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Article

Early-life neighborhood context, perceived stress, and preterm birth in African American Women

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ABSTRACT

Stressors from multiple sources, across the life-course, may have independent and joint associations with preterm birth (PTB) risk in African American women. Using data from the Life-course Influences on Fetal Environments Study (LIFE; 2009–2011) of post-partum African American women from Metropolitan Detroit, Michigan (n = 1365), we examined the association between perceived stress and PTB, and effect modification by perceptions of early-life neighborhood social control and disorder. We defined PTB as birth before 37 completed weeks of gestation. We used Cohen's Perceived Stress scale, and valid and reliable scales of early-life (age 10) neighborhood social control and social disorder to quantify exposures. We estimated prevalence ratios (PR) and 95% confidence intervals (CI) with log binomial regression models- with separate interaction terms for perceived stress and each early-life neighborhood scale. We considered $p < 0.10$ significant for interaction terms. PTB occurred in 16.4% (n = 224) of the study participants. In the total sample, perceived stress was not associated with PTB rates. However, there was suggestive evidence of a joint association between perceived stress and early-life neighborhood social disorder (p for interaction = 0.06), such that among women who reported high early-life neighborhood social disorder (n = 660), perceived stress was positively associated with PTB (adjusted PR: 1.31; 95% CI: 1.05, 1.63). There was no association between perceived stress and PTB for women in the low early-life neighborhood social disorder strata (n = 651) (adjusted PR: 0.95, 95% CI: 0.75, 1.21). There was no evidence that early-life neighborhood social control modified the association between perceived stress and PTB. Our results suggest that early-life neighborhood stressors may magnify the association between current perceived stress and PTB rates, in African American women. More research to confirm and explicate the biologic and/or psychosocial mechanisms of the reported association is warranted.

Introduction

Preterm birth (PTB), defined as birth before 37 completed weeks of gestation, is an important public health problem (CDC, 2013). Significant and persistent racial disparities in PTB exist, such that it is the 2nd leading cause of infant mortality overall, but is the leading cause of infant death among African Americans (Martin et al., 2013). While the reasons for this racial disparity are unknown, traditional biologic and behavioral risk factors do not account for the disproportionate burden of PTB among African Americans (Misra et al., 2017). Researchers estimate that if every PTB occurring in an urban area occurred just one week later, 25 million dollars in initial hospital costs could be saved (Hall & Greenberg, 2016). More research is warranted on specific exposures that increase the risk of PTB and are disproportionately experienced by African Americans, as this information could inform future interventions (Burris et al., 2016).

Stress is defined as the psycho-physiological outcome of any event that challenges an individual's ability to cope (Shapiro et al., 2013). Differential stress exposure may explain the increased risk for PTB among African American women, given their unique exposures to life-course stressors in the U.S. context (e.g., racism, discrimination, and neighborhood disadvantage) (Williams & Collins, 2001). While there is growing evidence that stress during childhood increases risk for adverse birth outcomes, including complications of pregnancy and PTB (Smith, Gotman, & Yonkers, 2016; Hillis et al., 2004; Christiaens, Hegadoren, & Olson, 2015), existing studies have not had adequate sample size to conduct race-specific analyses or to examine potential effect heterogeneity by other social factors.

Abbreviations: CI, confidence intervals; LIFE, Life influences on fetal environments study; PTB, preterm birth; PR, prevalence ratios

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Evidence suggests that disproportionate exposure to adverse childhood experiences (or ACEs) may predispose African American women to poor birth outcomes (Lu et al., 2010), and that early-life neighborhoods impact the development of the stress response system (Theall et al., 2013). For instance, stressors occurring in childhood have been shown to exacerbate stress responsivity during stressful experiences in adulthood (Kuras et al., 2017), and have been associated with significant antepartum and postpartum maternal stress development (Christiaens et al., 2015). Further, childhood adversity predicts greater emotional reactivity to stress in adulthood (Shonkoff et al., 2012), which increases risk for inflammatory-based conditions and diseases (Lewis et al., 2010). Importantly, inflammatory mechanisms have been causally linked to PTB (Romero et al., 2007).

Joint associations between *current* subjective neighborhood characteristics (social disorder, walkability, food availability, and safety) and educational attainment, on risk of PTB in African American women have been previously reported (Sealy-Jefferson et al., 2015). To our knowledge, the joint association of *early-life* neighborhood and current perceived psychosocial stressors on PTB risk in African American women has not been quantified. An examination of the joint association between stressors from different sources, including neighborhood contextual and psychosocial factors would increase our understanding of the etiology of PTB, among African Americans (Reagan & Salsberry, 2005; Pickett et al., 2002; Ahern et al., 2003).

To fill this gap in the literature, we used data from the Life-course Influences on Fetal Environments (LIFE) study to examine whether positive and negative aspects of early-life neighborhood context modify the association between perceived stress and PTB, among African American women. Our research questions are based on the widely adopted integrated perinatal health framework (Misra, Guyer, & Allston, 2003), which emphasizes a life-course approach with a multiple determinants model, and prior work indicating that perceptions of positive and negative features of the *current* residential environment, are associated with PTB rates (Sealy-Jefferson et al., 2015). We hypothesized that subjective measures of early-life neighborhood social disorder (defined as "visible cues indicating no order and lack of social control") (Ross & Mirowsky, 2001) would magnify (potentially through the stress pathway), and early-life neighborhood social control (which refers to the enforcement of behavioral norms by community members) (Kramer, 2000) would buffer against the influence of current perceived psychological stress on PTB risk (potentially through behavioral mechanisms), among African American women.

Methods

Sample

Details of the LIFE study have been previously published (Sealy-Jefferson et al., 2015). Briefly, the LIFE study is a retrospective cohort of postpartum African American women recruited from 2009–2011 from a suburban hospital in Metropolitan Detroit, MI. Women were recruited from the labor and delivery and postpartum hospital unit. Women were eligible to participate in the study if they self-identified as African American, were at least 18 years of age, and had a singleton birth. Exclusion criteria included: (1) non-English speaking, and (2) intellectual disability, serious cognitive deficits, or significant mental illness, on the basis of medical history or any prior records. During the postpartum hospital stay, trained interviewers, who were race and gender matched to study participants, conducted interviews (45–60 min long) in the women's hospital rooms after delivery to collect survey data on social, psychosocial, and biomedical factors. Study participant medical history was abstracted from their medical records during the postpartum hospitalization. A $50 gift card to a local store was provided as an incentive for study participation. The final sample included 1410 women (which represented 71% of the women approached for study participation). The participants of the LIFE study had similar sociodemographic characteristics and prevalence of adverse birth outcomes as Non-Hispanic Black and African American women in the U.S., the state of Michigan, and Wayne County (which includes Detroit) (Osypuk, Slaughter-Acey, Kehm, & Misra, 2016). Our analytic sample included 1365 women, who had non-missing data on our main exposure and outcome. All relevant institutional review boards approved the study, and all study participants gave written informed consent.

Exposure

Current perceived stress is defined as the extent to which situations in one's life are judged as stressful (Shapiro et al., 2013), and has been shown to measure actual stress levels more accurately than objective scales of stressful life events (Hobel, Goldstein, & Barrett, 2008). Therefore, we used the 14-item Cohen's Perceived Stress Scale (PSS) to assess perceived stress during the past month, measured with a five-point Likert scale ("never" to "very often"). Reverse coding was performed as necessary, and individual scale items were summed to create an overall score, with possible scores ranging from 14–70, and a sample range of 14–64 (higher = more stress). Internal consistency reliability (Cronbach's α) for the scale was 0.87.

Effect modifiers

Middle childhood and early adolescence have been hypothesized as the point at which youth have increasingly direct contact with their neighborhood, and children would engage in psychological "meaning-making", or developing perceptions of their neighborhood context (Brooks-Gunn, 1997). As a result, we adapted valid and reliable measures of adult neighborhood context, to refer specifically to the social disorder and informal social control of the neighborhood where study participants lived when they were 10 years old (Osypuk, Kehm, & Misra, 2015). Early-life neighborhood social disorder (Earls et al., 1995; Sampson & Raudenbush, 1999; Sampson & Raudenbush, 2004) was reported on a three-point Likert scale assessing how much of a problem each item was in her neighborhood (from "a big problem" to "not a problem") including: (1) litter, broken glass, or trash on sidewalks and streets, (2) graffiti on buildings and walls, (3) vacant or deserted storefronts or houses, (4) drinking in public, (5) selling or using drugs, and (6) teenagers or adults hanging out and causing trouble. Early-life neighborhood social control (Earls et al., 1995; Sampson & Raudenbush, 1999; Sampson, Morenoff, & Earls, 1999; Sampson, Raudenbush, & Earls, 1997) was reported on a five-point Likert scale ("very likely" to "very unlikely"), assessing whether people from the neighborhood would intervene or speak up about the following situations: (1) children skipping school and hanging out on a street corner, (2) children spray painting graffiti on a local building, (3) children showing disrespect to an adult, or (4) a fight in front of your house and someone was being beaten or threatened. Both the early-life neighborhood social control and social disorder scales were reliable and valid (α: 0.89, 0.93, respectively), and were reverse coded for the analysis, such that higher scores equated more disorder and more social control. Prior work by the LIFE research team has demonstrated high internal consistency reliability for these early-life subjective neighborhood context measures (Osypuk et al., 2015).

Outcome

PTB was defined as birth before 37 completed weeks of gestation, which was determined using data ascertained from medical records. We used a hierarchical algorithm to categorize gestational age, with priority given to the estimate based on early ultrasound (between 6–20 weeks of gestation), since this is considered the most valid measure (Kalish et al., 2004; Verburg et al., 2008).

Covariates

Based on the literature, we considered sociodemographic factors as potential confounders. Age, marital status, educational attainment, and income were self-reported by study participants. We used the 10% change in estimate criterion to identify true confounders (Rothman, Greenland, & Lash, 2008), to avoid adjusting for variables that may be on the pathway between perceived stress and PTB, which could attenuate the association we were trying to quantify, and compromise the precision of our estimates (Schisterman, Cole, & Platt, 2009).

Analysis

We conducted all analyses in SAS version 9.4 for Windows. (SAS institute Inc., Cary, NC). Cut-points for covariates were based on sample distributions. Univariate and bivariate statistics were used to describe the data, with chi-square tests to quantify differences in categorical variables, and Wilcoxon rank sum tests for continuous variables. The relationship between perceived stress and early life neighborhood variables was estimated with Pearson correlations. We assessed all variables for missing data (with < 5% missing for all variables), and used list-wise deletion in our statistical models. The continuous perceived stress variable was rescaled by dividing by its interquartile range, to allow us to interpret the results as risk of PTB comparing women in the 75th (high) versus the 25th (low) percentile of the distribution. Given that the prevalence of PTB in this cohort was > 10%, the rare disease assumption for logistic regression was not met. We used log binomial regression (Deddens & Petersen, 2008) to estimate prevalence ratios (PR) and 95% confidence intervals (CI) for the likelihood of PTB comparing women with high versus low perceived stress. Models were run unadjusted and adjusted for marital status (married/not married), as it was the only covariate to meet our 10% change in estimate criterion. To examine multiplicative interaction between social exposures, we included separate interaction terms between perceived stress and early-life neighborhood social control and social disorder in adjusted models. We considered $p < 0.10$ significant for interaction terms (Selvin, 2004), as has been specified in prior effect modification literature, given the difficulty in detecting interactions relative to main effects; we present stratum specific results as warranted. Non-positivity, or when specific segments of the study population only experience one level of the exposure (Diez Roux, 2004; Messer, Oakes, & Mason, 2010; Oakes, 2004), is often overlooked in observational research (Westreich & Cole, 2010).We examined the tabular distribution of quartiles of the perceived stress scale by early-life neighborhood social disorder and control, and we and found no evidence of non-positivity (Westreich & Cole, 2010).

Results

Table 1 shows the demographic characteristics of the sample, and bivariate associations with PTB, of our entirely African American cohort (n = 1365). 16.4% of the study participants had a PTB (n = 211). Women with low income (< $35,000/year) were 31% more likely to have a PTB than women with higher levels of household income (CI: 1.01, 1.39). Over 70% of the sample had attained 12 or more years of education; a similar proportion (71%) were not married. In bivariate models, neither early-life neighborhood social disorder nor social control were significantly associated with PTB risk. Correlations between perceived stress and early-life neighborhood social disorder and social control were low (0.09, and −0.11, respectively), and the correlation between the two early-life neighborhood variables was −0.50; all correlations were significantly different from zero ($p < 0.0001$) (data not shown).

In Table 2, we present the results of our log binomial regression models. In the total sample, we found no significant association between current perceived stress and PTB (adjusted PR: 1.14, CI: 0.97, 1.34). However, we observed suggestive evidence of effect modification between perceived stress and early-life social disorder ($p = 0.06$). In models stratified by early-life neighborhood disorder, women who reported high early-life neighborhood social disorder and high current stress had 31% higher odds of PTB than women who reported low current stress (PR: 1.31, CI: 1.05, 1.62). There was no evidence of an association between perceived stress and PTB among women with low early-life neighborhood social disorder (adjusted PR: 0.95, CI: 0.75, 1.21). We found no evidence of an interaction between early-life neighborhood social control and current perceived stress ($p = 0.29$).

Table 1
Socio-demographic characteristics of study participants (N = 1365), stratified By PTB, and results of bivariate log-binomial regression models, Life-course Influences on Fetal Environments Study (LIFE; 2009–2011).

	Term Delivery (n = 1141) N (%)	Preterm (n = 224) N (%)	PR	95% CI
Age				
18–19	102 (8.94)	14 (6.25)	0.81	0.47, 1.41
20–24	346 (30.32)	71 (31.70)	1.15	0.83, 1.59
25–29	310 (27.17)	54 (24.11)	*Referent*	
30–34	217 (19.02)	42 (18.75)	1.09	0.75, 1.58
35 +	166 (14.55)	43 (19.20)	1.39	0.96, 1.99
Married				
No	816 (72.08)	155 (69.82)	*Referent*	
Yes	316 (27.92)	67 (30.18)	1.10	0.84, 1.42
Education (years)				
≤ 12	322 (28.22)	60 (26.79)	*Referent*	
> 12	819 (71.78)	164 (73.21)	1.06	0.81, 1.39
Income				
Under $35,000	496 (49.21)	85 (41.26)	1.31	1.01, 1.68
$35,000 or more	512 (50.79)	121 (58.74)	*Referent*	
Early-life neighborhood social control				
Low (≤ 17)	569 (51.54)	99 (45.21)	*Referent*	
High (> 17)	535 (48.46)	120 (54.79)	1.24	0.97, 1.58
Early-life neighborhood social disorder				
Low (≤ 7)	539 (49.45)	112 (50.68)	*Referent*	
High (> 7)	551 (50.55)	109 (49.32)	1.04	0.82, 1.32

Discussion

The primary finding of this study is that in the overall sample, current perceived stress was not a significant predictor of PTB among urban African American women. However, we found suggestive evidence that early-life exposure to neighborhood social disorder might magnify the association between perceived stress and risk of PTB among urban African American women. We found no evidence for effect heterogeneity by early-life neighborhood social control.

The null findings of our main effects analyses between perceived stress and PTB are in contrast to those discussed in reviews of the literature on the association between perceived stress and PTB, which overwhelmingly suggest a significant positive association (Shapiro et al., 2013; Staneva et al., 2015). Importantly, none of the existing studies use data from a cohort comprised entirely of African Americans, and as a result, were not able to conduct with-in group analyses. Perceived stress measures have not consistently been predictive of PTB among African Americans, which may suggest that they are not pertinent across all racial/ethnic and socioeconomic groups (Sealy-Jefferson et al., 2016). Misra et al. reported evidence that social and psychosocial factors operate in complex ways to impact PTB risk among African American women (Misra, Strobino, & Trabert, 2010). Further, Sealy-Jefferson et al. reported that perceived stress was not on the pathway linking perceptions of *current* neighborhood social disorder,

Table 2
Results of log-binomial regression analysis for associations between perceived stress and PTB in the total sample and stratified by early-life neighborhood social disorder; Life-course Influences on Fetal Environments Study (LIFE; 2009–2011).

	Total Sample		Early-life Neighborhood Social Disorder			
	(n = 1365)		Low (n = 651)		High (n = 660)	
	Unadjusted PR (95% CI)	Adjusted PR (95% CI)	Unadjusted PR (95% CI)	Adjusted PR (95%CI)	Unadjusted PR (95% CI)	Adjusted PR (95% CI)
Perceived stress						
Low	*reference*		*reference*		*reference*	
High	1.12 (0.95, 1.31)	1.14 (0.97, 1.34)	0.96 (0.76, 1.21)	0.95 (0.75, 1.21)	1.27 (1.02, 1.58)	1.31 (1.05, 1.63)

PR: prevalence ratio; CI: confidence ratio; Models adjusted for marital status; P for interaction: perceived stress X early-life social control: 0.29; P for interaction: perceived stress X early-life social disorder: 0.06

walkability, food availability, or safety, to risk of PTB using data from LIFE (Sealy-Jefferson et al., 2016). In other words, perceived stress was not an independent predictor of PTB in this group. The current study adds to the existing literature suggestive evidence regarding early-life neighborhood contextual stressors that may magnify the association of current psychosocial stress and risk of PTB among African American women. Future research should examine potential mechanisms of these associations.

The stress-sensitization model posits that childhood adversity may sensitize individuals to have heightened responses to consequent stressors (Roberts et al., 2011; McLaughlin et al., 2010; Keyes et al., 2012; Hammen, Henry, & Daley, 2000; Essex et al., 2002), which exacerbates the health consequences of stressors in adulthood. Accelerated aging theories, such as the Weathering hypothesis, suggest that marginalized groups have differential exposure to life-course stressors, and that physiological aging is accelerated, as a result of extreme exposure to adversity (Hogue, 2002; Geronimus et al., 2006; Geronimus, 2001). Life-course theory is important for generating new hypotheses about potential predictors of PTB in high risk groups, because it encourages the study of early-life factors jointly with later life influences to characterize risk and protective factors for poor health (Kuh et al., 2003). Our study is the first, to our knowledge, to take a life-course approach and to provide evidence that early- life neighborhood social disorder may sensitize African American women to adult psychological stressors, exposures which may jointly increase risk of PTB.

In bivariate models, neither early-life neighborhood social disorder nor social control predicted PTB risk, which is in line with literature that demonstrates no independent associations but rather found joint associations among current neighborhood and other social factors and risk of PTB in African American women (Sealy-Jefferson et al., 2015, 2016). Specifically, research has demonstrated that educational attainment modified the association between perceptions of *current* neighborhood context (including walkability, food availability, safety, and social disorder) and PTB (Sealy-Jefferson et al., 2015), and that religious coping modified the association between overall sociodemographic neighborhood disadvantage and PTB risk (Sealy-Jefferson et al., 2016). In order to understand the mechanisms of these joint associations, Sealy-Jefferson et al. reported that for African American women with comparable psychosocial indicators (including psychological distress, perceived stress, and depressive symptoms), those who reported more current neighborhood disorder had higher PTB rates than those who reported less disorder (Sealy-Jefferson et al., 2016). The current study extends the existing literature on neighborhood predictors of PTB among African American women, by using a life-course approach to examine the joint association between *early-life* neighborhood social disorder, social control, and current psychological stress and risk of PTB.

Informal social control at the neighborhood level, refers to all the sanctions and constraints used by significant others, families, friends, neighbors, and community networks, in an effort to ensure individual conformity to behavioral norms (Kramer, 2000). Low neighborhood informal social control has been cited by criminologists as a risk factor for individual and neighborhood level criminal behavior (Cullen, 1994). Research has also shown that adolescent reports of neighborhood social control, as compared to parent reports, were better predictors of developmental outcomes like aggression among youth (Byrnes et al., 2007). Given this, and the large literature which suggests that high neighborhood social control reduces or buffers against stress (Diez Roux & Mair, 2010), we hypothesized that early-life neighborhood informal social control could theoretically buffer against the impact of adulthood stress on risk of PTB, potentially through behavioral mechanisms. Our findings did not support this hypothesis, though future studies should examine other early-life neighborhood characteristics as independent and joint predictors of PTB among high risk groups.

Past and current neighborhood social disorder may be a stronger predictor of PTB than other domains of the neighborhood context (i.e., social control) because this characteristic captures disinvestment that is beyond the control of the individual (Sampson & Morenoff, 2004). Importantly, neighborhood disorder has been associated with physical decline, depressive symptoms, perceived powerlessness, and distress (Cutrona et al., 2000; Geis & Ross, 1998; Ross & Mirowsky, 2001). Residents of such neighborhoods may interpret the physical signs of disorder as deeper neighborhood dysfunction, which may undermine health (Sampson & Raudenbush, 2004). In the current study, we verified that early-life and current neighborhood social disorder were weakly correlated (0.11, $p < 0.001$), which suggests that the early-life neighborhood environment is not simply a proxy of the current neighborhood environment. Future studies should confirm our findings, with special attention to *early life* neighborhood exposures, and identify the biologic, behavioral, and psychosocial mechanisms of these associations.

Our study has several strengths, and extends the current literature. First, our study used data collected directly from study participants which allowed us answer the question: for whom might increase stress during pregnancy increase risk of PTB?. Our results suggest that among African American women who lived in highly disordered neighborhoods as children, higher psychological stress may be associated with higher risk of PTB. Our methodology improves upon studies which use vital statistics data which lacks detailed information on social factors that may increase PTB risk (Schoendorf & Branum, 2006). The LIFE study included a large cohort of women recruited in the immediate postpartum period, which means that both women who received late or no prenatal care, as well as those with earlier yet interrupted or irregular prenatal care were included in our study. Our retrospective cohort study design increased the likelihood of heterogeneity of PTB risk in the study, and likely increased the generalizability of our findings. Our study is also unique in that we primary collected data on social risk factors that are salient for African American women.

However, the results of this study should be interpreted in light of

the following limitations. As in all neighborhood effects research, neighborhood selection (ie. the nonrandom selection of individuals into neighborhoods) cannot be ruled out (Slopen et al., 2014; Mayer & Jencks, 1989; Jencks & Mayer, 1990). Our measures of current psychosocial stress and early-life neighborhood context may be susceptible to recall bias if women with a PTB (compared to women with term births) differentially report exposures. However, in research on congenital malformations, specifically designed to evaluate the potential for recall bias related to adverse outcomes, little evidence of recall bias in mother's exposure reports was found (Zierler & Rothman, 1985; Klemetti & Saxen, 1967; Mackenzie & Lippman, 1989). Further, in a prior study using LIFE data, little evidence of recall bias in the retrospective reports of early-life neighborhood social disorder or social control was found, and the authors concluded that this method for operationalizing early-life neighborhood exposures is cost effective, valid, and reliable (Osypuk et al., 2015). Further, our early-life neighborhood measures only captured exposures during middle childhood (age 10), not early or late childhood/adolescence. Future studies should consider the impact of longitudinal changes in neighborhood exposures, across the sensitive periods of development, on risk of adverse birth outcomes. Next, our study sample was recruited from one suburban hospital in Metropolitan Detroit, Michigan, however, this site was chosen for several reasons: (1) it's wide catchment area, (2) the heterogeneity of women receiving medical care (patients lived in 64 municipalities across 3 counties), and (3) the large number of babies delivered per year (Sealy-Jefferson et al., 2016). Finally, our study was not based on a probability sample, and generalizing our results to populations other than African American women should be done with caution.

Summary

This study adds to the current literature suggestive evidence of heterogeneity of effect for the association between current perceived stress and risk of PTB, by early life neighborhood social disorder, among African American women. Our results highlight the need for additional research using life-course approaches. Future work should seek to confirm our findings and to identify the intervening mechanisms. Efforts that address early-life neighborhood social disorder may be viable strategies for reducing future PTB risk among African American women.

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Ethics approval SSM

Institutional review boards at the University of Michigan, Wayne State University, and Providence Hospital approved the study, and all study participants gave written informed consent.

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