

# Nursing Continuing Professional Development

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# Happiness in Pregnant African American Women

What Are the Biobehavioral Correlates?

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# ABSTRACT

The detrimental effects of prenatal stress on maternalinfant well-being have been well established and highlight increased concern for pregnant African American women. Research supports the notion that positive emotions may have a beneficial impact on the stress process and outcomes. However, the data have been largely restricted to non-African American pregnant women.

This study's purpose was to examine potential relationships of both positive (happiness) and negative (stress, anxiety, and depressive symptoms) emotions and proinflammatory cytokines (interleukins-1 $\beta$ , -6, -8, -12, -17, tumor necrosis factor, and interferon- $\gamma$ ) in 72 pregnant African American women for a more complete picture of the stress process in this at-risk population.

Results of this exploratory secondary data analysis show strong positive correlations between negative emotions

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and strong negative correlations between happiness and negative emotions. Interleukin-8 was positively correlated with negative emotions and negatively correlated with happiness. Results show mean ratings of negative emotions were higher than previously reported with more heterogeneous samples, while happiness ratings were in the moderate range. Findings suggest that pregnant African American women may experience higher stress and depressive symptoms than women in more heterogeneous samples. However, moderate levels of happiness might contribute to buffering the stress response.

**Key Words:** African American, biobehavioral, happiness, pregnancy, stress

Perinatal mental health is a critical societal issue, given the potential impact on the health of the mother, infant, and family.<sup>1</sup> This is especially evident during pregnancy, a time characterized by multiple challenges requiring pregnant women to adjust and cope with the increased stress levels.<sup>2</sup> Maternal stress, defined as demands perceived as threatening and unmanageable, can trigger the stress response often leading to negative emotions such as anxiety and depressive symptoms as well as physical responses impacting health.<sup>3</sup> This response plays a role in pregnancy complications, negative birth outcomes, and adverse infant neurodevelopmental outcomes.<sup>1,4,5</sup>

Of particular concern is the significant racial differences in the levels and clustering of stress as well as health outcomes in pregnant African American women. This population experiences a greater number of stressful life events, reports a higher prevalence of stress and depression, as well as a higher cumulative level of stressors compared with women of other races or ethnicities.<sup>6–8</sup> The increased exposure to stressors has

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been posited to explain the racial disparities in infant mortality and adverse birth outcomes.<sup>6,9</sup>

Confounding this picture is the role of positive emotions. There is growing indication that positive emotions, such as happiness, are associated with better health across a range of outcomes including stress and mood.<sup>10</sup> Happiness has been found to increase one's ability to manage stress.<sup>10</sup> Thus, while it is essential to evaluate stress in pregnant women, it may be equally significant to explore how positive emotions play a role in the stress process and maternal well-being.<sup>11</sup> This is especially relevant for pregnant African American women vulnerable to the accumulation of multiple stressors.<sup>9</sup>

The pathway from stress, maternal emotions, and outcomes is complex and likely involves an inflammatory process mediated by inflammatory markers, such as cytokines.<sup>12</sup> Inflammatory cytokines play a crucial role in the stress response and occurrence of symptoms such as anxiety and depressive symptoms as well as health outcomes.<sup>13</sup> Conversely, happiness may provide a protective physiological pathway linking to improved health.<sup>14</sup>

An understanding of these relationships is needed to explain potential mechanisms of stress and emotions in this vulnerable population of pregnant African American women. Therefore, the purpose of the study was to examine the relationships of positive and negative emotions and pro-inflammatory cytokines in pregnant African American women.

#### BACKGROUND

Happiness, a positive emotion, is conceptualized as having multiple facets such as a sense of satisfaction, meaning, and purpose in life<sup>15</sup> and is gaining clinical and research interest.

A recent review highlighted the associations of positive emotions in the general population to include longer life, enhanced cardiovascular health, and improved outcomes in chronic disease.<sup>10</sup> Studies suggest that happiness is strongly correlated with perceived good health and reduced mortality.<sup>16,17</sup> Following that line of reasoning, researchers are investigating the role of positive emotions such as happiness in the context of stress and related symptoms. Studies in the general population have reported an inverse relationship between happiness and stress, anxiety, and depression.<sup>18,19</sup> It is suggested happiness may be a possible foundation for resilience, which is key in the process of adopting well when challenged with significant sources of stress.<sup>20</sup>

There are studies examining the role of positive emotions during the perinatal period. Research suggests happiness about being pregnant is inversely associated with depressive symptoms.<sup>21</sup> Positive emotion during pregnancy is negatively associated with postpartum perceived stress and depressive symptoms,<sup>22</sup> associated with reduced risk of preterm birth,<sup>23,24</sup> better childbirth experiences,<sup>25</sup> and a positive predictor of fetal weight.<sup>26</sup> In addition, antenatal positive emotional states have been associated with improved neonatal outcomes to include infant cognitive, language/communication, and social development.<sup>27</sup> The majority of the research participants in these studies were Hispanic White or non-Hispanic White women. Thus, a critical gap in the literature is the role of happiness in pregnant African American women, a population at risk for increased stress and poor maternal-child health outcomes.

Cytokines are proteins that mediate and regulate immunity and inflammation, typically classified as "pro-" or "anti-"inflammatory.28 Pro-inflammatory cytokines include interleukin (IL)-1*β*, IL-6, IL-8, IL-11, IL-12, IL-17, IL-18, tumor necrosis factor (TNF- $\alpha$ ), and interferon- $\gamma$ (IFN- $\gamma$ ).<sup>28</sup> In the perinatal period, there is evidence linking the inflammatory pathway with negative emotions. In a study of racially/ethnically diverse pregnant women, higher perceived stress correlated with higher circulating levels of IL-6 and TNF- $\alpha$ <sup>29</sup> Higher levels of pro-inflammatory cytokines are associated with severe levels of depression and anxiety in the third trimester<sup>30</sup>; anxiety was positively correlated with IL-12, and IL-13 during mid-pregnancy<sup>31</sup>; and higher depression scores were related to significantly higher levels of IL-6,32 IL-13, IL-12, and IFN- $\gamma$ .<sup>31</sup> Among second-trimester pregnant African American women, increased levels of IL-6 and IL1 $\beta$  were associated with depressive symtpoms.<sup>33</sup> These results are concerning as elevated levels of pro-inflammatory cytokines are linked to preterm contractions, cervical ripening, rupture of membranes, and preterm birth28,34 as well as adverse neonatal outcomes including infection and central nervous system dvsfunction.28,35

In contrast, positive emotions have been reported to be negatively associated with inflammatory markers in heterogenous participants<sup>36</sup> and higher happiness predicted lower IL-6 levels in diabetic patients.<sup>14</sup> While results of these studies with heterogenous participants are encouraging, the impact of positive emotions in pregnant African American women remains undetermined. There have been no studies that examined the relationship between happiness, negative emotions, and pro-inflammatory cytokines in pregnant African American women early in the second trimester. Incorporating both negative and positive emotions in studies that evaluate mechanistic pathways such as inflammation may provide a more comprehensive and dynamic approach to studying stress and health outcomes.

#### CONCEPTUAL FRAMEWORK

The biobehavioral framework guiding this study (see Figure 1) is an adaptation of a psychoneuroimmunology (PNI) paradigm for advancing empirical knowledge of psychosocial and physiologic relationships contributing to health,<sup>37</sup> which may elucidate the mechanistic pathway between emotions and health outcomes in the perinatal period. The PNI framework provides a comprehensive approach to integrate the dynamics of stress and coping and positive emotions.<sup>3</sup> The model allows for the co-occurrence of positive and negative emotions during stressful periods, with positive emotions providing a restorative function to stress perception, physiological and psychological coping resources, and serves as a buffer against adverse consequences of stress.<sup>3,38</sup>

# METHODS

#### **Research design**

This cross-sectional correlational study examined psychosocial data and plasma cytokine samples collected in pregnant African American women at 14 to 17 weeks' gestation as part of a larger parent study examining the biobehavioral effects of a relaxation-imagery intervention on stress and symptom managment.<sup>39</sup> The next step is to assess the multifaceted and complex process between emotions and biologic pathways in pregnant African American women. The aim of this study was to examine the relationships between emotions (both positive and negative) and inflammatory cytokines using a biobehavioral framework. The following hypotheses drove the exploratory secondary analysis: (1) perceived stress, anxiety, depressive symptoms, and pro-inflammatory cytokine levels will be significantly positively correlated; and (2) happiness scores will be significantly negatively correlated with perceived stress, anxiety, depressive symptoms, and pro-inflammatory cytokine levels.

The sample of 72 pregnant African American women receiving prenatal care in 2 obstetric clinics located in Southeastern Virginia were recruited during a standard prenatal care appointment using brochures, flyers, word of mouth, clinician referral, and direct approach by a research nurse in the obstetric clinics. The institutional review boards (IRBs) of sponsoring institutions approved the protocol. Participants provided verbal and written consent, in accordance with the IRB-approved protocol.

#### **Participants**

Enrolled participants (N = 72) met the following criteria: (1) self-identified as African American between 18 and 40 years old; (2) between 14 and 17 weeks' estimated gestational age; (3) no history of major medical problem; (4) no current obstetrical problems (uncomplicated pregnancy); (5) no dissociative disorders, borderline personalities, or psychotic pathology; (6) ability to read, write, and understand English; and (7) verbalize at least one source of social support. Because the study was focused on perceived stress rather than specific types of stressful life events, data on the sources of stress, such as the number and ages of children, were not collected. Upon providing informed consent, the medical history was reviewed to confirm inclusion criteria. It was determined a sample size of N = 72 had the power of 90% to be able to detect correlation values as small as between -0.20 and 0.2at  $\alpha = .05$ .



Figure 1. A psychoneuroimmunology model of biobehavioral correlates of happiness.<sup>37</sup>

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#### **Study measures**

#### Demographic and health history

The demographic and health history questionnaire assessed participant's demographic information including age, marital status, education, range of income, method of insurance, gravidity, health history (medical and obstetric), and current health behaviors.

#### **Biobehavioral factors: Psychosocial Measures**

#### Perceived Stress Scale

The Perceived Stress Scale (PSS) is a 10-item selfreported measure of global perceived stress that measures the degree to which a respondent appraises one's life as being stressful, particularly in terms of unpredictability, uncontrollability, and overload over the past month.<sup>40,41</sup> The categories for a response range from *never* (0) to *very often* (4). The score range is 0 to 40, with a higher score indicating a higher level of perceived stress. Cronbach's  $\alpha$  of 0.814 was obtained for the PSS, indicating adequate internal consistency for the sample. The mean for normative groups ranges from 12.8 for Caucasian, 14.0 for Hispanic, and 14.7 for African American US respondents.

# State-Trait Anxiety Inventory Scale (STAI-Form Y)

The State-Trait Anxiety Inventory (STAI) is a self-report measure that comprises 20 items to assess current, "at this moment" (state; STAI-S) anxiety and 20 items to measure more general, usual (trait; STAI-T) level of anxiety.<sup>42</sup> Items are rated from *not at all* (1) to *very much so* (4). Scores range from 20 to 80, with higher scores indicating higher levels of state and trait anxiety. For the present sample, Cronbach's  $\alpha$  of 0.925 was obtained indicating adequate internal consistency.

# Center for Epidemiologic Studies-Depression

The Center for Epidemiologic Studies-Depression (CES-D) is a 20-item self-report measure of depressive symptoms.<sup>43</sup> The participants rated how they felt during the past week and categories range from *rarely or none of the time* (0) to *most or all of them time* (3). The score range is 0 to 60, with a score of 16 or more frequently used to indicate a positive screen for depression.<sup>43</sup> Cronbach's  $\alpha$  for the present sample was 0.835, indicating adequate internal consistency for the sample.

# Oxford Happiness Questionnaire44

The Oxford Happiness Questionnaire (OHQ) is a 29-item questionnaire composed of 3 domains—life satisfaction as well as positive and negative affect—and is used for measuring happiness. The categories for a response range from *strongly disagree* (1) to *strongly agree* (6). The score range is 29 to 174, with a higher score indicating a higher level of happiness. The reliability of the scale was tested with 172 undergraduate students and Cronbach's  $\alpha$  was 0.91. Cronbach's  $\alpha$  for present sample was 0.801, indicating adequate internal consistency for the sample.

# **Biobehavioral factors: Biologic measures**

# Pro-inflammatory cytokines

The circulating pro-inflammatory cytokines included were IL-1 $\beta$ , TNF- $\alpha$ , IL-6, IL-8, and IL-12, IL-17, and IFN- $\gamma$ . Two milliliters of maternal blood was collected by venipuncture into heparinized vacutainer tubes. Plasma samples were cryopreserved and batched processed to reduce interassay variability at the research laboratory. The plasma samples were analyzed for levels of cytokines using the 17-plex kit with the BioPlex Pro (Bio-Rad; Hercules, California).

# Procedure

Participants completed the study measures and a blood sample was obtained in a private room in the prenatal clinic setting. Each participant received \$25 as compensation for time and effort. Participants who scored above the cut-off on the CES-D ( $\geq$ 16) were asked the 2 probe questions recommended by the United States Preventive Health Care and screened for suicidal thoughts.<sup>45</sup> As appropriate, participants were encouraged to discuss feelings with the prenatal care providers and were given a list of counselors and mental health support services in the local community. Referrals to healthcare providers were provided as indicated.

#### Data analysis

Data were analyzed using SPSS software version 26 and JMP software version 15.1. All variables' distributional properties were examined graphically. The internal consistency reliability of the measures was examined using Cronbach's  $\alpha$ . The cytokine data were skewed positively (nonnormal) so a log transformation was used on these biologic measures. Descriptive statistics were used to summarize the sociodemographic characteristics and to calculate the means and standard deviations for the PSS, STAI-S, STAI-T, CES-D, and the OHQ. Pearson's product moment correlation coefficient was used to estimate the strength of the associations between the variables of interest. The level of significance was set at  $P \leq .05$ . Due to the pilot nature of this study, no adjustment for multiplicity was used.

Table	1. Demographic variables of	of
partici	pants ( <i>N</i> = 72)	

Variable	Mean (SD)
Age Gravida Estimated gestational age	24.26 (0.64) 2.63 (0.22) 15.43 (0.13)
	% ( <i>n</i> )
Education High school or less Post high school Post college Employment Full-time/part-time Unemployed Income Less than 15,000	12.37 (2.01) 49% (35) 37% (27) 14% (10) 39% (28) 61% (44) 68% (49)
Between 15 000 and 44 999 More than 45 000 Marital status Married/partnered Single	26% (19) 5% (4) 14% (10) 86% (62)

Abbreviation: SD, standard deviation.

#### RESULTS

The study participants' sociodemographic information is presented in Table 1.

Participants' mean age was 24.26 years, with 12.37 years of education. The majority were not married, 39% were employed full-/part-time, and 60% unemployed, with 68% reporting an income of less than \$15000. The average gestational age at entry into the study was 15.43 weeks and the average number of pregnancies for the sample was 2.63.

The means, standard deviations, and ranges of scores of the psychosocial measures are displayed in Table 2.

Scores on the PSS ranged from 1 to 33, with a mean score of 19.39 (SD = 6.97). Scores on the STAI-S ranged from 20 to 71, with a mean score of 39.10 (SD = 13.25), and the STAI-T scores ranged from 22 to 72, with a

Table 2. Study variable means							
	Mean	SD	n	SE	Min	Мах	
PSS STAI-S STAI-T CES-D OHQ	19.39 39.10 42.12 19.42 121.05	6.97 13.25 11.87 10.80 23.22	70 72 71 71 71	0.83 1.56 1.41 1.28 2.76	1 20 22 2 60	33 71 72 47 170	

Abbreviations: CES-D, Center for Epidemiologic Studies-Depression; OHQ, Oxford Happiness Questionnaire; PSS, Perceived Stress Scale; SD, standard deviation: SE, standard error; STAI-S, State-Trait Anxiety Inventory-State; STAI-T, State-Trait Anxiety Inventory-Trait. mean score of 42.12 (SD = 11.87). Scores on the CES-D ranged from 2 to 47, with a mean score of 19.42 (SD = 10.80). There were no positive screens for suicidal ideation. Scores on the OHQ ranged from 60 to 170, with a mean score of 121.05 (SD = 23.22).

There were significant correlations among stress, anxiety, depressive symptoms, happiness, and a proinflammatory cytokine. The pairwise correlations of the variables are displayed in Tables 3 and 4.

Using the conventional approach to interpreting the magnitude of a correlation coefficient,<sup>46</sup> there were strong positive correlations between all psychosocial measures of negative emotion: PSS and STAI-S (r = 0.64); PSS and CES-D (r = 0.69); PSS and STAI-T (r = 0.77) as well as CES-D and STAI-S (r = 0.71) and STAI-T (r = 0.79). There were strong negative correlations between measures of positive emotion (happiness) and negative emotions: OHQ and PSS (r = -0.71); OHQ and STAI-S (r = -0.64); OHQ and STAI-T (r = -0.82); and OHQ and CES-D (r = -0.76).

There were significant weak positive correlations between IL-8 and PSS (r = 0.27) and CES-D (r = 0.31) as well as a weak negative correlation between IL-8 and OHQ (r = -0.29). No other correlations between variables were found.

#### DISCUSSION

The goal of this study was to examine the relationships among perceived stress, anxiety, depressive symptoms (negative emotions), happiness (positive emotion), and pro-inflammatory cytokines (biologic immune measure) in pregnant African American women using a biobehavioral framework. Findings demonstrated several statistically significant correlations between positive and negative emotions as well as a biologic immunologic measure.

Pregnant African American women in this study reported higher levels of stress compared with nonpregnant normative group means as well as pregnant non-Hispanic and/or Hispanic Whites in previous research.41,47,48 A possible reason for these findings is the chronic stressors the women face. In addition to the multiple challenges of pregnancy, African American women experience the stressors of discrimination. Within the socioeconomic context of the women's lives, the majority of participants reported being single, unemployed, and of low socioeconomic status-all social determinants of health closely linked with stress and associated symptoms of anxiety and depression.<sup>49</sup> These demographic characteristics may explain why the mean depression score in this study was higher compared with pregnant African American women with more education and reported income.33

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Table 3. Pairwise correlations of psychosocial measures						
	Correlation	Count	Lower 95%	Upper 95%	<i>P</i> value	
STAI-SPSSSTAI-TPSSSTAI-TSTAI-SCES-DPSSCES-DSTAI-SCES-DSTAI-TOHQPSSOHQSTAI-SOHQSTAI-TOHQCES-D	$\begin{array}{c} 0.6473\\ 0.7766\\ 0.8122\\ 0.6954\\ 0.7189\\ 0.7943\\ -0.7109\\ -0.6475\\ -0.8242\\ -0.7630\\ \end{array}$	70 69 71 69 71 70 69 71 70 70 70	0.4863 0.6615 0.7143 0.5491 0.5834 0.6876 - 0.8111 - 0.7652 - 0.8873 - 0.8463	0.7658 0.8559 0.8790 0.8004 0.8154 0.8674 - 0.5702 - 0.4880 - 0.7307 - 0.6434	<.0001 <.0001 <.0001 <.0001 <.0001 <.0001 <.0001 <.0001 <.0001	

Abbreviations: CES-D, Center for Epidemiologic Studies-Depression; OHQ, Oxford Happiness Questionnaire; PSS, Perceived Stress Scale; STAI-S, State-Trait Anxiety Inventory-State; STAI-T, State-Trait Anxiety Inventory-Trait.

Table 4. Pairwise correlations pro-inflammatory cytokines and psychosocial measures						
		Correlation	Count	Lower 95%	Upper 95%	<i>P</i> value
L=1β  L=1β  L=1β  L=1β  L=1β TNF-α	PSS STAI-S STAI-T CES-D OHQ PSS	0.1969 - 0.0802 0.0794 0.0648 - 0.1068 0 1422	70 72 71 71 71 71 70	- 0.0400 - 0.3062 - 0.1568 - 0.1711 - 0.3318 - 0.0959	0.4127 0.1543 0.3071 0.2936 0.1298 0.3650	.1024 .5031 .5102 .5915 .3755 2401
TNF-α TNF-α TNF-α TNF-α IL-6	STAI-S STAI-T CES-D OHQ PSS	- 0.0326 0.0887 - 0.0350 - 0.1627 0.1679	72 71 71 71 71 70	- 0.2622 - 0.1477 - 0.2661 - 0.3815 - 0.0698	0.2006 0.3155 0.2000 0.0734 0.3876	.7860 .4621 .7722 .1753 .1648
IL-6 IL-6 IL-6 IL-6 IL-8	STAI-S STAI-T CES-D OHQ PSS	- 0.0155 0.0577 - 0.0137 - 0.0889 0.2773	72 71 71 71 70	- 0.2462 - 0.1780 - 0.2463 - 0.3156 0.0452	0.2170 0.2871 0.2203 0.1475 0.4809	.8975 .6329 .9094 .4611 .0201ª
IL-8 IL-8 IL-8 IL-8 IL-12	STAI-S STAI-T CES-D OHQ PSS	0.1767 0.2500 0.3129 - 0.2984 0.2180	72 71 71 71 70	- 0.0573 0.0177 0.0858 - 0.4971 - 0.0179	0.3923 0.4566 0.5090 - 0.0699 0.4309	.1375 .0355ª .0079ª .0115ª .0699
IL-12 IL-12 IL-12 IL-12 IL-17	STAI-S STAI-T CES-D OHQ PSS	0.0312 0.1565 0.1784 - 0.1974 0.1843	72 71 71 71 70	- 0.2019 - 0.0797 - 0.0573 - 0.4118 - 0.0530	0.2610 0.3761 0.3953 0.0376 0.4019	.7948 .1925 .1366 .0989 .1267
IL-17 IL-17 IL-17 IFN-γ IFN-γ IFN-γ IFN-γ IFN-γ IFN-γ IFN-γ	STAI-S STAI-T CES-D OHQ PSS STAI-S STAI-T CES-D OHQ	0.1662 0.1771 0.1560 - 0.1453 0.1897 - 0.0131 0.0422 - 0.0740 0.0036	72 71 71 70 72 71 71 71	- 0.0681 - 0.0586 - 0.0802 - 0.3662 - 0.0474 - 0.2441 - 0.1930 - 0.3021 - 0.2299	0.3831 0.3941 0.3757 0.0911 0.4066 0.2192 0.2728 0.1621 0.2367	.1630 .1395 .1938 .2265 .1157 .9127 .7267 .5398 .9765

Abbreviations: CES-D, Center for Epidemiologic Studies-Depression; IFN, interferon; IL, Interleukin; OHQ, Oxford Happiness Questionnaire; PSS, Perceived Stress Scale; STAI-S, State-Trait Anxiety Inventory-State; STAI-T, State-Trait Anxiety Inventory-Trait; TNF, tumor necrosis factor. <sup>a</sup>P ≤ .05.

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However, despite the negative emotions reported, participants expressed a moderate level of happiness, reinforcing the concept that negative and positive emotions can co-occur during the stress process.<sup>3</sup> There was a significant strong inverse association between happiness and measures of negative emotions. These findings suggest pregnant African American women who reported higher levels of happiness perceived lower levels of stress, anxiety, and depressive symptoms. The results demonstrate the role of happiness within the context of stress is important. While the stress is not reduced, happiness is thought to provide a psychological break or respite to replenish drained resources and support continued coping efforts to manage the stress.<sup>3</sup> Researchers reported African American women who reported being happy with the pregnancy were more likely to use a greater range of cognitive and behavioral coping strategies to manage negative affect or mood states compared with those unhappy with the pregnancy.50

Another key finding supporting our hypothesis was the predicted relationship between IL-8 and emotions (negative and positive). Although not often measured in cytokine studies during pregnancy, positive correlations between IL-8 and depression and anxiety in patients have been reported.<sup>51</sup> The significant correlation between happiness and IL-8 is unique to this study and may possibly suggest a protective physiological pathway, as IL-8 has been associated with negative pregnancy and birth outcomes. However, more research is needed to fully explain the clinical meaning of this finding.

The nonsignificant findings related to the relationships between emotions (negative and positive) and the other pro-inflammatory cytokines were inconsistent with previous research and did not support part of the study's hypothesis. While no relationship between stress and multiple cytokines was found in innercity mothers,<sup>52</sup> other studies did report the predicted relationship.<sup>29-31,53</sup> These findings may be explained by the variances in the study population. Whereas this study examined cytokines at 14 to 17 weeks in pregnant African American women with no major medical problems, other studies have examined cytokines later in pregnancy in Finland<sup>31</sup>; between 20 and 39 weeks in women with severe perinatal anxiety and depression<sup>30</sup>; between 8 and 20 weeks in Hispanic, African American, and Caucasian women<sup>29</sup>; average of 15 weeks in African American, Caucasian and Asian women<sup>32</sup>; and 13 to 28 weeks in African American women.33 Variations in race and timing may influence findings. For example, differing patterns of cytokine profiles have been reported for African American and Caucasian pregnant women and the immune responses switch from Th1-type immune responses in favor of Th2 responses during pregnancy.<sup>28</sup> Thus, it is possible the sample population and the timing of cytokine examination are variables to consider when examining relationships.

It is theoretically possible happiness contributed to the participants' resilience to stress enhancing the ability to bounce back more quickly, thus blunting the physiological inflammatory response and decreasing the level of measurable cytokines.<sup>54</sup> Happiness may have provided a sense of psychological rest to help buffer against stress and restore coping efforts, which in turn may have suppressed physiological responses such as inflammation generated by negative emotions.<sup>55</sup> Determining the feasibility of such a pathway will require additional research.

Based on these initial findings, there are numerous options for future research. Prospective longitudinal studies are warranted to examine the trends of these study variables and determine whether one variable predicts another variable over time. Longitudinal studies examining mediators, moderators, and causal modeling may also reveal the mechanisms that explain these correlational and causal connections to further refine a biobehavioral pathway.<sup>54</sup> These future studies should be powered for multiple comparisons and modeling.

Because subjective well-being is related to health behaviors and health outcomes,15 future research should consider intervention design and testing to foster pregnant African American women's positive emotions as well as reduce negative emotions. There is evidence of the effectiveness of such interventions in nonpregnant populations. For example, a web-based happiness training intervention led to higher scores in measures of happiness and life satisfaction while perception of stress significantly decreased in working adults.<sup>56</sup> Similarly, a gratitude and mindfulness intervention was found to decrease depression and stress while reports of happiness increased in women of childbearing age.57 However, the effects of such interventions on well-being and health outcomes in the vulnerable population of pregnant African American women is a gap in the literature and is critical to address in future research.

The results of this study have several implications for practice. While it is not possible to prevent exposure to all the multiple stressors pregnant African American women face, behavioral and biological pathways provide potential targets for interventions.<sup>58</sup> Reducing stress, anxiety, and depressive symptoms and increasing the positive emotion of happiness may influence the immune pathway and health outcomes. Emotions can be assessed at the clinical setting and may be modifiable to interventions.<sup>59</sup>

Present trends of family-centered practices provide the potential for incorporating more individualized

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assessment and involvement of pregnant women in determining needs. Thus, working with pregnant African American women to assess how they are doing emotionally and incorporating appropriate support services when indicated could be incorporated into comprehensive care plans.

In addition, the possibility of happiness providing a possible respite to stress may provide insight into potential interventions. The findings of this study and future research can further the understanding of happiness and how to incorporate it into effective interventions.

# STRENGTHS AND LIMITATIONS

There are several study strengths. The application of a biobehavioral framework to examine the relationships of both positive and negative emotions as well as biologic measures results in a more comprehensive picture of the stress process in pregnant African American women, a population at high risk for stress. The timing of the study, at 14 to 17 weeks' gestation, provides evidence of the need for early pregnancy support and interventions to lessen negative emotions and encourage positive emotions to possibly improve health.

Interpretation of our findings must be viewed within the context of the study limitations. While the correlations revealed the generality of the associations in this population, these are not causal connections. The analysis was based on 1 time point in early pregnancy, so the observed associations may not continue or may change as the pregnancy progresses potentially presenting a different picture. The timing and collection of the biologic sample in this study may have influenced outcomes. Cytokines are synthesized only when needed, released in small quantities and have a short half-life, which may impact sample collection and transportation to the laboratory for processing.<sup>51</sup> In addition, variables that might influence cytokine levels such as diet, exercise, and time of day<sup>51</sup> were not controlled. It is conceivable our samples did not capture the complexity of the inflammatory markers. Finally, the study examined only the pro-inflammatory cytokines in a complex immune system. It is possible examination of these variables within the context of Th1 (pro-inflammatory markers) and Th2 (anti-inflammatory markers) in pregnancy may provide a more in-depth analysis.

#### CONCLUSION

Significant correlations in the expected direction were found between stress, anxiety, depressive symptoms, and happiness but not the majority of pro-inflammatory cytokines in pregnant African American women at 14 to 17 weeks' gestation. This study was one of the first to examine the predicted relationships between negative and positive emotions as well as immunologic factors within a biobehavioral framework in this population at risk for adverse perinatal mental health. Further research is needed to examine mechanisms to explain these correlations in order to refine a biobehavioral pathway and target interventions to improve perinatal well-being.

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