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Original Article

Racial discrimination predicts greater systemic inflammation in pregnant African American women

Carmen Giurgescu, PhD, RN [a,*], Christopher G. Engeland, PhD [b], Thomas N. Templin, PhD [a], Shannon N. Zenk, PhD, RN [c], Mary Dawn Koenig, PhD, RN [c], Lindsey Garfield, PhD, RN [d]

[a] College of Nursing, Wayne State University, Detroit, MI, USA, 48202
[b] Department of Biobehavioral Health and College of Nursing, Pennsylvania State University, University Park, PA, USA, 16802
[c] College of Nursing, University of Illinois at Chicago, Chicago, IL, USA, 60612
[d] Marcella Niehoff School of Nursing, Loyola University, Chicago, IL, USA, 60660

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ABSTRACT

Purpose: Chronic exposure to racial discrimination by pregnant African American women may lead to allostatic overload; thereby, predisposing women to systemic inflammation. Thus, the goal of this study was to examine if experiences of racial discrimination are related to systemic inflammation in pregnant African Americans.
Methods: A sample of 96 African American women from Chicago completed questionnaires and had blood drawn during the second trimester of pregnancy (19.7 ± 2.5 weeks).
Results: Experiences of racial discrimination were associated with higher cytokine levels of interleukin (IL)-4 ($B = 2.161$, 95% CI = 1.02–3.30, $p < .001$) and IL-6 ($B = 1.859$, 95% CI = .61–3.11, $p = .004$) when controlling for covariates.
Conclusion: These findings suggest that experiences of racial discrimination may cause physiological wear and tear on the body leading to alteration of immune functions. Nurses should inquire about women's experiences of racial discrimination and make referrals for community or church support groups for women who report racial discrimination.

1. Introduction

Pregnant African American women are more likely to experience racial discrimination, defined as being hassled or made to feel inferior due to one's race, ethnicity, or color (Krieger et al., 2010), compared with pregnant non-Hispanic white women (Dominguez, Dunkel-Schetter, Glynn, Hobel, & Sandman, 2008). Chronic exposure to racial discrimination in African American women may cause physiological wear and tear on the body known as allostatic load (McEwen, 2012). The theory of allostatic load describes acute stress as an adaptive physiological process that helps the individual overcome (or avoid) a stressor, and maintain balance or allostasis. In contrast, chronic or cumulative stress increases one's allostatic load (dysregulation of the adaptive system that can lead to disease) and alters allostasis, leading to alteration of immune functions and negative health outcomes.

Chronic exposure to racial discrimination has been related to higher levels of inflammation in non-pregnant minority populations. In one study of a multiethnic sample of women, greater everyday discrimination predicted higher C-reactive protein (CRP), a well-established marker of systemic inflammation (Beatty Moody, Brown, Matthews, & Bromberger, 2014). Similarly, African American women reporting 1 or 2 experiences of racial discrimination had higher levels of CRP compared with those reporting no experiences of racial discrimination (Cunningham et al., 2012). In a study of elderly African American women and men, greater self-reported experiences of racial discrimination were related to higher CRP levels (Lewis, Aiello, Leurgans, Kelly, & Barnes, 2010). In another study, African American adolescents exposed to racial discrimination had higher levels of inflammation [composite of interleukin IL-1β, IL-6, IL-8, and IL-10, tumor necrosis factor (TNF)-α, interferon (IFN)-γ] when assessed three years later (Brody, Yu, Miller, & Chen, 2015). However, one study found no relationship between racial discrimination and IL-6 in African American and Latina non-pregnant women (Ratner, Halim, & Amodio, 2013). Although there is a clear relationship between higher levels of racial discrimination and greater systemic inflammation in non-pregnant populations, no study has examined the relationship between racial discrimination and inflammation in pregnant women.

The immune system during pregnancy is regulated by a complex array of cytokines that protects the fetus and promote placental development (Chatterjee, Chiasson, Bounds, & Mitchell, 2014; Schminkey &

* Corresponding author at: College of Nursing, Wayne State University, Cohn Bldg. 368, 5557 Cass Ave., Detroit, MI, 48202.
E-mail addresses: carmen.giurgescu@wayne.edu (C. Giurgescu), cge2@psu.edu (C.G. Engeland), ac0410@wayne.edu (T.N. Templin), szenk@uic.edu (S.N. Zenk), marydh@uic.edu (M.D. Koenig), lgarfield@luc.edu (L. Garfield).

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Groer, 2014). The second trimester (14–27 weeks) is a predominantly anti-inflammatory period which is promoted by an increase in progesterone-induced anti-inflammatory cytokines (e.g., IL-10); these in turn contribute to uterine quiescence and maintenance of pregnancy (Chatterjee et al., 2014; Schminkey & Groer, 2014). Toward the end of pregnancy pro-inflammatory cytokines (e.g., IL-1β, IL-6, IL-8) induce prostaglandin synthesis in the placenta that stimulates uterine contractions resulting in cervical ripening, rupture of membranes, labor and birth (Chatterjee et al., 2014; Giurgescu, Engeland, Zenk, & Kavanaugh, 2013; Schminkey & Groer, 2014). While this is a normal process, higher inflammation during the second trimester may lead to premature rupture of membranes, preterm labor, and preterm birth (<37 completed weeks gestation) (Coussons-Read et al., 2012; Giurgescu et al., 2013; Vogel et al., 2007). Pregnant African American women are more likely to have greater systemic inflammation in the second trimester compared with pregnant white women (Blackmore et al., 2014; Christian, Glaser, Porter, & Iams, 2013). We postulate that the chronic exposure to racial discrimination may lead to allostatic overload thereby predisposing women to systemic inflammation. Hence, the purpose of this study was to examine whether experiences of racial discrimination are associated with systemic inflammation in the second trimester of pregnancy in African American women.

2. Materials and methods

2.1. Design and sample

This study used a cross-sectional design among pregnant African American women from a midwifery practice of a medical center in Chicago. Participants were enrolled if they were at least 18 years of age; had singleton pregnancy; were in the second trimester of pregnancy; and had a low-risk pregnancy. Women with medical complications (e.g., chronic hypertension, diabetes) or receiving steroid treatment were excluded since these factors may influence inflammatory levels. A sample of 114 women was enrolled into the study. Seven women did not complete the questionnaires or the questionnaires were lost in the mail. Of the 107 women who completed the questionnaires, 11 women did not have blood samples collected or the samples were not processed within three hours of venipuncture and were not included in the analysis. A final sample of 96 women had completed questionnaire data and had useable blood samples.

2.2. Variables and instruments

2.2.1. Maternal characteristics

Maternal characteristics included socio-demographic and obstetrical characteristics and depressive symptoms. Maternal socio-demographic and obstetrical characteristics (e.g., maternal level of education, employment, income, prior pregnancies, medical history, smoking during pregnancy, and body mass index [BMI]) were collected from self-administered questionnaires or medical records. BMI (kg/m^2) was calculated using pre-pregnancy weight and height from medical records.

Depressive symptoms were measured by the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1977). This scale assesses the presence of salient symptoms of depression within the past seven days. The CES-D does not provide a diagnosis of clinical depression, but a customary cutoff score of 16 or higher is used to identify those with elevated (e.g., clinically relevant) levels of depressive symptoms. The instrument has been used with good reliability in prior research with pregnant African American women (Garfield et al., 2015; Giurgescu et al., 2015). In the current study the Cronbach's alpha was 0.87.

2.2.2. Experiences of racial discrimination

The Experiences of Discrimination (EOD) instrument measures self-reported experiences of racial discrimination in one's lifetime (Krieger, Smith, Naishadham, Hartman, & Barbeau, 2005). The EOD asks about 9 situations of experienced discrimination due to race, ethnicity, or color (e.g., at school; at work; getting medical care). For each situation, respondents may reply *yes* = 1 or *no* = 0. The sum of all 9 situations equals the total score (range 0–9). EOD has established construct validity in a sample of African American adults (Krieger et al., 2005). The instrument has been used in prior research with postpartum African American women (Giurgescu et al., 2012). In the current sample the Cronbach's alpha was 0.83. Because of extreme positive skewness EOD was used as dichotomous variable [0 = no (0 situations); 1 = yes (1–9 situations)] in regression models.

2.2.3. Systemic inflammation

Plasma levels of IL-1β, IL-2, IL-4, IL-6, IL-8 and IL-10 were measured by multiplex bead immunoarrays (Life Technologies, Grand Island, NY). Compared with ELISAs, these multiplex arrays provide simultaneous measurement of interrelated cytokines, high sensitivity, and reductions in inter-plate variability. The minimal detection limit is <0.5 pg/ml for each analyte and the inter-assay coefficients of variation were 4.4%–8.6%.

2.3. Procedures

The study was approved by the institutional review board at the participating medical center. Women who received prenatal care at the midwifery practice and fit the inclusion criteria of the study were invited to participate. Women completed an informed consent process prior to data collection. Women completed the questionnaires in a private room in the clinic or at home and returned them in an envelope provided by the research staff. The participant's venous blood was drawn by a registered nurse or medical assistant through antecubital venipuncture (within 30 sec. of venipuncture) into a sterile serum separator tube (10 ml) and placed on ice. This was done in the afternoon (1:00 p.m.–5:00 p.m.) to control for the influence of circadian rhythm on variations in cytokine levels. Many serum cytokines show a circadian rhythm opposite to that of cortisol, with highest values during sleep periods and lower values during wakefulness (Vgontzas et al., 2005). Participants received a monetary incentive of $25 for their participation and time. The blood samples were transported on ice to the laboratory where they were centrifuged (1500 g × 15 min at 4 °C) and aliquoted (400 μl per tube) within three hours of withdrawal. The aliquoted samples were frozen at −80 °C. The assays were performed by a laboratory technician in duplicate according to manufacturer's specifications and under the supervision of one of the study co-authors (CGE).

2.4. Data analysis

Data were entered, cleaned and prepared for analysis on an ongoing basis by the principal investigator or research staff using SPSS 22.0 (SPSS Inc., Chicago, IL). Twelve samples for IL-1β, 17 samples for IL-2, 18 samples for IL-6, 18 samples for IL-8, and 22 samples for IL-10 were below the limits of detection in duplicate wells. This occurred without sampling errors (Luminex, Riverside CA) indicating that the values were valid but below detection threshold, therefore these values were replaced with zero. Cytokine values were positively skewed; therefore, natural log transformations for cytokine data were conducted to normalize the distributions. Descriptive statistics were used to describe the maternal characteristics, experiences of racial discrimination and cytokine levels. Pearson's *r* correlation coefficient and point–biserial correlations were used to examine relationships among maternal characteristics, experiences of racial discrimination and cytokines. Hierarchical multiple linear regression analyses were conducted to examine if experiences of racial discrimination predicted systemic inflammation in the second trimester of pregnancy in African American women when controlling for maternal characteristics [low levels of education (coded as yes = high school or lower; and no = some college or higher), unemployment (coded as yes vs. no), smoking during pregnancy (coded as