference in risk when racial inequalities in education and employment were extreme but income inequality was low. However, women in areas with high income inequality and low employment inequality remained at increased risk relative to women in areas where levels of both racial and income inequality were low (low employment inequality/high income inequality AOR = 1.58; 95% CI = 1.03, 2.43).

DISCUSSION

We examined the joint effects of income inequality and indicators of structural racism on risk of SGA birth and found that structural racism, assessed according to racial inequalities in educational attainment, employment, and incarceration, was strongly associated with SGA birth when it occurred in combination with high income inequality. The relationships were not explained by state-level differences in absolute poverty or individual-level differences in demographic characteristics or biological or behavioral risk factors. When co-occurring at high levels, the joint effects of income inequality and structural racism increased the risk of SGA birth nearly 2-fold. This effect was not modified by race, implying that the deleterious context of high income inequality in combination with racial inequality applies to all women, regardless of race. The similar effect of structural racism observed for Black and White women may suggest some further unmeasured contextual risk factors that are disproportionately present in areas of high racial inequality and equally harmful to both White and Black members of the community.[17]

Our results highlight the complex joint impact of class and race on pregnancy health. In our data, high income inequality had a strong influence across the study population, adversely affecting all women and therefore attenuating racial differences in SGA birth (but not eliminating them entirely). Meanwhile, low income inequality buffered the adverse effects

TABLE 4—Association of Small-for-Gestational-Age Birth With Race and Racial and Socioeconomic Inequality Indicators: Consortium on Safe Labor (CSL) Study, United States, 2002–2008

Variable	AOR (95% CI)
Model 1: no income or racial inequality measures	
Race	
White (Ref)	1.00
Black	1.56 (1.24, 1.97)
Model 2: educational inequality measure	
Race	
White (Ref)	1.00
Black	1.53 (1.22, 1.92)
Educational inequality	
Low (Ref)	1.00
High	1.24 (1.05, 1.45)
Model 3: employment inequality measure	
Race	
White (Ref)	1.00
Black	1.57 (1.25, 1.96)
Employment inequality	
Low (Ref)	1.00
High	1.21 (1.01, 1.44)
Model 4: incarceration inequality measure	
Race	
White (Ref)	1.00
Black	1.57 (1.27, 1.95)
Incarceration inequality	
Low (Ref)	1.00
High	1.29 (1.13, 1.64)
Model 5: income inequality measure	
Race	
White (Ref)	
Black	1.61 (1.36, 1.91)
Income inequality	
Low (Ref)	1.00
Medium	1.12 (0.97, 1.30)
High	1.70 (1.07, 2.71)

Note. AOR = adjusted odds ratio; CI = confidence interval. Models were adjusted for maternal age; prepregnancy body mass index; year of birth; history of asthma, depression, thyroid disease, and hypertension; tobacco and alcohol use; insurance and marital status; parity; and state-level poverty. All race by inequality measure interactions were nonsignificant ($P > .05$). CSL states included in analysis were California, Delaware, the District of Columbia, Florida, Illinois, Indiana, Maryland, Massachusetts, New York, Ohio, and Texas.

of structural racism, which was not associated with SGA birth in more equitable states (however, racial differences in crude SGA risk were somewhat larger in these areas).

Our results are consistent with previous work demonstrating the deleterious effects of income inequality on reproductive health and infant birth weights in particular.[34–38] Income inequality may have a negative impact on health by creating differences in access to opportunities and material goods that benefit health or through systemic lack of investment in societal infrastructure in highly unequal communities such that the socioeconomically disadvantaged members of the population are less able to prevent and treat disease.[39] These conditions, in turn, may arise from state-level funding policies that dictate investments in areas such as education and health care and establish the structure of opportunities available to state residents. This context, combined with the targeted effects of systemic racial disadvantage (including limited access to employment and education and systematic incarceration among Blacks),[26] may be one of the mechanisms through which state-level structural racism and income inequality synergistically affect health.

Stress is another frequently referenced pathway through which exposure to discrimination or persistent disadvantage is thought to have a negative impact on birth outcomes.[40] With regard to Black women in particular, Geronimus' "weathering" hypothesis proposes that the chronic stress created by disenfranchisement, racism, and societal and economic disadvantage leads to more rapid declines in health status—beginning in young adulthood—among Black women than White women in the United States.[41] Work focused on physiological stress pathways highlights how weathering may cause more rapid biological aging, thereby placing women at risk for adverse birth outcomes, including SGA infants, before they are even pregnant.[42] Physiological dysregulation induced by chronic exposure to stress may lead to excess circulating corticotrophin-releasing hormone and cortisol, which may slow fetal growth.[43] Furthermore, dysfunction of maternal cardiometabolic processes contributes to the pathogenesis of intrauterine growth restriction, which may result in SGA birth.[44]

Limitations

This study complements previous work on discrimination and pregnancy health by examining the combined influence of institutionalized racial and socioeconomic inequality while controlling for individual-level characteristics available in detailed medical record data that do not rely on self-reports for ascertainment of outcomes. Our study was limited by the deidentified nature of the CSL data; information on women's home addresses was not available, and therefore we assumed that women resided in the same state as that of their delivery hospital for the tenure of their pregnancy. Relatedly, we had no information about how long before and during their pregnancy women resided in their delivery state, an important consideration given the possible effects of lifetime and even trans-generational exposure to poor socioeconomic conditions that may have differing influences on racial patterns of SGA birth and other adverse birth outcomes.[45]

In addition, the medical record race data did not include detailed information on ethnicity, so we cannot evaluate any potential differences among Hispanic Black or Hispanic White women. A further caution in interpreting our results is their limited generalizability outside of the jurisdictions included in the CSL. Our analyses included measures from only 10 states and the District of Columbia, and although the geographic and regional representation of these states is relatively comprehensive, we cannot assume that relationships between race, racial and socioeconomic inequality, and SGA birth are the same across all states.

Furthermore, most of the states we analyzed included births from a single hospital, and because most of the hospitals represented in the CSL were located in urban centers, our results may not generalize to the experiences of women in more rural regions where alternate risk factors for SGA may be more or less influential than those arising from the social context of racial and socioeconomic inequality in an urban setting. The state-level effects observed here are potentially actionable but certainly do not negate any local-area effects that might be present.

Finally, we examined only 3 indicators of structural racism, and these indicators may not have fully captured the ways in which state-level practices and policies systematically disadvantage Black members of the population and

TABLE 5—Association of Small-for-Gestational-Age Birth With the Joint Effects of Structural Racism and Income Inequality: Consortium on Safe Labor Study, United States, 2002–2008

Variable	AOR (95% CI)
Education	
Low racial inequality, low/medium income inequality (Ref)	1.00
Low racial inequality, high income inequality	1.37 (0.93, 2.03)
High racial inequality, low/medium income inequality	1.10 (0.96, 1.26)
High racial inequality, high income inequality	2.11 (1.59, 2.80)
Incarceration	
Low racial inequality, low/medium income inequality (Ref)	1.00
Low racial inequality, high income inequality	0.98 (0.79, 1.21)
High racial inequality, low/medium income inequality	0.99 (0.87, 1.13)
High racial inequality, high income inequality	1.81 (1.28, 2.56)
Employment	
Low racial inequality, low/medium income inequality (Ref)	1.00
Low racial inequality, high income inequality	1.26 (0.76, 2.07)
High racial inequality, low/medium income inequality	1.04 (0.92, 1.19)
High racial inequality, high income inequality	1.85 (1.23, 2.79)

Note. AOR = adjusted odds ratio; CI = confidence interval. Models were adjusted for maternal age; prepregnancy body mass index; year of birth; history of asthma, depression, thyroid disease, and hypertension; tobacco and alcohol use; insurance and marital status; parity; and state-level poverty. CSL states included in analysis were California, Delaware, the District of Columbia, Florida, Illinois, Indiana, Maryland, Massachusetts, New York, Ohio, and Texas.

dictate trends in population health. More work is needed to develop quantitative indicators of structural racism and to understand how to conceptualize and directly measure racism and its adverse health effects.

Conclusions

Although it is clear that racial inequality and socioeconomic inequality—and particularly their concomitant effects—are associated with negative effects on pregnancy health, both are amenable to policy interventions. State-level policies intended to promote equity in education and employment opportunities may help reduce the disparities that divide women along racial and socioeconomic lines. Furthermore, as future studies continue to focus on structural racism as a system of institutional practices and policies intended to maintain racial inequality, we may begin to see progress toward systemic solutions to long-standing health disparities. ■

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Contributors

M. E. Wallace was responsible for the study concept and design. All of the authors analyzed and interpreted the data, and reviewed and revised the article.

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Human Participant Protection

The Consortium on Safe Labor study was approved by the institutional review boards of all of the participating sites. All records were anonymous, and individual patient consent was not obtained.

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