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Racial/Ethnic Inequities in Low Birth Weight and Preterm Birth: The Role of Multiple Forms of Stress

Joanna Almeida[1], **Laia Bécares**[2], **Kristin Erbetta**[1], **Vani R. Bettegowda**[3], **Indu B. Ahluwalia**[4]

[1]Simmons School of Social Work, Simmons College, Boston, MA, USA

[2]University of Manchester, Manchester, UK

[3]Perinatal Data Center, March of Dimes Foundation, White Plains, NY, USA

[4]National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control & Prevention, Atlanta, GA, USA

Abstract

Introduction—Racial/ethnic inequities in low birth weight (LBW) and preterm birth (PTB) persist in the United States. Research has identified numerous risk factors for adverse birth outcomes; however, they do not fully explain the occurrence of, or inequalities in PTB/LBW. Stress has been proposed as one explanation for differences in LBW and PTB by race/ethnicity.

Methods—Using the Pregnancy Risk Assessment Monitoring System (PRAMS) data from 2012 to 2013 for 21 states and one city (n = 15,915) we used Poisson regression to estimate the association between acute, financial and relationship stressors and LBW and PTB, and to examine the contribution of these stressors individually and simultaneously to racial/ethnic differences in LBW and PTB.

Results—Adjusting for age and race/ethnicity, acute ($p < 0.001$), financial ($p < 0.001$) and relationship ($p < 0.05$) stressors were associated with increased risk of LBW, but only acute ($p < 0.05$) and financial ($p < 0.01$) stress increased risk of PTB. Across all models, non-Hispanic blacks had higher risk of LBW and PTB relative to non-Hispanic whites (IRR 1.87, 95% CI 1.55, 2.27 and IRR 1.46, 95% CI 1.18, 1.79). Accounting for the effects of stressors attenuated the risk of LBW and PTB by 17 and 22% respectively, but did not fully explain the increased likelihood of LBW and PTB among non-Hispanic blacks.

Discussion—Results of this study demonstrate that stress may increase the risk of LBW and PTB. While stressors may contribute to racial/ethnic differences in LBW and PTB, they do not fully explain them. Mitigating stress during pregnancy may help promote healthier birth outcomes and reduce racial/ethnic inequities in LBW and PTB.

✉Joanna Almeida, Joanna.almeida@simmons.edu.

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Keywords

Racial/ethnic inequities; Adverse birth outcomes; Low birth weight; Preterm birth; Psychosocial stressors

Introduction

Low birth weight (LBW) and preterm birth (PTB) are major causes of infant mortality and leading contributors to health complications among infants in the United States (US).[1,2] In 2015, 8.1% of *all* infants born in the US were LBW and 9.6% were born prematurely (Martin et al. 2017). Rates of LBW and PTB vary across racial and ethnic groups, and some of the most persistent health inequities continue among infants born LBW and preterm (Martin et al. 2017). Specifically, the rate of LBW among non-Hispanic black women (13.1%) is almost twice that of non-Hispanic whites (7.0%) and Hispanics (7.0%) and higher than among Asians (8.2%) and American Indian/Alaskan Natives (AI/AN)(7.6%).[3] Similarly, non-Hispanic black women have the highest rate of PTB (13.3%), while AI/ANs (10.4%), Hispanics (9.1%), non-Hispanic whites (9.0%) and Asians (8.5%) have lower rates.[3] Eliminating racial/ethnic inequities in adverse birth outcomes remains a national objective of Healthy People 2020 with the goals of reducing the overall rates of LBW and PTB.[4]

While myriad socioeconomic, demographic, behavioral and medical variables have been identified as risk factors for LBW and PTB, they do not fully explain the occurrence of, or inequities in, these adverse birth outcomes (Goldenberg et al. 1996; Page 2004; Strobino et al. 1999). This has prompted renewed attention to potential psychosocial factors, including stress, which may contribute to adverse birth outcomes and to differences in rates of PTB and LBW across racial/ethnic groups. The adverse effects of stress on health have been extensively documented (McEwen 1998; Thoits 2010; McEwen and Stellar 1993; Pearlin 1999). More recently, researchers have begun investigating the association between stress and adverse birth outcomes in a growing body of literature (Hobel et al. 2008; Loomans et al. 2012; Lu and Chen 2004; Parker Dominguez et al. 2008; Witt et al. 2014a, b; Ahluwalia et al. 2001; Sharapova 2012; Hux et al. 2014; Littleton et al. 2010). While evidence points to the possibility that stress before and during gestation may contribute to adverse birth outcomes, results of the extant literature have been mixed (Hobel et al. 2008; Loomans et al. 2012; Lu and Chen 2004; Parker Dominguez et al. 2008; Witt et al. 2014a, b; Ahluwalia et al. 2001; Sharapova 2012; Hux et al. 2014; Littleton et al. 2010). For example, research has shown that women who experienced stress (measured by allostatic load) was higher among women who delivered preterm and small for gestational age infants compared to women who delivered full-term and normal weight infants (Hux et al. 2014). Other work demonstrated that women with high psychosocial strain had significantly increased rates of

[1]March of Dimes. Premature babies. Retrieved April 2, 2017 from http://www.marchofdimes.org/baby/premature-babies.aspx.
[2]March of Dimes. Low birth weight. Retrieved April 2, 2017 from http://www.marchofdimes.org/baby/low-birthweight.aspx.
[3]National Center for Health Statistics. Final natality data. Retrieved from http://www.marchofdimes.org/peristats.
[4]Healthy People 2020. Washington, DC: U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion. Retrieved April 24, 2017 from https://www.healthypeople.gov/2020/topics-objectives/topic/maternal-infant-and-child-health.

LBW babies compared to women with low psychosocial strain (Loomans et al. 2012). This relationship also held for PTB (Loomans et al. 2012). Conversely, other researchers have found that stress is not significantly associated with PTB (Lu and Chen 2004). Moreover, a 2010 meta-analysis concluded that the association between psychosocial stress and adverse birth outcomes, although statistically significant, is very small and likely explains < 1% of the variability in outcomes (Littleton et al. 2010). The discrepant findings in the extant literature may in part be attributable to varying definitions and measurement of stress, as well as the timing of the stressor (e.g. childhood, pre-pregnancy, during pregnancy) relative to the birth. Additionally, studies have inconsistently controlled for factors that could confound the relationship between stress and birth outcomes. A more complete understanding of these associations is critical given that stress is potentially modifiable, and a reduction in it, or response to it, could subsequently reduce the incidence of LBW and PTB if stress is indeed associated with these adverse birth outcomes (Lee et al. 2012; Straub et al. 2014).

Disparities in exposure to stress between racial/ethnic groups in the US have recently been documented (Sternthal et al. 2011). A study of adults in Chicago, IL found significant differences in number and type of stressors across racial and ethnic groups. Relative to non-Hispanic whites, non-Hispanic blacks and US-born Hispanics also reported more exposure to stress (Sternthal et al. 2011). Results of other research point to a slightly more nuanced association between race/ethnicity and stress. Specifically, when accounting for socioeconomic status (SES), the relationship between race/ethnicity and traumatic vs. non-traumatic stressful experiences are inconsistent (Hatch and Dohrenwend 2007). Nonetheless, on balance studies generally find that non-Hispanic blacks, and to a lesser extent other racial/ethnic minorities report more stressful events than non-Hispanic whites (Sternthal et al. 2011). However, the question of whether and how much stress contributes to racial/ethnic differences in LBW and PTB remains less clear. Research shows that racial/ethnic minorities, notably non-Hispanic blacks and AI/AN experience increased stressful events before and during pregnancy (Lu and Chen 2004; Parker Dominguez et al. 2008; Sharapova 2012). Using a cross-sectional study design, Lu and Chen (2004) found that stress explained a negligible amount of the association between race/ethnicity and PTB, specifically, that accounting for stress reduced the odds of PTB among non-Hispanic black women from 1.61 to 1.60 (Lu and Chen 2004). By contrast, Parker Dominguez et al. (2008) demonstrated that when stress (measured as lifetime perceived racism) was tested as a mediator of racial differences in birth weight, there was a significant decrease in the standardized regression coefficient for race (from -0.25, $p < 0.01$ to -0.20, $p < 0.05$) (Parker Dominguez et al. 2008).

To date, few population-based studies have investigated the contribution of stress to racial/ethnic inequities in adverse birth outcomes. Consistent with the larger body of work on the role of stress in racial/ethnic differences in health that have primarily focused on inequities between non-Hispanic blacks and whites, studies on the role of stress in racial/ethnic differences in adverse birth outcomes have also occurred largely to the exclusion of *other* racial/ethnic minority groups (Parker Dominguez et al. 2008; Sharapova 2012; Sternthal et al. 2011). This is problematic given Hispanics' high birth rates (Hamilton et al. 2015) and increased stress due to job hazards, poverty and immigration status (Finch et al. 2004;

Williams et al. 2010). Additionally, because Asians are now the fastest growing racial/ethnic minority group in the US (Colby and Ortman 2015), greater attention to the potential role of stress in birth outcomes across *multiple* racial/ethnic groups is warranted (Sternthal et al. 2011). Moreover, recent work has cited the need to examine a *broader range* of stressors to determine the independent and cumulative role of stress to comprehensively understand the impact of stressors on LBW and PTB (Witt et al. 2014a, b).

We address the aforementioned gaps in research in three ways. First, we move beyond the black-white dichotomy by using population-based data with *multiple* racial/ethnic groups. Second, we answer the call to more comprehensively assess psychosocial stress by leveraging an expanded measure of this construct. Third, we update a similar study done with PRAMS data from 19 US states in 2000, with a larger sample of 21 US states and New York City. Given the equivocal association between stress and adverse birth outcomes, the notion that stress in the US is at the highest rate it has been the past decade (American Psychological Association 2017), and the increased racial/ethnic diversity in this country (Colby and Ortman 2015), our study had three objectives. First, we examined the distribution of multiple forms of stress prior to and during pregnancy across racial/ethnic groups. Second, we tested the association between multiple forms of stress (both individually and then simultaneously) and LBW and PTB. Finally, we investigated the role of stress in explaining racial/ethnic inequities in LBW and PTB.

Methods

This study used data from Pregnancy Risk Assessment Monitoring System (PRAMS), a mailed survey linked with certain items from the infant birth certificate. PRAMS is an ongoing surveillance system overseen by the US Centers for Disease Control and Prevention (CDC) and implemented by individual states which is designed to monitor maternal experiences and behaviors before, during and shortly after pregnancy. Each month, a stratified sample of 100–300 women who have given birth in the previous 2–6 months in participating PRAMS states is selected from birth certificates. For this study data were analyzed from 21 states and one city that took part in PRAMS and had a weighted response rate of > 60% (AK, CO, DE, GA, IL, MA, MD, MN, MO, NE, NH, NM, NY, OH, OK, OR, TN, UT, WA, WI, WY and New York City) during the years 2012–2013, the most recent years for which data were available.

The two outcomes of interest were LBW and PTB. Low birth weight was categorized dichotomously as a birth weight of < 2500 or ≥ 2500 g. A birth was deemed preterm if it occurred prior to 37 completed gestational weeks and was measured with the clinical estimate of gestational age. The independent variable stress was derived from the PRAMS original 13-item measure of stressful experiences *as well as* three additional questions from the survey which assessed stress in order to examine three domains of psychosocial stress: traumatic stress, financial stress and relationship stress *during pregnancy and 3 months prior to becoming pregnant*. This is congruent with previous studies that have called for examining a broad range of stressors across multiple domains in an effort to more comprehensively understand the role of stress in health generally and in adverse birth outcomes specifically (Sternthal et al. 2011; Hatch and Dohrenwend 2007; O'Leary 2012).

"Appendix" describes questions within each domain of stress and shows internal consistency reliability scores. Maternal race/ethnicity data were obtained from the infant birth certificate and was categorized as non-Hispanic white, non-Hispanic black, Hispanic, AI/AN and Asian/Native Hawaiian.

We accounted for maternal socio-demographic covariates including age (≤ 19; 20–34; 35 + years), education (< high school vs. ≥ high school), pre-pregnancy maternal body mass index (BMI) categorized as underweight (< 19.8 kg/m^2); normal (19.8–26 kg/m^2); overweight (> 26–29 kg/m^2) and obese (> 29 kg/m^2), previous live birth, previous LBW and PTB and method of payment for healthcare (self-pay or private insurance, Medicaid, other) all of which came from the birth certificate. We also controlled for marital status (married vs. other), prenatal care initiation (1st, 2nd, 3rd trimester) and whether the woman used any tobacco products or drank any alcohol during the last 3 months of pregnancy, all of which were obtained from the PRAMS survey. In an effort to be parsimonious, we included covariates that are established socio-demographic risk factors for the outcomes of interest (Strobino 1999). Finally, we adjusted for the state where the PRAMS data were collected.

Analytic Plan

Following previous powerful methods for modeling stress (Sternthal et al. 2011), we developed three domains characterizing different types of stressors (described in "Appendix"). Individual stress items were first summed to create a summary variable of each type of stressor. We then created a z-score of each summary variable and categorized the z-scores into quintiles. We used the highest quintile to indicate the highest level of stress in each particular domain. For the analyses that examined the association between each domain of stress and LBW and PTB, we used a dichotomous variable that indicated whether the respondent was in the highest quintile of stress, or in all other categories. Following the work of previous stress researchers, we used the highest quintile approach to capture both severity and accumulation of stressors (Sternthal et al. 2011). Finally, to explore racial/ethnic inequities in LBW and PTB, and to examine the contribution of each domain of stress (both individually and simultaneously) to racial/ethnic differences in LBW and PTB, we modelled stressors using the z-scores.

To test the association between LBW, PTB and each type of stressor, racial/ethnic differences in LBW and PTB, as well as the contribution of each stressor to these inequities, we used Poisson regression to estimate incidence rate ratios (IRR). The first set of analyses examined the association between LBW and PTB, and each type of stressor adjusted only for maternal age and race/ethnicity. The second set of analyses assessed racial/ethnic inequities in LBW and PTB, and explored the individual contribution of each type of stressor individually as well as the contribution of all three types of stressors simultaneously in explaining any racial/ethnic inequities. Models for this set of analyses were built in steps. The first model (Model 1) included only the outcome and maternal race/ethnicity. Model 2 additionally adjusted for *all* maternal socio-demographic covariates (listed above). Model 3a adjusted for maternal race/ethnicity, all maternal socio-demographic covariates, and the z-score of traumatic stressors. Model 3b adjusted for maternal race/ethnicity, all maternal socio-demographic covariates and the z-score of financial stressors. Model 3c was identical

to model 3b except relationship stress replaced financial stress. Model 4 included all three types of stressors in addition to maternal race/ethnicity and all maternal socio-demographic covariates. Analyses included cases with no missing values, and excluded women who delivered multiple infants (n = 2262) and those who did not self-identify as non-Hispanic white, non-Hispanic black, Hispanic, AI/AN or Asian/Native Hawaiian (n = 1030). Data were weighted for complex survey design and non-response. We used survey commands in STATA to account for the complex survey design.

Results

The overall prevalence of LBW and PTB in the sample was 6.1% and 10.4% respectively. Rates of LBW were highest among non-Hispanic blacks (9.7%) and lowest among Asian/Native Hawaiians (5.0%). The prevalence of PTB among non-Hispanic blacks was 13.5%, while among Asian/Native Hawaiians it was 8.4%. Table 1 displays all maternal characteristics as well as stressors across the total sample and by race/ethnicity. We found significant differences across all socio-demographic characteristics by race/ethnicity ($p < 0.0001$). Non-Hispanic white women had the highest levels of socioeconomic status (SES), as measured by education level and private insurance/self-pay. Additionally, non-Hispanic white women had the highest prevalence of reported tobacco use during the third trimester of pregnancy (17.6%), compared to 2.5% of Asian/Native Hawaiian women and 2.5% of Hispanic women. The prevalence of stressors also varied by race/ethnicity; AI/AN women had the highest percentage in the highest quintile of all three types of stressors. Conversely, Asian/Native Hawaiian women had the lowest percentage in the highest quintile of each type of stressor (Table 1).

Table 2 displays the association between each type of stressor and LBW and PTB adjusted for maternal age and race/ethnicity. Relative to women in the bottom four quintiles, those in the highest quintile of traumatic stressors had an increased risk of LBW (IRR 1.38, 95% CI 1.22, 1.56). Similarly, the risk of LBW for women in the highest quintile of financial stressors and relationship stressors was significantly higher than that among women in the bottom four quintiles of these stressors (IRR 1.24, 95% CI 1.10, 1.39 and IRR 1.18, 95% CI 1.01, 1.37, respectively). Only women in the highest quintiles of traumatic and financial stressors (IRR 1.14, 95% CI 1.00, 1.30 and IRR 1.19, 95% CI 1.06, 1.34), respectively, had significantly increased risk of PTB. While women in the highest quintile of relationship stressors had an increased risk of PTB relative to those in the lower four quintiles, this association was not statistically significant.

Multivariable Analyses: LBW

Model 1 of Table 3 shows the unadjusted risk of LBW stratified by race/ethnicity. Each group, except Asian/Native Hawaiians, had a significantly higher risk of LBW relative to non-Hispanic whites. The inclusion of maternal socio-demographic characteristics in Model 2 attenuated the risk of LBW for non-Hispanic blacks (IRR 2.24 vs. IRR 1.96) but remained significantly higher relative to the referent group. Risk among Hispanics was still higher than the referent group with the addition of socio-demographic covariates, and AI/AN's risk was no longer significantly different from non-Hispanic whites (IRR 1.11,

95% CI 0.81, 1.52). Models 3a, 3b and 3c added traumatic, financial and relationship stressors individually to Model 2. Women in the highest quintile of traumatic stressors had a significantly increased risk of LBW (IRR 1.09, 95% CI 1.02, 1.15). Being in the highest quintile of financial stressors was not associated with a significantly increased risk of LBW, but women in the highest quintile of relationship stressors had an increased risk of LBW (IRR 1.09, 95% CI 1.01, 1.18). When all three types of stressor were modeled simultaneously (Model 4), none were statistically significantly associated with LBW. Further, with the inclusion of stressors simultaneously, non-Hispanic black women still had almost twice the risk of LBW relative to non-Hispanic white women (IRR 1.87, 95% CI 1.55, 2.27).

Multivariable Analyses: PTB

Model 1 of Table 4 shows the unadjusted risk of PTB stratified by race/ethnicity. With the exception of Asians/Native Hawaiians, each racial/ethnic group had a significantly increased risk relative to non-Hispanic whites. The adjustment for maternal socio-demographic factors in Model 2 slightly reduced the risk among non-Hispanic blacks (IRR Model 1 = 1.88 vs. IRR Model 2 = 1.49) and Hispanics (IRR Model 1 = 1.34 vs. IRR Model 2 = 1.23), and rendered risk among AI/AN statistically insignificant (IRR Model 1 = 1.54, 95% CI 1.28, 1.85 vs. IRR Model 2 = 0.92, 95% CI 0.67, 1.27). Model 3a included traumatic stressors, which were not associated with PTB. Models 3b and 3c show that neither financial stressors, nor relationship stressors individually, were significantly associated with increased risk of PTB. When relationship stressors were included in the model, risk of PTB among Hispanic women was no longer significantly different from non-Hispanic white women (IRR = 1.15, 95% CI 0.91, 1.46). When all three types of stressor were modeled simultaneously (Model 4) non-Hispanic black women still had a significantly increased risk of PTB (IRR 1.46, 95% CI 1.18, 1.79) relative to their white counterparts.

Discussion

Results of this study demonstrate significant differences in stressors across racial/ethnic groups; AI/AN women had the highest prevalence of all three types of stressors in the 12 months prior to delivery. This finding contrasts with most previous research which has demonstrated that non-Hispanic blacks experience more stressors than other racial/ethnic groups before and during pregnancy and in adulthood in general (Lu and Chen 2004; Sternthal et al. 2011). However, the inconsistent finding is likely due in part to the differences in measurement (e.g. timing) of stress and the representation of AI/NA in the current study, unlike many of the previous investigations.

The second objective was to examine the relationships between stress and LBW and stress and PTB, which has been the focus of increased study during the past decade, but with indeterminate findings (Loomans et al. 2012; Lu and Chen 2004; Parker Dominguez et al. 2008; Littleton et al. 2010). Once we adjusted for all maternal socio-demographic covariates (e.g. SES) only traumatic and relationship stressors were related to LBW (Table 3). This finding points to the importance of disentangling and identifying whether disadvantaged social position or the stress associated with it, is the mechanism by which birth weight may

be impacted (Williams et al. 2010; Blumenshine et al. 2010). A study of PRAMS data linked with US Census data found that the association between neighborhood socioeconomic disadvantage and LBW was partially mediated by maternal stressors (Nkansah-Amankra et al. 2010). In models adjusted only for age and race/ethnicity, traumatic and financial stress, but not relationship stressors were associated with increased risk of PTB (Table 2). However, once all socio-demographic factors were accounted for, none of the individual stressors had an impact on PTB (Table 4). Consistent with Lu and Chen's (2004) findings, when all stressors were modeled simultaneously, none were associated with an increased risk of PTB (Lu and Chen 2004).

Our final study aim was to determine the extent to which documented racial/ethnic inequities in LBW and PTB could be explained by differences in stressors. Such an understanding is critical given that stress, as well as the response to it, is potentially modifiable (Lee et al. 2012; Straub et al. 2014), and the notion that an extensive body of research has identified myriad socio-demographic, behavioral and medical risk factors for LBW and PTB, which do *not* account for racial/ethnic inequities in these adverse birth outcomes (Nkansah-Amankra et al. 2010). Adjusting for maternal socio-demographic factors explained the increased risk of LBW and PTB among AI/AN women found in unadjusted models, despite the highest levels of traumatic, financial and relationship stressors reported among this group (Table 4). In unadjusted models, Hispanic women had significantly higher risk of LBW and PTB relative to non-Hispanic white women. Adjusting for all maternal socio-demographic variables reduced, but did not eliminate these inequities.

Accounting for maternal socio-demographic factors reduced the risk of LBW and PTB among non-Hispanic black women relative to white women. Moreover, the addition of each stressor further attenuated the difference in risk, but none of the stressors, individually or simultaneously explained differences in risk of LBW or PTB between non-Hispanic black and white women. This finding is consistent with previous studies by Parker Dominguez et al. (2008) and Mustillo et al. (2004), who demonstrated that stress, measured as racism during childhood and throughout the lifetime, partially accounted for differences in birth weight and preterm delivery between non-Hispanic blacks and whites (Parker Dominguez et al. 2008; Mustillo et al. 2004). Conversely, Lu and Chen (2004), who used PRAMS data and also assessed stress in the 12 months before delivery, but modeled it somewhat differently, found that these constructs minimally influenced the association between race and PTB (Parker Dominguez et al. 2008). Comparison of findings is hampered by the dissimilar measures of stress used across studies. However, on balance, those studies that evaluated stress across the life course, not just in the year preceding delivery, as well as those that included some measure of racism as a relevant stressor, may be better suited to identify and explain racial/ethnic inequities in adverse birth outcomes (Parker Dominguez et al. 2008; Witt et al. 2014a, b; Mustillo et al. 2004; Lu and Halfon 2003).

Our findings should be considered in the context of certain limitations. Research has shown that the cumulative effects of stressors over the life course, including intergenerationally, can influence a woman's birth outcomes (Geronimus 1996, 1992; Wildsmith 2002). Consequently, our measure of psychosocial stress, which captured just the gestational period and 3 months prior to it, provides only a brief snapshot of the possible exposure to stressors

that a woman may experience over her life course that could subsequently impact her reproductive outcomes. In addition, given the growth of the foreign-born population in the US, specifically among Hispanics and Asians, the fact that we were unable to examine the associations of interest by nativity status is a limitation which warrants further research (Colby and Ortman 2015). Our measure of stress followed the methodology used by Sternthal et al. (2011), whereby the top quintile, representing the highest level of stress, was compared to all other quintiles in order to capture the severity and accumulation of stressors. This approach is the most suitable for the aims of our study, as research has shown that experiencing chronic and cumulative stressors, which is captured in the highest quintile of our stress measure, is correlated with the worst health outcomes (Sternthal et al. 2011). However, the method is not without limitations. It is possible that our analyses may underestimate the effect of being in the highest quintile by including the third and fourth quintile in the comparison group. Additionally, it may pre-clude us from examining dose-response relationships across severity of stress. Although these are important limitations, we aimed to examine the role of cumulative stress, rendering the approach used by Sternthal and colleagues the most suitable for our purposes. Lastly, model misspecification may be an issue if we omitted potential confounders or modelled variables (e.g. SES) too crudely to capture such nuanced associations.

Despite these limitations, our study adds to the body of work on stress, adverse birth outcomes and racial/ethnic inequities by updating investigations of this relationship with a large population-based survey of women from states across the country. Pursuant to calls to comprehensively measures stress, we leveraged the existing 13-item measure of stress from the PRAMS survey developed by the CDC, expanded it with three additional questions on stressful experiences and used powerful statistical methods to capture the contribution of each domain of stress individually and simultaneously (Lu and Chen 2004, 2014a, b; Ahluwalia et al. 2001; Sternthal et al. 2011). Thus, we begin to examine a broader range of stressors to understand the contribution to adverse birth outcomes (Witt et al. 2014a, b; Sternthal et al. 2011). This study also moves beyond the black-white dichotomy to examine the associations between birth outcomes and stress experiences in *multiple* racial/ethnic groups (Parker Dominguez et al. 2008; Sharapova 2012; Mustillo et al. 2004).

Our study builds on the literature suggesting that racial/ethnic minority women experience increased psychosocial stressors which may contribute to adverse birth outcomes. Findings demonstrate that stress and socio-demographic variables explain some of the racial/ethnic inequities in LBW and PTB, with the exception of non-Hispanic blacks. Although stress accounted for some of their increased risk, the persistent inequity between non-Hispanic blacks and whites remained. Future population based studies of perinatal experiences should measure stress more comprehensively across the life course. This information could aid our understanding and preventive actions to address this enduring inequity.

Appendix

Traumatic Life Stressors: ($\alpha = 0.46$)

A close family member was very sick and had to go into the hospital

I moved to a new address

I was homeless or had to sleep outside, in a car, or in a shelter

My husband, partner, or I went to jail

Someone very close to me had a problem with drinking or drugs

Someone very close to me died

Financial Stressors: (α = 0.49)

My husband or partner lost his job

I lost my job even though I wanted to go on working

I had problems paying the rent, mortgage, or other bills

Relationship Stressors: (α = 0.58)

I got separated or divorced from my husband or partner

I argued with my husband or partner more than usual

My husband or partner said he didn't want me to be pregnant

During pregnancy did your husband or partner push, hit, slap, kick, choke, or physically hurt you in any other way?

During the 12 months before pregnancy did your husband or partner push, hit, slap, kick, choke, or physically hurt you in any other way?

Acknowledgment of paternity

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Significance

Racial/ethnic inequities in low birth weight (LBW) and preterm birth (PTB) persist in the United States (US). Research has identified numerous risk factors for these adverse birth outcomes; however, they do not fully explain the occurrence of, or inequalities in PTB/LBW. Stress has been proposed as a possible explanation for racial/ethnic inequities in LBW and PTB, but results of studies to date have been inconclusive. The majority of this research has compared non-Hispanic black and white mothers, to the exclusion of other racial/ethnic minority groups. Using population-based data from 21 US states, we address this gap by investigating the contribution of multiple stressors to inequities in LBW and PTB across numerous racial/ethnic groups.

Table 1

Sociodemographic characteristics, birth outcomes, and stressors by race/ethnicity, pregnancy risk assessment monitoring system (PRAMS), 2012–2013

Unweighted n Weighted n	**Total N = 15,915 N = 815,892%**	**White non-Hispanic n = 7725 n = 460,547%**	**Black non-Hispanic n = 3892 n = 179,131%**	**Hispanic n = 2875 n = 151,035%**	**American Indian/ Alaskan Native n = 1188 n = 15,642%**	**Asian and Native Hawaiian n = 235 n = 9537 %**	**p-Values**
Age							
≤19	11.6	10.4	13.4	13.4	14.9	2.5	< 0.0001
20–34	77.3	78.3	78.2	73.5	77.2	76.9	
35 +	11.1	11.3	8.5	13.1	7.9	20.7	
Marital status							
Married	25.0	32.8	11.8	16.4	13.7	54.6	< 0.0001
Other	75.0	67.2	88.2	83.6	86.3	45.4	
Education							
<High school	18.5	12.2	18.5	37.0	27.7	16.9	< 0.0001
≥High school	81.5	87.8	81.5	63.0	72.3	83.1	
Maternal BMI							
Underweight (< 19.8 kg)	10.6	12.0	8.2	8.6	6.2	28.6	< 0.0001
Normal (19.8–26 kg)	45.6	48.0	40.1	44.6	42.3	56.8	
Overweight (> 26–29 kg)	14.4	13.2	15.4	17.0	17.6	7.9	
Obese (> 29 kg)	29.3	26.8	36.2	29.8	33.9	6.6	
Tobacco use during last trimester of pregnancy	12.2	17.6	6.7	2.5	16.5	2.5	< 0.0001
Alcohol use during last trimester of pregnancy	10.63	10.63	9.17	13.06	5.79	12.06	< 0.0001
Trimester of start of prenatal care							
First	78.8	82.3	73.7	75.7	64.1	81.8	< 0.0001
Second	17.2	14.3	21.5	19.5	29.5	15.6	
Third	4.0	3.4	4.9	4.7	6.4	2.6	
Method of payment for healthcare							
Medicaid	60.4	50.7	74.3	72.8	75.4	49.4	< 0.0001
Self-pay/private insurance	35.2	45.0	22.1	22.6	13.9	45.9	
Other	4.4	4.4	3.7	4.6	10.8	4.7	
Previous live birth	53.9	52.5	53.3	58.4	61.4	44.2	< 0.0001

Unweighted n Weighted n	Total N = 15,915 N = 815,892%	White non-Hispanic n = 7725 n = 460,547%	Black non-Hispanic n = 3892 n = 179,131%	Hispanic n = 2875 n = 151,035%	American Indian/ Alaskan Native n = 1188 n = 15,642%	Asian and Native Hawaiian n = 235 n = 9537 %	p-Values
Previous low birth weight	6.6	5.1	8.8	9.0	5.1	6.7	< 0.0001
Previous preterm birth	7.3	6.4	8.6	8.4	9	7.3	< 0.0001
Low birth weight	6.1	5.1	9.7	5.1	5.7	5.0	< 0.0001
Preterm birth	10.4	9.2	13.5	10.5	10.9	8.4	< 0.0001
Traumatic stressors[a]	13.4	15.4	12.6	7.6	23.2	5.3	< 0.0001
Financial stressors[a]	15.6	16.2	15.8	13.8	16.7	9.8	< 0.0001
Relationship stressors[a]	10.3	10.2	11.8	8.6	14.0	6.8	< 0.0001

[a]Percentage in highest quintile. Analytical sample consists of PRAMS data collected from AK, CO, DE, GA, IL, MA, MD, MN, MO, NE, NH, NM, NY, OH, OK, OR, TN, UT, WA, WI, WY and New York City

Table 2

Associations between stressors and adverse birth outcomes, PRAMS, 2012–2013

	Low birth weight IRR (95% CI)	Preterm birth IRR (95% CI)
Traumatic stressors[a]	1.38*** (1.22–1.56)	1.14* (1.00–1.30)
Financial stressors[a]	1.24*** (1.10–1.39)	1.19** (1.06–1.34)
Relationship stressors[a]	1.18* (1.01–1.37)	1.13 (0.97–1.33)

Model adjusts for age group and race/ethnicity. Analytical sample consists of PRAMS data collected from AK, CO, DE, GA, IL, MA, MD, MN, MO, NE, NH, NM, NY, OH, OK, OR, TN, UT, WA, WI, WY and New York City

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

[a] Highest quintile

Table 3

Incidence rate ratios (IRR) of low birth weight, PRAMS, 2012–2013

	Model 1 IRR (95% CI)	**Model 2 IRR (95% CI)**	**Model 3a IRR (95% CI)**	**Model 3b IRR (95% CI)**	**Model 3c IRR (95% CI)**	**Model 4 IRR (95% CI)**
White non-Hispanic	Reference	Reference	Reference	Reference	Reference	Reference
Black non-Hispanic	2.24*** (2.05–2.46)	1.96*** (1.67–2.30)	1.96*** (1.67–2.31)	1.98*** (1.69–2.33)	1.85*** (1.53–2.28)	1.87*** (1.55–2.27)
Hispanic	1.18*** (1.07–1.29)	1.24** (1.05–1.47)	1.28*** (1.08–1.51)	1.26** (1.06–1.48)	1.14 (0.93–1.41)	1.18 (0.96–1.47)
American Indian/Alaskan Native	1.57*** (1.28–1.95)	1.11 (0.81–1.52)	1.10 (0.80–1.51)	1.10 (0.79–1.51)	0.96 (0.67–1.38)	0.94 (0.65–1.38)
Asian and Native Hawaiian	1.10 (0.93–1.31)	1.16 (0.83–1.64)	1.18 (0.84–1.66)	1.15 (0.82–1.62)	0.84 (0.44–1.62)	0.85 (0.43–1.67)
Traumatic stressors			1.09* (1.02–1.15)			1.03 (0.96–1.11)
Financial stressors				1.04 (0.98–1.11)		1.03 (0.95–1.12)
Relationship stressors					1.09* (1.01–1.18)	1.07 (0.99–1.17)

Model 1 is unadjusted, Model 2 adjusts for all maternal socio-demographic covariates, Models 3 a-c adjust for all maternal socio-demographic covariates and each stress factor individually, Model 4 adjusts for all maternal socio-demographic covariates and all stress factors simultaneously. Analytical sample consists of PRAMS data collected from AK, CO, DE, GA, IL, MA, MD, MN, MO, NE, NH, NM, NY, OH, OK, OR, TN, UT, WA, WI, WY and New York City

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Table 4

Incidence rate ratios (IRR) of preterm birth, PRAMS, 2012–2013

	Model 1 IRR (95% CI)	**Model 2 IRR (95% CI)**	**Model 3a IRR (95% CI)**	**Model 3b IRR (95% CI)**	**Model 3c IRR (95% CI)**	**Model 4 IRR (95% CI)**
White non-Hispanic	Reference	Reference	Reference	Reference	Reference	Reference
Black non-Hispanic	1.88*** (1.71–2.06)	1.49*** (1.25–1.77)	1.47*** (1.23–1.76)	1.51*** (1.26–1.80)	1.45*** (1.81–1.78)	1.46*** (1.18–1.79)
Hispanic	1.34*** (1.21–1.48)	1.23* (1.03–1.49)	1.25* (1.03–1.50)	1.25* (1.04–1.51)	1.15 (0.91–1.46)	1.18 (0.93–1.50)
American Indian/Alaskan Native	1.54*** (1.28–1.85)	0.92 (0.67–1.27)	0.94 (0.68–1.30)	0.94 (0.67–1.30)	0.82 (0.56–1.19)	0.84 (0.58–1.24)
Asian and Native Hawaiian	0.92 (0.75–1.13)	0.83 (0.57–1.22)	0.82 (0.56–1.22)	0.82 (0.56–1.21)	1.00 (0.51–1.97)	1.03 (0.52–2.03)
Traumatic stressors			0.97 (0.92–1.03)			0.99 (0.91–1.06)
Financial stressors				1.01 (0.95–1.07)		1.03 (0.95–1.11)
Relationship stressors					1.00 (0.92–1.08)	0.99 (0.91–1.08)

Model 1 is unadjusted, Model 2 adjusts for all maternal socio-demographic covariates, Models 3 a-c adjust for all maternal socio-demographic covariates and each stress factor individually, Model 4 adjusts for all maternal socio-demographic covariates and all stress factors simultaneously. Analytical sample consists of PRAMS data collected from AK, CO, DE, GA, IL, MA, MD, MN, MO, NE, NH, NM, NY, OH, OK, OR, TN, UT, WA, WI, WY and New York City

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$