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Olivia Barnes

Structural Racism and Preterm Birth in the United States

By

Olivia Barnes
Master of Public Health


Global Epidemiology




Michael Kramer, PhD
Committee Chair

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B.A., University of Michigan, 2013

Thesis Committee Chair: Michael Kramer, PhD

An abstract of
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**Abstract**

Structural Racism and Preterm Birth in the United States
By Olivia Barnes

Preterm birth is a leading cause of morbidity and mortality among infants in the United States. Non-Hispanic Black women are almost twice as likely to have a preterm birth than are White women. A growing body of research suggests that racism plays a key role in health outcome disparities. While many studies have analyzed interpersonal racism, in this cross-sectional study we examined racism at an institutional level across 43 states in the U.S. We used a novel technique, calculating Black-White disparities across 3 state-level indicators 1) educational attainment, 2) occupational level, and 3) incarceration to determine a structural racism "score," ranging from 0 to 3 for each state. Data on preterm birth and maternal state residency were obtained from 2013 birth certificates compiled by the National Center for Health Statistics (N=2,297,257). We used logistic regression models controlled for individual level factors to calculate prevalence odds ratios by race, using women in states with a score of 0 as the referent group. Contrary to our hypothesis, Black women living in states with the highest structural racism score of 3 had statistically significant lower odds of preterm birth (OR=0.88 95% CI= [0.83, 0.94]). Consistent with our hypothesis, White women living in states with structural racism scores of 1, 2, and 3 had progressively lower odds of preterm birth (OR= 0.98 95% CI= [0.88, 1.09], OR= 0.91 95% CI= [0.79, 1.05], OR=0.83 95% CI= [0.77, 0.88], respectively). These results for White women support emerging theories that racism at an institutional level benefits those who claim superiority. The results for Black women are not consistent with theory that institutional racism harms the health of the subordinate group, nor is there any empirical evidence supporting our finding, raising questions of whether our analysis may be affected by unmeasured confounding.

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## CHAPTER I – Background

**Preterm Birth**

Preterm birth is defined as birth prior to 37 completed gestational weeks. According to the CDC, 1 in every 10 infants born in 2015 were preterm (6). Preterm birth has serious short-term and long-term health consequences. Mostly notably, it is a leading risk factor for infant death; 36% of infant deaths in 2013 were due to preterm-related causes (6). Complications of preterm birth mainly result from under-development of the baby's organs and include respiratory distress, lung disease, apnea, intestinal injuries, a compromised immune system, neurological problems, cardiovascular disorders, anemia, vision problems, and hearing problems (22). Babies who do survive the complications of preterm birth are still more likely to have motor, cognitive, visual, hearing, behavioral, social-emotional, health, and growth problems later in life (22). While these short-term complications and long-term health issues are more severe the earlier the baby is born, infants born closer to term still have more complications than those born at term (22).

In addition to serious health consequences for the infant, preterm birth also takes a toll on the baby's family as well as society. Parents of preterm babies experience higher levels of emotional distress, although this specific topic requires more research (22). Additionally, preterm has economic consequences for families and society as a whole. Not only are there increased hospital costs for the care of the child, but also lifetime care costs for infants who develop long-term developmental disabilities. According to the NIH, the societal economic burden of preterm birth, which includes medical care services

and lost household and labor market productivity, was about $26.2 billion in the United States in 2005 (22).

The underlying causes of preterm birth are unknown; however, research suggests it is a combination of individual-level behavioral and psychosocial factors, socio-demographic characteristics, environmental exposures, genetics, and medical conditions (22). While behavioral factors can be difficult to measure, heavy alcohol use, tobacco use, lack of physical activity, and chronic and catastrophic stress during pregnancy have all been significantly associated with preterm birth in various research studies (22). Socio-demographic and community level influences of preterm birth include maternal age (younger than 16 or over 35 years of age), marital status (unmarried), low socioeconomic status, and adverse neighborhood conditions such as poverty and crime (22). Various medical illnesses such as chronic hypertension and pre-pregnancy diabetes are also associated with an increased risk of preterm birth (22). Finally, the role of genetics is still being investigated but there is some evidence of familial and intergenerational influences on preterm birth (22). Furthermore, these different factors interact with and influence one another, suggesting further research is needed to understand how these various micro and macro-level elements are connected (22).

**Racial Disparities in Preterm Birth**

There are serious ethnic and racial disparities in preterm birth outcomes that have persisted for decades. Non-Hispanic African American women are almost twice as likely to have a preterm birth than non-Hispanic White women; in 2015, 13% of live births to African American women were preterm, compared to 9% among White women (6). Early research suggests that African American women are more likely to experience

certain individual-level factors that are known to increase the risk of preterm birth such as being unmarried, having a lower socioeconomic status or educational level, and having pre-pregnancy health issues (22). However, recent studies have since discovered that even after controlling for socioeconomic status and educational attainment, African American women still have significantly higher rates of preterm birth (22). While the odds of preterm birth decrease with increasing levels of maternal education, African American women with greater than 16 years of education still have significantly higher rates of preterm birth than non-Hispanic White women with only 9 years of education (22).

A.T. Geronimus introduced the "weathering hypothesis" in 1992 to explain this Black-White maternal health disparity by linking biological factors to the social context in which they occur. The hypothesis suggests that "the effects of social inequality on the health of populations may compound with age, leading to growing gaps in health status through young and middle adulthood that can affect fetal health" (14,15). African American women, particularly those who are socioeconomically disadvantaged, experience more rapid health deterioration ("weathering") than women of other racial and ethnic backgrounds (14). More specifically, in her study of Black women in Michigan, Geronimus found that the odds of low birth weight among Black women in living in low income areas increased 3-fold between the maternal ages of 15 and 35 (14). Such an increase was not observed in white women, even those who were also socioeconomically disadvantaged, suggesting that Black women experience this unique "weathering" from adolescence into adulthood which results in poorer health outcomes, including adverse birth consequences (14). One theory that may help explain such weathering and the high

rates of preterm birth among African American women in the U.S. is that of increased stress due to discrimination. Stress, particularly chronic and catastrophic psychological stress before or during pregnancy, is believed to increase the risk of preterm birth (22).

Research investigating interpersonal racism began in the 1990s with Nancy Krieger's CARDIA study where she examined risk factors for high blood pressure (17). She developed a measure of interpersonal racism where she asked participants "about their experiences of racism at work, at school, when getting medical care, when receiving service at stores or restaurants, and when finding housing" (17, 22). The first study to examine interpersonal racism and birth outcomes in African American women used Krieger's measure from the CARDIA study and found that mothers of preterm, low birth weight infants were twice as likely to report experiences of racial discrimination during pregnancy while adjusting for other individual level factors such as education, income, and age (8). Collins et al. then went on to investigate life-long discrimination and found that after adjusting for age, cigarette smoking, and education, African American women with preterm, low birth weight infants, had a 2.6 higher odds (95% CI= [1.2, 5.3]) of reporting lifetime racial discrimination in three or more domains of life compared to African American women with normal birth weight infants (9).

Findings from studies comparing birth outcomes of African American in the U.S. to those of foreign born Black women and other races are consistent with A.T. Geronimus' weathering hypothesis that Black women in the U.S. demonstrate unique, age-specific perinatal outcome patterns. First, a study by Elo et al. found that foreign-born Black women had about 30% lower odds of preterm birth compared to Black women born in the United States, even after adjusting for various risk factors (11). Such

results suggest that the experience of being a Black woman born in the United States carries its own risk. Furthermore, the researchers propose that "life–time exposures to disadvantage and the historical legacy of slavery in the production of poor health" contributes to the significantly worse preterm birth outcomes among US-born non-Hispanic Black women in their study (11).  Second, in a study in Bediako et al. using national birth certificate data, they compared birth outcomes among Black, Hispanic, and Black Hispanic women in the United States (4). They found that Black mothers had the highest burden of all adverse birth outcomes, including low birth weight, preterm birth, and small for gestational age (4). Subsequently, Black Hispanic, Hispanic, and White mothers had lower rates of these adverse birth outcomes. Most importantly, they found that while Hispanic mothers had socio-demographic characteristics similar or worse than Black women, they had preterm birth predicted probabilities (7.00; 95% CI = [6.89, 7.02]) more comparable to that of White women (6.19; 95% CI = [6.15, 6.24]) than to that of Black women (9.50; 95% CI = [9.40, 9.59]) (4). In addition, Black Hispanic mothers had higher predicted probabilities (7.69; 95% CI = [7.43, 7.94]) than their non-Black counterparts but were still closer to Hispanics than Black women suggesting that "it is possible that Hispanic women who self-identify as Black may share some of the phenotypic features of Black women, including skin color, that is associated with discrimination and racism" (4).

**Structural Racism in the United States**

Various research studies have established the connection between interpersonal racism and poor health outcomes. As mentioned above, African American women who give birth to preterm babies are significantly more likely to report interpersonal racism

throughout their lifetime compared to African American women who deliver term babies (8, 9). While many studies have examined racism on a personal level to study health inequities, few have investigated racism on a structural level. According to Powell, structural racism can be defined as "the macrolevel systems, social forces, institutions, ideologies, and processes that interact with one another to generate and reinforce inequities among racial and ethnic groups" (21). Many behavioral scientists have theorized that racism occurs at multiple levels, ranging from the individual, interpersonal level to the institutional, macro level. Nancy Krieger's Ecosocial theory provides a framework on how to study discrimination as it is manifested in health inequities (18). Ecosocial theory states "methods must address the lived realities of discrimination as an exploitative and oppressive societal phenomenon operating at multiple levels and involving myriad pathways across both the life course and historical generations" (18). In addition, the theory's core construct of embodiment refers to how "people literally embody, biologically, their lived experience, in societal and ecologic context, thereby creating population patterns of health and disease" (18). In the example of discrimination, the socially inferior race, in this case African Americans, literally embodies the exploitative and oppressive social relations through various pathways, resulting in health inequities (18). While racism at a structural level needs further research, Krieger notes that developing a way to accurately study these macosocial determinants of health inequity is challenging (18).

Due to complexity of measuring structural racism, only a few studies have attempted to analyze it at the state level. Two recent studies, by Lukachko et al and Wallace et al, used various state-level indicators to evaluate institutional racism (19, 25).

Lukachko et al's study investigated myocardial infarction and examined Black-White racial disparities across four domains including political participation, employment and job status, educational attainment, and judicial treatment to categorize states into either low or high levels of structural racism for each indicator (19). After adjusting for individual-level covariates, they found a statistically significantly higher odds of myocardial infarction in the past year among Blacks living in states with high odds of structural racism in the domains of representation in state legislature (OR = 1.35; 95% CI = [1.09,1.69]), participation in the civilian labor force (OR = 1.22; 95% CI=[1.04,1.44]), employment (OR = 1.74; 95% CI = [1.48, 2.04]), incarceration (OR = 1.32, 95% CI = [1.12, 1.56]), and disenfranchisement (OR = 1.28, 95% CI = [1.08, 1.52]) (19). Furthermore, they also found a null or decreased odds of past year myocardial infarction among Whites living in states with high levels of structural racism in the domains of voting practices (OR = 0.85; 95% CI = [0.74, 0.98]), state elected officials (OR = 0.80; 95% CI = [0.70, 0.91]), incarceration (OR = 0.84; 95% CI = [0.74, 0.96]), and death sentencing (OR = 0.86; 95% CI = [0.74, 1.00]) (19). In a study in 2015, Wallace et al. examined the effects of structural racism in combination with income inequality on small-for-gestational-age (SGA) birth in 12 U.S. states. Drawing on the structural indicator method from Lukachko et al's recent study, they used state-level racial disparities in educational attainment, employment level, and incarceration as measures of structural racism (25). They also measured the Gini coefficient for each state to quantify the degree of income inequality. Contrary to their hypothesis, they found that rates of SGA were not statistically significantly higher in states with higher levels of inequality across each structural racism indicator, compared to states with lower levels of inequality

across the indicators (25). Rather, the interaction of each structural racism indicator with high levels of income inequality, was associated with higher odds of SGA (25). For example, high levels of racial inequality in incarceration combined with high levels of income inequality resulted in an 81% greater odds of SGA (95% CI = [1.28, 2.56]) (25). These odds did not differ significantly between Black and White women (25). Both studies use a novel method to study structural racism, however, further research should focus on new ways to quantify structural racism.

Black-White disparities in drug-related incarceration, educational attainment, and employment levels continue to persist in the United States. Each of these factors has a unique history and contributes to the institutional exclusion of African Americans from resources and mobility in society.

**Incarceration**

Mass incarceration is a formidable issue in the United States. Racial disparities have long existed in incarceration rates, particularly in drug-related arrests. Many researchers argue that the mass incarceration of the African American populous can be understood as a reaction to the Civil Rights Movement (1, 16). Following the Civil war when slavery ended, Jim Crow laws emerged to enforce racial segregation in the South. The Civil Rights Movement struck down these laws in the 1960's but Richard Nixon's "War on Drugs" began thereafter in the 1980's followed by a 274% increase in the prison and jail population (16). One of the most infamous and questionable policies was the Anti-Drug Abuse Act, which was signed into law by Ronald Regan in 1986 and punished equally the sale of five grams of crack-cocaine and the sale of 500 grams of powder

cocaine and required a five-year minimum sentence for possession of crack cocaine (16).

At the time, crack-cocaine was associated with African Americans and powder cocaine

with Whites. 80% of those arrested under this law were African American, resulting in a

disproportionate increase in the African American prison population for drug-related

offenses (1). In addition, Marijuana possession account for 44% of drug-related arrests

nationwide (16). Such policies not only placed millions in prison for non-violent

offenses, but also left them criminal record, stifling rates of employment post

incarceration. This "tough on crime" agenda continued during the Clinton presidency.

Furthermore, Clinton expanded these policies to welfare where he instituted five-year

lifetime limits on welfare assistance and a lifetime ban on welfare and food stamps for

anyone convicted of a drug-related crime, including simple possession (1). Michelle

Alexander refers to these various racially motivated policies in the form of drug-related

mass incarceration as "The New Jim Crow" in her book. Following the abolition of Jim

Crow laws in which discrimination in employment, housing, and education was legal, the

"War on Drugs" resulted in more than two million people, mostly Blacks and Latinos,

incarcerated (1). While politicians explained these "tough on crime" policies in race-

neutral terms, mass imprisonment became a new way to deny those same basic rights to

African Americans and push to them the "margins of mainstream society" (1).

　　　In addition to the overtly racist history of drug policies, a study by Beckett et al,

investigated the racial composition of those who distribute four serious drugs (crack

cocaine, meth, heroin, and cocaine powder) in the Seattle area and compared it to the

racial composition of those arrested for these drug crimes (3). They discovered a

statistically significant disparity; while Whites were the majority of drug distributers,

Blacks comprised 64.2% of those arrested for those crimes (3). This is in part due to the law enforcement's focus on crack offenders rather than any of the other serious drugs: "an estimated 33.3 percent of all drug transactions in Seattle involving one of these four drugs involved crack, yet the vast majority (78.7 percent) of delivery arrests involving these four drugs involved that particular substance" (3). They ultimately concluded that implicit racial biases in perceptions of crime appear to be true in the context of drugs among law enforcement as well as the general public (3).

The results of this study and these historically racially motivated policies are evident in the shocking statistics of the prison and jail population today. First and foremost, while the U.S. comprises 5% of the world population, it has 25% of world prisoners (10). African Americans are incarcerated at six times the rates of Whites. While 12-13% of the U.S. population is African American, they make up about 37% of prison population; Of the 2.3 million prisoners in this country, 1 million are African American (10). One in three Black men can expect to go to prison in their lifetime (10). Furthermore, five times as many Whites report using drugs compared to African Americans, yet African Americans are sent to prison for drug offenses at 10 times the rate of Whites (10). Finally, African Americans represent 12% of the total population of drug users, but 38% of those arrested for drug offenses, and 59% of those in state prison for a drug offense (10).

**Education**

Like incarceration, public education in the U.S. has a history of discrimination that persists today. At the beginning of the Civil Rights Movement, prior to the abolition of Jim Crow laws, the Supreme Court ruled segregation in schools to be unconstitutional

in the Brown v. Board of Education case of 1954. Following this ruling, there was serious opposition from the White community, resulting in the physical and emotional abuse of African American school children and the forced integration of students in some locales (20). American schools became more integrated in the 1960's through the 1980's, however, there has been a resurgence in segregation in more recent years with the number of Black students attending 90% segregated schools increasing between 1980 and 2009 (20, 5).

There are various factors that may explain this trend including an increase in concentrated poverty and racial isolation, resource inequity in majority-minority schools, as well as the failure of the federal government to adequately monitor and enforce policies to combat segregation (12). As a result, African American students have fallen behind their White counterparts. Most notably, Black students have a high-school graduation rate of about 60%, compared to the 83% rate of White students (12). Such a disparity also exists beyond secondary school: 55.7 percent of Black students enroll in postsecondary education, compared with 71.7 percent of White graduates and Black students complete a degree their first time at four-year University at half the rate of White students (12). Such inequality in higher educational attainment stems from both the poverty Black students are more likely to face, as well as the under-preparation of Black students due to lack of resources in low-income schools (12). African American students are more likely to attend under-funded schools in poorer neighborhoods (12). The U.S. Department of Education found Black students were three times more likely to attend schools where fewer than 60% of teachers have adequate state licensure and credentials (7). Majority-minority schools tend to teach a less-demanding curriculum compared to

wealthier, non-minority schools, and students are less prepared for a college education

(12). In addition, Black students are much more likely to be disciplined than White

students; K-12 Black students are 3.8 times more likely to receive one or more out-of-

school suspensions compared to White students, with Black girls receiving more

suspensions than all other girls and most boys (7). Such inequitable treatment of students

by teachers and school administrators deters African American students from attending

school and furthering their education.

### Occupational Status

In addition to public education, occupational segregation of Blacks and Whites

also declined after the Civil Rights movement. African American women have a unique

history in the U.S. labor market due their double burden of racial and gender

discrimination in the work place. In the 1960's through the 1980's, occupational

segregation decreased as Black women began to decrease their presence in previously

primarily Black occupations, such as service workers in private households, and increase

their representation in other fields such as clerical workers (2). Following affirmative

action in the 1970's, African American women began to appear more in technical,

managerial, and professional positions (2). However, the decreasing trend of occupational

segregation began to stall starting in the 1980's until the 2000's, coming to a halt in

recent years. Such a standstill resulted from abatement of political pressures to end

segregation and discrimination in the workplace following the Civil Rights and

affirmative action movements (2). When Alonso-Villar and del Rio examined differences

in education and occupation segregation they found that "the wages of occupations in

which African American women with university degrees concentrate also tend to be

below the average wage of occupations in which graduates work" (2). Black women with university degrees have an extremely low presence in highly paid occupations such as chief executives, program administrators, lawyers, and engineers (2). Ultimately, occupational segregation and occupational wages have worsened for African American with a university degree since the 1970's, while improving for other groups up until the 2000's (2). Alonso-Villar and del Rio concluded that,

*When compared with their peers in education, highly educated African American women seem to be as disadvantaged as those with lower educational credentials. This suggests that although those with bachelor's degrees are more evenly distributed across occupations, this is not particularly beneficial for them if we compare them with their peers in education* (2).

In accordance with the study by Alonso-Villar and del Rio, the U.S. Department of Labor released a report noting clear disparities in occupational attainment and wages. While women make up nearly half of the U.S. workface, they still only make 77 cents to each dollar made by a White male. This number is even lower for Black women who make 64 cents to every dollar made by White males (23). African Americans are the only racial group where women are a larger part of the workforce compared to men. Even so, Black women will only make 91 cents to each dollar made by a Black man (23). In addition, African American unemployment rates are higher those White employment rates at every educational level (23). Finally, Black men and women are underrepresented in the fast-growing fields of manufacturing and professional and business services (23).

**Objectives of this Research**

As described above, there are substantial racial disparities in the educational, occupational, and incarceration systems in the United States. Not only does discrimination in these structures restrict the opportunities and upward mobility of African Americans in society, but it is also the source of the stressful life experiences Black women in the United States face throughout their lives. Extensive research suggests that maternal exposure to chronic, long-term stress increases the odds of preterm birth. This stress caused by persistent institutional discrimination has led to a significant disparity in preterm birth outcomes between African American and White women.

The objectives of this research are to first examine the level of structural racism in each U.S. state by determining the level of disparity between African Americans and Whites across three domains: 1) educational attainment, 2) occupational level and, 3) incarceration to develop a structural racism "score," ranging from 0 (no structural racism) to 3 (the highest level of structural racism). Second, we will investigate whether the odds of preterm birth are greater among African American women living in states with higher levels of structural racism (scores 1, 2, and 3), compared to African American women living in states with low levels of structural racism (score of 0). We will also assess whether there is reduced odds of preterm birth among White women living in states with higher levels of structural racism (scores 1, 2, and 3), compared to White women living in states with low levels of structural racism (score of 0).

## CHAPTER II - Manuscript

**Abstract:**

Preterm birth is a leading cause of morbidity and mortality among infants in the United States. Non-Hispanic Black women are almost twice as likely to have a preterm birth than are White women. A growing body of research suggests that racism plays a key role in health outcome disparities. While many studies have analyzed interpersonal racism, in this cross-sectional study we examined racism at an institutional level across 43 states in the U.S. We used a novel technique, calculating Black-White disparities across 3 state-level indicators 1) educational attainment, 2) occupational level, and 3) incarceration to determine a structural racism "score," ranging from 0 to 3 for each state. Data on preterm birth and maternal state residency were obtained from 2013 birth certificates compiled by the National Center for Health Statistics (N=2,297,257). We used logistic regression models controlled for individual level factors to calculate prevalence odds ratios by race, using women in states with a score of 0 as the referent group. Contrary to our hypothesis, Black women living in states with the highest structural racism score of 3 had statistically significant lower odds of preterm birth (OR=0.88 95% CI= [0.83, 0.94]). Consistent with our hypothesis, White women living in states with structural racism scores of 1, 2, and 3 had progressively lower odds of preterm birth (OR= 0.98 95% CI= [0.88, 1.09], OR= 0.91 95% CI= [0.79, 1.05], OR=0.83 95% CI= [0.77, 0.88], respectively). These results for White women support emerging theories that racism at an institutional level benefits those who claim superiority. The results for Black women are not consistent with theory that institutional racism harms the health of

the subordinate group, nor is there any empirical evidence supporting our finding, raising

questions of whether our analysis may be affected by unmeasured confounding.

**Introduction:**

Preterm birth is a leading cause of morbidity and mortality among infants in the

United States. Defined as birth before 37 completed gestational weeks, preterm birth has

negative long-term consequences for infants and their families. Preterm babies are at

greater risk for mortality in the first month of life, in addition to medical complications

such as acute respiratory, gastrointestinal, immunologic, central nervous system, hearing,

and vision problems, as well as longer-term motor, cognitive, visual, hearing, behavioral,

social-emotional, health, and growth problems (22). In addition to medical risks, families

of preterm infants often endure serious emotional and socioeconomic stress due to the

cost of medical expenses. Preterm birth also has implications in the public sector, with an

annual societal economic burden of at least $26.2 billion (22).

Previous studies found that there are large racial disparities in birth outcomes.

Non-Hispanic Black women are almost twice times as likely to have a pre-term birth

compared to White women (4). Many researchers suggested that the experience of being

a black woman in the United States, in particular the long-term stress and discrimination,

leads to these poor birth outcomes. Eco-sociological theorist Nancy Krieger, suggests that

current research underestimates the impact of racism on health. Furthermore, when

investigating a health outcome, "methods must address the lived realities of

discrimination as an exploitative and oppressive societal phenomenon operating at

multiple levels and involving myriad pathways across both the life course and historical

generations" (18). Thus, examining discrimination at both an individual and an institutional level is crucial in identifying racial disparities in health outcomes.

While many studies analyzed interpersonal racism and preterm birth, only a few examined racism at an institutional level across the United States. One of these studies, by Lukachko et al., investigated state-level institutional racism through various indicators (including judicial treatment, political participation, employment and job status, and educational attainment) and rates of myocardial infarction (19). They found that African Americans in states with high levels of structural racism were more likely to report an incident of myocardial infarction in the past year (19). Another recent study by Wallace et al. found that structural racism (measured by racial inequalities in educational attainment, employment, and incarceration) was associated with higher small-for-gestational age birth when it occurred in combination with high-income inequality (25). To our knowledge, this is the first cross-sectional study to examine structural racism at a state level and the odds of pre-term birth among Black and White women.

**Methods:**

**Sample**

For this study, we conducted cross-sectional analyses using state-level data from different public online sources, including the 2013 Census American Community Survey and The Sentencing Project's 2014 criminal justice data. Information and outcome data is from 2013 birth certificates compiled by the National Center for Health Statistics (NCHS) through the National Vital Statistics System. Because the birth certificate data is de-identified and the exposure data are from public documents, no Institutional Board

Review (IRB) approval was required. Due to the lack of state level data on educational attainment, occupational status, or incarceration, six states (Iowa, Montana, North Dakota, South Dakota, Vermont, Wyoming) as well as the District of Columbia were excluded.

The study sample included 2,297,257 non-Hispanic White and non-Hispanic Black women, aged 15-50 who had a live, singleton birth in 2013. Women of all other races and not born in the United States were excluded. Other exclusions included missing birth certificate information on gestational weeks at birth and home state of the mother. Observations with a maternal home state from any of the seven excluded states listed above, were not included in the analysis. Selected characteristics, many of which were controlled for as covariates, were also extracted from the birth certificate data.

**Structural Indicators (Exposure)**

The measures of structural racism included three domains: (1) educational attainment, (2) occupational level, and (3) incarceration. These state-level racial disparities across different domains were used to represent the systematic exclusion of Blacks from resources and mobility in society.

Information on the educational attainment was obtained from the U.S. Census Bureau, American Community Survey 2013 3-year estimates (https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml).

To assess educational attainment, we first calculated the number of Black women in each state who attained a bachelor's level degree or higher and compared it to the total number of Black women in the state. We then calculated the same proportion for White women.

Finally, we compared these two proportions to examine the disparity in the total proportion of highly educated Black women to the total proportion of highly educated White women by state.

We also obtained employment level from the American Census Bureau, using American Community Survey 2013 3-year estimates (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml).

To evaluate occupational level, we calculated the number of Black women in each state who were in managerial or professional positions and compared it to the total number of employed Black women in the civilian labor force. After determining the same proportion for White women, we compared the two proportions to examine the disparity in the proportion of Black women in managerial and professional positions to the proportion of White women in such positions by state. Managerial and professional positions include the following occupations according to the U.S. Bureau of Labor Statistics: business & financial, management, computer & mathematical, architecture & engineering, life, physical, & social science, community & social services, legal, education, training, & library, arts, design, entertainment, sports, media, healthcare practitioner & technical positions (https://www.bls.gov/opub/ted/2009/ted_20090807.htm).

We acquired 2014 incarceration data from The Sentencing Project's 2014 state-level criminal justice data (24). We used their specific ratios for Black-White disparity in incarceration which were calculated by dividing the Black imprisonment rate per 100,000

people by the White imprisonment rate per 100,000 people.

For each of these indicators (educational attainment, occupational level, and incarceration), we examined the disparity proportion for each state and determined a median cut-point. For incarceration ratios, states below the cut-point were considered to have "low" structural racism and were assigned a score of 0. States above the cut-point were considered to have "high" structural racism in incarceration assigned a score of 1. For the education and occupation ratios, states above the median cut point for each indicator were considered to have "low" structural racism and assigned a score of 0 for each of these measures. States below the median cut-point were considered to have "high" structural racism in occupation and education and assigned a score of 1 for each of these measures. We then calculated the total structural racism "score," ranging from 0 to 3 for each state by adding the points from the different measures (incarceration, education, and occupation).

**Outcome**

The outcome, pre-term birth, was defined as less than 37 completed weeks of gestation. Gestational age information was extracted from birth certificates and dichotomized, with births occurring after 37 completed gestational weeks as "term" and births occurring prior to 37 completed gestational weeks as "pre-term."

**Covariates**

Data related to individual-level differences in maternal characteristics were extracted from the birth certificate data. These data included cigarette smoking during pregnancy, parity, age, marital status, and education.

**Statistical Analyses**

Differences in maternal characteristics by structural racism score were calculated using chi square tests. An average of all state disparity proportions was used to calculate a mean ratio comparing the relative proportion of Blacks and Whites for each indicator for each structural racism score. These analyses examined the average racial disparity between Blacks and Whites across all the states for each indicator to provide background before we began our investigation into our outcome of preterm birth.

Generalized estimating equations were then used to evaluate the association of the structural racism score with pre-term birth while controlling individual level factors. Prevalence odds ratios were calculated for each race using states with a score of 0 as the referent group. We controlled for age and parity in the logistic regression models. We were unable to control for education or smoking status because approximately 95% of the data was missing in 8 states (Alabama, Arizona, Arkansas, Connecticut, Hawaii, New Jersey, Rhode Island, and West Virginia). Logistic regression models excluding these 8 states but controlling for education and smoking status were run as part of a sensitivity analysis. Statistical analyses were conducted using SAS Version 9.4.

**Results:**

The selected characteristics of women by structural racism score are shown in Table 1B. There are various statistically significantly differences in maternal characteristics among different structural racism score groups. Most notably, there were slightly fewer preterm births (8.23%) in the states with the highest structural racism score of 3, compared to states with lower scores. The racial distribution was much different in

this group with about 10% fewer Black women, compared to the states in the lower score groups. Women in the score 3 group were also older, with a much lower percentage falling into the 15-19 and 20-24 age ranges. Almost a third (30.78%) of the women in this group fell into the 30-34 age range and there were significantly more women in the 40-50 age range, compared to women in states with a score of 0 or 1. While there were few differences in parity among the 4 different score groups, women in the referent group (score 0), were slightly more likely to be having their first child. Women in the score 3 group were less likely to be single, with at least 10% more married women than those in the lower score groups. They were also significantly more educated, with 40% having a Bachelor's degree or higher. Finally, women in the score 1 group had the most smokers during pregnancy (13.43%), and women in the score 3 group had the fewest smokers (11.61%).

The relative proportions of Blacks to Whites (mean ratio) among 43 U.S. states for each structural racism indicator by structural racism score are shown in Table 1A. In all score groups, Black women were underrepresented in educational attainment and professional and managerial positions compared to White women. In contrast, the average incarceration rate among Black men and women was at least 2 times greater than the rate among White men and women in all score groups, with an average of 8.66 times greater in the highest structural racism score group.

The associations of the structural racism score at the state level with pre-term birth by race are shown in Table 2. The prevalence odds ratios compare the odds of preterm birth for women living in states with structural racism score of 1, 2, or 3 to the odds of preterm birth among women living in states with a structural racism score of 0 by

race. Among Black women, living in states with a structural racism score of 1 was associated with 12% greater odds of having a preterm birth (OR=1.12 95% CI= [0.99,1.28]), although this finding was borderline significant. Black women living in states with a score of 2 also had a slightly higher (2%) odds of preterm birth, but this finding was insignificant. For women in states with the highest structural racism score of 3, there was an inverse effect, with a statistically significant 12% reduction in the odds of preterm birth (OR 0.88 95% CI= [0.83, 0.94], which was contrary to our hypothesis. Consistent with our hypothesis, we observed a pattern of greater reduced odds of preterm birth with increasing state structural racism score among White women. We found a 2% reduced odds of preterm birth among White women in states with a score of 1 and a 9% reduced odds of preterm birth among White women in states with a score of 2, however, neither of these results were statistically significant. Women living in states with a score of 3 had a 17% reduced odds of preterm birth and this finding was statistically significant (OR=0.83 95% CI= [0.77, .88]). While we were unable to control education or smoking status due to the high level of this missing data in 8 specific states, we did conduct a sub-analysis where we excluded these states but included education and smoking status in the model. These results are also shown in Table 2 and are not very different than the results of our main model.

**Discussion:**

Contrary to our hypothesis, we found that state-level racism, assessed through racial disparities in educational attainment and drug-related incarceration, was statistically significantly associated with reduced odds of preterm birth among African

American women living in states with the highest structural racism score of 3. While we did find increased odds of preterm birth among Black women living in states with a scores of 1 and 2, these results were not statistically significant. On the other hand, White women in states with a structural racism score of 1, 2, and 3 had lower odds of preterm birth, as hypothesized.

Some of the results of this study are consistent with Nancy Krieger's eco-social theory that "inequitable race relations simultaneously—and not sequentially benefit the groups who claim racial superiority at the expense of those whom they deem intrinsically inferior" (18). Greater racial disparities at the state level, or a higher structural racism score, was associated with lower odds of preterm birth among White women. However, the lower odds of preterm birth among Black women in states with the highest structural racism of 3 is not consistent with eco-social theory and there are no other theories or empirical evidence that supports that structural racism has a protective health effect for Black women.

The results of this study are also not entirely consistent with findings from prior research studies on the deleterious health effects of state-level structural racism. Lukachko et al. found that Black-White state level disparities in political representation and incarceration were associated with higher odds of self-reported myocardial infarction in the past 12 months among Blacks and lower or nulls odds among Whites (19). One main difference between the studies is the health outcome; as it applies to the study sample. Lukachko et al's sample included men and women, while our study was focused on preterm birth and therefore only included women in the sample. Furthermore, we only included women of childbearing age (16-40), while the Lukachko et al. study included

participants aged 18 and older; therefore, the results of our study may be generalizable only to this smaller sub-population. Wallace et al. also examined structural racism, measured through racial disparities in educational attainment, employment, and incarceration at the state level. They found an association of high levels of these racial disparities in combination with income inequality with small-for-gestational-age (SGA) birth among Black and White women (25). While the study population was similar (women of childbearing age), they only investigated disparities in 10 U.S. states rather than in the entire U.S. Additionally, their results included income inequality, which was controlled for at an individual level, rather than examined as an exposure as in our study. Finally, they found that high levels structural racism was associated with higher odds of SGA birth among White women, in contrast to our study in which we found that high levels of structural racism were associated with lower odds of structural racism.

**Strengths and Limitations**

To our knowledge, this is the first study to examine state-level structural racism and pre-term birth. Our study presents a new method to quantify structural racism, contributing to this new but growing area of research. The main strength of the study was our assessment of the exposure as we could include all births in the U.S. in 2013, rather than just a sample. By examining racial disparities and pre-term birth outcomes on a state-level, our results and other future studies may be able inform state policy interventions to improve some of the factors that may contribute to high levels of discrimination in certain states. There are also various limitations to this study. First and foremost, we used only three indicators to examine structural racism- these measures may not fully or accurately encompass state policies, practices, and opportunities across the

states. Structural racism is difficult to quantify and perhaps other indicators could be used to better illustrate state-level racial disparities, particularly among women. Furthermore, we assumed that each of these indicators contributes equally to the overall structural racism level in a state, which may or may not be true. In addition, the cross-sectional design of the study only allowed us to examine a particular moment in time. Finally, by using the state indicated on a mother's birth certificate, we could not account for the fact that a woman may have lived in other parts of the country throughout her lifetime and therefore experienced different levels of institutional racism than that of the mother's state of residence listed on the birth certificate.

Considering that the reduced odds of preterm birth among Black women in states with the highest structural racism score of 3 is not supported by any current theories or research, the states in this category likely have some characteristic that we failed to control for. Women in these states were more educated, slightly older, less likely to smoke, and more likely to be married than women in states in the lower score categories. While we could control for these individual level factors, there could also be larger institutional factors, such as quality of and access to medical care or state level policies to assist disadvantaged women and children, that we did not account for.

We did conduct sensitivity analyses to determine if using cut points for the high and low structural racism categories of each indicator changed the associated odds ratios significantly. We ran the models using tertile (33 and 67) and quartile (25 and 75) cut points, and found no drastic difference in results or direction of the association than when we used the median cut points. We also limited our study population to the 10 states from the Wallace et al. study and found no difference in the direction of the associations (see

Appendix Table 3), suggesting that it is our indicators of structural racism that may not be accurately capturing the structural experiences between states, or that there may be some unmeasured confounding in those states with the highest level of structural racism.

Overall, while many of our results were statistically insignificant or unexpected, we hope that our new epidemiological approach to analyzing structural racism at a state level will both draw attention to the issue and inform future research in the field.

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**Tables:**

**Table 1A. Distribution of Indicators by Total Structural Racism Score˜ Across 43 U.S. States from the 2013 U.S. Census American Community Survey and 2014 Sentencing Project Incarceration Data**

| | Structural Racism Score | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | **3** |
| N [states] | 10 | 12 | 9 | 12 |
| **Mean Ratio* (SD; Range)** | | | | |
| Educational Attainment (Bachelor's Degree or greater) ^ | 0.74 (0.08; 0.69 – 0.95) | 0.73 (0.04; 0.68 – 0.81) | 0.63 (0.03; 0.58 – 0.67) | 0.56 (0.05; 0.47 – 0.61) |
| Occupational Status (Professional or Managerial Positions) ^ | 0.81 (0.07; 0.75 – 0.99) | 0.76 (0.06; 0.68 – 0.85) | 0.75 (0.05; 0.65 – 0.82) | 0.68 (0.04; 0.63 – 0.74) |
| Incarceration (Prison and Jail Population) | 4.1 (0.78; 2.4 – 4.8) | 4.7 (1.5; 3.0 – 7.3) | 6.3 (2.4; 3.6 – 8.9) | 8.66 (2.36; 5.0 – 12.2) |

*Relative Proportion of Blacks to Whites within each state
^Indicator only includes women
~~The structural racism score was calculated by adding up the points for three indicators (education, occupation, and incarceration) which were dichotomized into low (0) vs. high (1) based on the median of the distribution of the indicator across the states.

**Table 1B. Maternal Descriptive Statistics by Structural Racism Score˜ of State on 2013 Birth Certificate^ (Total N=2,297,257)**

| | State Structural Racism Score | | | | |
|---|---|---|---|---|---|
| | **0** | **1** | **2** | **3** | **P Value** |
| N (Total Births) | 476,120 | 482,994 | 786,314 | 551,929 | |
| **N (%)** | | | | | |
| Preterm Birth | 48,249 (10.13%) | 50,526 (10.46%) | 76,718 (9.76%) | 45,449 (8.23%) | <0.001 |
| Race | | | | | <0.001 |
| White | 379,764 (79.76%) | 373,000 (77.24%) | 602,386 (76.61%) | 476,538 (86.34%) | |
| Black | 96,356 (20.24%) | 109,894 (22.76%) | 183,928 (23.39%) | 75,391 (13.66%) | |
| Age (years) | | | | | <0.001 |
| 15-19 | 38,743 (8.14%) | 38,402 (7.95%) | 53,700 (6.83%) | 25,672 (4.65%) | |
| 20-24 | 126,886 (26.65%) | 130,560 (27.04%) | 187,474 (23.84%) | 105,196 (19.06%) | |
| 25-29 | 143,096 (30.05%) | 145,293 (30.09%) | 227,769 (28.97%) | 158,389 (28.70%) | |
| 30-34 | 113,591 (23.86%) | 114,725 (23.76%) | 208,986 (26.58%) | 169,868 (30.78%) | |
| 35-39 | 44,307 (9.31%) | 44,524 (9.22%) | 88,349 (11.24%) | 76,022 (13.77%) | |
| 40-44 | 9,004 (1.89%) | 8,913 (1.85%) | 18,863 (2.40%) | 15,730 (2.85%) | |
| 45-50 | 493 (0.10%) | 477 (0.10%) | 1,173 (0.15%) | 1,052 (0.19%) | |
| Parity | | | | | <0.001 |
| 1 | 162,951 (34.31%) | 159,431 (33.98%) | 266,178 (34.19%) | 184,264 (33.49%) | |
| 2 | 135,493 (28.53%) | 132,003 (28.14%) | 223,561 (28.71%) | 158,271 (28.76%) | |
| 3+ | 176,446 (37.16%) | 177,731 (37.88%) | 288,833 (37.10%) | 207,749 (37.75%) | |
| Marital Status | | | | | <0.001 |
| Married | 279,280 (58.66%) | 280,943 (58.18%) | 447,816 (56.95%) | 368,034 (66.68%) | |
| Single | 196,840 (41.34%) | 201,951 (41.82%) | 338,498 (43.05%) | 183,895 (33.32%) | |
| *Education | | | | | <0.001 |

| | | | | | |
|---|---|---|---|---|---|
| Less than high school | 43,196 (11.18%) | 48,934 (11.35%) | 85,527 (10.99%) | 36,195 (7.63%) | |
| High School/GED, Some College, or Associate's Degree | 226,239 (58.54%) | 261,472 (60.66%) | 443,534 (56.99%) | 247,421 (52.10%) | |
| Bachelor's Degree or Higher | 117,015 (30.28%) | 120,639 (27.99%) | 249,210 (32.02%) | 191,123 (40.27%) | |
| *Missing* | 89,670 (18.83%) | 51,849 (10.74%) | 8,043 (1.02%) | 77,370 (14.02%) | |
| *Smoked During Pregnancy | | | | | <0.001 |
| Yes | 49,691 (12.88%) | 44,678 (13.43%) | 89,934 (11.55%) | 53,115 (11.61%) | |
| No | 336,220 (87.12%) | 287,896 (86.57%) | 688,638 (88.45%) | 404,313 (88.39%) | |
| *Missing* | 90,209 (18.95%) | 150,320 (31.13%) | 7,697 (0.98%) | 94,501 (17.12%) | |

*Note that ~95% of data for this variable was missing in the following states Alabama, Arizona, Arkansas, Connecticut, Hawaii, New Jersey, Rhode Island, and West Virginia

^Birth certificate data is form 2013 and complied by the National Center for Health Statistics (NCHS) through the National Vital Statistics System

~~Data is from sources listed in Tables 1A; the structural racism score was calculated by adding up the points for three indicators (education, occupation, and incarceration) which were dichotomized into low (0) vs. high (1) based on the median of the distribution of the indicator across the states.

**Table 2. Associations of Structural Racism Score˜**
**with 95% Confidence Intervals for Pre-Term birth by Race;**

| Structural Racism Score | Black *OR [95% CI] ^OR [95% CI] | White *OR [95% CI] ^OR [95% CI] |
|---|---|---|
| 0 | Ref. | Ref. |
| 1 | 1.12 [0.99, 1.28] *1.10 [0.94, 1.28]* | 0.98 [0.88, 1.09] *0.97 [ 0.87, 1.08]* |
| 2 | 1.02 [0.91, 1.16] *1.02 [0.90, 1.15]* | 0.91 [0.79, 1.05] *0.92 [0.81, 1.05]* |
| 3 | 0.88 [0.83, 0.94] *0.86 [0.82, 0.95]* | 0.83 [0.77, .88] *0.86 [0.80, 0.92]* |

~Data is from sources listed in Tables 1A; the structural racism score was calculated by adding up the points for three indicators (education, occupation, and incarceration) which were dichotomized into low (0) vs. high (1) based on the median of the distribution of the indicator across the states.

*Adjusted at the individual level for maternal age and parity, but not education or smoking status due to 95% of data missing in 8 states

^Adjusted at the individual level for maternal age, parity, education, and smoking status, but excluded all data from 8 states where 95% data was missing in education and smoking status

## CHAPTER III - Summary, Public Health Implications, Possible Future Directions

A growing body of research suggests that greater, macro-social determinants may have deleterious effects on health, especially among vulnerable populations such as African American women. Long term stress due to life-long discrimination as well as the idea of biological "weathering" have been suggested as potential reasons for the significantly worse birth outcomes African American women experience compared to women of all other races. The educational, employment, and incarceration systems in the U.S. each have a long history of discriminatory practices which have resulted in significant racial disparities today. The unjust treatment of African Americans in these systems has inhibited them from upward mobility in society, leaving a disproportionate number of Black communities experiencing ongoing cycles of poverty, constant stress, and various associated health conditions.

The purpose of this study was to first assess structural racism at a state level by measuring Black-White racial disparities in educational attainment, occupational status, and incarceration. These indicators were meant to serve as a quantitative measure of institutional racism. Second, we aimed to evaluate whether Black women in states with higher levels of structural racism had higher odds of preterm birth, compared to women in states with low levels of structural racism. Third, we hypothesized that structural racism had a protective effect for White women, and that those in states with a higher level of structural racism would have lower odds of preterm birth compared to those in states with low structural racism. We developed a scoring system where the disparity proportion for each indicator was analyzed. Using median cut-points, those states above the median (for incarceration) or below the median (for education and occupation) were

given a score of 1. They were otherwise given a score of 0. The points from each indicator were added to determine a final structural racism score, ranging from 0 to 3. Those states falling in the 0 category, were deduced to have the lowest level of structural racism and used as the referent group in our analyses.

Most of our results were not consistent with our hypotheses. While we did find increased odds of preterm birth among Black women living in states with structural racism scores of 1 and 2, these findings were not statistically significant. Among Black women living in states with a structural racism score of 3, we actually found reduced odds of preterm birth that was statistically significant. Among White women in states with scores of 1, 2 and 3, there was progressively lower odds of preterm birth, as predicted.

Some of the states in highest structural racism score group of 3 were not anticipated (see Appendix Table 4). Hence, our choice of indicators or the use of our scoring system may not be the most accurate way to measure structural racism at the state level. In addition, there could be unique characteristics of these states that we failed to control for and contribute to the lower odds of preterm birth for Black and White women.

We attempted to measure racism at an institutional level, however, in doing so we may not have captured the full extent to which Black women are exposed to discrimination. Furthermore, there could be could be additional mechanisms through which Black women are made more vulnerable to preterm birth. Our study did not include individual behavioral factors or even local community factors such as a neighborhood deprivation. Various behavioral theories, such as eco-social theory and the social ecological model, posit that health issues need to be understood and addressed at

multiple levels including individual, interpersonal, organizational, community, and policy. Ideally, future studies should draw on factors from each of these levels when studying both discrimination and preterm birth.

Considering that racism at a structural level is difficult to measure, further research should be conducted to experiment with different types of quantitative methods. In addition, studies should be done to assess which specific institutional factors have the greatest impact on certain health conditions. As we continue to gather more information on what types of potentially discriminatory policies or practices result in significant health disparities, we can better understand how to accurately develop quantifiable indicators of structural racism. Ultimately, as research in this area continues to grow, we hope that it may inform state-policy interventions aimed at reducing racial disparities in health.

**APPENDIX**

**Table 3. Associations of Structural Racism Score˜**
**with 95% Confidence Intervals for Pre-Term birth by Race in 10**
**Selected States^ from Wallace et al Study;**

| Structural Racism Score | Black | White |
|---|---|---|
| | *OR [95% CI] | *OR [95% CI] |
| 0 | Ref. | Ref. |
| 1 | - | - |
| 2 | 1.01 [0.84, 1.20] | 0.93 [0.77, 1.12] |
| 3 | 0.86 [0.80, 0.92] | 0.84 [0.78, 0.90] |

~Data is from sources listed in Tables 1A; the structural racism score was calculated
by adding up the points for three indicators (education, occupation, and incarceration)
which were dichotomized into low (0) vs. high (1) based on the median of the
distribution of the indicator across the states.
^10 states included California, Delaware, Florida, Illinois, Indiana, Maryland,
Massachusetts, New York, Ohio, and Texas; none of these states had a
structural racism score of 1
*Adjusted at the individual level for maternal age, education, smoking status and parity

**Table 4. States (By Name) in Each Structural Racism Score Category˜**

| Structural Racism Score | | | |
|---|---|---|---|
| **0** | **1** | **2** | **3** |
| Arizona | Alabama | California | Colorado |
| Arkansas | Alaska | Florida | Connecticut |
| Delaware | Georgia | Illinois | Iowa |
| Hawaii | Kentucky | Louisiana | Kansas |
| Indiana | Michigan | Nebraska | Massachusetts |
| Maryland | Mississippi | North Carolina | Minnesota |
| Oklahoma | Missouri | Ohio | New Jersey |
| Tennessee | Nevada | Pennsylvania | New York |
| Texas | New Hampshire | South Carolina | Rhode Island |
| West Virginia | New Mexico | | Virginia |
| | Oregon | | Washington |
| | Utah | | Wisconsin |

~~ Data is from sources listed in Tables 1A; the structural racism score was
calculated by adding up the points for three indicators (education, occupation,
and incarceration) which were dichotomized into low (0) vs. high (1)
based on the median of the distribution of the indicator across the states.