


Biological Embedding of Chronic Stress Across Two Generations Within Marginalized Communities

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ABSTRACT—*Significant racial health disparities in infant mortality, preterm birth, and infant neurodevelopment exist in the United States. These disparities highlight a critical public health problem: Children of color are at a developmental disadvantage before birth. In this article, we describe how pregnant women from marginalized communities are disproportionately more likely to experience chronic stress in the form of discrimination, historical trauma, and acculturation. We integrate these understudied forms of chronic stress into allostatic load and prenatal programming models to describe how they can affect the health of two generations: the pregnant woman and her child. We describe psychophysiological ramifications of this early-life stress in infants of color. The prenatal programming field has largely ignored the experiences of women of color, and we highlight the need for researchers to include, or focus exclusively on, diverse samples in their research to reduce disparities that are evident at birth.*

KEYWORDS—*prenatal programming; psychophysiology; health disparities*

Racial and ethnic health disparities emerge before a child is born (Almli et al., 2020). For instance, African-American race is the second-strongest predictor of shortened gestation, second only to the mother having a prior history of preterm birth (Yang

et al., 2016), which highlights the need to consider the effects of racism and discrimination on birth outcomes (Slaughter-Acey, Talley, Stevenson, & Misra, 2019). In studies of prenatal stress, the effects of racism and discrimination on pregnant women and fetuses have been largely ignored, despite evidence that these potent stressors have biological consequences in nonpregnant adults (Green & Darity, 2010). Epidemiological research is clear: Pregnant women from marginalized communities are at high risk for problematic birth experiences due to historical trauma and exposure to racism and discrimination, the biological and psychosocial consequences of which likely persist for generations (Green & Darity, 2010; Lehmer & Yehuda, 2018). The biological mechanisms implicated in these prenatal health disparities on the developing child are unclear. In this article, we describe how experiences of chronic stress in marginalized communities can become biologically embedded to affect the development of fetal and infant stress response systems.

A striking number of noncommunicable medical diseases and psychological problems across the lifespan likely have prenatal or early-life origins (Gluckman & Hanson, 2006). The developmental origins of the health and disease model provide a framework to understand the emergence of fetal and infant stress responses following prenatal exposures (Barker, 2007; Gluckman & Hanson, 2006). This model is used to explain how a wide range of cues that a fetus is exposed to prenatally—including, but not limited to, changes in maternal cortisol output and immune system functioning—can program changes in tissue structure and function during prenatal and postnatal life to alter risk for psychological and physical morbidity (Barker, 2007; Gluckman & Hanson, 2006). This field of research emerged in response to studies in which adults at highest risk for cardiovascular disease and Type 2 diabetes later in life were born with low birth weights (Barker, 2007; Gluckman & Hanson, 2006). The framework has been extended to research on prenatal stress more generally (Glover, 2011), though never with a focus on how this model can be leveraged to more fully understand health disparities in birth and later neurodevelopmental outcomes. In this article, we provide evidence for how experiences

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of racism and discrimination experienced in marginalized communities are a largely unexplored prenatal stressor that can influence both the pregnant woman and her child before birth, with reverberations throughout life.

EXPOSURE TO CHRONIC STRESS IN MARGINALIZED COMMUNITIES: AN INTEGRATION WITH THE ALLOSTATIC LOAD MODEL

We know little about how prenatal exposure to chronic stress among individuals living in marginalized communities can exert programming influences on the developing fetus and infant. This knowledge gap is a problem because health disparities originate at conception and persist throughout life, in part due to exposures to chronic stress that disproportionately affect people of color (Green & Darity, 2010; Jones et al., 2020). People of color are not inherently predisposed to experience the negative physical and mental health consequences of discrimination because race and ethnicity are social, not biological, constructs (Jorde & Wooding, 2004). Instead, people of color are far more likely to experience discrimination; in a pregnant woman, this can not only affect her biology and increase her risk for physical and mental health problems but also affect the physical and mental health of her unborn child (Thayer & Kuzawa, 2015).

Chronic stress facing pregnant women and infants from marginalized and socially dispossessed communities takes many forms (see Figure 1). These can be organized into individual, community, and structural-level factors, such as poverty, racial discrimination, and exposure to trauma, which makes it important to not just examine the effect of one type of stressor, but to look at how cumulative, correlated adversities affect pregnancy outcomes in marginalized communities. Although evidence suggests that these forms of chronic stress are correlated (Giurgescu et al., 2012), we do not know precisely how they operate (e.g., in an additive or multiplicative process). Next, we describe the key biological mechanisms by which these chronic stressors can lead to impaired birth outcomes and altered physiological responses to stress in infancy.

Stress in marginalized communities stems in part from experiencing prejudice, discrimination, occupational and language barriers, and stigma as a result of racial, ethnic, or sexual orientation (Green & Darity, 2010). People of color disproportionately experience chronic stress, defined as unfair treatment due to their race or ethnicity (Thayer & Kuzawa, 2015). These experiences of discrimination are insidious and pervasive across multiple systemic domains; they range from everyday discrimination and microaggressions, such as low-quality service at restaurants, to institutional racist incidents, such as being denied a job because of race or ethnicity (Beck et al., 2020). Racial

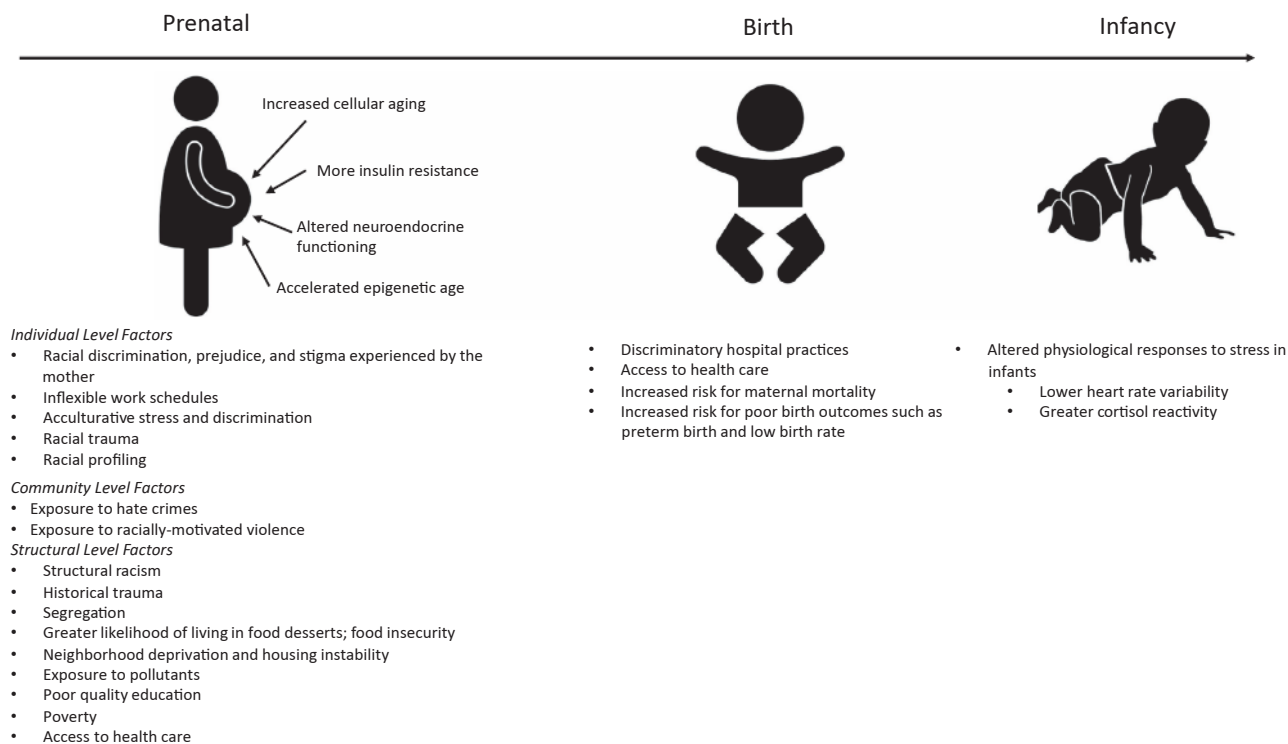


Figure 1. Multiple forms of chronic stress facing pregnant women, their newborns, and their infants from marginalized and socially dispossessed communities.

discrimination is conceptualized as a form of trauma that can affect both mental and physical health outcomes (Williams, Metzger, Leins, & DeLapp, 2018). Racially motivated violence, racial profiling, hate crimes, and historical traumas all contribute to increased anxiety and hypervigilance, boosting the likelihood of a diagnosis of post-traumatic stress disorder (PTSD) and other stress-related disorders (Williams et al., 2018).

People of color are also disproportionately more likely to experience socioeconomic disadvantage due to centuries of exclusionary housing and job discrimination practices, neighborhood segregation, and Jim Crow laws that prevented them from receiving fair wages (Rothstein, 2017). Discrimination experienced in the context of poverty may exacerbate negative health outcomes, such as coronary calcification in African-American women (Lewis et al., 2006). These systemic, structural discriminatory practices have made it more likely that African Americans live in low-income neighborhoods, attend low-quality schools, and receive low-quality medical care (Beck et al., 2020). Thus, people of color face many forms of interwoven marginalization that also contribute to health disparities in pregnant women.

Individuals from marginalized communities experience not only present-day discrimination but also historical trauma, or the public narrative of a “complex and collective trauma experienced over time and across generations by a group of people who share an identity, affiliation, or circumstance” (Mohatt, Thompson, Thai, & Tebes, 2014, p. 128). Historical trauma affects a wide range of marginalized communities, including African Americans, Native Americans, children of Holocaust survivors, Mexican Americans, and many other cultural groups that have experienced oppression, discrimination, and victimization (Mohatt et al., 2014). The immediate effect of the trauma can involve children separated from their parents and the disruption of communities. This effect can alter sensitive and responsive parenting practices—yet another mechanism of transmitting stress between parents and children—which can further exacerbate health disparities (Mohatt et al., 2014). For example, survivors of the Holocaust who developed PTSD had children who were more likely to experience symptoms of anxiety than Holocaust survivors who did not have PTSD; they also were more likely to have dysregulated activity of the hypothalamic pituitary adrenal axis, which regulates the amount of the stress hormone cortisol that is secreted in the body (Lehrner & Yehuda, 2018).

These significant chronic stressors can be integrated within the allostatic load model, which posits that protracted and repeated stress over the life course can effect wear and tear on the body’s regulatory systems (McEwen, 1998), which can affect birth outcomes for pregnant women (Almli et al., 2020). Researchers have called for a broader application of the allostatic load model to explain how chronic stress among people of color becomes embedded biologically, leading to health

disparities (Green & Darity, 2010). However, few studies have applied this model to pregnant women of color (Chaney, Lopez, Wiley, Meyer, & Voleggia, 2019). In nonpregnant individuals, high levels of exposure to discrimination were related to increased allostatic load, and high levels of discrimination mediated the relation between African-American race and high allostatic load in a large group of women (Upchurch et al., 2015). We know little about how stress response systems in the fetus are formed in utero. Among mostly European American pregnant women, the way a pregnant woman reacts to and recovers from stress could be related to fetal and infant responses to stress (Glover, 2011). More research has been conducted on how general forms of chronic stress manifest across generations, particularly in marginalized communities, than on specific chronic stressors such as racism and discrimination.

INTERGENERATIONAL TRANSMISSION OF CHRONIC STRESS IN MARGINALIZED AND UNDERREPRESENTED GROUPS

Perinatal Exposure to Stress and Newborn Health Outcomes

In the United States, pregnant women from marginalized communities have some of the least optimal perinatal health outcomes (Corwin et al., 2013). African-American women have higher rates of gestational diabetes and infants born with low birth weight than European American women. After birth, African Americans and Hispanics are more likely than European Americans to visit an emergency room with their infants (Beck et al., 2020). Variation in prenatal stress could drive these disparities. For example, African-American and Hispanic pregnant women who said they had high relational and financial stress and Asian and Pacific Islanders who reported more physical stress also had more symptoms of depression (a risk factor for preterm birth and birth complications) than European Americans (Liu, Giallo, Doan, Seidman, & Tronick, 2016).

Chronic stressors, which disproportionately affect marginalized women during pregnancy, affect health across two generations. For instance, exposure to discrimination increases risk for preterm birth and low birth weight (Giurgescu et al., 2012; Slaughter-Acey et al., 2019). Furthermore, children’s experiences of discrimination can affect maternal physical health outcomes in women of reproductive age, suggesting that discrimination acts bidirectionally on the well-being of the family system (Colen, Li, Reczek, & Williams, 2019). Women exposed to high chronic stress before their babies were conceived had infants with lower birth weights than women who experienced lower levels of chronic stress, and this effect was stronger in African Americans and Latinas than in European Americans (Strutz et al., 2014). Based on data from the National Longitudinal Study of Adolescent Health, a one-unit increase in exposure to chronic stress prior to conception predicted an almost 200-gram decrease in the birth weight of a woman’s first-

born child (Strutz et al., 2014). Women who reported high levels of racial discrimination while pregnant had both newborns with low birth weight and 6-month olds with lower weights for their age (Dixon et al., 2012). Moreover, Mexican-American women who reported high levels of acculturative stress had infants with lower birth weight and higher infant weight at 6 weeks, a risk factor for later obesity (Luecken, Jewell, & MacKinnon, 2017).

Perinatal Exposure to Stress and Health Outcomes in the First Two Years

The effects of prenatal stress on infant outcomes may be exacerbated in contexts of low socioeconomic status and in communities of color. Infants whose mothers experience chronic stress because of their marginalized status may have altered physiological responses to stress (Jacob, Byrne, & Keenan, 2009; Luecken et al., 2013; Luecken, MacKinnon, Jewell, Crnic, & Gonzales, 2015), though no studies have examined this association between experiences of discrimination while pregnant and infant biobehavioral stress responses directly. In research on prenatal stress and infant physiological responses to stress, most participants are White (Gatzke-Kopp, 2016; Jones-Mason, Alkon, Coccia, & Bush, 2018). This lack of representativeness is a problem in the field of developmental psychology in general and in psychophysiological research in particular (Gatzke-Kopp, 2016). Demographic factors such as race, ethnicity, sex, and socioeconomic status are important moderators of environmental effects on brain functioning (Gatzke-Kopp, 2016). However, the lack of psychophysiological data on infants and children is troubling, because what is considered a normative physiological response to stress in Whites may not be so in other racial and ethnic groups (Gatzke-Kopp, 2016).

In a recent meta-analysis, few studies of infant physiological responses to a mild social stressor, the still-face paradigm, included racially and ethnically diverse samples (Jones-Mason et al., 2018). In those studies with enough racial and ethnic diversity, few physiological differences in response to the still face were found. In one review, the primary physiological indicator of interest was respiratory sinus arrhythmia (RSA), a cardiovascular marker of parasympathetic nervous system functioning (Berntson, Cacioppo, & Quigley, 1993). African-American infants had higher resting RSA than European American infants. African-American infants also showed less RSA withdrawal during the stress of the still face (Moore et al., 2009). In infants born to healthy African-American women living in poverty, RSA was significantly lower than in infants born to mothers who experienced depression and whose mothers experienced high levels of life stress (Jacob et al., 2009). These results suggest that it is difficult to draw conclusions about physiological differences between racial groups given the few studies that have included a large enough number of diverse participants.

Several studies have examined whether experiences of stress among Mexican-American women were associated with infants'

neuroendocrine system functioning. In a study of low-income, Mexican-American mothers, exposure to high prenatal stress and low support from partners predicted high infant cortisol reactivity to mother–infant interaction tasks designed to elicit frustration at 6 weeks (Luecken et al., 2013). In a separate study on the same population, more dyadic dysregulation and economic stress predicted high infant cortisol reactivity at 12 weeks in response to these frustration tasks (Luecken, Crnic, Gonzales, Winstone, & Somers, 2019). Also, high infant cortisol reactivity predicted more symptoms of depression in mothers at 24 weeks (Luecken et al., 2019). Finally, pregnant women with high levels of symptoms of depression and low levels of social support, and with infants who were temperamentally more negative, also had infants with high daily cortisol output (Luecken et al., 2015).

Mechanisms Underlying Biological Embedding of Chronic Stress in Pregnant Women and Infants

Traumatic discriminatory experiences may be transmitted from parent to child via a variety of complex, dynamic mechanisms (Lehrner & Yehuda, 2018; see Figure 1). Potential mechanisms by which prenatal exposure to chronic stress in people of color can affect the development of infant stress response systems include the neuroendocrine and immune systems, cellular aging, and epigenetic processes (Carter et al., 2019; Corwin et al., 2013; Miller, Yu, Chen, & Brody, 2015). These mechanisms are not unique to pregnant women of color; however, the evidence we have reviewed suggests that pregnant women of color may be at high risk for adverse birth outcomes because they experience chronic stress due to their marginalized status, above and beyond the types of stressors European American pregnant women experience. Few studies have examined the mechanisms by which prenatal exposure to chronic stress in marginalized groups affects pregnant women and their fetuses.

Chronic stress may be biologically embedded in pregnancy in marginalized groups via the neuroendocrine system. A large body of work has documented how maternal prenatal stress can program the fetal hypothalamic–pituitary–adrenal axis, in part because of increased exposure to cortisol circulating in the mother (Glover, 2011). Indeed, prenatal exposure to discrimination is related to higher evening levels of circulating cortisol in mothers (Thayer & Kuzawa, 2015). Prenatal exposure to chronic stress that is experienced disproportionately by people of color may also be related to glucocorticoid resistance and a poorly regulated immune system (Corwin et al., 2013).

Racial discrimination is associated with body mass index (BMI) and insulin resistance in nonpregnant adults. African Americans who experienced high levels of racial discrimination as adolescents had higher BMIs and more insulin resistance than their counterparts who reported lower levels of racial discrimination (Brody, Yu, Chen, Ehrlich, & Miller, 2018), but we do not know how these factors affect pregnant women. If similar associations are replicated in pregnant women of color, the

findings would point to a possible mechanism by which prenatal exposure to racial discrimination could lead to less optimal health outcomes in mothers and their infants.

Exposure to chronic racism and discrimination may induce increased cellular aging. Higher levels of discrimination in 10- to 15-year-old African Americans was related to accelerated cellular-level aging (Carter et al., 2019). African-American women experiencing more racial discrimination had shorter telomeres than African-American women who reported less racial discrimination (Pantesco et al., 2018). Thus, increased cellular aging in pregnant women could be a mechanism by which exposure to discrimination contributes to racial health disparities at birth.

Epigenetic processes could also be a pathway for the biological embedding of chronic stress experienced by people of color. One study reviewed 10 papers on DNA methylation and preterm birth in African-American women; DNA methylation is an epigenetic mechanism that is typically inversely related to gene expression (Bird, 2007). The study found mixed evidence for associations between differential DNA methylation across a range of genes and higher risk for preterm birth; because most studies of this kind feature small samples and cross-sectional designs, they cannot draw clear conclusions (Barcelona de Mendoza et al., 2017). Another study concluded that resilience in African-American men may be only skin deep (Miller et al., 2015). African-American men who participated in an intervention to improve self-control enhanced their self-control significantly, but this occurred at the expense of their epigenetic age if the men were from low socioeconomic backgrounds. Epigenetic age is a signature of age estimated via DNA methylation, relative to one's chronological age. While this finding has not been extended to pregnant women, pregnant women who appear resilient in the face of stress stemming from discrimination at the behavioral level may have less optimal outcomes at the physiological or epigenetic levels; this is as a result, in part, of the systemic experiences of chronic stress that can wear down body systems for marginalized populations despite persistence and resolve to break free from lower-quality life conditions.

CONCLUSIONS

The biological embedding of chronic stress experienced by marginalized communities during the perinatal period is understudied. In this article, we reviewed several chronic stressors unique to pregnant women of color. These stressors affect pregnant women from marginalized communities disproportionately, though the mechanisms by which they exert effects on the pregnant woman and her fetus are not specific to women of color. While the evidence for health disparities is apparent at birth, we lack information about the specific biological mechanisms that give rise to these disparate health outcomes in infants and pregnant women of color. The research we have reviewed is important because for some people of color, behavioral resilience may be only skin deep; in other words, individuals who

experience discrimination and subsequent improvements in behavioral health may not show concomitant improvements at the physiological level (Miller et al., 2015). If similar effects are documented in pregnancy, then prenatal interventions should be altered to improve the behavioral health of the mother and provide relief at the level of her stress physiology, given that the fetus experiences physiological stress cues from the mother.

The research we have reviewed points clearly to the need to increase representation of people of color in psychological research in general, and in pregnant women of color and their infants in particular. For instance, a recent review identified only 11 published studies of biological changes that occurred as a result of chronic discrimination in pregnant African-American women (Chaney et al., 2019). Work in this field should also recognize and acknowledge the historical legacies of oppression that have intergenerational impacts on health and wellness, even before a child is born (Owens & Fett, 2019). Both policies and practices are needed to address these health disparities in birth outcomes that appear to be growing in our current sociopolitical context (e.g., Thoma et al., 2019), especially during this time of increased police brutality targeting African Americans (Edwards, Lee, & Esposito, 2019) and during the COVID-19 pandemic, which affects African Americans disproportionately, largely because of our history and current practices of systemic racism (Devakumar, Shannon, Bhopal, & Abubakar., 2020). In this article, we sought to shed light on a major gap in our understanding of the biological embedding of chronic stress that is unique to people of color in efforts to reduce the major health disparities in marginalized communities.

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