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Assessing the Relationship Between Self-Reported Stress and Cortisol in Pregnant Women

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Running head: SELF REPORTED STRESS AND CORTISOL

Assessing the Relationship Between Self-Reported Stress and Cortisol in Pregnant Women

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October 23, 2010

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Abstract

As health professionals work with women experiencing anxiety, depression and other stress related mental illness, understanding the relationship between a woman's subjective (i.e., self-report) and objective (i.e., salivary cortisol) symptoms will enable accurate diagnosis and treatment of stress related mood disorders. The first objective was to investigate the relationship between self-reported and biologically mediated measures of stress in a sample of 184 pregnant women (158 African-American and 26 Hispanic) at four time points during pregnancy (second trimester, third trimester, birth and four week post birth). Using an age-matched subset, the main hypothesis, that salivary cortisol and self-reported stress were positively correlated, was partially supported. There was a significant positive relationship between cortisol concentration and self-reported anxiety, depression and perceived stress at one month postnatal age. The second objective was to investigate if self-report stress profiles were different among African-American and Hispanic women. There were two statistical trends suggesting that African-American pregnant women endorse more cognitive/affective related depression symptoms (vs. somatic symptoms) at the second (p=0.076) and third trimester (p=0.075). Understanding differential profiles of distress in pregnant vs. non-pregnant women as well as varying ethnicities becomes important when the women present for mental health services. The potential significance of the current study is further amplified in this sample of pregnant women because stress related maternal illnesses have been suggested to negatively affect fetal development (Emory & Dieter, 2006; Field et al., 2004).

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Assessing the Relationship Between Self-Reported Stress and Cortisol in Pregnant Women

The human body's physiological response to stressful experiences is well documented in the empirical literature (C. Kirschbaum & Hellhammer, 1989; Lobel, Dunkel-Schetter, & Scrimshaw, 1992). There is less evidence showing a relationship between the body's physiological response to psychosocial stress and a woman's self report of psychological stress, especially during the perinatal period (Field et al., 2009; Hellhammer, Wüst, & Kudielka, 2009; Peoples, 1997; Simeonova, 2005). Psychological stress during pregnancy has been suggested to have negative psychological and behavioral impacts on pregnant women and their offspring (Alder, Fink, Bitzer, Hosli, & Holzgreve, 2007; Milgrom et al., 2008). The current study aimed to explore and clarify some of these issues by investigating the relationship between self-report and biological measures of stress in a short-term longitudinal study of African-American and Hispanic pregnant women.

Cortisol and Stress Defined

Stress is defined as "environmental demands that tax or exceed the adaptive capacity of an organism, resulting in biological and psychological changes that may be detrimental and place the organism at risk for disease" (Cohen, Kessler, & Gordon, 1995). Stress responses can be emotional, physiological, or behavioral reactions to appraised stress (Lobel, et al., 1992).

For the current study, psychological stress was defined and operationalized as perceived stress, anxiety symptoms, and depression symptoms obtained from self-report measures of those constructs. Examples of psychological stress symptoms associated with depression include social withdrawal, agitation, difficulty concentrating and insomnia (American Psychiatric Association [*DSM-IV-TR*], 2000). Examples of psychological stress symptoms associated with

anxiety include consistent fear without a real threat, abnormal sympathetic nervous system arousal, excessive worry, and significant muscle tension (*DSM-IV-TR*, 2000). This type of stress can also be called a category of subjective stress since it relies on an individual's personal appraisal. Examples of measures of objective stress include cortisol, adrenocorticotrophic hormone (ACTH), corticotrophin releasing hormone (CRH) and blood pressure. Both objective and subjective stress have been linked to depression (Aaron T. Beck, Steer, Ball, & Ranieri, 1996).

Cortisol is the principal glucocorticoid in humans which modulates anxiety and stress (Arranz, Guayerbas, & De la Fuente, 2007) through very specific processes. When a human perceives stress, the corticotrophin releasing hormone (CRH) is released from the hypothalamus (Tsigos & Chrousos, 2002). The hypothalamus receives and monitors environmental information and coordinates the response of nerves and hormones (Padgett & Glaser, 2003; Tsigos & Chrousos, 2002). After CRH is released, it stimulates the synthesis and release of adrenocorticotrophic hormone (ACTH) from the pituitary gland, which in turn triggers cortisol synthesis and release by the adrenal cortex (Gold & Chrousos, 2002; Tsigos & Chrousos, 2002). Under ideal conditions, cortisol works with melatonin and other bodily functions, synchronized around a diurnal, 24 hour light/dark cycle (Weber et al., 2000), to keep the body functioning optimally.

For the current study, salivary cortisol concentrations was used as an objective measure of stress consistent with other studies (Field, et al., 2009; Kalra, Einarson, Karaskov, Van Uum, & Koren, 2007; Peoples, 1997; Simeonova, 2005). Cortisol found in blood and urine is widely accepted and utilized (Hellhammer, et al., 2009; C. Kirschbaum & Hellhammer, 1994) as a biomarker of stress.

Numerous biological measures have been shown to relate to mood disorders. For example, plasma cortisol has been shown to increase in women who self-reported their anxiety (Goodyer et al., 1996). Results from a sample of Spanish women in Madrid found increased plasma cortisol in anxious women compared with nonanxious controls. Overall the study suggested that high levels of anxiety lead to impairment in the immune response (Arranz, et al., 2007).

For the current study, salivary cortisol was utilized as a biological marker of distress. There are many advantages to using salivary cortisol; Kirschbaum (C. Kirschbaum & Hellhammer, 1989) suggest that salivary cortisol is versatile, can be measured at unlimited frequency and is easier to access than blood cortisol when assessing the hormone "free" fraction of cortisol.

When bodily systems are not performing optimally, they could be experiencing excessive allostatic load (McEwen & Stellar, 1993). Allostasis refers to the normal fluctuations of the autonomic nervous system, the hypothalamic-pituitary-adrenal (HPA) axis as well as the metabolic, cardiovascular and immune system. These bodily systems help to maintain stability and protect the body as it encounters internal and external stressors. Allostatic load describes the physiological cost of overtaxing and increasing the vulnerability of bodily systems mobilized by stress hormones (McEwen & Stellar, 1993). Recently, the theory of allostasis has been updated to reflect that no single ideal set of steady-state conditions in life exist and different stressors elicit different patterns of activation of the sympathetic nervous and adrenomedullary hormonal systems.

Allostatic load from major and minor stressful events can adversely affect numerous components of human physiological systems (Padgett & Glaser, 2003). Specifically, cortisol is

among the principal hormones that contribute to the functional alteration of lymphocytes, white blood cells responsible for the immune response (Rabin, 1999). Therefore, dysregulation of stress hormones can compromise the immune system and increase vulnerability of the human body to infectious agents. Perceived chronic stress has been associated with elevated cortisol secretions (C. Kirschbaum & Hellhammer, 1994; Ockenfels, Porter, Smyth, Kirschbaum, & et al., 1995). Chronic stress had demonstrated permanent changes in the HPA axis (Walker & Diforio, 1997).

Empirical studies have also suggested permanent change to the hippocampus, which is involved in short term memory, from cortisol elevation beyond the normal range. Correlational studies suggest that individuals who experience prolonged, high levels of stress tend to have smaller hippocampi (Rabin, 1999). Alterations to the immune system and hippocampi are just two of many documented impacts of a dysregulated cortisol synthesis from stress.

Cortisol and Stress in Pregnant Women

Dysregulation of the HPA systems and ACTH release has been associated with major depression (Heuser, 1998). However, depressive symptoms (e.g., fatigue, changes in sleep pattern) during pregnancy can be difficult to distinguish from the normative experience of pregnancy (Harville et al., 2007). For instance, elevated levels of somatic complaints have been reported on self-report scales of depression by pregnant women who do not meet full criteria for major depression (Mastorakos & Ilias, 2003).

Animal and human research have shown that elevated cortisol levels are associated with maternal anxiety and mood changes as well as negatively affecting the birthing process. Many of the studies in this area have focused on stress levels measured via self-report inventories while

few studies have examined both self-report and physiological and hormonal responses (Li, Power, Kelly, Kirschbaum, & Hertzman, 2007).

Maternal salivary cortisol profiles have exhibited a clear circadian rhythm during pregnancy (similar to non-pregnant controls) with an increase in mean salivary cortisol from the 25th to 28th week and onwards. By late pregnancy, concentrations may be more than twice as high as in non-pregnant controls but they rapidly return to normal levels after delivery (Allolio et al., 1990). One study found an increase in baseline cortisol values between the 3rd to 7th month of pregnancy (Simeonova, 2005). Additionally, a few studies have noted that self-reported depression is linked to higher basal cortisol in both the second and third trimesters of pregnancy (Field, et al., 2004; Lundy et al., 1999; Peoples, 1997).

Animal experiments have further shown that pregnant rats exposed to stress have structural malformations and offspring with low birth weight (Hay, Pawlby, Waters, Perra, & Sharp, 2010). In humans, depression and anxiety during the first trimester is associated with increased placental CRH and an increased risk for preeclampsia (Glynn, Schetter, Chicz-DeMet, Hobel, & Sandman, 2007).

One study suggested that pregnant women comorbid for depression and anxiety had significantly higher salivary cortisol than controls or individuals with only one of these diagnoses (Evans, Myers, & Monk, 2008). This finding is noteworthy because anxiety and depression are often co-morbid mental illnesses (S. Goldstein, Halbreich, Asnis, Endicott, & et al., 1987) whose symptoms have been difficult to differentiate. The above studies suggest the possibility of a unique allostatic load for pregnant women who are experiencing both clinically significant depression and anxiety versus either one alone.

There are also deleterious effects of stress on the fetus and ultimately on the infant from maternal stress. Relatively high levels of maternal anxiety and depression have resulted in reduced birth weight and smaller head size (an early measure of infant brain development) (Hellhammer, et al., 2009). Studies with humans suggest that high maternal depression and anxiety compromise maternal emotional responsivity and infant socioemotional functioning (Harville, et al., 2007). Overall, the literature indicates that maternal stress is associated with negative pregnancy outcomes independent of other biomedical and sociodemographic risk factors (Dunkel-Schetter, Wadhwa, & Stanton, 2000).

Depression Statistics in Women

In terms of prevalence, there are two major large scale US studies that are often cited. The Epidemiologic Catchment Area (ECA) was one of the initial sources of psychiatric disorder prevalence in the early 1980s which obtained rates from five US communities while the follow-up national US community sample, the National Comorbidity Survey (NCS) was conducted in the early 1990s (Robins, Locke, & Regier, 1991; Somervell, Leaf, Weissman, Blazer, & Bruce, 1989).

The initial ECA study found that lifetime major depression prevalence was 7.0% for women (much higher than the 2.6% rate for men) (Robins, et al., 1991). The data from the NCS revealed that same trend; the lifetime prevalence of major depression was much higher for females (21.3%) than for males (12.7%) (Blazer, Kessler, McGonagle, & Swartz, 1994). Some have posited that the differences in the scale of prevalence rates from the two studies is due to the different structured interviews that they utilized (Bernal, Trimble, Burlew, & Leong, 2003).

For the current study, depression rates according to ethnicities were also obtained. Lifetime prevalence from the NCS data revealed that Hispanic women (23.9%) and Caucasian women (22.3%) were both much higher than African-American women (15.5%). However a much different trend was observed when looking at 30 day prevalence which was 11.1% for Hispanics, 5.7% for African-Americans and 5.4% for Caucasian women (Blazer, et al., 1994). Lifetime prevalence rates of depression consider if criteria for a particular disorder have ever been met versus assessing symptoms during a specified time period (e.g., 30 day, 6 month, 1 year, etc.). The relationship between lifetime rates and rates during a specified duration enables researchers to estimate the frequency that depression remains chronic or remits (Robins, et al., 1991) suggesting that mood illnesses might remain chronic or remit differentially in ethnic groups. However, these results must be analyzed with caution since some age categories of Hispanic and African-American women had low sample size, sometimes resulting in prevalence data not being reported.

Ethnicity is an important variable to consider. A majority of the empirical studies on female depression and cortisol have been conducted with Caucasian samples (Bernal, et al., 2003; Carrington, 2006). Given depression and anxiety rates for various ethnic groups differ, it is important to understand if there are racial or other group physiological differences in the stress response.

Across the NCS data, there were significant differences between age groups of different ethnic female groups. For example, the highest 30 day prevalence for Caucasian woman was 15-24 years of age, while it was 35-44 for African-American women and 45-54 years of age for Hispanic women. However, the NCS analysis suggested that the prevalence of depression in Hispanic women is greater than African-American women, regardless of age (Blazer, et al.,

1994). The current study might be able to shed light on this observation by evaluating if age is a factor that differentiates self-reported stress or salivary cortisol.

Statistics on Depressed/Stressed pregnant women and new mothers

One study suggested that anxiety means were lowest in late pregnancy compared to middle pregnancy or postpartum when controlling for prior depressive symptoms, social support, and sleep quality (Skouteris, Wertheim, Rallis, Milgrom, & Paxton, 2009). A few meta-analyses suggested that there are six core risk factors for postnatal depression including antenatal depression, major life events, low social support, depression history and low self-esteem (Milgrom, et al., 2008; O'Hara & Swain, 1996). Depression during pregnancy has been estimated to be between 10-25% (Skouteris, et al., 2009).

Ethnicity/Race as a Variable

Ethnicity is multifactorial in nature and involves shared common cultural traditions such as ancestry, psychological factors, common language, shared values, and sometimes a shared religion (Anand, 1999; Crews & Bindon, 1991; Senior & Bhopal, 1994). Race refers to biological aspects that differentiate humanity by the physical characteristics of a person such as skin color, eye color, stature, and facial features (Okazaki & Sue, 1995; Senior & Bhopal, 1994). In our study, we relied on individuals to self report their ethnicity. For the current study, ethnicity and race will be used interchangeably to refer the broad category of physical characteristics and culture traditions ascribed certain groups of people by individuals.

Ethnicity and race are often not included as variables in research investigating the relationship between physiological and psychological distress. When ethnicity is included, it is

important to note that ethnicity or race do not causally contribute to explaining findings about psychological or physiological distress. Specifically, if ethnicity is found to be a significant factor in explaining variance in results, this finding should prompt further investigation to determine the cause of phenomenological differences (e.g., psychosocial factors, nutrition, experiential differences). For instance, a combination of experiential and biological differences could shed light on how depressive disorder risk factors impact group differentially (Cuellar & Roberts, 1997).

When studies investigate minority mental health with respect to the experiences of Caucasian Americans this inadvertently suggests a viewpoint that any deviation from this group is problematic or abnormal (Jones, 1991). By investigating African-American and Hispanic pregnant women, the current study aims to clarify intergroup and intragroup differences in psychological and physiological distress in these women.

Depression in Minority Populations

Some researchers have posited that results from national surveys like ECA and NCS are inaccurate for minority women. Researchers to date have further suggested that minority women underreport mental health symptoms, and that health care professions misdiagnose or under-diagnose mental health symptoms of minority women (Neal-Barnett & Smith, 1997). An important shortcoming of research describing the female stress response is the low sample size which does not enable conclusions with adequate statistical power. Consequently, less is known about whether or not this group has a unique presentation of mental illness. Depression and anxiety prevalence rates suggest similar levels among all ethnic groups, by and large. However, prevalence data should be reconciled with studies indicating that racial and ethnic minorities

have higher rates of morbidity and mortality across the life span, related to mood disorders (Malone, 1985).

There is little synergy between the biological, psychosocial and behavioral explanations regarding ethnic disparities in mental and physical health. Ethnic minorities, especially those of lower social classes, perceive generic life stressors (i.e., stressors that are typical in modern life: occupational, parental, relationships) as more stressful and report more psychological distress than their Caucasian counterparts. As a result, individuals of lower socioeconomic status may be especially vulnerable to long-term effects of high allostatic load (Collins et al., 1998). Chronic stress due to financial strain, inadequate housing, crowding and violence may also contribute to more frequent activation of stress-response systems and prolonged exposure to stress hormones (Anderson, McNeilly, & Myers, 1991). Underrepresented minorities have a disproportionate percentage of individuals of low socioeconomic status compared to Caucasians. There is a shortage of empirical studies to conclusively support the theories presented above about underrepresented minorities. Among studies that include minority women, a larger number include African-American women compared to other underrepresented groups (such as Hispanic American and Asian American). More empirical studies should be executed in order to evaluate the theories above and specify critical factors to understanding the psychological and physiological stress responses in women of varying ethnicities.

African-American Mental Health

Regarding the underreporting of depressive symptoms by minority women, some researchers have suggested that the presentation of mental illness in African-Americans is potentially influenced primarily by cultural norms and lore. There are theories suggesting that

individuals within the African-American culture ascribe organic causes as the source of psychological disorders. Furthermore, researchers have suggested that African-Americans experiencing psychological distress seek health services for physical symptoms versus symptoms presumably associated with mental health difficulty at a much higher rate than Caucasians. Sussman (1987) suggested that African-Americans with major depressive disorder were less likely to have spoken to a health and healing professional (health care, clergy, spiritual healer, etc,) regarding emotional distress than Caucasians.

When considering misdiagnosis, numerous studies have reported that African-Americans express somatic complaints (e.g., headaches, dizziness, weakness, pounding heart, hot flashes, and chills) in relation to underlying physical disorders. Wohl et al. (1997) analyzed structured clinical interview data that revealed that Caucasian women were more likely to articulate depressed mood and psychomotor agitation, while African-American women experienced greater diurnal variation, an important marker of a vegetative/endogenous depression.

Some researchers have linked this presentation of somatic symptoms in African-Americans as being related to the higher likeliness of African-Americans to use medical services rather than mental health services (Heurtin-Roberts, Snowden, & Miller, 1997; Snowden, 1999). Data from the ECA study suggested that African-American women had significantly higher rates of somatization disorder (0.74%) than non-African-American women (0.17%). Somatization disorder is characterized by multiple, recurrent and multiple physical complaints of several years' duration for which medical attention has been sought but which do not implicate a specific physical disorder (Association, 2000). The higher rate of somatization disorder in African-American women highlights the necessity to distinguish potential differences between various

distress symptoms (e.g., somatic or cognitive related) reporting by individuals of different ethnicities.

Hispanic American Mental Health

Similar to African-Americans, many authors have reported that Hispanics report higher rates of somatic complaints compared with other ethnic groups (Golding, Aneshensel, & Hough, 1991; Roberts, 1992) although there have been findings to the contrary (Roberts, 1992; Wohl, et al., 1997). The underutilization of mental health services by Hispanic Americans has been associated with language and cultural differences (Salman, Diamond, Jusino, Sanchez-LaCay, & Liebowitz, 1997) . Studies which utilize bilingual health professionals (instead of, for example bilingual family members) have seen an increase in utilization of mental health services by Hispanic Americans (Bernal, et al., 2003). For the current study, bilingual health professionals were utilized.

Mental Health Comparison in Hispanic and African-American Women

There are limited empirical results to conclusively support theories about differences in depression and anxiety response in Hispanic and African-American pregnant women. As mentioned earlier, studies have suggested that non-pregnant minority adult women report increased somatic complaints compared to other non-pregnant women and have further suggested that this difference holds true during pregnancy (Golding, et al., 1991; Heurtin-Roberts, et al., 1997; Roberts, 1992). Furthermore researches have suggested that greater exposure and greater reactivity to stress are linked to negative pregnancy outcomes (Bernal, et al., 2003). However, there has been far less information from pregnant women of varying

ethnicities in comparison to underrepresented minority non-pregnant women which is also small. Furthermore, the fact the state of pregnancy is usually a time of increased somatic complaints is a major confounder. One recent study revealed an interesting finding to shed light about potential ethnic differences in the reporting of mood disorders in a sample of non-pregnant women.

In a 2002 study (Myers et al., 2002), self-report measures and structured interviews were administered to assess depressive symptoms in a sample of clinically depressed African-Americans, Caucasians and Hispanic women. Structured interview results revealed that Hispanics, who were primarily recent immigrants, were more severely depressed than African-Americans and Caucasians, even when controlling for differences in education, employment and marital status. On self-report measures of depression symptoms, the authors noted that Hispanic women reported more depression than Caucasian women, but the same amount as African-American women (Myers, et al., 2002). This is interesting because researchers have suggested that Hispanic immigrants have lower rates of mood disorders than US born Hispanics. This suggest that if more US born Hispanic women were in the study, the difference would have been greater between Hispanic and African-American women (Milgrom, et al., 2008).

Another interesting finding was that African-American women rated themselves as more psychologically distressed than the ratings from the structured interviews (Myers, et al., 2002). African-American women reported more somatic complaints than Hispanic women, which contrast other studies (Compton & Jones, 1991; Golding, et al., 1991).

For mental health care professionals who readily use self-reported measures of depression and anxiety, it is important to be able to better understand if there are differences in the way women of different ethnicities endorse items. The Myers (Meyers et al., 2002) study is

just one of the few studies that has suggested differences between symptom reporting and the actual presence of core mental illness features in minority women when using structured interviews (Myers, et al., 2002; Sussman, et al., 1987).

Anxiety Prevalence

Numerous studies have found elevated basal cortisol levels for adults who meet criteria for anxiety (panic disorder, generalized anxiety disorder and obsessive compulsive disorder) (S. Goldstein, et al., 1987; Kluge et al., 2007; Tafet et al., 2001). Because anxiety and depression are often comorbid mental illness, the data of Goldstein et al. (1987) were interesting because the authors suggested that at least one abnormality of the HPA axis found in subjects with panic disorder overlapped with the abnormality found in major depressive disorder (S. Goldstein, et al., 1987).

African-Americans reportedly have a higher prevalence of anxiety disorders compared to other populations, although limited studies have utilized minority populations (Bernal, et al., 2003). ECA analysis suggested that African-American women have a higher prevalence of generalized anxiety disorders (4.63%) than individuals who did not have panic disorder or major depression) compared to Caucasians (3.27%) and Hispanics (2.21%) women. Women under 30 years of age had the highest anxiety prevalence across all races in the ECA study. In this age range, African-American women had higher prevalence (8.24%) rates compared to Caucasians (3.14%) and Hispanic women (1.84%).

Additionally, African-Americans are three times more likely to have simple phobias than Caucasians as well as experience panic disorders more than other populations (Snowden, 1999). Karno (1987) reported that U.S. born Mexican American have lower rates of anxiety disorders than Caucasians. In general, there are far less data about anxiety in Hispanic populations. The

current study hopes to add to literature about Hispanic women and anxiety. This is particularly important to understand in pregnant women because of the impact of stress on the mother's well being and fetus' development.

Studies of Cortisol and Mood

Given the background definitions and prevalence data above, this section hopes to provide a brief review of empirical studies about cortisol and mood. Although there is not a widely agreed biological marker for mental disorders (Bernal, et al., 2003), the hypothalamic-pituitary-adrenal (HPA) axis, is a neuroendocrine system of great interest for the study of the relationship of stress and mental/physical health. Numerous studies have suggested that higher or increased cortisol levels are associated with stress and anxiety (Boulenger & Uhde, 1982; C. Kirschbaum & Hellhammer, 1994; Smith et al., 1990). Poor modulation of the HPA axis has been suggested to relate to alterations in mood (Goodyer, et al., 1996) and increased life, psychological, and occupational stress (C. Kirschbaum & Hellhammer, 1989). Some have reported that HPA axis hyperactivity depicts the most prominent neuroendocrine abnormality in major depression, occurring in 30-50% of patients with major depression (O'Toole & Johnson, 1997).

Increased secretion of cortisol in depression is widely held to be a central physiological response to psychosocial stress (Arborelius, Owens, Plotsky, & Nemeroff, 1999; Dinan, 1994). However, from reviewing many studies there has not been overwhelming empirical evidence to support this widely discussed positive correlation between cortisol concentration and stress. Overall, studies on cortisol and self-reported mood in healthy individuals have produced conflicting results (Brooks, 2000; Burton, Hinton, Neilson, & Beastall, 1996; Hjortskov, Garde,

Orbaek, & Hansen, 2004; Simpson et al., 2008). Some of the contrary findings can be attributed to methodological issues such as questionnaires with different psychometric properties or a mix of populations (age, clinical vs. non clinical, etc.). For instance, a recent study that examined stress, depressive symptoms, and HPA axis functioning in a group of female nursing students found a significant correlation between perceived stress scores and self-reported depression symptoms while participants separated by stress and depressive symptomatology (Brooks, 2000). More research needs to be done to disentangle results assessing different types of stress (e.g., acute, chronic, lab induced, naturally occuring) and measurement type (self-reported, biological basis).

Table 1 is a list of studies that have evaluated some component of the current research question. The primary inclusion criterion was that adult women were part of the study that related cortisol with stress (perceived stress, anxiety and/or depression) assessed via self-report measure or structured interview. Table 1 also highlights the different study methods utilized (e.g., area under the curve, single vs. multiple measures, baseline cortisol, etc.). It is hypothesized that such variations relate to inconsistencies on data relating cortisol and emotional distress (Vedhara et al., 2003). A majority (75%) did not find a correlation between cortisol and mood but some posited interesting characteristics of distressed participants.

One study (Study 5, Table 1) which included African-American pregnant women evaluated cortisol as an objective measure of stress while self-report measures were labeled as subjective measures of stress (Peoples, 1997). This study showed that pregnant women have higher urinary cortisol values than non-pregnant women. There were no differences in cortisol values of the Caucasian and African-American participants (Peoples, 1997). Additionally, the

study suggested that there were no differences in life events or anxiety scores of pregnant and non-pregnant women.

Although other studies in Table 1 did not find a relationship between cortisol and mood, the studies had other interesting findings. Peeters et al. (2003) suggested that in contrast to controls, depressed subjects do not have an increase in cortisol in response to daily stressors. Vedhara et al. (2003) suggested a non-linear relationship between diurnal change in cortisol levels and self-reported measures of stress and anxiety, but not depression. While (Strickland et al., 2002) suggested that depressed women categorized as low and high depression showed differences in cortisol concentrations – depressed women did not show diurnal changes in cortisol concentration while controls did. Of the studies in Table 1 that did find a relationship between mood and cortisol, both did not use salivary cortisol but instead hair or plasma cortisol (Kalra, et al., 2007; Tafet, et al., 2001).

The pattern of mixed results in mood and cortisol studies is evident in a recent review of 14 studies investigating the association between self-reported work-related mental distress and salivary cortisol. The review found that eight studies found no association, four studies found a positive association and 2 studies reported negative associations. This is a similar pattern with the studies in Table 1 in which a majority of studies did not find any correlation. It must be noted that they were a wide range of methods utilized and cortisol analysis techniques in the 14 studies reviewed. Additionally, many of the studies that found no association controlled for depression (Hjortskov, et al., 2004). Nonetheless, this review supports the opinion that the data about the relationship of self-reported stress and cortisol is an equivocal topic.

There have also been studies investigating ethnic differences in HPA functioning. One study attempting to find the difference between the HPA axis of obese and non-obese African-

American and Caucasian women found ethnicity differences although there were no correlation with their body mass index (Yanovski, Yanovski, Gold, & Chrousos, 1993). Specifically African-Americans had increased CRH-stimulated plasma ACTH concentrations. One study that did not find any correlation between the cortisol and self-reported depression or perceived stress suggested that Caucasians have a more robust HPA response to psychological stress than African-Americans. Robustness was defined as a higher mean ACTH (Chong, Uhart, McCaul, Johnson, & Wand, 2008).

Current Study Hypothesis

Based on the empirical studies reviewed, it was proposed that the current study would add to the understanding of the relationship of mood and cortisol in pregnant women. First, age will be a major factor to be considered, not just controlled for like other studies. Secondly, it is expecting that useful information will be uncovered when investigating somatic and cognitive related depression symptoms. Lastly, the current study should add to studies positing unique HPA activity in minority women. Based on the literature, the five primary hypothesis of the current study are as follows:

Hypothesis #1: Based on data about pregnant women and cortisol, it is essential to understand the cortisol trajectory across gestation. It is hypothesized that similar to other studies (Field, et al., 2004; Peoples, 1997; Simeonova, 2005), the salivary cortisol concentration of pregnant women will increase across gestation. For the current study, this will be evaluated by assessing if the salivary cortisol concentrations are higher in the third semester compared to the second trimester for the entire sample.

Hypothesis #2: Based on numerous theories about the positive correlation between mood and cortisol (Arborelius, et al., 1999; Goodyer, et al., 1996; C. Kirschbaum & Hellhammer, 1989), it is posited that there will be there will be a positive correlation between cortisol and scores on the four distress measures. Specifically, higher scores on the four distress measures assessing depression, anxiety, and perceived stress will correlate with higher salivary cortisol concentrations.

Hypothesis #3: When study participants are grouped into "no symptom" and "mild symptom and greater" groups according to published cut-offs or groupings of the respective self-report distress measure, there will be significant difference in salivary cortisol concentration between groups.

Hypothesis #4: This study will corroborate findings about anxious and depressed pregnant women (Evans, et al., 2008); the combination of high anxiety and high depression scores will be more strongly correlated with cortisol values than either high anxiety or depression alone for participants.

Hypothesis #5: Studies (Blazer, et al., 1994; Myers, et al., 2002; Robins, et al., 1991) have suggested that Hispanic non-pregnant women have higher depression prevalence and/or symptom endorsement than African-American women. For the current study, it is hypothesized that Hispanic pregnant women will have higher salivary cortisol values as than African-American pregnant women.

Hypothesis #6: It is hypothesized that somatic depression will be more strongly correlated with cortisol than cognitive depression based on the fact that the participants are both minority (Golding, et al., 1991; Roberts, 1992; Wohl, et al., 1997) and pregnant women (Mastorakos & Ilias, 2003) using the Beck Depression Inventory, 2nd Edition (BDI-II).

Method

Participants

Participants recruited during the first and second trimester of pregnancy from the Psychiatry Obstetrics Consultation/Liaison Service (Psych/OB) at Grady Memorial Hospital in Atlanta, Georgia. A total of 191 participated in the larger study larger National Institute of Health (NIH) study of maternal psychopathology and fetal and neonatal development. The current study sought to understand cortisol and self-reported distress among the African-American and Hispanic pregnant women. There was an inadequate representation of other ethnic groups to be included in the analysis. One hundred eighty four pregnant women (158 African-American women and 26 Hispanic women) agreed to participate and met the screening and inclusion criteria for the study. Women self-reported their demographic information (age, race, highest education level, yearly income, etc.) in Table 2.

All participants were at least 18 years of age and resided in the Atlanta, Georgia metropolitan region. Hispanic participants (age M=27.40, SD=6.66) were significantly older, t (28.364)=-3.535, p=<.01, than African-American participants (age M=22.49, SD=4.88). There were no significant differences between the two ethnic groups in terms of socioeconomic class, marital status and parity.

The sample was comprised of women whose socioeconomic class was lower to lower/middle income (30.9% and 38.8% respectively). About one-fifth of participant's socioeconomic class was middle income (18.49%) while remaining participants were upper-middle (4.89%) and upper income (1.63%).

Three-fourths of study participants were single (72.5%) women while 16.3% were partnered, 8.4% were married, and 1.2% were separated. There were a similar percentage of participants with children (50.6%) and those without; 24.5% of the women had one child before the start of the study.

Measures

Psychological Measures. Four self-report measures were used to assess depression, anxiety, and perceived stress among study participants. The instruments used in the current study included:

The Beck Depression Inventory-II (BDI; A.T. Beck, 1996) consists of 21 items scored on a four-point Likert scale, ranging from not present (0) to severe (3). Items address the presence or absence and severity of physical symptoms, behaviors, thoughts, and feelings associated with depression that the participant may have experienced in the last two weeks on persons 13 years of age and older. The BDI-II was specifically has previously been used to study the relationship of maternal depression and psychosocial stress during pregnancy (Seguin, Potvin, St-Denis, & Loiselle, 1995). Generally the psychometric properties of the BDI-II are quite sound with coefficient alpha estimates of reliability for outpatients of 0.92 and was 0.93 for the nonclinical sample. The one-week test-retest reliability coefficient was quite high at 0.93 (A.T. Beck, 1996; Grant et al., 2004). Scores of the BDI-II indicate the presence of symptoms are categorized as none (0-9), mild (10-19), moderate (20-29) and severe (30-39). For the current study, the BDI-II was further categorized into cognitive/affective symptoms and somatic symptoms based on established procedures of the larger study.

The Beck Anxiety Inventory (BAI; A.T. Beck, 1990) consists of 21 items scored on a four-point Likert scale that measures the severity of anxiety in adults and adolescents which are

minimally shared with those of depression. The BAI is scored on the same range as the BDI-II and therefore lends itself more easily to a comparison of the severity of anxious to depressive symptoms. The BAI has high reliabilities and coefficient alpha, typically above 0.90. Similarly, internal consistency reliability coefficients is excellent, ranging between 0.85 and 0.94 (D. Goldstein & McEwen, 2002). Scores of the BAI indicate the presence of symptoms are categorized as none (0-9), mild (10-19), moderate (20-29) and severe (30-39).

Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) is a 20 item screening tool for assessing clinically significant psychological distress experienced in the previous week. The CES-D items comprise six scales reflecting major depression namely depressive mood, feelings of guilt and worthlessness, psychomotor retardation, loss of appetite, and sleep disturbance. Internal consistency reliability ranges from 0.84 to 0.90. The CES-D has also been shown to be reliable measure for assessing number, type and duration of depressive symptoms across race, gender and age categories. The cutoff score of 16 or greater is suggestive of clinical depression.

The Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983) is a 14-item instrument that will be used to assess the degree to which mothers perceive their lives as burdensome, uncontrollable, and unpredictable. The Perceived Stress Scale is a global measure of perceived stress that assess the degree to which a person appraises their life as stressful (Cohen, et al., 1983; Cohen & Williamson, 1988) which has been validated on obstetric populations (Kalra, et al., 2007). The higher the degree and longer the duration of self-perceived stress, indicated by a higher score, is considered a risk factor for a clinical psychiatric disorder. It measures the degree to which situations in one's life over the past month are appraised as stressful. Items were designed to detect how unpredictable, uncontrollable, and overloaded

respondents find their lives. The reliability and validity are usually greater than 0.85. Cohen (1983) describes using the sample mean to suggest clinically significant groups (higher than the group mean).

Physiological Measures. At each visit, salivary cortisol was collected twice from each participant. Most women had fluid samples collected between 8:30 a.m. and 10:30 am. The collection procedure consisted of the mother placing a cotton swab in her mouth until it is saturated with saliva. The swab was then placed into a large syringe (without a needle) and the plunger was applied so that the salvia sample transferred from the cotton into a small specimen tube, which was then capped. Each sample was frozen at -20 degrees Celsius until it was assayed via high-pressure liquid chromatography with electrochemical detection. The salivary-cortisol level was assayed by using an enzyme immunoassay kit (Salimetrics, State College, PA) and analyzed with a Stat Fax 2100 microplate reader.

Study Design and Procedures

Participants were recruited from the Psychiatry Obstetrics Consultation/Liaison (Psych/OB) Service at Grady Memorial Hospital, a public hospital in Atlanta, Georgia. Written informed consent was obtained from participants before they began the study. For the current study, prenatal data was assessed for the ethnic groups with a significant number of participants, namely African-American and Hispanic participants. One hundred eighty four pregnant women (158 African-American women and 26 Hispanic women) were assessed at four time points: second trimester, (26-28 weeks gestation), third trimester (32-34 weeks of gestation), birth (40 weeks gestation, even in instances where the child was born prior to 40 weeks) and four weeks post birth (four weeks after 40 weeks gestation).

Pregnant women were eligible to participate if they have no medical condition other than a psychiatric diagnosis of Major Depressive Disorder (MDD). Additionally, women were eligible to participate if they were between the ages of 18-45 and the gestational age (determined via ultrasound examination) of her fetus at recruitment for the first visit was less than 26 weeks and less than 32 weeks for the second visit.

Women were excluded based on the following criteria: 1) they were carrying more than one fetus; 2) they smoked, drank alcohol, or used illicit drugs; 3) the fetus had serious abnormalities, as seen on an ultrasound exam; 4) the pregnancy had medical complications (e.g., maternal diabetes, hypertension, placenta previa); 5) the mother was prescribed medication other than prenatal vitamins or antidepressants; 6) the mother did not give birth at Grady Memorial Hospital; 7) the mother had a psychiatric condition such as bipolar disorder or schizophrenia; and lastly 8) the mother was not utilizing psychotherapy/counseling services.

Participants were assessed at four time points: second trimester, (26-28 weeks gestation), third trimester (32-34 weeks of gestation), birth (40 weeks gestation, even in instances where the child was born prior to 40 weeks) and four weeks post birth (four weeks after 40 weeks gestation). Study participants provided urine samples at each visit to determine the presence of several classes of illicit drugs including opioids, barbiturates, stimulants, and marijuana. All participants were paid between $25.00 to $35.00 per visit (depending on the length of the study protocol for the visit) plus a transportation subsidy ($2-$5).

During the two prenatal visits (second and third trimester visits), the cortisol samples were collected prior to (pre) and after (post) a fetal monitoring procedure associated with the larger study. At the post-natal visits (birth and four weeks after birth visits), the cortisol samples were collected prior to (pre) and after (post) questionnaires were completed by participants.

Henceforth, Pre and Post prefixes in front of the cortisol will refer to the timing of the cortisol samples relative to the fetal monitoring or questionnaires.

All participants were offered psychotherapy and/or told about pharmacological options based on results of structured interviews and diagnosis made by the licensed clinical psychologist and psychiatrist involved in the study. If the study staff was not deemed appropriate, women were referred to outside individuals/organizations for services.

Additional Methodological Considerations

Socioeconomic Status. Data for the National Comorbidity Study (NCS) suggest that rates of all disorders decline monotonically with income and education. There is also data from this study that points to the consistent tendency for socioeconomic status (SES) to be more powerfully related to anxiety disorders than to affective disorders (e.g., depression, bipolar I or II, etc.). The authors hypothesized this indicates that the resources associated with SES are more protective against the onset (and exacerbation) of worries and fears than of sadness (Kessler, McGonagle, Zhao, Nelson, & et al., 1994). Quite a few studies have suggested that adults of lower SES have higher cortisol secretion (Kapuku, Treiber, & Davis, 2002; Steptoe et al., 2003). One study of depression during pregnancy and postpartum suggest the prevalence of depression in a sample of economically impoverished women to be twice that of middle class pregnant women (Hobfoll, Ritter, Lavin, Hulsizer, & Cameron, 1995). Moreover, this study and others have specifically suggested that low SES is a major risk factor for depression (Belle, 1990; Bruce, Takeuchi, & Leaf, 1991; Hobfoll, et al., 1995; Riolo, Nguyen, Greden, & King, 2005).

For the current study the Hollingshead Four-Factor Index of Social Status (Hollingshed; Hollingshed, 1975) will be utilized. The Hollingshead is a scale that determines SES by weighting a subjects occupation and education and coming up with a composite number that

categories individuals in one of five SES ranges. Hollingshead criteria was used to categorize participants in the following social status classes: lower (1), lower-middle (2), middle (3), upper middle (4) and upper (5).

Utilizing Self-Report Measures

The current study is focused on using self-reported measures of stress to better understand its relationship with salivary cortisol. Although using self-report questionnaires are more time efficient, some have posited that specificity is lost when comparing it to structured interviews (Evans, et al., 2008). However, Meehl (1945) encourages those who are concerned about mistaking self-rating questionnaires as a surrogate for behavior to consider a different viewpoint. Specifically, the answers of individuals who endorse items should be viewed as the way participants, in our case African-American and Hispanic pregnant women, respond to certain items versus if they truly represent core features of a particular mental illness as defined by the Diagnostic Statistical Manual of Mental Disorders IV-TR for example (American Psychiatric Association, 2000). Hence, self-reports could be particularly valuable for diagnostic purposes, but must clearly be understood and accurately interpreted in relation to core symptoms.

Results

Demographics information for all 184 participants is summarized in Table 2 including age, marital status, parity, and socioeconomic class. The mean participant age was 23.19 years old (SD=5.375). The majority of participants were African-American (85.9%), had no children prior the study, and were in the lower-middle socioeconomic class (using Hollingshead's scale).

Due to the statistically significant (p=0.001) age difference between Hispanic (M=22.49, SD=4.88) and African-American (M=27.40, SD 6.66) women, supplemental analysis was completed using an age matched sub-sample. The sub-sample was matched on age and

socioeconomic status. There was not a significant difference with age or socioeconomic status between African-American and Hispanic women within the sub-sample. The age matched sub-sample consisted of twenty-six African-American (age M=26.15, SD=6.16) and twenty-six Hispanic (age M=27.40, SD=6.66) women as detailed in Table 2. Within the sub-sample, more Hispanic women were married or in long term partnered (85.7%) relationships compared to African-American women. Additionally, there was a significant difference of parity for African-American women (median=0) and Hispanic Women (median= 1).

Self-Reported Distress Measures

Table 3 lists the descriptive information of participants on the self-reported distress (e.g., depression, anxiety, perceived stress) questionnaires within the age-matched sub-sample. Results revealed that endorsements on the Perceived Stress Scale (PSS) suggested that there were ethnic differences in perceived stress at the third trimester, t (38) =4.065, p=<.01, and birth, t(24) =3.049, p=<.01, while there was a trend at the second trimester, t(43) =1.896, p=0.065. Perceived stress scores at the third trimester and at birth were higher for African-American women than Hispanic women, while at birth scores were trending towards being higher for African-Americans.

Results on depression symptomatology assessed on the Center for Epidemiologic Studies Depression Scale (CES-D) revealed that African-American participants endorsed statistically significant higher depression scores, t(22)=2.354, p<0.05, at birth and trended towards higher CES-D scores at the third trimester, t(40)=1.771, p=0.084. Results on depression symptomatology assessed on the Beck Depression Inventory II (BDI-II) scores revealed a trend towards African-American participants having higher depression scores than Hispanic participants at 4 weeks post birth, t(15.23)=2.085 , p=0.054.

Results revealed that there were no statistically significant differences in total endorsements of anxiety symptomatology assessed by the Beck Anxiety Inventory (BAI) between African-American and Hispanic participants. There was a trend towards at four weeks post birth, $t(17.38)=1.869$, $p=0.079$ suggesting that African-Americans were close to having significantly higher anxiety than Hispanic participants.

Cortisol Analysis

Table 4 details the cortisol concentrations across study time points for the entire sample as well as the age matched sub-sample. In the entire and age matched sub-sample, violations of normality were observed. Consequently, cortisol concentrations were transformed by removing outliers. Across the entire sample there was one significant difference, $t(60)=4.150$, $p<0.001$, between salivary cortisol concentrations taken prior and after that lab task; cortisol concentrations were higher prior to the lab task. Within the age matched sub-sample, there were no statistically significant trends. However, there were results that were approaching significance at the third trimester, suggesting that Hispanic participants had higher salivary cortisol concentrations than African-American participants, $t(33)=-1.687$, $p=0.101$, prior to the lab task as well as after the lab task, $t(32)=-1.835$, $p=0.076$. Additionally, result that were approaching significance suggests that African-American participants were close to having higher salivary cortisol concentrations after the lab task, $t(25)=1.841$, $p=0.078$, four weeks after the birth of their children.

The mean salivary cortisol collection times are specified in Table 6 for each time point. For both the entire sample and age matched subset, there were no differences by race in the time of the day of the cortisol analysis.

Hypothesis 1

For the entire sample, paired t-test revealed that there was a statistically significant difference in the salivary cortisol concentrations across gestation. Specifically, within the entire sample, pregnant women had higher salivary cortisol concentrations at the third trimester compared to the second trimester prior to the lab task, $t(26)=-3.398$, $p=0.02$, and after the lab task, $t(20)=3.246$, $p=0.004$.

Hypothesis 2

Pearson partial correlations were conducted to assess the relationship between cortisol concentration and self-reported distress for the entire sample and age matched sample, controlling for collection time of cortisol assessment time. For the entire sample, there were notable significant correlations at the third trimester and four weeks post birth. Specifically, at the third trimester, CES-D scores were significantly correlated, $r(59)=0.287$, $p<0.05$, with pre (lab-task) cortisol concentration and there was a trend for BAI, $r(59)=0.216$, $p=0.095$, and cortisol concentrations. Four weeks post birth, there were significant correlations for cortisol concentration and three self-report measures after the lab task, BDI-II, $r(41)=0.398$, $p<0.01$; BAI, $r(41)=0.302$, $p<0.05$; and PSS, $r(41)=0.330$, $p<0.05$. In all instances, higher scores on the self-reported distress measures were associated with higher cortisol concentrations.

For the age-matched sample, there were significant correlations between salivary cortisol and self-reported distress at the second trimester, birth, and four week after birth during the period prior to the lab task and after the lab task. See Table 5 for a full listing of the cortisol and distress measure correlations for the age matched sub sample. Results prior the lab task will be discussed herein. In the second trimester, salivary cortisol was significantly correlated with BDI-II scores, $r(26)=-0.477$, $p<0.01$, higher salivary cortisol scores were associated with lower BDI-II scores. Correlations between other measures, the CES-D and the PSS, were close to

approaching significance ($p<0.10$) during the second trimester. At birth, there was one significant correlation, higher BAI scores were associated with higher cortisol concentrations, $r(9)=0.777$, $p<0.01$; BDI-II were close to approaching a significant correlation with the cortisol concentration. At four weeks after birth, there were two significant correlations suggesting that high salivary cortisol concentrations were associated with higher scores on the BDI-II, $r(6)=0.912$, $p<0.01$ and CES-D, $r(6)=0.736$, $p<0.05$. Notably, there were no significant correlations or those approaching significance at the third trimester.

At birth, there was one significant correlation, higher BDI-II scores were associated with higher pre cortisol concentrations, $r(16)=0.668$, $p<0.025$. At 4 weeks post birth, there were three significant correlations indicating that high pre cortisol concentrations were associated with higher scores on three self-reported distress measures, BDI-II, $r(16)=0.533$, $p<0.025$; BAI, $r(16)=0.574$, $p<0.05$; and CES-D, $r(16)=0.648$, $p<0.01$.

Hypothesis 3

This hypothesis was analyzed using the age matched sub-sample to assess if there were differences in cortisol concentrations when splitting participants according to published cut-offs for each distress measure. BDI-II, BAI and CES-D cutoffs were determined with published cut-offs (BDI-II>19, BAI>19, CES-D>16) while PSS cut-offs was based on the sub-sample mean score (A.T. Beck, 1990, 1996; Cohen & Williamson, 1988). Published cut-offs are not significant for diagnosis but are an indicator that mental health professionals should follow-up () to see if diagnostic criteria is met. There were no significant findings. There were two significant trends relating cortisol concentration. At the second trimester pre cortisol concentrations were approaching statistically significance for being higher, $t(35)=1.986$, $p=0.055$, for women with lower BDI-II depression scores. The second trend, at the third

trimester, suggested that pre cortisol concentrations were close to being significantly higher, $t(33)=1.880$, $p=0.069$, for women with lower BDI-II depression scores.

Hypothesis 4

There were no significant differences in cortisol for women who had both high anxiety and high depression (as defined according to published cutoffs) according to the BDI-II and BAI versus women who had either high anxiety or high depression.

Hypothesis 5

There were no significant ethnicity differences in BDI-II somatic and cognitive symptoms using a non-parametric test, Mann-Whitney, since the distribution had high kurtosis. Although there were no significant differences, there were two trends that were approaching statistical significance. Both trends involved African-American women who endorsed more BDI-II cognitive/affective symptoms than Hispanic women at both the second trimester, $U(25)=231$, $z=-1.775$, $p=0.076$, and the third trimester, $U(21)=150$, $z=-1.780$,.

Discussion

The current study had two overarching goals. The first goal was to explore the relationship between salivary cortisol concentration and self-reported distress in a sample of pregnant African-American and Hispanic women. The second goal was to determine if there were ethnic differences in cortisol concentrations and/or self-reported psychological distress between the two ethnic groups. The study employed a longitudinal design with two prenatal and two postnatal assessment time points. Important components of the current study included analysis on all 184 pregnant women as well as an age-matched sub sample of 52 women (26 African-American and 26 Hispanic pregnant women).

Results corroborated previous findings showing that cortisol concentration increases across gestation, peaking at the third trimester and dramatically declining after birth (Allolio, et al., 1990; Field, et al., 2009; Harville, et al., 2007; Mastorakos & Ilias, 2003; Simeonova, 2005). The current study revealed maternal salivary cortisol trajectory in an understudied population of Hispanic and African-American pregnant women.

The strongest relationship between salivary cortisol and self-report stress was observed at four weeks post birth. Partially supporting the study hypothesis, the current study revealed a strong positive relationship between salivary cortisol and psychological distress. There were positive relationships between salivary cortisol concentration and psychological distress measures assessing anxiety, depression, and perceived stress. The positive correlation between cortisol and self-reported measures of depression and anxiety was revealed in the entire sample and the age-matched sub sample. Within the age-matched sub sample, depression was also positively associated with cortisol concentrations at birth.

There was also modest statistical support for a positive relationship between salivary cortisol concentrations and self-reported psychological distress symptoms during pregnancy. Specifically at the third trimester, depression self-report ratings were positively associated with salivary cortisol concentration for the entire sample. Additionally, there was a trend in the entire sample suggesting that anxiety ratings were positively related to salivary cortisol. These third trimester findings revealed in the larger sample were not replicated in the age matched sub-sample. There also was not a relationship between cortisol and self-reported stress revealed during the first trimester for the entire sample or sub-sample. One reason for the lack of significant findings during the second trimester of pregnancy could have to do with less stressful thoughts/behaviors for women, compared to the third trimester and beyond. At the third

trimester there are more physical demands and changes in work situations for women. After birth, there is stress associated with caring for a newborn. More data is needed from other studies to determine if these were spurious findings or if these findings represent a reliable phenomenon. Notably, there were no significant findings for prenatal maternal distress during the second trimester.

Positive cortisol and self-reported distress relationships in the current study are supported by studies with non-pregnant and pregnant samples. Those findings suggest that women endorsing more psychological distress have increased cortisol concentration (Field, et al., 2009; Kalra, et al., 2007; Peoples, 1997; Tafet, et al., 2001). However, it is difficult to reconcile these positive findings with studies that suggested that there was not a relationship with cortisol concentration and self-reported distress in pregnant women and non-pregnant women (Peeters, et al., 2003; Peoples, 1997; Simeonova, 2005; Strickland, et al., 2002; Vedhara, et al., 2003). There were no glaring differences (i.e., methods, inclusion criteria, results analysis) between studies that had positive findings and those with negative or no relationship.

The current study is the only one that assessed salivary cortisol in pregnant women while the others assessed urinary or hair cortisol (Field, et al., 2009; Kalra, et al., 2007; Peoples, 1997; Simeonova, 2005). There were also methodological differences when comparing the current study with others comparing self-reported and physiological distress. One study, which did not find any relationships, only included participants if they self-identified as depressed which may have limited the range of different self-reporting behaviors investigated (Simeonova, 2005).

Similar to the current study, another longitudinal study assessed women prenatally (second and third trimester) and postnatally with the CES-D (Field, et al., 2009) . The Field (2009) study however, found more significant positive relationships between cortisol and self-

reported depression criteria at more time points than the current study. The most striking difference between this study and the other longitudinal study discuss, was the previous study only included women who met diagnostic criteria for depression using structured interviews versus the current study which utilized self-report measures (Field, et al., 2009). Additionally, studies highlighted the difference in categorizing mental disorders with structured interviews versus self-reported distress in a diverse sample of women (Myers, et al., 2002).

The current study utilized both the BDI-II and CES-D. The BDI-II was initially intended as a measure of depressive severity for individuals already diagnosed as clinically depressed (A. T. Beck & Steer, 1993) and the CES-D was initially intended as a measure of depressive severity for adults in the general population (Radloff, 1977). Another difference between the two scales is that the CES-D emphasizes the affective component of depression (Radloff, 1977, 1991), whereas the BDI-II has a much stronger cognitive component (Beck et al., 1961, 1979). Future analysis should better discern if there are certain aspects of measures (e.g., physiological symptoms, somatic symptoms) and ultimately the intended construct, which better correlates with salivary cortisol. Some exploratory analysis revealed that there was not a correlation with either cognitive or somatic symptoms of depression in the participants and salivary cortisol concentration.

For future research studies, it would help researchers know which outcome measure of physiological stress to include depending on the type of stress is being evaluated. For example, would it be better to include plasma or salivary cortisol in a study attempting to understand cognitions associated with distress in a cognitive behavioral depression study? In a clinical setting, it might be helpful to understand when a patient reports somatic complaints, whether state or trait symptoms of anxiety should be followed up on. In the future, it is also important to

be able to distinguish psychological and physiological distress profiles in both clinical and non-clinical populations.

Similar to depression questionnaire findings, Field (2009) also revealed positive relationships between cortisol and anxiety symptom ratings at more time points than the current study. Additionally, the Field (2009) used a state-trait anxiety (STAI) measure while the current study used Beck's (1990) anxiety measure (BAI). Some have highlighted that the BAI and STAI are moderately (0.56 to 0.68 depending on the STAI scale) correlated. However, it has also been suggested that the BAI and STAI have different factor loadings measuring separate, although not necessarily independent, constructs (Creamer et al, 1995).

Creamer et al. (1995) further suggest that the BAI is great at differentiating anxiety from depression but is probably a better measure of state versus trait a stable personality characteristic/trait (Creamer, et al., 1995). Most importantly Creamer et al. (1995) hypothesized that the profile of factor loading is expected to be different between clinical and normal populations. The difference between the aspects of anxiety tapped by the BAI versus the STAI could have been one difference that led to different findings between the current study and the Field (2009) study. Interestingly, the Peoples (1997) study found that it was trait anxiety versus state anxiety which was positively correlated with urinary cortisol. More studies with similar methods are needed to reconcile the findings.

The finding that higher salivary cortisol concentrations for women who postnatally endorsed more anxiety, depression, and perceived stress symptoms lends further support to the widely hypothesized relationship between psychological stress and HPA axis dysregulation in non-pregnant women. Regarding pregnancy, the overall pattern of findings from the current study suggests a pattern of a positive relationship between salivary cortisol and self-reported

psychological distress after birth for the study participants. Contrary to the study hypothesis, there were not overwhelming findings supporting a positive relationship between salivary cortisol and self-reported distress during pregnancy.

Findings may have mirrored others if the time point after birth was not included. Most other studies that evaluated the same relationship did not include the time after birth. Secondly, there could be a differential stress response during pregnancy versus after birth. For example estrogen, which increases during pregnancy, may directly regulate the expression of the human CRH gene (as cited in Mastorakos & Ilias, 2003, Vamvakopoulos et al., 1993). It is further hypothesized that saliva is uniquely different than in blood or plasma cortisol in the impact and body and consequent evaluation as an indication of physiologic stress response.

The second overarching goal of the current study was to assess if there were ethnic differences in salivary cortisol and psychological distress symptom reporting. We did not find ethnic differences in salivary cortisol concentrations, similar to previous studies assessing ethnic differences in stress hormones (Allolio, et al., 1990; Mastorakos & Ilias, 2003; Yanovski, et al., 1993). Studies that did reveal a difference in physiological and psychological distress along ethnic lines, evaluated the stress hormone, ACTH, although there were mixed information on the direction of the relationship (Glynn, et al., 2007; Yanovski, et al., 1993). It is important to understand if there are definitive ethnic differences in physiological stress reactivity of specific stress hormones. In pregnant women, understanding the hormone type and specific aspect of psychological distress might add to the understanding of negative birth outcomes which have a higher incidence in African-American and Hispanic populations (Emory & Dieter, 2006; Singer, Davillier, Bruening, Hawkins, & Yamashita, 1996).

Despite the lack of ethnic differences in physiological distress, data from the current study revealed ethnic differences in distress symptom reporting. Within the age matched sample, African-American pregnant women endorsed significantly more perceived stress items prenatally and at birth; depression symptoms prenatally and at birth; and anxiety four weeks at birth than Hispanic pregnant women. African-American women endorsement of higher distress symptoms across multiple measures suggests a qualitatively different pattern than Hispanic pregnant women in the study despite no observed difference in physiological stress which supports previous studies (Myers, et al., 2002). Better understanding ethnic differences in qualitative reporting of distress might help identify mechanisms (social support, mother-fetal attachment, nutrition) that relate to self-reported distress and eventual fetal outcomes, especially negative outcomes for children.

A previous study revealed ethnic differences in depression self-report symptoms while there were no ethnic differences in clinical depression assessed via structured interviews (Myers, et al., 2002). Ethnic differences in self-reporting of depression might suggest differences in sub-threshold of depression. Future studies should corroborate and elaborate on ethnic differences in self-reported distress. Understanding more about factors contributing to African-American endorsing higher depression could help understand why this population has the highest rates infant mortality and morbidity (Reddy, Ko, Raju, & Willinger, 2009; Singer, et al., 1996). Exploratory analysis revealed a trend of African-American women endorsing more somatic and cognitive affective depression symptoms than Hispanic women. We suggest that if there were a larger sample of women within each ethnic group, there may have been more conclusive findings.

Investigations of diverse ethnic groups might be able to clarify if race is a distinguishing variable of stress reactivity variation in women or if some other psychosocial factors or environmental context better distinguishes stress reactivity. More Hispanic women in the current study had a spouse/partner compared to African-American, which could have contributed to better coping, increased social support, and decreased stress from financial strain (Singer, et al., 1996). Future analysis should directly look at coping as a mediator or explanatory variable. It is posited that for the Hispanic women in this study, spousal partner might be a protective factor. Published research has suggested that low partner support is a risk factor for antenatal depression (Milgrom, et al., 2008). Lack of spousal or partner support could also be an explanatory factor for African-American women having higher scores on self-reported distress compared to Hispanic women.

Additionally social support, prior depression diagnosis, and sleep quality have been associated with depression symptomatology during pregnancy (Milgrom, et al., 2008; Skouteris, et al., 2009). The larger scale study collected many other psychosocial factor variables which were not included in the current analysis. Future studies should include pertinent variables as mediators or moderators. More detailed information on mechanisms that explain stress reactivity predisposition and expression may also help tailor psychological interventions targeted at pregnant women with higher incidence of negative child outcomes such as low birth weight (Singer, et al., 1996).

It is particularly important to understand the behavior of pregnant women as expressed on self-report measures versus structured interviews. This also becomes especially significant because self-report measures might be more readily utilized in clinical (versus research) settings. However, there are disadvantages to using self-report measures, especially as a screening tool

(Milgrom, 2008 and Skouteris, 2008). Similar to other studies it would be advantageous to include how structured interview delineations of psychopathology relate to stress indicated by physiological measures.

There were not prenatal ethnic differences in self-reported distress or salivary cortisol concentrations when women were grouped into high and low distress groups, which did not support the current study hypothesis. The lack of significant results could have been impacted by the low sample size in each group. Low sample size did not enable the postnatal comparison of low and high distress groups and salivary cortisol concentration. If there were a larger sample size, it is expected that postnatal results would mirror the positive relationship between salivary cortisol and self-reported distress after birth. We would expect women categorized in high distress groups via self-report measures would have higher salivary cortisol concentrations.

One shortcoming of the current study was the fact that the prenatal lab task included fetal heart rate monitoring which was omitted at the birth and at four weeks post birth time points. It is unclear how the fetal heart rate monitoring may have increased a mother's stress prenatally. For the future, similar lab task and procedures should be administered prenatally and postnatally.

Another shortcoming of the current study was there was missing parity and marital status date among women within the age matched control comparison. Having less missing data could have better controlled for psychosocial differences among the African-American and Hispanic women investigated. A small sample of Hispanic women, in comparison to African-American women also limited the effect size of the current study findings.

An additional consideration is that many of the Hispanic women utilized an interpreter for study procedures. Although the Spanish versions of a majority of the self-report measures were utilized, numerous study participants posed questions that might have reflected language

translation difficulty. It is possible that the Hispanic women could have been trying more to impress the study administrators and less likely to endorse distress items. Notably, many of the Hispanic women in the study were Spanish speaking. The results might be different for Hispanic pregnant women who speak English and have lived in the United States for many years versus those that just immigrated and are fluent in a non-English language. Data suggest that reported depression rates are less in Hispanic immigrants compared to Hispanics who have lived in the United States for a significant amount of time (Grant, et al., 2004).

Based on the current study, there are numerous suggestions for future researchers of the physiological and psychological distress indicators in pregnant women. First, studies should be repeated to insure that the findings have good validity, especially conclusion and external validity. There are limits to the generalizability of results to the United States population at large. The sample was comprised of pregnant women mainly of low socioeconomic status who utilized a public hospital in the southeastern United States for their prenatal visits and birth. If women of higher socioeconomic status were included in the current study, it is expected that the self-reported stress and salivary cortisol relationship would remain the same. However, if women were match on various psychosocial variables are comparable, it is expected that women of higher socioeconomic status would report significantly lower physiological and psychological stress.

Future studies should consider using different measures or interpretation techniques when investigating the relationship of self-reported stress to physiological distress in pregnant women. For example, anxiety during pregnancy has been posited to be a distinctively different phenomena than anxiety in non-pregnant samples (Clemens Kirschbaum, Tietze, Skoluda, & Dettenborn, 2009). Future research should consider using a pregnancy anxiety measure which

includes pregnancy specific items (e.g., anxiety about pregnancy, childbirth, and hospitalization) (Huizink, Mulder, Robles de Medina, Visser, & Buitelaar, 2004; Levin, 1991).

Research suggest that published BDI-II cutoff scores may fail to identify urban African-American women with depression (Chaudron et al., 2010). It has been suggested that the optimal BDI-II scores for urban mothers should be lower than published cutoff which are more likely correlate to categorization using structured interviews like SCID (Chaudron, et al., 2010). Lastly, hair cortisol can be considered as a retrospective calendar of cortisol production (Clemens Kirschbaum, et al., 2009). Using hair cortisol could be a cost and labor efficient way of assessing longitudinal hormonal changes by requiring women to visit the study setting less.

Overall, the current investigation made a significant impact to research on behavioral and physiological indicators of stress reactivity. From a theoretical standpoint, it bolstered maternal cortisol trajectory findings by notably demonstrating the trajectory in a sample of African-American and Hispanic pregnant women. It also added empirical evidence to the widely touted relationship of physiological and psychological distress, most prominent postnatally in the current study.

By comparing two minority subgroups, there were strong suggestions that psychosocial factors such as social support are critical in understand stress reactivity. Conversely, there was not empirical data from the current study to suggest ethnic differences in physiologically or psychologically distress. Race may potentially serve as a proxy for psychosocial or other neurodevelopment factors that can be operationalized. More importantly, psychosocial factors might be critical to understanding the disproportionate incidence of negative birth outcomes (e.g., low birth weight, birth complications, and postpartum development) in minority women. Our study also highlighted the need for studies of psychological and physiological distress to

include minority groups with significant sample size to make highly powered conclusions. Overall, the current study has implications to scientific study as well as well-established public health concerns of low birth weight and preterm deliveries rates which disproportionately occur in non-Caucasian populations in the United States.

Table 1

Studies on the Relationship of Self-Reported Distress Measures and Cortisol In Pregnant Women

Study	ID #	Population	Location	Measure	Cortisol Assessment Technique	Results	Cortisol/ & Mood Corr
Furlan et al. (2005)	1	N=19, women aged 52-79 assessed for bone mineral density	Pennsylvania, USA	Depression Symptoms (SCID, BAI, BDI)	Salivary Cortisol AUC	No significant difference in depression between groups based on depression history (from stressor task or and increase from baseline cortisol analysis) in response to lab induced speech task	No
Vedhara et al (2003)	2	N=54, women assessed for breast cancer	Bristol, UK	Depression Symptoms (PSS, HAD)	Salivary Cortisol (Abs & Rate of Chg)	No significant relationship with absolute cortisol levels and distress measures; Small significant effect of rate of change and the PSS and anxiety on the HAD)	No
Kalra et al. (2007)	3	N=25, preg women aged 18-45	Toronto, Canada	Stress Symptoms (PSS)	Hair Cortisol, absolute	Hair cortisol positively correlated with PSS scores for non-depressed participants	Yes
Tafet et al (2001)	4	N total =28, 12 males and 18 females age 36-60	Buenos Aires, Argentina	Depression Symptoms (SCID)	Plasma Cortisol, absolute	Significant increase in afternoon plasma cortisol for those with generalized anxiety & major depressive disorder compared to controls. No significant findings for morning plasma cortisol.	Yes
Peoples (1997)	5	N=60, Caucasian (N=30) & Black(N=30); preg (N=34) & non-preg (N=26) women	Georgia, USA	Stress and Anxiety Symptoms (LES, STAI)	Urinary Cortisol, absolute	No significant relationship between urinary cortisol and stae anxiety distress measures for pregnant and non-pregnant women. Positive relationship between trait anxiety and cortisol for pregnant women.	Yes
Strickland et al. (2002)	6	N= 437 women (94 depressed; 166 vulnerable to depression; 177 controls)	Manchester, UK	Depression Symptoms and Vulnerability (ICD-10, DSM-IV, LEDS, HRQ)	morning & evening absolute & diurnal chg in salivary cortisol	Depressed women did not have diurnal change in cortisol concentration; controls had an diurnal increase from morning to afternoon. No difference in cortisol concentration for depressed group & controls. For all, life events associated with diurnal increase in cortisol concentrations.	No
Peters et al. (2003)	7	N=84, depressed and non-depressed men and women	Maastricht, Netherlands	Major depression (SCID, HDRS, SCL-90, BDI)	Salivary Cortisol, baseline and diurnal	Depressed & controls did not differ in basal cortisol elevation. No gender differences in basal cortisol. Depressed participants did not show an increase in cortisol after negative events.	No
Simeonova (2005)	8	N=85, Caucasian (N=60) & Black (N=25) depressed preg women	Georgia, USA	Depression (BDI, SCID), Anxiety (STAI) and Stress Symptoms	Urinary Cortisol	Gestational age was not correlated with cortisol, no correlation between mood (depression, anxiety and stress) and cortisol	No
Fields et al. (2009)	9	N=336 Black preg women, depressed (n=205) and non-depressed (n=131)	Large US University	Depression (SCID, CES-D), Anxiety (STAI), Daily Hassles	Urinary Cortisol	Depressed women had higher anxiety, anger, daily hassles, sleep disturbance scores at prenatal and postnatal visit. Depressed women had higher cortisol levels at the 2nd prenatal visit.	Yes

Measures: ICD-10: International Classification of Diseases (Fritz, 2000), SCID: Structured Clinical Interview for DSM-IV (Littleton, Breitkopf, & Berenson, 2007), BDI: Beck Depression Inventory (A.T. Beck, 1996), BAI: Beck Anxiety Inventory (A.T. Beck, 1990), CES-D: Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) , PSS: Perceived Stress Scale (Cohen, et al., 1983), HAD-S: Hospital Anxiety and Depression Scale (van Bussel, Spitz, & Demyttenaere, 2009), LES: Life Experiences Survey (Stowe & Nemeroff, 1995), STAI: State-Trait Anxiety Inventory for Adults (O'Hara & Swain, 1996), SCAN: Schedules for Clinical Assessment in Neuropsychiatry (van Gülick-Bailer, Maurer, & Häfner, 1995), HRQ: Health and Relationships Questionnaire (A. T. Beck & Steer, 1993), LEDS: Life Event and Difficulty Scale (A. T. Beck & Steer, 1993) , SESS: Self Evaluation and Social Support Scale (Singer, et al., 1996); DSM-IV: Diagnostic and Statistical Manual of Mental Disorders (4th edition) (Association, 2000); HDRS: Hamilton Depression Rating Scale (Chapman, Williams, Mast, & Woodruff-Borden, 2009); SCL-90: Symptom Check List (Riecher-Rossler & Steiner, 2005)

Cortisol Assessment and Other Abbreviations: AUC (Area under the curve), Chg (Change), Abs (Absolute), Cort (Cortisol), Corr (Correlation), Preg (Pregnant)

Table 2

Demographics for Entire Sample (N=184)

Variable	All (N=191)	African-American (N=158)	Hispanic (N=26)	
Age, Mean(SD)	23.19 (5.375)	22.49 (4.88)	27.40 (6.66)	**
Number of Children, Median (Range)	0 (0-6)	0 (0-6)	1 (0-4)	
Hollingshead SES Class, Median (Range)	2 (1-5)	2 (1-5)	2 (1-4)	
Marital Status				
Single/Separated	74.1	84.0	14.3	
Married/Partnered	25.9	16.0	85.7	

Age-Matched Demographics (N=52)

Variable	African-American (N=26)	Hispanic (N=26)	
Age, Mean(SD)	26.15 (6.162)	27.40 (6.66)	
Number of Children, Median (Range)	0 (0-2)	1 (0-4)	*
Hollingshead SES Class, Median (Range)	2 (1-5)	2 (1-4)	
Marital Status			
Single/Separated	60	14.3	*
Married/Partnered	40	85.7	

Note: Hollingshead SES Class: 1=Lower, 2=Lower-Middle, 3=Middle , 4=Upper-Middle , 5=Upper; Standard Deviation (SD) or Median are reported based on the appropriate scale of measurement

*Significant ethnicity difference, $p < 0.05$

**Significant ethnicity difference, $p<0.01$

Table 3

Self-Reported Distress Measure Means and Standard Deviations, Matched Age Sample

	Race		African-American (N=26)		Hispanic (N=26)	
			Mean	SD	Mean	SD
2nd Trimester	BDI-II		17.35	9.96	13.73	10.43
	BAI		13.35	9.53	11.28	11.38
	CES-D		18.69	10.34	16.74	11.43
	PSS	*	25.04	9.11	19.86	9.20
3rd Trimester	BDI-II		12.00	7.69	10.48	8.25
	BAI		11.76	8.51	8.67	8.59
	CES-D	*	15.33	8.49	10.86	7.88
	PSS	***	26.67	9.26	16.74	5.51
Birth	BDI-II		6.73	6.46	5.79	4.19
	BAI		7.94	8.62	8.00	5.56
	CES-D	**	12.81	10.28	6.08	4.54
	PSS	***	25.33	9.40	15.73	5.24
Post Birth	BDI-II	*	10.86	11.62	4.10	2.92
	BAI	*	9.79	10.83	3.90	3.93
	CES-D		14.64	12.97	10.67	5.41
	PSS		18.60	14.32	17.00	6.02

Note: 2nd Trimester=26-28 weeks gestation, 3rd Trimester=32-34 weeks gestation, Birth=40 weeks gestation, Post-Birth=4 weeks after conception; BDI-II: Beck Depression Inventory (Beck, 1996), BAI: Beck Anxiety Inventory (Beck, 1990), PSS: Perceived Stress Scale (Cohen, et al., 1983), CESD: Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977)

*Significant difference between ethnicity, $p < 0.10$

**Significant difference between ethnicity, $p < 0.05$

***Significant difference between ethnicity, $p<0.01$

Table 4

Cortisol concentration (nmol/L) across time points

All Women

Time Point	*Prior to lab task*	*Post lab task*	p value
2nd Trimester	7.55	6.96	
3rd Trimester	10.22	9.50	
Birth	7.98	7.97	
Post Birth	6.04	3.44	***

Sub-Sample

	Prior to lab task			*Post lab task*		
	African-American	Hispanic	p value	African-American	Hispanic	p value
2nd Trimester	7.08	8.10		6.79	7.14	
3rd Trimester	8.70	12.23	*	7.07	10.47	*
Birth	6.41	6.27		6.22	4.50	
Post Birth	7.30	5.50		4.62	2.67	*

Note. *=$p < 0.10$, **=$p<0.05$, ***=$p<0.01$

Table 5

Pearson partial correlations between salivary cortisol concentrations and self-report measures within the age matched sub-sample; controlling for sample time

Second trimester

	Pre-Lab Task				
	Cort	BDI-II	BAI	CES-D	PSS
Cort	1.000				
BDI-II	-.477 ***	1.000			
BAI	-.103	.345 *	1.000		
CES-D	-.338 *	.738 ***	.538 ***	1.000	
PSS	-.358 *	.752 ***	.468 ***	.605 ***	1.000

	Post-Lab Task				
	Cort	BDI-II	BAI	CES-D	PSS
Cort	1.000				
BDI-II	-.366 **	1.000			
BAI	-.190	.542 ***	1.000		
CES-D	-.330 *	.806 ***	.613 ***	1.000	
PSS	-.252	.771 ***	.543 ***	.666 ***	1.000

Third trimester

	Cort	BDI-II	BAI	CES-D	PSS
Cort	1.000				
BDI-II	-.206	1.000			
BAI	-.039	.079	1.000		
CES-D	-.015	.536 **	.317	1.000	
PSS	-.245	.135	.199	.462 **	1.000

	Cort	BDI-II	BAI	CES-D	PSS
Cort	1.000				
BDI-II	-.267	1.000			
BAI	.053	.044	1.000		
CES-D	.103	.496 **	.282	1.000	
PSS	-.106	.081	.161	.354	1.000

Birth

	Cort	BDI-II	BAI	CES-D	PSS
Cort	1.000				
BDI-II	.597 *	1.000			
BAI	.777 ***	.880 ***	1.000		
CES-D	.408	.698 **	.774 ***	1.000	
PSS	.405	.570 *	.545 *	.830 ***	1.000

	Cort	BDI-II	BAI	CES-D	PSS
Cort	1.000				
BDI-II	.194	1.000			
BAI	.481	.847 ***	1.000		
CES-D	-.583 *	-.020	-.231	1.000	
PSS	-.141	.069	-.220	.735 **	1.000

One Month Post Birth

	Cort	BDI-II	BAI	CES-D	PSS
Cort	1.000				
BDI-II	.912 ***	1.000			
BAI	.609	.417	1.000		
CES-D	.736 **	.717 **	.397	1.000	
PSS	.582	.355	.368	.307	1.000

	Cort	BDI-II	BAI	CES-D	PSS
Cort	1.000				
BDI-II	.800 *	1.000			
BAI	-.022	.248	1.000		
CES-D	.350	.840 **	.391	1.000	
PSS	.282	.358	.711	.295	1.000

Note. *= $p < 0.10$, **=$p < 0.05$, ***=$p < 0.01$

Cort: Salivary Cortisol Concentration, **BDI-II:** Beck Depression Inventory, 2nd edition, **BAI:** Beck Anxiety Inventory, **CES-D:** Center for Epidemiologic Studies Depression Scale, **PSS:** Perceived Stress Scale.

Table 6

Mean Cortisol Collection Time, Sub-Sample

	Pre/Post Lab Task	Time of Day	
2nd Trimester	Pre	12:19	PM
	Post	12:47	PM
3rd Trimester	Pre	11:35	AM
	Post	12:04	PM
Birth	Pre	12:56	PM
	Post	13:46	PM
Post Birth	Pre	11:15	AM
	Post	12:31	PM

Note: Fetal Monitoring was the lab task during 2nd and 3rd trimester; Questionnaire completion was the lab task at birth and 4 weeks post birth

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