A BIOPSYCHOSOCIAL MODEL OF ATTACHMENT STYLES AND ADVERSE BIRTH OUTCOMES IN HIGH-RISK PREGNANCIES

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DEDICATION

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A BIOPSYCHOSOCIAL MODEL OF ATTACHMENT STYLES AND ADVERSE BIRTH OUTCOMES IN HIGH-RISK PREGNANCIES

by

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Because stress during pregnancy can contribute to preterm birth, low birth weight, and other adverse birth outcomes, there is a need for research on psychosocial factors that may mitigate this risk. Social support and attachment security have been shown to buffer the effects of stress in certain contexts. This study therefore evaluated the degree to which social support, attachment anxiety, and attachment avoidance affect stress-related birth outcomes in a sample of women with high-risk pregnancies. The study focused on women who had been hospitalized for pregnancy complications, as the population was identified as in need of further biopsychosocial research. The hypotheses were that women with more secure attachment would have greater social support, less stress, and therefore superior birth outcomes. Participants (*N* = 188) completed the 10-Item Perceived Stress Scale, Social Provisions Scale, and Experiences in Close Relationship Scale–Short Form, during their pregnancies. Birth outcome data (gestational age, birth weight, and Apgar scores) were extracted from their medical records after delivery. Biserial correlation analyses revealed that high stress levels were associated with more insecure attachment styles. Analysis of variance indicated that participants were more likely to have avoidant attachment if they were black, poorly educated, or unmarried. Hierarchical multiple regression analyses revealed that stress, social support, and attachment levels were not predictive of birth outcomes over and above the effects of physiological risk factors. This result diverges from research on low-risk pregnancies, where a clear link is observed between stress and adverse birth outcomes. By contrast, in this sample of high-risk pregnancies, psychosocial factors did not influence the profound effects of biological risk. In high-risk pregnancies, therefore, psychosocial interventions may be better suited to target psychosocial, rather than biological, outcomes. Furthermore, this study highlights a need for further research into demographic disparities in attachment styles, as well as the sociocultural factors that may impact them.

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PRIOR PUBLICATIONS

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Cassedy, H. F., Enander, R. A., Robinson, R. C., Evans, H. M., Frank, B., Tucker, C., … Stringer, C. A. (2015). Attachment theory as a model of doctor-patient interaction. *Journal of Applied Biobehavioral Research, 20*(4), 151-178.

POSTERS/PRESENTATIONS

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LIST OF ABBREVIATIONS

AAI	Adult Attachment Interview
ACTH	Adrenocorticotropic hormone
ANOVA	Analysis of variance
ARI	Autonomy and Relatedness Inventory
BUMC	Baylor University Medical Center
CRH	Corticotropin-releasing hormone
ECR	Experiences in Close Relationships
ECR-R	Experiences in Close Relationships–Revised
ECR-S	Experiences in Close Relationships–Short Form
EMR	Electronic medical record
HPA	Hypothalamic-pituitary-adrenocortical
IRB	Institutional Review Board
PSS	Perceived Stress Scale
PSS10	10-Item Perceived Stress Scale
RSQ	Relationship Style Questionnaire
RQ	Relationship Questionnaire
SAM	Sympathetic-adrenomedullary
SPS	Social Provisions Scale
UTSW	University of Texas Southwestern Medical Center

CHAPTER 1

INTRODUCTION

A pregnant woman is admitted to the hospital for severe complications that endanger her life and the life of her baby. Medical complications can be stressful, and she may respond to that stress in various ways. She may worry about her health, her family at home, or her limited control over the situation. She may find comfort in being cared for by medical professionals, or in being released from work and household responsibilities. She may turn to loved ones for support when she is scared, or for companionship when she is hopeful; and for some women, that support and companionship significantly moderates their stress. That matters, because maternal stress has well-established effects on fetal health: women who are under stress during their pregnancies give birth to less-healthy babies with more birth complications. The social and relational experience of high-risk pregnancy, therefore, has a very real effect on neonatal health.

There are many ways to understand how a woman might respond to pregnancy complications. One could examine how external factors, such as the hospitalization itself, may affect her experience (Mischel & Shoda, 1995). Others might focus on how internal characteristics, or inborn temperament, might drive her responses to this situation (Kagan, 1997). John Bowlby (1969) offers a more interactionist perspective. He theorized that the emotional quality of our early attachments informs our internal working models, a set of if–then cognitive schemas that help make sense of external reality and our subjective reactions within it (Bowlby, 1969). "If I worry about my health," for example, "then I turn to doctors and loved ones for support." These schemas structure how we react to stressful situations: how readily we seek help from others, how confident we feel in our capacity to self-regulate, and how reactive our bodies are to stress (Collins & Feeney, 2004; Sroufe & Siegel, 2011). The present study uses Bowlby's attachment theory as a framework for examining adverse birth outcomes and the social factors that may buffer them.

Adverse birth outcomes, such as preterm birth and low neonatal birth weight, are major public health concerns. Eight to twelve percent of pregnancies in the United States result in preterm birth, which is the leading cause of infant mortality (Bezold, Karjalainen, Hallman, Teramo, & Muglia, 2013). Preterm birth and low birth weight also contribute to immediate maternal and neonatal vascular problems, as well as sensory, respiratory, and neurological impairments throughout development (Institute of Medicine, 2007).

Stress during pregnancy is the single most predictive psychosocial risk factor for these adverse birth outcomes (Cardwell, 2013). Through various physiological mechanisms, stress can not only exacerbate, but also induce complications that result in preterm birth and low birth weight (Giscombe & Lobel, 2005). Due to the impact that stress can have on birth outcomes and lasting health, researchers are investigating protective factors that may lessen the impact of prenatal stress.

Social support is one factor that affects the experience of stress during pregnancy (McDonald, Kingston, Bayrampour, Dolan, & Tough, 2014). Social support not only promotes healthy behaviors, but it also buffers the physiological effects of stress (Holt-Lunstad, Smith, & Layton, 2010; Stanton & Campbell, 2014). This suggests that by lessening the effects of stress, increased social support should also lessen the severity of stress-related birth complications. Following this promising line of research, investigators have attempted many interventions that promote social support during pregnancy. So far, the interventions have resulted in welcome psychosocial benefits, but have been ineffective at altering the rates of adverse birth outcomes (Hodnett, Fredericks, & Weston, 2010).

A piece seems to be missing from the equation. Stress is related to adverse birth outcomes, and social support can lessen the severity of stress. Why, then, does increasing social support not lessen the severity of adverse birth outcomes? Attachment theory may help answer this question.

Attachment theory is an account of interpersonal relatedness that developed from observational and ethologic studies of development (Bowlby, 1969). Documented "from the cradle to the grave" (Bowlby, 1969, p. 208), attachment styles reflect individuals' internal working models and emotion regulation strategies across the lifespan (Sroufe, 2005). Although originally developed as a categorical model, attachment styles are now often conceptualized along two dimensions: attachment anxiety and avoidance. High attachment anxiety indicates discomfort with self-reliance, whereas high attachment avoidance suggests reluctance to rely on others for help. Low levels of both domains, also known as secure attachment, suggest a healthy balance of self-reliance and help-seeking tendencies (Fraley & Waller, 1998).

These tendencies affect not only relationship outcomes, reflecting the interpersonal context for which they were originally conceptualized, but also outcomes across numerous psychosocial and physiological domains. Attachment levels are implicated in one's subjective and biological responses to stress (Kidd, Hamer, & Steptoe, 2013; Quirin, Pruessner, & Kuhl, 2008). They also inform one's appraisal of social support networks, and the effectiveness with which one uses social support (Mikulincer & Shaver, 2009; Waters & Waters, 2006). Although attachment levels have not yet been studied in relation to birth outcomes, they have been implicated in the outcomes of several other physical conditions (Feeney, 2000; Gerretsen & Myers, 2008). By accounting for individual differences in relationship styles, attachment theory could elucidate the ways in which social support may be more or less effective at buffering the physiological reactions to stress.

This study evaluates a model of birth outcomes that accounts for stress, social support, and attachment levels. The rationale for this biopsychosocial approach is that attachment levels may affect how women appraise their social support networks, which in turn could affect their stress and associated risk of adverse birth outcomes. This study tests the applicability of the model on a sample of women who are hospitalized for high-risk pregnancies, a population that could benefit acutely from this research. A literature review in support of this model is detailed in Chapter 2. The study's methods, results, and discussion sections are presented in Chapters 3, 4, and 5, respectively.

CHAPTER 2

REVIEW OF THE LITERATURE

Adverse birth outcomes, such as preterm birth and low birth weight, significantly contribute to morbidity and mortality rates across the lifespan (Dunkel-Schetter, 2011). Stress can exacerbate the risk of these adverse outcomes (Cardwell, 2013), and social support can lower the risk by relieving stress (Uchino, 2006). Attachment levels inform a person's experience of stress, appraisal of social support, and response to health complications (e.g., Mikulincer & Shaver, 2009), making attachment theory an apt frame for a biopsychosocial model of adverse birth outcomes.

The history, methodology, and research basis of attachment theory will be detailed later in this chapter. First, however, a word about vocabulary. Although attachment styles are often discussed as "secure" or "insecure," this text uses the more dimensional descriptors of attachment "levels" in order to distinguish the two dimensions of *attachment anxiety* (discomfort with self-reliance) and *attachment avoidance* (discomfort with dependence on others). Since "insecure attachment" is ambiguous as to whether there is an elevation of anxiety, avoidance, or both, this text avoids the secure/insecure vocabulary and instead refers independently to the "levels" of the two dimensions. Hence, instead of secure or insecure attachment, the present study addresses higher or lower levels of attachment anxiety and avoidance, corresponding to more and less interpersonal discomfort (Fraley & Waller, 1998).

This study proposes that attachment levels can help explain how some women may be more or less satisfied with social support during their pregnancies (Mikulincer & Shaver, 2009), thereby altering the buffering effects that social support can have against stress-related pregnancy outcomes (McDonald et al., 2014). The following sections review literature on the interconnections between adverse birth outcomes, stress, perceived social support, and attachment levels. Within each of these domains, emphasis is placed on research applicability to women who are hospitalized for high-risk pregnancies, as this is the population from which this study sampled. The chapter concludes with a hypothesized model of adverse birth outcomes that accounts for physiological risk factors, stress, social support, and attachment levels.

Adverse Birth Outcomes

Adverse birth outcomes typically refer to preterm birth (<37 weeks completed gestation) and low birth weight (≤2,500 grams irrespective of gestational age). Preterm birth occurs in 8-12% of pregnancies in the United States, and is the leading cause of infant mortality worldwide (Bezold et al., 2013). Most preterm births also result in low birth weight due to the abbreviated opportunity for growth in utero (Dunkel-Schetter, 2011). An additional 1/3 of infants with low birth weight are born at full term, but nonetheless suffer from intrauterine growth restriction (Institute of Medicine, 2007).

Infants born prematurely and/or with low birth weight are at increased risk of mortality, a risk that increases exponentially with lower gestational age and birth weight (Institute of Medicine, 2007). These birth outcomes are associated with immediate and lasting sensory, motor, growth, respiratory, and neurodevelopmental problems (Institute of Medicine, 2007).

Preterm birth and low birth weight are risk factors for asthma, high blood pressure, hypertension, and other chronic diseases throughout the lifespan (Alexander, Dasinger, & Intapad, In Press; Ligi, Grandvuillemin, Andres, Dignat-George, & Simeoni, 2010). In extreme cases, they are also associated with cerebral palsy and mental retardation (Fawke, 2007).

Apgar scores are another way to quantify birth outcomes. These numerical ratings (1-10) are recorded as clinical estimates of neonatal health one and five minutes after delivery. Unlike gestational age and birth weight, low Apgar scores do not necessarily indicate adverse birth outcomes. They can, however, quantify immediate risk of neonatal death, and are thus used as clinically relevant augmentations to the more objective measures of gestational age and birth weight (Casey, Mcintire, & Leveno, 2001; Laptook et al., 2009; Moster, Lie, Irgens, Bjerkedal, & Markestad, 2001).

Due to the immediate and lasting health consequences, investigators have been eager to identify any physiological risk factors that may predict, cause, or contribute to adverse birth outcomes. In the following sections, all empirically based risk factors have been compiled and divided into the following three categories: maternal risk factors that exist before pregnancy; maternal risk factors that develop during pregnancy; and fetal risk factors. Grouping risk factors in this manner is a novel way to highlight the various conditions that can arise before, during, and as a result of pregnancy.

Pre-existing maternal risk factors. The following pre-existing maternal conditions are considered risk factors for preterm birth and low birth weight: chronic hypertension (Yanit, Snowden, Cheng, & Caughey, 2012); vascular disease (Howarth, Gazis, & James, 2007);

diabetes mellitus (Howarth et al., 2007); renal insufficiency (Ramin, Vidaeff, Yeomans, & Gilstrap, 2006); infection, such as those that are sexually transmitted, systemic, urogenital, vaginal, bacterial, or periodontal (Jarjoura et al., 2005; Klein & Gibbs, 2004; Simhan, Caritis, Krohn, & Hillier, 2003); anemia in early pregnancy (Xiong, Buekens, Alexander, Demianczuk, & Wollast, 2000); history of preterm delivery (Bloom, Yost, Mcintire, & Leveno, 2001); history of second trimester pregnancy loss or abortion (Edlow, Srinivas, & Elovitz, 2007; Shah & Zao, 2009); and history of cervical surgery (Albrechtsen, Rasmussen, Thoresen, Irgens, & Iversen, 2008). In addition to these medical conditions, cigarette smoking and substance abuse are also behavioral risk factors for adverse birth outcomes (Chao et al., 2010; Kyrklund-Blomberg & Cnattingius, 1998). Lastly, there are two known demographic risk factors for preterm birth and low birth weight: advanced maternal age (>35 years old; 2011 Mills & Lavender, 2011; Kenny et al., 2013) and black race (Collins & David, 2009; Institute of Medicine, 2007).

Pregnancy-specific maternal risk factors. The following medical conditions are considered pregnancy-specific maternal risk factors for preterm birth and low birth weight: preeclampsia or eclampsia (Bibbo, Celi, Thomas, Blake-Lamb, & Wilkins-Haug, 2014); gestational diabetes (Garrison & Jagasia, 2014); weight gain that falls outside the recommended range (Han, Mulla, Beyene, Liao, & McDonald, 2011; McDonald, Han, Mulla, & Beyene, 2010); uterine abnormality, such as distension, leiomyoma, fibroids, diethylstilbestrol-induced changes, or excessive contractility (Davis, Ray-Mazumder, Hobel, Baley, & Sassoon, 1990); cervical abnormality, such as premature dilation, effacement, short length, or incompetence (Newman et al., 2008); and vaginal bleeding in the first trimester (Williams, Mittendorf, Lieberman, & Monson, 1991).

Fetal risk factors. In addition to maternal risk factors, there are several fetal risk factors that can increase the chance of preterm birth and/or low birth weight: multifetal gestation (Kiely, 1998); fetal growth restriction (Morken, Kallen, & Jacobsson, 2006); oligohydramnios or polyhydramnios (Manikanta, Senthil, & Sanjeeva, 2013); placental disorders, such as accreta, praevia, or abruption (Comstock, 2011); ruptured membranes (Ekwo, Gosselink, & Moawad, 1992); and fetal or congenital abormality (Dolan et al., 2007).

In sum, the following medical and demographic risk factors for adverse birth outcomes have been identified and are listed in Table 1: *pre-existing maternal risk factors* (advanced maternal age, anemia in early pregnancy, black race, chronic hypertension, cigarette smoking, diabetes mellitus, history of second trimester pregnancy loss/abortion, history of cervical surgery, history of preterm delivery, infection, renal insufficiency, substance abuse, vascular disease); *pregnancy-specific maternal risk factors* (cervical abnormality, gestational diabetes, eclampsia, preeclampsia, uterine abnormality, vaginal bleeding in first trimester, weight gain outside of recommended range); and *fetal risk factors* (fetal/congenital abnormality, fetal growth restriction, multifetal gestation, oligohydramnios, placenta accrete, placentas abruption, placenta praevia, polyhydramnios, ruptured membranes).

Insert Table 1

Of the medical variables, a history of preterm delivery is considered the greatest risk factor for preterm birth (Bloom et al., 2001). The others are all equally dangerous, as any given medical condition is no more predictive of birth outcomes than the next. The only exception to this is eclampsia: this hypertension-induced convulsion necessarily develops from preeclampsia, the condition of high blood pressure during pregnancy. Because eclampsia is one potential outcome of severe preeclampsia, the former is considered a more severe risk factor than the latter. Overall, the other medical risk factors are considered to be equivalently predictive of adverse birth outcomes (Bibbo et al., 2014; Goldenberg, Culhane, Iams, & Romero, 2008).

The relationships between risk factors and adverse birth outcomes are often non-linear. Interactions between biological, psychological, and social factors can coalesce to inform overall risk. The identification of black race as a risk factor, for example, accounts for genetic vulnerability to infection (Culhane & Goldenberg, 2011), psychological burden of chronic stress (Dominguez, Dunkel-Schetter, Glynn, Hobel, & Sandman, 2008), and social factors related to acculturation and segregation (Howard, Marshall, Kaufman, & Savitz, 2006). One could focus on any one of these components for each of the myriad risk factors. The interaction between them, however, can add to the cumulative and comprehensive picture of biopsychosocial risk (Bezold et al., 2013).

Several psychosocial factors may affect the biological underpinnings of adverse birth outcomes. The following section details how stress contributes to adverse birth outcomes through direct and indirect physiological mechanisms (Cardwell, 2013). The subsequent section explains how social support is thought to buffer the effects of stress both behaviorally and physiologically (McDonald et al., 2014). Lastly, attachment levels will be introduced as another potential protective factor against stress during pregnancy (Feeney, 2000). The present study investigates the ways in which these three psychosocial variables – stress, social support, and attachment – interact with the physiological mechanisms of adverse birth outcomes.

Stress

Stress is a broad, encompassing concept, where elements can be defined in multiple ways: from anxiety to nervousness, physical pressure to psychological strain. Lazarus and Folkman (1984) proposed a cognitive theory of stress, for example, hypothesizing that individuals compare the intensity of an external demand with the availability of their coping resources. If they judge themselves to have sufficient resources, the demands are experienced as challenges that provoke more motivation than stress. If they judge themselves to have insufficient resources, on the other hand, the demands are experienced as threats, and stress ensues (Lazarus & Folkman, 1984).

The theory of allostasis offers a more physiological, rather than cognitive, way to conceptualize stress. Allostasis refers to the physiological adjustments that one's body employs in order to maintain homeostasis in the face of various demands (Sapolsky, 2004). McEwen and Wingfield (2003) propose that allostatic overload occurs when a demand exceeds the body's ability to maintain physiologic stability. Animals can respond to allostatic overload by fleeing the external demand, such as by escaping a predator, and allowing physiological regulation once they have reached safety. Social conflict causes more chronic allostatic overload, as this type of demand can be persistent and inescapable. Chronically high allostatic load results in physiological disequilibrium and taxes the cardiovascular, metabolic, endocrine, and sympathetic nervous systems (McEwen & Wingfield, 2003).

During pregnancy, these physiological systems affect gestational age and birth weight, making stress the single greatest psychosocial risk factor for adverse birth outcomes (Cardwell, 2013). Given this relevance to the present study, the physiological mechanisms of stress will now be detailed in reference to general, interpersonal, and pregnancy contexts.

Physiology of stress. Stress affects the body through two primary mechanisms: the sympathetic-adrenomedullary (SAM) system, and the hypothalamic-pituitary-adrenocortical (HPA) axis. Both systems are activated by a signal from the cortex to the hypothalamus when a threat is detected. SAM activation involves the sympathetic nervous system, or “fight-or-flight” response. The adrenal medulla releases the catecholamines epinephrine and norepinephrine, which affect tissue and vascular functioning throughout the body: peripheral blood vessels constrict, heart rate increases, and blood pressure rises (Taylor, 2003). HPA activation involves the corticotropin-releasing hormone (CRH), which stimulates the release of adrenocorticotropic hormone (ACTH) and glucocorticoids from the adrenal cortex. One glucocorticoid in particular, cortisol, reduces inflammation in the event of injury, and helps the body return to baseline after the threat subsides (Glaser & Kiecolt-Glaser, 2005).

Prolonged stress can have several important health consequences. Excessive levels of epinephrine and norepinephrine (from SAM activation) sustain high blood pressure, rapid heart rate, and can even provoke ventricular arrhythmias. Excessive cortisol levels (from HPA activation) impair the functioning of white blood cells so that they are less toxic to infections and other foreign agents (Taylor, 2003). Not only are high cortisol levels dangerous, but the rapid decline from high to low cortisol can also cause problems. Under chronic stress, the body loses its ability to return to homeostasis in a controlled way, resulting in HPA deregulation. After prolonged cortisol elevations, cortisol levels can drop below baseline, a rapid process that further suppresses immune functioning by 40-70% (Sapolsky, 2004; Papadimitriou & Priftis, 2009).

With compromised immune functioning, the body is less able to avoid infection, and is worse at fighting off infection once it has developed (Taylor, 2003). As previously described, infection during pregnancy is one of the empirically supported risk factors for preterm birth and low birth weight (Klein & Gibbs, 2004). The next section explains that interpersonal stress can be particularly harmful, and that the physiological implications of stress are especially important during pregnancy.

Interpersonal stress. For some people, interpersonal stress is a prolonged or chronic state. Those who struggle to resolve interpersonal conflicts are vulnerable to the physiological sequelae of prolonged stress, as they suffer from what McEwen and Wingfield (2003) would define as chronic allostatic overload. Although attachment levels will be further explained in a later section, it is helpful to note at this point that they are highly relevant to the efficiency and effectiveness with which individuals resolve interpersonal conflict. In other words, attachment levels help us understand how interpersonal stressors may be more or less persistent, thus implicating immune functioning to varying degrees (Corcoran & Mallinckrodt, 2000).

Recall that individuals with secure attachment have neither high attachment anxiety nor high attachment avoidance levels (Fraley & Waller, 1998). They exhibit comfort in their self-reliance and in their dependency needs, and they tend to resolve interpersonal conflicts with relative ease and efficiency. Those with high attachment anxiety, on the other hand, tend to be uncomfortable with independence. As such, they can prolong interpersonal conflicts as they fight against what they may fear to be abandonment. Conversely, those with high attachment avoidance exhibit a preference for independence and may thus avoid the resolution of interpersonal conflicts. Both types of attachment elevations are therefore associated with prolonged interpersonal conflict, whereas individuals with secure attachment resolve social conflicts more efficiently (Corcoran & Mallinckrodt, 2000).

Given that attachment anxiety and avoidance elevations are associated with more persistent and pervasive interpersonal conflict, it follows that they are also associated with more impaired immune functioning (Picardi et al., 2013). Indeed, individuals with attachment elevations (insecure attachment styles) are particularly vulnerable to the physiological consequences of interpersonal stress, and are more likely to exhibit immunosuppression and the contraction of infection than those with secure attachment (Picardi et al., 2013).

Successful interpersonal encounters, on the other hand, can have great physiological benefits, most notably due to the neuropeptide oxytocin (Grewen, Girdler, Amico, & Light, 2005). Oxytocin is released during affiliative behaviors, such as grooming a child or soothing a loved one’s fears. Experimental studies demonstrate that the administration of exogenous oxytocin to parents not only increases their affiliative behaviors with their children, but it also increases their children's endogenous oxytocin levels in response to their parents' affection (Weisman, Zagoory-Sharon, & Feldman, 2012).

Elevated oxytocin levels have been shown to buffer the negative implications of stress by reducing cortisol levels in a slow and steady manner (Grewen et al., 2005). Caregivers and care-receivers with higher oxytocin levels exhibit not only more affiliative behaviors, but also lower cortisol levels and hence less immunosuppression (Feldman, Gordon, & Zagoory-Sharon, 2010; Heinrichs, Baumgartner, Kirschbaum, & Ehlert, 2003).

This suggests that individuals who can more successfully connect with others, such as those with secure attachment, may be less susceptible to stress-related immunosuppression and infection (Tops, Van Peer, Korf, Wijers, & Tucker, 2007). Given the relevance of these physiological processes during pregnancy, this study proposes that stress and interpersonal factors may be highly relevant to birth outcomes.

Stress and pregnancy outcomes. Stress during pregnancy can exacerbate and even cause preterm birth and low birth weight (Giscombe & Lobel, 2005; Littleton, Bye, Buck, & Amacker, 2010). The physiological mechanisms of stress-related birth outcomes are twofold: they involve CRH (the initiator of the HPA stress response system), and cytokines (proteins involved in the immune system; Cardwell, 2013).

As previously discussed, the hypothalamus synthesizes CRH in response to stress. During pregnancy, CRH is additionally synthesized by the placenta as part of standard fetal development. CRH levels increase exponentially in the final weeks of a normal pregnancy. This induces labor by activating the release of ACTH and glucocorticoids. Rising stress levels during pregnancy can stimulate this process prematurely, resulting in preterm birth and low birth weight (Austin & Leader, 2000; Gennaro & Hennessy, 2003). In addition to initiating spontaneous preterm labor, elevated CRH levels can also make women more susceptible to infection, which itself can lead to spontaneous or induced preterm labor (Hobel & Culhane, 2003).

Stress also increases levels of cytokines, proteins involved in the immune system. Some cytokines facilitate prostaglandin production, which can initiate labor through changes in the cervix. As such, high levels of stress during pregnancy can initiate spontaneous preterm labor, irrespective of other medical risk factors (Gennaro & Hennessy, 2003).

Stress can therefore induce preterm labor through two physiological mechanisms, CRH and cytokines (Gennaro & Hennessy, 2003; Hobel & Culhane, 2003). Given the temporality of these mechanisms, the association between stress and adverse birth outcomes is generally understood to be unidirectional: stress can cause adverse birth outcomes (Cardwell, 2013). This relationship becomes more complex with medically compromised pregnancies, however, such as those that require antepartum hospitalization (the focus of this study). In this population, the experience of pregnancy complications may cause stress, which could in turn exacerbate physiological risk. In other words, the association between stress and physiological risk may be reciprocal, not unidirectional. Unfortunately, there is no known research on the reciprocal relationship among stress and physiological risk factors for adverse birth outcomes in antepartum populations; the strength of this relationship is therefore unknown. The following section details the limited research on stress during antepartum hospitalization.

Stress during antepartum hospitalization. Women with severely complicated pregnancies are sometimes hospitalized in antepartum units so that they can stay within seconds of Labor and Delivery in the event of a medical emergency. Patients in these units tend to report heightened stress levels for several reasons. Most commonly, they cite the feeling of being a burden, loss of control, loss of privacy, separation from family, relentless boredom, and impaired self-image as primary stressors during their antepartum hospitalizations (Doyle, Monga, Kerr, & Hollier, 2004; Heaman, 1990; Maloni, Park, Anthony, & Musil, 2005; Richter, Parkes, & Chaw-Kant, 2007).

Although patients encounter many stressors during antepartum hospitalization, the hospital stay itself can provide relief and reduce some domains of psychological distress. Patients' levels of uncertainty and the severity of their depressive symptoms, for example, tend to decline over the course of antepartum hospitalization (Clauson, 1996; Maloni et al., 2005). Stress levels, on the other hand, tend to remain stable over prolonged antepartum hospitalizations, suggesting that the hospitalization neither adds to nor detracts from the experience of stress (Maloni, Margevicius, & Damato, 2006). In the presence of strong social support, however, stress levels can actually decline over the course of prolonged antepartum hospitalization (Kent, Yazbek, Heyns, & Coetzee, 2015). This illustrates the buffering effect that social support can have against stress, and demonstrates the relevance of both psychosocial constructs to the hospitalized antepartum population.

Social Support

Social support is the perception of being cared for, valued, and included in an interpersonal network (Wills, 1991). It can include the perception that others are available to provide emotional, instrumental, and informational support, or satisfaction with various relationships in one's life (Taylor, 2007). To measure social support, some researchers quantify the size of one's social network by counting the number of reported friends, acquaintances, and family members, or the length of one's romantic partnership (Hirsch, 1979). Others measure satisfaction in different relationships in order to identify how one evaluates various providers of social support (Sarason, Levine, Basham, & Sarason, 1983).

Another way to tap the perception of social support is to measure the degree to which one appraises various social needs as being fulfilled in one's life (Taylor, 2007). The Weiss (1974) model of social provisions outlines six social needs: attachment (the need for emotional security); social integration (the need for shared interests); opportunity for nurturance (the need to care for others); reassurance of worth (the need for positive affirmation); reliability of alliance (the need for dependable availability); and guidance (the need for informational support). It is proposed that satisfaction within these domains, rather than satisfaction with particular relationships, offers a more direct picture of how individuals subjectively appraise the receipt of social support (Weiss, 1974).

The subjective perception of social support is linked to many psychosocial benefits across the lifespan (Taylor, 2007). Of particular interest to this study is the extensive body of literature documenting the health benefits of perceived social support (e.g., Berkman & Syme, 1979; House, Landis, & Umberson, 1988). A recent meta-analysis demonstrates that in 148 studies, strong perceived social support is associated with increased lifespan across numerous medical conditions, including early stage cancer (e.g., Ell, Nishimoto, Mediansky, Mantell, & Hamovitch, 1992) and cardiovascular disease (e.g., Case, Moss, Case, McDermott, & Eberly, 1992), among others (Holt-Lunstad et al., 2010). These findings demonstrate that social support is beneficial across a wide range of conditions, similarly to how smoking cessation and physical activity are known to be broadly good for one's health (Critchley & Capewell, 2003; Holt-Lunstad et al., 2010; Katzmarzyk, Janssen, & Ardern, 2003). The following sections outline the physiological mechanisms underlying social support both in and out of pregnancy.

Physiology of social support. Researchers have proposed a buffering hypothesis to explain why social support is so beneficial to one's health. The hypothesis is that social support moderates the body's stress response system: it reduces allostatic load and aids the body's return to homeostasis when faced with extreme or prolonged stressors (Cohen & Wills, 1985). This hypothesis has been supported by numerous physiological studies, showing that social support moderates the body's endocrine, immune, and vascular responses to stress (Uchino, 2006).

It has been demonstrated that stress elevates cortisol levels and causes immunosuppression, and that oxytocin lowers cortisol and repairs immune functioning (Feldman et al., 2010; Heinrichs et al., 2003). Given the affiliative implications of oxytocin, it is not surprising that individuals with more social support tend to exhibit higher oxytocin and lower cortisol levels than those with less social support (Grewen et al., 2005; Heinrichs et al., 2003; Hostinar & Gunnar, 2013; Turner-Cobb, Sephton, Koopman, Blake-Mortimer, & Spiegel, 2000). Consequently, those with less social support tend to have worse immune functioning and a relatively impaired ability to fend off viruses, infections, and other foreign agents (Dunn, Bruce, Ikeda, Old, & Schreiber, 2002; Lutgendorf et al., 2005).

In addition to these endocrine and immunological implications, social support has also been shown to buffer stress through vascular mechanisms. Individuals with more social support tend to have lower blood pressure at baseline, regardless of the presence of stressors (Gump, Polk, Kamarck, & Shiffman, 2001; Steptoe, Lundwall, & Cropley, 2000). When faced with stressors, those with less social support exhibit heightened cardiovascular reactivity, a risk factor for vascular disease across the lifespan and for complications during pregnancy (Treiber et al., 2003; Mezuk, Diez Roux, & Seeman, 2010).

Social support and pregnancy outcomes. Social support during pregnancy can be a powerful protective factor against both preterm birth and low birth weight. It protects against preterm birth through endocrine, immune, and vascular mechanisms (Dolatian et al., 2014; Uchino, 2006). As previously noted, social affiliation raises oxytocin levels, which lowers cortisol levels, thereby strengthening immune functioning and lowering the risk of infection (Heinrichs et al., 2003). Because infection is a risk factor for preterm birth, the immune implications of social support can have powerful effects on neonates' completed gestational age (Feldman et al., 2010). It has also been documented that social support can moderate cardiovascular reactivity, which lessens the risk of gestational diabetes (Javid, Simbar, Dolatian, & Majd, 2015; Treiber et al., 2003). Since gestational diabetes is a known risk factor for preterm birth, it makes sense that social support serves as a protective factor (Chao et al., 2010;

Goldenberg et al., 2008). In fact, social support is considered the primary protective factor against stress-related preterm delivery in the general population (McDonald et al., 2014).

Social support also protects against low birth weight through vascular mechanisms (Feldman, Dunkel-Schetter, Sandman, & Wadhwa, 2000). Recall that 1/3 of infants with low birth weight are not born prematurely, but nonetheless exhibit restricted or slowed intrauterine growth (Institute of Medicine, 2007). Regardless of gestational length, high blood pressure during pregnancy can limit fetal growth by tightening the restriction of umbilical and uterine arteries (Albuquerque, Smith, Johnson, Chao, & Harding, 2004). Social support can reduce or prevent this restriction by lowering stress-related blood pressure and cardiac reactivity (Feldman et al., 2000; Hobel, Goldstein, & Barrett, 2008). Conversely, low social support is highly correlated with fetal growth restriction and low birth weight, even when controlling for gestational age (Campos et al., 2008; Da Costa, Dritsa, Larouche, & Brender, 2000; Dole et al., 2003; Keeley et al., 2004; Lespinasse, David, Collins, Handler, & Wall, 2004). Social support can thus protect against low birth weight that arises from preterm delivery, and also that which arises from independent growth restriction.

Advances in ways to improve social support during pregnancy could profoundly improve maternal and neonatal health, as well as development across the lifespan. So far, however, social support interventions have not demonstrated improvement in birth outcomes. Some demonstrate impressive effects in psychosocial domains (e.g., Dennis & Kingston, 2008; Rahman, Malik, Sikander, Roberts, & Creed, 2008), but none have significant effects on the rates of preterm birth, low birth weight, or neonatal mortality (Hodnett & Fredericks, 2003; Hodnett et al., 2010; Lu, Lu, & Schetter, 2005).

These disappointing results suggest that other factors may be at play. This study proposes that interpersonal styles, such as attachment levels, may help explain how social support can be more or less influential on birth outcomes. Attachment levels reflect individual differences in how people approach social support. During pregnancy, women with secure attachment report greater satisfaction in their social networks, for example (Stapleton et al., 2012). Those with more avoidant coping (such as high attachment avoidance levels) report less social support than others (Rudnicki, Graham, Habboushe, & Ross, 2001). Because attachment levels inform pregnant women's perception of social support, they could also inform their physiological responses to social support. And because social support moderates stress during pregnancy (McDonald et al., 2014), the present study examines how attachment may indirectly affect stress-related birth outcomes.

Attachment Theory

Attachment theory is an apt lens through which to view the buffering effects of social support on stress-related birth outcomes. Recent research shows the effects of attachment styles on health behaviors and physiological reactions to stress, demonstrating the theory's potential applicability to stress-related birth outcomes (Zachariah, 2009). Attention to its relevance to adults' physical health is a relatively new development, however, far from the theory's origins in child development. Before delving into its potential implications for birth outcomes, therefore, this literature review first takes a step back to survey the context and methodology with which attachment theory has developed.

History. Attachment theory draws on both psychoanalytic and ethologic perspectives (Karen, 1998). Freud theorized that infants attach to their mothers to satisfy their biological need for nourishment, and Lorenz documented similar attachment (or "imprinting") behaviors of newly hatched goslings (Freud, 1964; Lecroy, 2000). Harlow's work on rhesus monkeys suggested that newborns attach to caregivers for more than physical protection, however: their apparent preference for comforting mother figures suggested that they sought emotional, not just biological, nourishment (Harlow, 1958; Karen, 1998).

Building from this perspective, Bowlby (1969) proposed that infants rely on their caregivers not only for physical care, but also for emotional and interpersonal development. Those that develop secure attachment, or affective bonds, with their caregivers tend to internalize effective regulatory strategies, such that they are more efficient at calming themselves under stress. Infants without secure attachment, Bowlby observed, not only lack the caring presence of an adult, but also lack the ability to self-soothe when distressed (Bowlby, 1969; Karen, 1998).

Bowlby proposed that under stress, infants seek proximity to their caregivers for both physical protection and for emotional attunement. The responsive caregiver becomes a "safe haven," a stable figure that can help regulate the infant's distress. With a consistently responsive caregiver, the infant internalizes the regulatory strategies and develops confidence that the caregiver can serve as a "secure base" from which to explore the world. Children with secure attachment thus exhibit a healthy balance between independent exploration when they feel safe, and proximity-seeking when they feel distressed. Those with insecure attachment exhibit varying degrees of discomfort with independence and proximity (Bowlby, 1988; Karen, 1998).

Children with reliably unresponsive caregivers can develop in an apparently self-sufficient manner. They learn to deactivate their drive for proximity, instead developing a preference for autonomy and a discomfort with dependence on others. With caregivers who only inconsistently meet their needs, on the other hand, children tend to hyper-activate their drive for proximity. Being unable to predict their caregivers' responsiveness, these children attempt to elicit care from those around them, exhibiting a hyper-reliance on others and a general discomfort with independence. A small subset of these children also develops fear of others, typically in response to abusive or acutely incongruous caretaking (Karen, 1998). These types of insecure childhood attachments were later classified as "avoidant-dismissive," "anxious-ambivalent," and "disorganized-disoriented," respectively (Ainsworth, 1978; Main & Solomon, 1990).

Measurement. Attachment theory would remain fully theoretical without practical techniques for measurement. There have been two dominant perspectives on attachment style measurement: a developmental perspective, which uses in-vivo observation, and a social-psychological perspective, which uses self-report measures. Both perspectives, each with their own strengths and limitations, have helped refine concepts of attachment styles across the lifespan and across different domains of relationships.

Developmental perspective. Ainsworth developed the first method for measuring and categorizing attachment styles in children. The Strange Situation is a standardized method for observing and coding enactments of attachment behaviors. It involves separating infants from their caregivers and then observing the infants' regulatory behaviors upon reunion. Infants with secure attachment seek comfort from their caregivers and are efficiently soothed by their presence. Those with anxious-ambivalent attachment style exhibit difficulty making use of their caregivers' support: they may embrace their caregivers but remain inconsolable, for example. Infants with avoidant-dismissive attachment style, on the other hand, may appear unfazed by the reunion while actually resisting the caregiver's embrace (Ainsworth, 1978). Disorganized-disoriented attachment style, a category later added by Main and Solomon (1990), is characterized by bizarre reunion behaviors. These children may walk or crawl backwards to their caregivers, for example, in order to approach and avoid them simultaneously (Main & Solomon, 1990).

Main (1981) proposed that these attachment styles persist throughout the lifespan, a theory that has since been corroborated by longitudinal studies (Fraley, Vicary, Brumbaugh, & Roisman, 2011; Sroufe, 2005; Waters, Merrick, Treboux, Crowell, & Albersheim, 2000). Along with Weston (1981), Kaplan, and Cassidy (1985), Main developed the Adult Attachment Interview (AAI) to expand the study of attachment to adults. The semi-structured interview is coded to evaluate the coherence and content of adults' childhood memories. Adult attachment styles are classified as "autonomous," "preoccupied," "dismissing," and "unresolved/disorganized." These are directly parallel to the childhood categories, secure, anxious-ambivalent, anxious-avoidant, and disorganized-disoriented, respectively (George, Kaplan, & Main, 1985; Main & Goldwyn, 1984).

Social psychological perspective. The developmental approach to measuring attachment relies on in-person observation, and classifies attachment styles as falling into distinct categories (George et al., 1985). By contrast, the social psychological perspective relies more heavily on self-report questionnaires, which tend to be less labor intensive than observational techniques. This perspective also takes into account the factors that are common to different measures of attachment, which allows for the conceptualization of dimensional, rather than categorical, attachment systems (Bartholomew, 1990).

Bartholomew (1990) conceptualized attachment from a dimensional perspective by proposing that adult attachment styles may be thought of as a set of primary and secondary domains. The primary dimension, she postulated, marks the intersection of one's internal working models of self and of others. These internalized models then contribute to the secondary dimension, dependence vs. avoidance, which was later relabeled "anxiety vs. avoidance" to be more consistent with original attachment language (Bartholomew, 1990; Crowell, Fraley, & Shaver, 1999; Griffin & Bartholomew, 1994).

Bartholomew and Horowitz (1991) created the Relationship Questionnaire (RQ) as a measurement of the primary domain, positive vs. negative internal working models of self and of others. One can have a positive or negative model of self, a positive or negative model of others, or any combination thereof (Bartholomew & Horowitz, 1991). The Relationship Style Questionnaire (RSQ) then superimposed these dimensions onto categorical titles, such that a combination of positive models of self and of others translates to "secure" attachment; a positive model of others with a negative model of self is called "preoccupied"; the inverse (positive model of self with negative model of others) is called "dismissing"; and negative models of both self and others is called "fearful" (Griffin & Bartholomew, 1994).

Brennan, Clark, and Shaver (1998) focused instead on the secondary domain, attachment anxiety vs. avoidance. Using a factor analytic approach, they deduced that the factors anxiety and avoidance were common to the majority of adult attachment measures at the time (Ravitz, Maunder, Hunter, Sthankiya, & Lancee, 2010). They accordingly developed the Experiences in Close Relationships scale (ECR), a questionnaire that models adult attachment style along the dimensions of attachment anxiety and avoidance. Also using factor analysis, Wei, Russell, Mallinckrodt, and Vogel (2007) created a short form, ECR-S, to improve psychometric properties and reduce respondent burden. As with the ECR, the ECR-S measures attachment anxiety and avoidance levels as orthogonal constructs: the two dimensions are measured and interpreted independently from one another (Wei et al., 2007).

Categorical attachment styles can be superimposed on the domains yielded by the ECR-S (see Figure 1). "Secure" attachment refers to a combination of low attachment anxiety and low attachment avoidance; "preoccupied" attachment refers to low attachment avoidance with high attachment anxiety; "dismissing" attachment refers to high attachment avoidance with low attachment anxiety; and "fearful" attachment refers to high levels of both attachment anxiety and avoidance (Brennan et al., 1998). Although these categorical titles add some convenience to interpretation, they also limit the depth of the data yielded by the ECR-S. Factor analysis reveals that attachment anxiety and avoidance are separate constructs, with ECR-S Anxiety scores having no bearing on ECR-S Avoidance scores, and vice versa (Wei et al., 2007). In line with this theoretical and empirical background, the present study therefore measures and interprets attachment anxiety and avoidance as orthogonal, dimensional constructs without implicit interaction.

Insert Figure 1

Benefits and disadvantages of the different perspectives. In sum, the measurement strategies from the developmental perspective (e.g., AAI) require observation of behavior. They create stressful situations in which attachment behaviors are enacted, thus providing rich, emotionally provocative data. This benefit is also a disadvantage: by creating emotionally provocative situations, these measures can cause significant participant burden, and are additionally labor intensive for administrators. Measures from the developmental perspective also classify attachment styles in categorical terms, which limit the depth of quantitative interpretation. Measures from the social psychological perspective (e.g., ECR-S), on the other hand, tend to be less evocative and less time intensive for respondents and researchers. This benefit is also a disadvantage: because the measures are entirely self-report, they can be susceptible to impression management (Weston, Gabbard, & Ortigo, 2008).

Impression management can confound any self-report measure, and it may be particularly relevant to measures of interpersonal vulnerabilities (Furr & Bacharach, 2014; Spector, 1994). Individuals who are susceptible to the effects of social desirability can present a more favorable self-image by reporting more secure interpersonal functioning and underreporting attachment anxiety and avoidance (Andrews, Meredith, & Strong, 2011; Leak & Parsons, 2001). The creators of the ECR-S were aware of this potential confound. They assessed the susceptibility of the ECR-S to impression management, as measured by the Impression Management subscale of the Balanced Inventory of Desirable Responding (Paulhus, 1984; Wei et al., 2007), and found minimal correlation between the measures. As such, it appears that ECR-S is not particularly vulnerable to impression management (Wei et al., 2007). In addition to allowing for efficient and research-friendly quantification, therefore, the social-psychological approach to attachment measurement also appears to be only minimally susceptible to impression management.

Attachment and stress. Regardless of measurement perspective, it is imperative to address stress in any study of attachment. Bowlby theorized that attachment systems are activated under stress: when children's safety, health, or emotional wellbeing are threatened, they seek their primary attachment figures for physical and psychological regulation (Bowlby, 1958; Karen, 1998). Similar patterns are found in adults. Adults do not generally navigate the world in acute states of attachment anxiety or avoidance. But when faced with illness, trauma, or other psychological disturbance, their interpersonal preferences become more pronounced, and their attachment levels become more measurable (Fraley & Shaver, 2000). The activation of attachment systems under stress has also been demonstrated experimentally: attachment-related themes are more readily accessible to those who have been primed with stressors than those who have been primed with neutral words (Mikulincer, Birnbaum, Woddis, & Nachmias, 2000).

One might expect that being hospitalized for a high-risk pregnancy would induce stress. As previously identified, women on antepartum units report stress due to: feeling like a burden, lacking control and privacy, being separated from their families, and being bored, among other reasons (Doyle et al., 2004; Heaman, 1990; Maloni et al., 2005; Richter et al., 2007).

Experiencing these demands as stressful likely results in the activation of attachment systems, such that high levels of stress would correspond with high levels of attachment anxiety and avoidance. Other patients may not experience these demands as stressful, however. Some may interpret them as motivating challenges; others may find hospitalization to be a comforting reprieve from their daily routines (Maloni et al., 2005; Maloni et al., 2006). Women who thus endorse low levels of stress during their hospitalization would likely report low levels of attachment anxiety and avoidance, as in the absence of stress their attachment systems would not be activated. Given these potential variations, it will be imperative for the present study to measure perceived stress alongside reported attachment levels in order to account for inter-individual variations in subjective experience.

It has been documented that high levels of stress can elevate attachment anxiety and avoidance levels (Fraley & Shaver, 2000), and that the experience of stress (and thus the elevation of attachment levels) will likely vary on an antepartum unit (Maloni et al., 2006). Also relevant is the reciprocal relationship – that is, the effects that attachment levels may have on the experience of stress. Individuals with different attachment levels respond differently to the experience of stress. Consistent with the hyper-activation of attachment needs in childhood, individuals with high attachment anxiety (those with strong dependency needs) report heightened levels of subjective stress in interpersonal (Rifkin-Graboi, 2008), cognitive (Kidd et al., 2013), and physical challenges (Meredith, 2013). Their physiological markers of stress also tend to be higher than those with lower attachment anxiety, both in stressful situations and at baseline (Quirin et al., 2008).

Conversely, individuals with high attachment avoidance (those who dismiss their dependency needs) have learned from a young age to deactivate their attachment systems and care for themselves independently (Mikulincer, Shaver, & Pereg, 2003). They tend to appear self-sufficient and report low levels of subjective stress (Mikulincer & Florian, 1998). Similarly, laboratory studies have found that when faced with cognitive challenges, these individuals do not exhibit particularly heightened physiological markers of stress (Kidd, Hamer, & Steptoe, 2011). They do exhibit heightened physiological stress in interpersonal situations, however, suggesting a tendency to physically experience, but not to subjectively identify, stress in relational contexts (Rifkin-Graboi, 2008).

There appears to be a complex interplay between stress and attachment levels. Stress can activate attachment systems, such that those who report high levels of stress are also likely to endorse heightened attachment levels (Fraley & Shaver, 2000). In addition, individuals with high attachment anxiety respond to stress in different ways than do those with high attachment avoidance (Mikulincer & Florian, 1998). It has also been documented that heightened attachment anxiety and avoidance levels are both associated with physiological reactivity to stress (Rifkin-Graboi, 2008), which has been established as the primary psychosocial risk factor for preterm birth and low birth weight (Cardwell, 2013). It is therefore theorized that stress and attachment levels are integral to this study's model of adverse birth outcomes. The third variable, social support, is also anticipated to link the psychosocial variables within the model.

Attachment and social support. It has been documented that social support can buffer the physiological effects of stress (e.g., Uchino, 2006), and that attachment levels are also associated with physiological reactions to stress (e.g., Rifkin-Graboi, 2008). This study investigates how attachment levels and social support may both impact stress-related health outcomes.

It is important to note that individuals with higher attachment levels (i.e., more insecure attachment styles) tend to have more unresolved interpersonal conflicts than those with lower attachment levels (more secure attachment). As previously mentioned, attachment anxiety is associated with prolonged interpersonal confrontations, and attachment avoidance is associated with minimal conflict resolution (Corcoran & Mallinckrodt, 2000). These extended conflicts result in prolonged stress activation, which can heighten allostatic load and impair the body's ability to return to homeostasis (Corcoran & Mallinckrodt, 2000). Indeed, individuals with high attachment anxiety and/or avoidance levels are prone to immunosuppression, which limits their ability to fend off viruses and infections, as well as their ability to fight illness once it has been contracted (Picardi et al., 2013).

Those with lower attachment levels (i.e., more secure attachment) tend to have more productive interpersonal encounters. They release more oxytocin during affiliative behaviors, which is associated with lower cortisol levels and better immune functioning (Strathearn, Fonagy, Amico, & Montague, 2009). These individuals also tend to be more receptive to receiving care from others, which increases oxytocin and lowers cortisol levels. They accordingly have less risk of stress-related immunosuppression than do those with higher (less secure) attachment levels (Tops et al., 2007).

It therefore appears that individuals with higher attachment levels are less effective at engaging with social support (Corcoran & Mallinckrodt, 2000). Because ineffective social support is a risk factor for stress-related immunological problems (through the mechanisms of oxytocin and cortisol), social support moderates the association between attachment levels and stress-related physiological functioning (Tops et al., 2007). Ditzen and colleagues (2008) demonstrated this empirically. Their study found no direct association between attachment levels and cortisol levels, but they did find a direct association between social support and cortisol levels. This connection was strengthened when attachment levels were added, such that the interaction between attachment levels and social support was a better predictor of cortisol than was either attachment or social support independently. This demonstrates that although attachment levels are not directly associated with stress physiology, they add to the buffering effect of social support. Social support may independently protect against the physiological sequelae of stress, but the strength of this protection is augmented by the indirect effects of attachment levels (Ditzen et al., 2008).

In addition to affecting one's physiological reactivity to stress, the interaction between attachment and social support can also affects one's perception of physical wellbeing (Stanton & Campbell, 2014). Individuals with low attachment anxiety and high social support tend to report fewer health problems than do those with low attachment anxiety and low social support, for example. By contrast, those with high attachment anxiety and similarly high social support report more health problems overall, demonstrating that high levels of social support do not uniformly alter one's perception of health (Stanton & Campbell, 2014).

These findings are consistent with the understanding that attachment levels can inform interactions with, and perceptions of, social support (Florian, Mikulincer, & Bucholtz, 1995). Individuals with high levels of attachment anxiety or avoidance have, in theory, developed concerns from a young age about the availability and dependability of caregivers (Karen, 1998). Similar concerns are observed in adults as they appraise the availability and dependability of their social support networks. Those with high attachment levels tend to endorse low levels of perceived social support (Florian et al., 1995), as well as low levels of positive emotions in social contexts (Mallinckrodt & Wei, 2005). Brain imaging studies reveal that attachment avoidance is associated with less neural reactivity to social reward, suggesting that these individuals overlook positive social encounters. Attachment anxiety, on the other hand, is associated with more neural reactivity to social punishment, demonstrating a tendency to focus on negative social cues (Vrticka, Andersson, Grandjean, Sander, & Vuilleumier, 2008).

These negative perspectives are also observed in interpersonal encounters. Individuals with high levels of attachment anxiety or avoidance tend to rate their partners' expressions of support more negatively than do those with lower (more secure) attachment levels, even when controlling for independent ratings of the partners' expressed support (Collins & Feeney, 2004). This suggests that high attachment levels may predispose individuals to negatively appraise their social support (Waters & Waters, 2006), which is consistent with the understanding that attachment styles reflect one's expectations about the availability of others' support (Mikulincer & Shaver, 2009).

Thus far, the literature review has documented that social support buffers the physiological sequelae of stress (e.g., Uchino, 2006); that attachment levels affect the use and appraisal of social support (e.g., Collins & Feeney, 2004); and that the interaction between attachment and social support better predicts physiological stress responses than does either independent predictor (Ditzen et al., 2008). These connections have not yet been applied to samples of pregnant women, but have been implicated in numerous other health outcomes.

Attachment and health outcomes. As attachment research develops beyond the family unit, investigators are documenting the implications of attachment levels across behavioral, physiological, and health domains (Sroufe, 2005). Within the medical field, for example, attachment anxiety and avoidance levels can inform one's engagement in healthy behaviors, one's ability to form and maintain patient-provider relationships, and one's adherence to treatment recommendations (Pietromonaco, Uchino, & Schetter, 2013). The effects of attachment levels can thus extend far beyond the infant-parent dynamics around which they were originally theorized, and inform not only behaviors related to health, but also susceptibility to illness across the lifespan (Feeney, 2000; Gerretsen & Myers, 2008).

Individuals with high attachment avoidance tend to engage in behaviors that reflect an apparent sense of invincibility: they smoke more cigarettes and wear fewer seatbelts than those with lower attachment avoidance, for example (Ahrens, Ciechanowski, & Katon, 2012; Ciechanowski et al., 2004; Kassel, Wardle, & Roberts, 2007). Those with higher attachment anxiety, conversely, can be over-solicitous of others. They tend to engage in riskier sexual behavior by being less willing to confront their sexual partners about sexual histories and condom use (Feeney, Peterson, Gallois, & Terry, 2000; Gentzler & Kerns, 2004).

Hunter and Maunder (2001) proposed that these types of unhealthy behaviors may reflect an over-reliance on external modulators of affect. Individuals with high attachment levels (i.e., insecure attachment styles) will have likely received insufficient models of affective regulation throughout their development. As adults, they may thus rely on external pleasure-seeking behaviors, such as consumption of illicit substances, fatty foods, and unsafe sex in an attempt to satisfy their immediate emotional needs. These behaviors can increase long-term risk of illness and even premature death, thus contributing to the finding that individuals with low attachment levels (secure attachment style) have better overall health outcomes than do those with elevated attachment levels (Hunter & Maunder, 2001).

In addition to informing one's health behaviors, attachment levels can also inform one's willingness to seek medical attention. Consistent with their independent dispositions, individuals with high attachment avoidance tend to resist medical care more than those with low avoidance levels (Maunder, Hunter, & Lancee, 2011). Avoidance of care can be especially detrimental for the treatment of conditions that require behavioral changes and routine follow-up, such as diabetes. A substantial body of literature demonstrates that high attachment avoidance levels in individuals with diabetes is associated with non-adherence to medication and behavioral recommendations, including diet, exercise, foot care, and smoking cessation (Bazzazian & Besharat, 2012; Ciechanowski & Katon, 2006; Ciechanowski et al., 2006; Morris et al., 2009). Such individuals also have higher mortality rates than individuals who have diabetes and lower levels of attachment avoidance (Ciechanowski et al., 2010).

Individuals with high attachment anxiety levels, on the other hand, may more readily seek medical attention and adhere to treatment recommendations, which can benefit their health in certain conditions (Ciechanowski et al., 2004; Feeney, 2000). However, patients with high attachment anxiety also exhibit difficulty in developing patient-provider relationships, as providers can perceive them as overly dependent or demanding (Maunder et al., 2006). In fact, patients with any type of insecure attachment style (high attachment anxiety and/or avoidance levels) tend to have worse patient-provider relationships than do those with secure attachment (Hooper, Tomek, & Newman, 2012). It has been well documented that these types of impaired patient-provider relationships are associated with worse treatment adherence, medical outcomes, and satisfaction with care (Ha & Longnecker, 2010; Hooper et al., 2012; Ridd, Shaw, Lewis, & Salisbury, 2009).

Attachment and pregnancy outcomes. Although there is a growing body of research on attachment and health outcomes, very little research has been conducted on attachment and pregnancy outcomes. Most research on attachment during pregnancy addresses emotional and interpersonal outcomes, rather than physical ones. Different attachment dimensions have been shown to relate to mood and anxiety symptoms during and after pregnancy, for example (Ayers, Jessop, Pike, Parfitt, & Ford, 2013; Bifulco et al., 2004). Although studies documenting the emotional correlates of attachment during pregnancy are important contributions to the fields of affective and interpersonal studies, the physical correlates relevant to health psychology remain largely unexamined. The present study therefore focuses on physical health outcomes associated with attachment during pregnancy, a sub-field with extremely limited research.

To this author's knowledge, only one study has examined the relationship among pregnant women's interpersonal styles and their birth outcomes. Zachariah (2009) demonstrated statistically significant relationships between physical birth outcomes and stress, social support, and relationship qualities. She found that social support, secure attachment, and psychological wellbeing were inversely correlated with antepartum complications; social support was inversely correlated with intrapartum complications; and psychological wellbeing was inversely correlated with neonatal complications (Zachariah, 2009).

Zachariah's (2009) study raises useful methodological questions. First, the outcomes were considered categorically without accounting for degree of medical severity. In assessing preterm birth, for example, participants were classified as either giving birth before or after 37 weeks gestation, rather than being scored on the dimensional range of gestational age. Birth weight was similarly classified as either more or less than 2500 grams; Apgar scores were classified as either above or below a score of 7. Assessing these outcomes in binomial terms makes it difficult to draw conclusions about severity of risk (Zachariah, 2009).

Second, the outcome categories in the Zachariah (2009) study (antepartum, intrapartum, and neonatal complications) include some variable overlap. The study classified preterm labor as an antepartum complication but preterm birth as a neonatal complication, for example. It classified hypertension as both an antepartum and an intrapartum complication as well. This variable overlap limits conclusions about how the variables relate, and to what degree they impact health outcomes (Zachariah, 2009).

Third, and perhaps most importantly, the Zachariah (2009) study used the Autonomy and Relatedness Inventory (ARI) as a measure of attachment, although this unpublished scale has not been validated alongside established measures of attachment styles or attachment levels (Schaefer & Edgarton, 1982; Hall & Kiernan, 1989). As such, the interpretation that high ARI scores indicate secure attachment cannot be supported by published research at this time. This limits the study's conclusions about the role of attachment styles in birth outcomes (Zachariah, 2009).

It has been established that attachment levels relate to health outcomes outside of pregnancy (e.g., Pietromonaco et al., 2013), and that social support relates to health outcomes both in and out of pregnancy (e.g., McDonald et al., 2014). Preliminary evidence suggests the feasibility of documenting relational variables in association with birth outcomes (Zachariah, 2009). Nonetheless, no study appears to have investigated the relationship among empirically validated attachment levels during pregnancy and physical outcomes of neonates upon delivery. The present study fills this gap in the literature by examining the association between attachment levels and birth outcomes in a sample of women who are hospitalized for medically complicated pregnancies.

Attachment during antepartum hospitalization. Due to the lack of research on attachment-related birth outcomes, there is even less research on this relationship in high-risk pregnancies. A recent doctoral dissertation supports the feasibility of this research, however. The study measured antenatal attachment (attachment to the fetus) in women who were hospitalized for severe pregnancy complications. Attachment levels were found to be unrelated to severity of medical risk, or to whether the risk was due to maternal or fetal complications (Brandon, 2006). This study specifically examined attachment to the fetus, rather than the overarching attachment levels that are proposed for the present study. Nonetheless, the Brandon (2006) study demonstrated that medical risk factors may not confound the measurement of attachment levels in women who are hospitalized for high-risk pregnancies, the targeted population of the present study (Brandon, 2006).

Scope of the Present Study

The literature review has identified several components that are applicable to a biopsychosocial model of adverse birth outcomes. There are numerous medical and demographic risk factors for adverse birth outcomes (Table 1), which are defined here as low birth weight, preterm birth, and low Apgar scores (Dunkel-Schetter, 2011). Stress increases these risk factors through various physiological mechanisms (Cardwell, 2013), and social support lessens these risk factors by buffering the physiological responses to stress (Uchino, 2006). Attachment levels affect the use and appraisal of social support (Mikulincer & Shaver, 2009), and they also augment the protective factor of social support against stress (Ditzen et al., 2008). Despite these myriad connections, no study to date has investigated the relationship among attachment levels and birth outcomes. The purpose of this study is to develop a biopsychosocial model of birth outcomes that accounts for attachment levels, social support, and perceived stress in a sample of women with high-risk pregnancies. This study focuses on a sample of women who are hospitalized for high-risk pregnancies because this population can benefit greatly from research on adverse birth outcomes. It also limits the scope to English-speaking participants in order to use questionnaires that have not been validated in other languages.

Aims and Hypotheses

Aim I: Examine the relationship among prenatal stress, social support, and birth outcomes.

Hypothesis Ia. Participants with higher prenatal stress levels have worse birth outcomes. Consistent with research on the adverse effects of stress on birth outcomes (Cardwell, 2013), it is predicted that participants with higher prenatal stress levels, as measured by the 10-Item Perceived Stress Scale (PSS10), will have worse birth outcomes, as measured by gestational age, birth weight, and Apgar scores. This analysis will control for medical and demographic risk factors. This hypothesis is illustrated in Figure 2.

Insert Figure 2

Hypothesis Ib. Stress and social support levels are inversely associated. Because social support has been shown to buffer the effects of stress (Uchino, 2006), it is predicted that participants with higher stress levels (PSS10) will have lower levels of social support, as measured by Social Provisions Scale (SPS), and vice versa. This is illustrated in Figure 3.

Insert Figure 3

Hypothesis Ic. Social support serves as a moderating variable between stress and birth outcomes. Previous research has demonstrated that social support during pregnancy can buffer stress levels (Kent et al., 2015). As such, it is predicted that social support (SPS) will moderate the association between stress (PSS10) and birth outcomes (gestational age, birth weight, and Apgar score), while controlling for the effects of risk factors. This is illustrated in Figure 4.

Insert Figure 4

Aim II: Examine the relationship among prenatal stress, social support, attachment levels, and birth outcomes.

Hypothesis IIa. Stress and attachment levels are positively associated. Because stress levels are activated under stress (Fraley & Shaver, 2000), it is predicted that participants with higher stress levels (PSS10) will have higher attachment anxiety and/or avoidance levels, as measured by the Experiences in Close Relationship Scale, Short Form (ECR-S). This hypothesis is illustrated in Figure 5.

Insert Figure 5

Hypothesis IIb. Attachment levels serve as moderating variables between stress and birth outcomes. Previous research has demonstrated that stress is detrimental to birth outcomes (Cardwell, 2013), and that attachment levels buffer the effects of stress (Ditzen et al., 2008). As such, it is predicted that attachment anxiety and avoidance levels will moderate the association between stress (PSS10) and birth outcomes (gestational age, birth weight, and Apgar score), while controlling for the effects of risk factors. This is illustrated in Figure 6.

Insert Figure 6

Hypothesis IIc. Stress, social support, and attachment levels together predict birth outcomes. Because individuals with lower attachment levels report greater social support (Mikulincer & Shaver, 2009), less stress (Fraley & Shaver, 2000), and better overall health (Hunter & Maunder, 2001), a biopsychosocial model of these variables is proposed. It is expected that stress (PSS10), social support (SPS), and attachment levels (ECR-S) will together predict birth outcomes, such that participants with lower stress, higher social support, and lower attachment levels will have higher (i.e., healthier) gestational age, birth weight, and Apgar scores. This analysis will also control for the effects of risk factors on birth outcomes. This is illustrated in Figure 7.

Insert Figure 7

CHAPTER 3

METHODOLOGY

The present study if part of a larger ongoing research project at Baylor University Medical Center (BUMC). The research protocol, including all recruitment materials, was approved by both BUMC and the University of Texas Southwestern Medical Center (UTSW) Institutional Review Boards (IRBs).

Participants

Participants were recruited from the BUMC antepartum unit, which treats women who are hospitalized for high-risk pregnancies. The unit also houses some postpartum women whose babies are either in the neonatal intensive care unit or who are housed in the mothers' hospital rooms; these women were not approached for participation in the study. The inclusion criteria were as follows: English-speaking, pregnant women who were 18 years or older and hospitalized in the BUMC antepartum unit. The exclusion criteria were as follows: patients with delirium, dementia, intellectual disability, psychosis, or active suicidal ideation; or those who are employees or students of BUMC.

Procedure

Research assistants shared the responsibility of screening all patients in the BUMC antepartum unit by reviewing electronic medical records (EMRs) and nursing station documentation on a daily basis. They approached eligible patients in their hospital rooms to explain the research aims and informed consent process. Patients were informed that participation in the study was voluntary and had no bearing on their medical treatment; that if they chose to participate, their responses would be de-identified and analyzed in composite form; that there were no immediate benefits or greater-than-minimal risks associated with participation; and that they might withdraw from the study at any time. They were informed that participation involved two components: participants completed a battery of paper-and-pencil questionnaires, and researchers extracted maternal and fetal medical information from participants' EMRs after they give birth. Patients who chose to participate in the study then completed a written informed consent document.

The self-report battery was comprised of the following questionnaires: 10-Item Perceived Stress Scale (PSS10; Cohen & Williamson, 1998), Social Provisions Scale (SPS; Russell et al., 1984), Experiences in Close Relationships Scale–Short Form (ECR-S; Wei et al., 2007), and a researcher-created demographic questionnaire. The battery took 30 minutes to complete, after which researchers returned to participants' rooms to retrieve the materials. Researchers subsequently monitored participants' hospital status via their EMRs to determine when participants had given birth. Once delivery information was available on the EMRs, researchers extracted medical variables that were recorded as part of standard clinical care (detailed below).

Data protection plans were approved by both institutions' IRBs. Participants were assigned numerical codes and data were recorded in de-identified form. Data were stored in a locked filing cabinet within a locked office on a secured hallway at BUMC. Links that connected codes to protected health information were stored separately from data.

Data collection ran from October 2014 to October 2015. 485 patients' medical charts were screened for eligibility. 180 (37.1%) were found to be ineligible; the reasons for ineligibility are detailed in Table 2. 28 patients (5.8% of those screened) were not approached for various reasons despite being eligible to participate in the study. A total of 277 patients (57.1%) were approached. Of those, $N = 188$ (67.9%) consented and participated in the study.

Insert Table 2

Instruments and Outcome Measures

10-Item Perceived Stress Scale (PSS10; Cohen & Williamson, 1998). The Perceived Stress Scale (PSS) was originally designed as a 14-item self-report measure of perceived stress. It measures the degree to which respondents appraise recent life events as stressful, unpredictable, and uncontrollable, as well as the degree to which they report the sense of being overloaded. The items pertain to respondents' thoughts and feelings over the past month, and are not specific to any particular type of stressor. The measure was designed for use with non-clinical respondents with junior high school reading levels (Cohen, Kamarck, & Mermelstein, 1983).

Cohen and Williamson (1998) used principal components analysis to refine the measure to 10 items. In addition to reducing patient burden, the PSS10 also boasts improved psychometric properties from the original PSS. Each item is rated on a 5-point Likert scale, with 4 items reverse-scored for interpretation. There are no cut-scores for the PSS10: as such, data can be analyzed either within a given sample, or in comparison to probability samples (e.g., Cohen & Janicki-Deverts, 2012). The PSS10 is considered the gold standard for measuring perceived stress (American Psychological Association, 2004). It is the stress measure most commonly used with pregnant women (Cardwell, 2013), and it has also been used in samples of high-risk pregnant women (Javid et al., 2015; Stark & Brinkley, 2007).

The PSS10 has been demonstrated to have high internal consistency, with Chronbach's alpha ranging from .78 to .91. Test-retest reliability is stronger for intervals less than four weeks (r = .74 to .88) than those at six weeks (r = .55), which is consistent with the fact that PSS10 inquires about stress within the past month (Cohen & Williamson, 1998; Lee, 2012). PSS10 is moderately associated with the appraisal of stress in an average week (r = .36), as well as with overall appraisal of negative life events (r = .25 to .54). It is consistently associated with measures of anxiety and depression (r = .60 to .73). Studies of discriminant validity demonstrate that the PSS10 appropriately lacks correlation with measures of sensation seeking, religious faith, and aggression (Cohen & Williamson, 1998; Lee, 2012).

Social Provisions Scale (SPS; Cutrona & Russell, 1987). SPS is a 24-item self-report measure of perceived social support designed for use in the general population. Respondents answer items on a four-point scale, indicating the degree to which each item reflects her experience of social support. Twelve of the items are subsequently reverse-scored for interpretation (Cutrona & Russell, 1987). SPS provides a total score of overall perceived social support, as well as sub-scores for the six social provisions developed from the Weiss (1974) model: Attachment, Social Integration, Opportunity for Nurturance, Reassurance of Worth, Reliable Alliance, and Guidance. This allows respondents to appraise the degrees to which various interpersonal needs are met, regardless of current relationship status or social network size (Cutrona, 1984; Cutrona & Russell, 1987; Russell et al., 1984; Weiss, 1974).

Several studies have used SPS with samples of pregnant women to measure the buffering effects of social support against postpartum depression (Leigh & Milgrom, 2008; Rudnicki et al., 2001). SPS was also recently used to measure the interaction of attachment styles and perceived social support in a gynecological cancer sample at BUMC (Adams, 2012).

Confirmatory factor analysis of SPS reveals that the six-factor model is a better fit than a single factor, but high correlations between subscales (r = .54 to .99) suggest the possibility of a second-order factor (Gottlieb & Bergen, 2010). Perhaps due to these high inter-subscale correlations, the overall measure appears to have excellent internal consistency, with Chronbach's alpha = .92. The internal consistency of each subscale ranges from .65 to .76 (Cutrona & Russell, 1987; Gottlieb & Bergen, 2010). Test-retest reliability ranges from .37 to .66 (Cutrona & Russell, 1987).

Convergent and discriminant analyses demonstrate that SPS scores are better correlated with other measures of social support than with measures of social desirability, distress, personality, and social skills (Cutrona & Russell, 1987; Gottlieb & Bergen, 2010). They are moderately related to measures of loneliness, life satisfaction, and depression, with correlations ranging from .28 to .31 (Cutrona & Russell, 1987). Although not designed to identify sources of social support, SPS subscales have been shown to relate to different types of relationship satisfaction. SPS Attachment scores relate to respondents' satisfaction with romantic relationships (beta = .547); Social Integration scores relate to satisfaction with friendships (beta

= .317); and Reliability Alliance scores relate to satisfaction with family (beta = .244; Cutrona & Russell, 1987; Russell et al., 1984).

Experiences in Close Relationships Scale–Short Form (ECR-S; Wei et al., 2007). Brennan, Clark, and Shaver (1998) developed the Experiences in Close Relationships Scale (ECR), a self-report inventory of attachment style on two dimensions. The authors created the measure by first pooling items from fourteen existing attachment measures, and then using factor analysis to reveal two underlying dimensions: attachment anxiety and attachment avoidance. The resulting 36-item ECR consists of two scales, Anxiety and Avoidance, and has served as the standard measure of attachment dimensionality since its creation (Brennan et al., 1998; Mikulincer et al., 2003). Fraley, Waller, and Brennan (2000) revised the ECR using item response theory: the resulting Experiences in Close Relationships–Revised (ECR-R) retains the same structure with improved psychometric qualities (Fraley et al., 2000).

The major limitation of the ECR and ECR-R has been their length. Wei, Russell, Mallinckrodt, and Vogel (2007) thus created a short form, ECR-S. As with the original, the ECR-S is comprised of two scales, Anxiety and Avoidance. Respondents indicate the degree to which they agree with twelve items on a seven-point scale; four items are then reverse-scored for interpretation (Wei et al., 2007). In a series of six studies, Wei and colleagues (2007) demonstrated that the ECR-S psychometric properties are comparable to, and in some cases exceed, those of the ECR.

The ECR-S Anxiety and Avoidance scales each have good internal consistency, with coefficient alphas ranging from .77 to .86 in the Anxiety scale, and from .78 to .88 in the

Avoidance scale. The two scales are minimally correlated with each other (*r* = .25 to .28), indicating that they measure distinct domains. Confirmatory factor analyses reveal that the data fit well with a two-factor structure (Anxiety and Avoidance). Lastly, the scales have strong test-retest reliability over three- and four-week intervals, with correlations ranging from .80 to .82 on the Anxiety scale, and from .83 to .89 on the Avoidance scale (Wei et al., 2007).

The ECR-S has been examined in numerous convergent and discriminant analyses. The Anxiety scale is most associated with reassurance-seeking (*r* = .41 to .45), emotional reactivity (r = .45), and psychological distress (*r* = .41). It is appropriately not associated with domains such as comfort with self-disclosure or emotional isolation. The Avoidance scale, on the other hand, is most associated with fear of intimacy (*r* = .74), emotional isolation (*r* = .59), and loneliness (*r* = .43). As expected, it is not associated with domains such as reassurance-seeking or emotional reactivity (Wei et al., 2007).

Demographic questionnaire. The self-report battery included a researcher-created demographic questionnaire. Respondents self-identified number of completed years of education, number of weeks pregnant, marital status, race, and ethnicity.

Electronic medical records (EMRs). Once delivery information was available on EMRs, researchers extracted medical variables that were recorded as part of standard clinical care (see below). Because the time from the self-report battery to delivery ranged from days to months, participants' survey and delivery dates were also recorded.

Physiological risk factors. The following variables were extracted from participants' EMRs after they had been discharged from the hospital: admitting diagnosis, additional diagnoses, past medical history, and past surgical history. These items were extracted verbatim from the EMRs and coded at a later time; see preliminary statistical analyses below.

Birth outcomes. After participants gave birth, the following outcome data were extracted from their EMR delivery summaries: completed gestational age (weeks), neonatal birth weight (grams), and Apgar score at one and five minutes after birth.

Preliminary Statistical Analyses

Power analysis. An a priori power analysis was conducted using G*Power 3.1 software (Faul, Erdfelder, Buchner, & Lang, 2009). The analysis indicated that for multiple regression with five predictors (number of risk factors, stress, social support, attachment anxiety, and attachment avoidance), a sample size of 108 would be sufficient to detect significant interaction with a power of .95, effect size $f^2 = .15$, and $\alpha = .05$.

Demographic characteristics. Descriptive frequency statistics were calculated to describe participants' age, race, ethnicity, educational attainment, and marital status, all of which were compared to local census data. Additional demographic information about participants' pregnancy (gestational age at survey and time between survey and delivery) was also examined.

Risk factor characteristics. Preliminary analyses were conducted to determine the risk factors for adverse birth outcomes in this sample. Risk factor analyses was conducted with a preliminary sample size of $N = 161$, of which $n = 122$ had available birth data at the time. Upon review of these participants' EMR data, it was observed that their medical conditions were documented with language that did not cleanly match the risk factors that had been previously identified in the literature. For example, cervical abnormalities were more precisely described in EMRs as “cervical effacement,” “cervical incompetence,” “short cervix,” etc. Given this variability in language, medical conditions of similar type were clustered together, and all clusters were coded regardless of whether or not they had been identified as risk factors in the literature.

A total of 763 conditions were identified in this sample, and then clustered into 42 unique demographic and medical codes. For example, histories of “cerclage,” “cervical conization,” “cold knife conization,” “cone biopsy,” “dilation and cutterage,” or “loop electrocautery excision procedure” (all cervical surgeries) were grouped under the single code, “history of cervical surgery.” Of the 42 codes, 28 had been identified as risk factors for adverse birth outcomes in the literature review. The remaining fourteen codes included conditions with no known birth risk, such as “gastrointestinal problem” or “thyroid problem.”

A biserial correlation analysis was conducted to assess which of the 42 coded conditions were associated with birth outcomes (birth weight, gestational age, or Apgar score) in this sample. A low threshold for significance was used for this analysis in order to prioritize sensitivity to associations that may later prove to be significant in a larger sample. As such, any correlation with $p \leq .05$ was considered significant, regardless of the correlation coefficient. Six of the 42 codes were identified as having significant associations with birth outcomes. Although this ratio is not much greater than chance, all six risk factors had been identified in the literature a priori. As such, they were subsequently considered risk factors and included as covariates for the remainder of the analyses. Table 3 describes the coding criteria for these six variables.

Insert Table 3

The final risk factor analysis was a one-way between-groups analysis of variance (ANOVA) to determine if there were differences in birth outcomes between participants who had maternal and/or fetal risk factors, as categorized in Table 4.

Insert Table 4

Self-report characteristics. Descriptive frequency statistics were conducted to examine the self-report variables (stress, social support, and attachment levels) and to compare the samples' scores to other populations of pregnant women. Additionally, a series of one-way between-group analyses of variance with post hoc comparisons was conducted to explore demographic differences in the self-report scores.

Birth outcome characteristics. Descriptive frequency statistics were conducted to explore the sample's birth outcomes (gestational age, birth weight, and Apgar scores). The prevalence of adverse birth outcomes in this sample was also compared to rates in the general population.

Preliminary correlations. A series of biserial correlations was computed to explore associations between self-report measures, risk factors, and birth outcomes. Due to high correlations between Apgar scores at one and five minutes after birth, a composite Apgar score was created for use in subsequent analyses.

Primary Statistical Analyses

Hypothesis Ia. Participants with higher prenatal stress levels have worse birth outcomes. To determine if participants with higher stress levels had worse birth outcomes, three linear regression analyses were conducted. In each, the predictor was PSS10 and the covariate was the number of risk factors. The criteria were gestational age, birth weight, and composite Apgar score, respectively.

Hypothesis Ib. Stress and social support levels are inversely associated. To determine if participants with higher stress had lower social support levels and vice versa, a Pearson product-moment correlation was conducted between PSS10 and SPS scores.

Hypothesis Ic. Social support serves as a moderating variable between stress and birth outcomes. To determine if social support moderated the association between stress and birth outcomes, three hierarchical multiple regression analyses were conducted. In each, the predictor was PSS10, the covariate was the number of risk factors, and the moderator was SPS. The criteria were gestational age, birth weight, and composite Apgar score, respectively.

Hypothesis IIa. Stress and attachment levels are positively associated. To determine if participants with higher stress levels had higher attachment anxiety and avoidance levels (and vice versa), two Pearson product-moment correlations were conducted: one between PSS10 and ECR-S Anxiety, and another between PSS10 and ECR-S Avoidance.

Hypothesis IIb. Attachment levels serve as moderating variables between stress and birth outcomes. To determine if attachment anxiety and/or attachment avoidance levels moderated the association between stress and birth outcomes, six hierarchical multiple regression analyses were conducted. In the first three analyses, the predictor was PSS10, the covariate was the number of risk factors, the criteria were gestational age, birth weight, and composite Apgar score (respectively), and the moderator was ECR-S Anxiety. In the last three analyses, the predictor was PSS10, the covariate was number of risk factors, the criteria were gestational age, birth weight, and composite Apgar score (respectively), and the moderator was ECR-S Avoidance.

Hypothesis IIc. Stress, social support, and attachment levels together predict birth outcomes. To examine the role of stress, social support, attachment anxiety, and attachment avoidance levels together, a series of three linear regression analyses was conducted. As with previous analyses, the covariate was the number of risk factors and the criteria were gestational age, birth weight, and composite Apgar score (respectively). The predictors were PSS10, SPS, ECR-S Anxiety, and ECR-S Avoidance.

CHAPTER 4

RESULTS

Preliminary Analyses

Demographic characteristics. The sample consisted of 188 pregnant women, ages 18 to 45 (M = 29.14, SD = 6.60 years). Demographic information and comparison census data are presented in Table 5. Half of the sample (n = 94, 50.0%) was married; 44.1% (n = 83) was single. 52.7% of the sample (n = 98) identified as white; 44.1% (n = 82) identified as black or African-American; 2.2% (n = 4) were American Indian/Alaska Native; and 1.1% (n = 2) were Asian. 85.1% (n = 160) identified as Non-Hispanic/Latina. Compared to the general population of Dallas County, this is an under-representation of Hispanic women (60.7% of women in Dallas identify as Non-Hispanic) and an over-representation of black women (23.1% of Dallas County reports black race; United States Census Bureau, 2014). Educational attainment ranged from 5 years (elementary school) to 21 years (terminal degree), with a mean education of 14.34 years (some college; SD = 2.83). 19.9% (n = 37) of the sample had more than a four-year college degree, compared to 10.1% in the general population (United States Census Bureau, 2014).

At the time of the self-report survey, participants were 4 to 38 weeks pregnant (M = 28.21, SD = 6.34 weeks), with the majority in their third trimester (n = 125, 66.5%). Participants completed the survey 0 to 212 days before they gave birth. The mean duration between survey and delivery was 37.38 days (SD = 39.11), or 5.34 weeks. The time between survey and delivery was found to have no significant impact on subsequent analyses.

Insert Table 5

Risk factor characteristics. To determine which of the 42 demographic and medical codes correlated with birth outcomes, a biserial correlation analysis was conducted. The results revealed that six of the 42 codes were at least minimally associated with birth outcomes, and were thus considered risk factors for the remainder of the analyses. Table 6 summarizes the correlations between the six risk factors and birth outcomes. Black race correlated with gestational age ($r = -.19$, $p = .04$) and birth weight ($r = -.21$, $p = .02$); cervical abnormality correlated with gestational age ($r = -.43$, $p < .001$), birth weight ($r = -.32$, $p < .001$), Apgar 1 minute ($r = -.20$, $p = .03$), and Apgar 5 minute ($r = -.36$, $p < .001$); multifetal gestation correlated with gestational age ($r = -.20$, $p = .03$) and birth weight ($r = -.20$, $p = .03$); ruptured membranes correlated with gestational age ($r = -.31$, $p < .001$) and birth weight ($r = -.25$, $p = .01$); placental abnormality correlated with Apgar 1 minute ($r = -.28$, $p = .01$); and uterine abnormality correlated with gestational age ($r = -.20$, $p = .03$) and Apgar 5 minute ($r = -.21$, $p = .03$).

The biserial correlation among the six risk factors revealed that black race, ruptured membranes, and placental abnormalities did not correlate with any of the other risk factors. Multifetal gestation was significantly correlated with cervical ($r = .32$, $p < .001$) and uterine abnormalities ($r = .23$, $p = .01$), although cervical and uterine abnormalities did not correlate with each other ($p = .07$).

Birth outcomes were strongly associated with one another: gestational age correlated with birth weight ($r = .82$, $p < .001$), Apgar 1 minute ($r = .62$, $p < .001$), and Apgar 5 minute ($r = .65$, $p < .001$); birth weight additionally correlated with Apgar 1 minute ($r = .42$, $p < .001$) and Apgar 5 minute ($r = .44$, $p < .001$), and Apgar 1 minute additionally correlated with Apgar 5 minute ($r = .72$, $p < .001$). Due to the strong association between Apgar scores at 1 and 5 minutes, a composite (mean) Apgar score was created and used for subsequent analysis.

Insert Table 6

Participants each had zero to five of the six identified risk factors. The mean number of risk factors per participant was 1.13 (*SD* = .95). Of the identified risk factors, black race was the most prominent, with almost half of the sample identifying as black (*n* = 82, 44.1%). 21.8% (*n* = 41) of the sample had a cervical abnormality, such as short cervix. 16% (*n* = 31) had multifetal gestation. 13.8% (*n* = 26) had preterm premature ruptured membranes. 6.9% (*n* = 13) had placental abnormalities, such as placenta previa or placental abruption. 8.0% (*n* = 15) had uterine abnormalities, such as uterine distension or a history of fibroid removal. Risk factor characteristics are presented in Table 7.

Insert Table 7

To determine if there were differences between the birth outcomes of participants with maternal and/or fetal risk factors, a one-way between-groups analysis of variance was conducted.

Participants were divided into three groups according to whether they had maternal risk factors (black race, cervical anomaly, and/or uterine anomaly), fetal risk factors (multifetal gestation, placental abnormality, and/or ruptured membranes), or both maternal and fetal risk factors. There were no statistically significant differences among the groups for any of the birth outcomes: gestational age: F (2, 113) = 1.99, p = .14; birth weight: F (2, 113) = 2.29, p = .11; or Apgar score: F (2, 111) = .51, p = .60.

Self-report characteristics. Table 8 presents the psychometric properties of the major study variables. The sample's mean perceived stress score (*M* = 15.52, *SD* = 7.94) was roughly equivalent to the average PSS10 score for U.S. females in a large population-based study (*M* = 16.14, *SD* = 7.56; Cohen & Janicki-Deverts, 2012). National averages were not available for the other measures used in this study, so smaller-scale studies with pregnant women were referenced for comparison. The sample's mean social support score of 85.39 (*SD* = 9.41) was higher than in another study of pregnant women at an urban hospital, where the SPS mean was 76.0 (*SD* = 11.3; Rudnicki et al., 2001). In the present study, the sample's attachment anxiety (*M* = 2.94, *SD* = .10) and attachment avoidance (*M* = 2.22, *SD* = 1.09) levels were relatively equal, compared to a recent U.K. study of pregnant women that found higher attachment anxiety (*M* = 3.13, *SD* = 1.09) than avoidance (*M* = 1.95, *SD* = 0.98) levels (Walsh, Hepper, & Marshall, 2014).

Insert Table 8

A series of one-way between-groups analysis of variance (ANOVA) was conducted to explore the impact of demographic variables on the self-report measures. The differences according to race are presented in Table 9. Attachment avoidance (as measured by ECR-S Avoidance) varied significantly among different races, although the effect size was modest: F (3, 181) = 3.04, p = .03, eta squared = .05. Post-hoc comparisons using the Tukey HSD test indicated that the mean ECR-S Avoidance score for black participants (M = 2.46, SD = 1.11) was significantly different from white participants (M = 2.00, SD = 1.05), such that black participants had more avoidant attachment than white participants. There were no significant differences in attachment anxiety scores according to race.

There was a statistically significant difference in social support scores (as measured by SPS) among races, with a moderate effect size: F (3, 147) = 3.85, p = .01, eta squared = .07. Post-hoc comparisons using the Tukey HSD test indicated that the mean SPS score for black participants (M = 82.81, SD = 10.35) was significantly different from white participants (M = 87.60, SD = 8.15), meaning that white participants reported more social support than black participants. There were no significant differences in stress scores (PSS10) according to race.

Insert Table 9

ANOVAs were also conducted to compare participants' self-report scores according to their levels of education. These results are presented in Table 10. As with racial differences, there was a significant difference in attachment avoidance, but not attachment anxiety, among participants with different levels of education: ECR-S Avoidance F (5, 180) = 3.60, p = .004. This effect size was moderate: eta squared = .09. Tukey HSD post-hoc comparisons indicated that the mean ECR-S Avoidance score for participants with high school degrees (M = 2.61, SD = 1.23) was significantly higher than those with graduate degrees (M = 1.79, SD = .81). Attachment anxiety (ECR-S Anxiety) did not vary significantly by education level.

There was also a significant difference in social support (SPS) scores among participants with different levels of education, with a large effect size: F (5, 145) = 8.33, p < .001, eta squared = .22. Tukey HSD post-hoc comparisons indicated that the mean SPS score for participants with less than a high school degree (M = 78.10, SD = 8.50) was significantly lower than those with a high school degree (M = 81.09, SD = 10.95). There were no differences in stress scores (PSS10) according to participants' education levels.

Insert Table 10

ANOVAs were also used to compare self-report differences among participants with different marital status. These results are presented in Table 11. As with the previous demographic comparisons, there was a significant difference in attachment avoidance but not attachment anxiety scores in participants with different marital status: ECR-S Avoidance F (3, 183) = 12.58, p < .001. This effect size was large: eta squared = .17. Tukey HSD post-hoc comparisons indicated that the mean ECR-S Avoidance score for single (never married) participants (M = 2.70, SD = 1.11) was significantly higher than married participants (M = 1.78, *SD* = .93), meaning single participants were more likely to have more avoidant attachment. Attachment anxiety levels (ECR-S Anxiety) did not vary significantly by marital status.

There was also a significant difference in social support (SPS) scores among participants with different marital status, with a moderate effect size: F (3, 149) = 4.18, p = .01, eta squared = .08. Tukey HSD post-hoc comparisons indicated that the mean SPS score for married participants (*M* = 88.14, *SD* = 6.88) was significantly higher than for single (never married) participants (*M* = 82.76, *SD* = 10.88). Stress levels (as measured by PSS10) did not vary significantly by marital status.

Insert Table 11

Birth outcome characteristics. Birth outcome characteristics are presented in Table 12. Of the 188 total participants, 154 had available gestational age and birth weight data at the time of data analysis. Slightly fewer had Apgar scores from 1 minute (n = 150) and 5 minutes (n = 151) after birth, as some EMRs were missing this data. The mean gestational age was 34.64 weeks (*SD* = 4.15), and the mean birth weight was 2339.62 grams (*SD* = 908.79). The mean Apgar score at 1 minute was 7.37 (*SD* = 1.98); at 5 minutes it was 8.38 (*SD* = 1.56).

Insert Table 12

Adverse birth outcome data, as well as general population comparisons, are presented in Table 13. 53.2% of the sample (*n* = 100) had preterm birth (birth before 37 weeks gestation), compared to 11.4% in the general U.S. population (Martin et al., 2015). 47.3% of the sample (*n* = 89) had low birth weight (≤2,500 grams), compared to 8% of the general population (Martin et al., 2015).

Insert Table 13

Preliminary correlations. Preliminary biserial correlation analyses were conducted among the primary variables. The summary of correlations between self-report measures and risk factors are presented in Table 14; the correlations between self-report measures and birth outcomes are in Table 15. There were few correlations between the self-report measures and risk factors. Multifetal gestation, ruptured membranes, placental abnormality, and uterine abnormality did not correlate with any self-report measures. Cervical abnormality minimally correlated with attachment avoidance ($r = -.18$, $p = .01$), but not with attachment anxiety, stress, or social support. Black race was the risk factor that correlated with the most self-report measures, although the strength of the correlations was very weak: black race correlated with perceived stress ($r = .17$, $p = .03$), social support ($r = -.26$, $p = .001$), and attachment avoidance ($r = .21$, $p = .001$). There were no significant correlations between self-report measures and birth outcomes.

Insert Table 14

Insert Table 15

Primary Analyses

Hypothesis Ia. A series of hierarchical multiple regression analyses was conducted to assess the hypothesis that participants with higher stress levels (as measured by PSS10) have worse birth outcomes (gestation age, birth weight, and Apgar scores), when controlling for risk factors for adverse birth outcomes. The results are presented in Table 16. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity, and homoscedasticity.

Insert Table 16

With gestational age as the outcome variable, risk factors were entered in the regression model at Step 1; they explained 17% of the variance. After PSS10 scores were entered at Step 2, the total variance explained by the model as a whole was still 17%, F (2, 149) = 15.39, $p < .001$, meaning that perceived stress did not account for a significant proportion of the variance after controlling for risk factors, R square change = .001, F change (1, 149) = .22, $p = .64$. Perceived stress was not statistically significant, *beta* = -.04, $p = .64$.

With birth weight as the outcome variable, risk factors entered at Step 1 explained 14% of the variance. After PSS10 was entered at Step 2, the total variance explained was still 14%, $F(2, 149) = 12.29$, $p < .001$. Perceived stress did not account for a significant proportion of the variance after controlling for risk factors, R square change = .001, F change $(1, 149) = .11$, $p = .74$, and perceived stress was not statistically significant, *beta* = -.03, $p = .74$.

With mean Apgar scores as the outcome variable, risk factors entered at Step 1 explained 4% of the variance. When PSS10 was entered at Step 2, the total variance explained was 5%, $F(2, 146) = 3.37$, $p = .04$. After controlling for risk factors, perceived stress did not account for a significant proportion of the variance in Apgar score, R square change = .01, F change $(1, 146) = .74$, $p = .39$. Perceived stress was not statistically significant, *beta* = -.07, $p = .39$.

Hypothesis Ib. To assess the hypothesis that stress (as measured by PSS10) and social support (as measured by SPS) levels are inversely associated, a Pearson product-moment correlation coefficient was examined. The results are presented in Table 17. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity, and homoscedasticity. There was a moderate, negative correlation between stress and social support, $r = -.37$, $n = 153$, $p < .001$, with high levels of stress associated with lower levels of social support.

Insert Table 17

Hypothesis Ic. To assess the hypothesis that social support moderates the association between stress and birth outcomes, a series of hierarchical multiple regression analyses were conducted for each of the 3 birth outcomes (gestational age, birth weight, and mean Apgar score). The results are presented in Table 18. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity, and homoscedasticity in each of the analyses.

Insert Table 18

In the gestational age analysis, the identified risk factors were entered at Step 1 as control variables; these explained 17% of the variance in gestational age. Stress (as measured by PSS10) and social support (as measured by SPS) scores were added at Step 2. The total variance explained by this model was still 17%, F (3, 119) = 8.25, $p < .001$, meaning that stress and social support did not account for a significant proportion of variance in gestational age when controlling for risk factors, R square change = .002, F change (2, 119) = .16, $p = .85$. To avoid potentially problematic high multicollinearity with the interaction term, the variables were centered and an interaction term between stress and social support was created. The interaction term between stress and social support was added to the regression model at Step 3. This did not account for a significant proportion of the variance in gestational age, R square change = .002, F change (1, 118) = .219, $p = .64$. The interaction term was not statistically significant, *beta* = .04, $p = .64$.

The same analyses were repeated with birth weight as the outcome variable. At Step 1, the risk factors explained 14% of the variance. When stress and social support were added at Step 2, the model still explained 14% of the variance, F (3, 119) = 6.59, $p < .001$, meaning that stress and social support did not account for significant variance in birth weight when controlling for risk factors, R square change = .002, F change (2, 119) = .11, p = .90. The centered interaction term between stress and social support was added at Step 3. This did not account for a significant proportion of variance in birth weight, R square change = .002, F change (1, 118) = .30, p = .59. The interaction term was not statistically significant, *beta* = -.05, p = .59.

Lastly, the analyses were repeated with mean Apgar scores as the outcome variable. The risk factors at Step 1 accounted for 4% of the variance. When stress and social support were added at Step 2, the model explained 5% of the variance, F (3, 116) = 1.85, p = .14, which was not a significant change. Stress and social support did not account for significant variance in Apgar scores when controlling for risk factors, R square change = .01, F change (2, 116) = .39, p = .68. At Step 3, the centered interaction term between stress and social support was added to the analysis. This did not account for a significant proportion of variance, R square change = .01, F change (1, 115) = .93, p = .34. The interaction term was not statistically significant, *beta* = .09, p = .34.

Hypothesis IIa. To assess the hypothesis that stress (as measured by PSS10) and attachment levels (as measured by ECR-S Anxiety and Avoidance, respectively) are positively associated, two Pearson product-moment correlation coefficients were examined. The results are presented in Table 17. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity, and homoscedasticity. There was a large, positive correlation between perceived stress and attachment anxiety scores, $r = .52$, $n = 186$, $p < .001$, such that high levels of stress were associated with high levels of attachment anxiety. There was a small, positive correlation between perceived stress and attachment avoidance scores, $r = .26$, $n = 187$, $p < .001$, indicating higher levels of stress are also associated with higher attachment avoidance.

Hypothesis IIb. To examine the hypothesis that attachment anxiety and avoidance levels moderate the association between stress and birth outcomes, a series of hierarchical multiple regression analyses were conducted. The results are presented in Tables 19 and 20. Preliminary analyses were conducted to ensure that the assumptions of normality, linearity, multicollinearity, and homoscedasticity were not violated.

Insert Table 19

With gestational age as the outcome variable, the identified risk factors were entered into the regression model at Step 1; they accounted for 17% of the variance. At Step 2, stress (as measured by PSS10) and attachment anxiety (as measured by ECR-S Anxiety) were added to the regression model. The total variance explained by this model was still 17%, F (3, 148) = 10.19, $p < .001$, which was not significant, R square change = .001, F change (2, 148) = .12, $p = .89$. In order to avoid potentially problematic high multicollinearity, the variables were then centered and an interaction term between stress and attachment anxiety was created. The interaction term was added to the regression model at Step 3, which did not account for a significant proportion of variance, *R* square change = .000, *F* change (1, 147) = .06, *p* = .81. The interaction term was not statistically significant, *beta* = -.02, *p* = .81.

The same analyses were conducted with birth weight as the outcome variable. The risk factors at Step 1 accounted for 14% of the variance. With stress and attachment anxiety added to the model at Step 2, the overall model still explained 14% of the variance, *F* (3, 148) = 8.15, *p* < .001, meaning that stress and attachment anxiety did not account for a significant proportion of variance in birth weight when controlling for risk factors, *R* square change = .001, *F* change (2, 148) = .06, *p* = .94. At Step 3, the centered interaction term was added; this also did not account for significant variance, *R* square change = .003, *F* change (1, 147) = .60, *p* = .44. The interaction term was not statistically significant, *beta* = .06, *p* = .77.

The same analyses were conducted with Apgar mean as the outcome variable. The risk factors at Step 1 accounted for 4% of the variance. With the addition of stress and attachment anxiety at Step 2, the model accounted for 5% of the variance, *F* (3, 145) = 2.25, *p* = .09, which was not a significant proportion when controlling for risk factors, *R* square change = .01, *F* change (2, 145) = .39, *p* = .68. At Step 3, the centered interaction term was then added; it did not account for significant variance, *R* square change = .01, *F* change (1, 144) = 1.26, *p* = .26. The interaction term was not statistically significant, *beta* = -.10, *p* = .26.

The same series of analyses were then conducted with attachment avoidance (as measured by ECR-S Avoidance) as the moderating variable (see Table 20). With gestational age as the outcome variable, the risk factors entered in Step 1 accounted for 17% of the variance. With stress and attachment avoidance added at Step 2, the model still accounted for 17% of the variance, $F(3, 136) = 16.10$, $p < .001$, meaning stress and attachment avoidance did not account for significant variance in gestational age when controlling for risk factors, R square change = .01, F change $(1, 148) = 10.31$, $p < .001$. In order to avoid potentially problematic high multicollinearity, the variables were centered and an interaction term between stress and attachment avoidance was created. The interaction term, entered at Step 3, did not account for significant variance, R square change = .01, F change $(1, 147) = 2.18$, $p = .14$. The interaction term was not statistically significant, *beta* = -.11, $p = .14$.

Insert Table 20

With birth weight as the outcome variable, the risk factors entered in Step 1 accounted for 14% of the variance. Stress and attachment avoidance were added at Step 2. This model accounted for 16% of the variance, $F(3, 148) = 9.44$, $p < .001$. This was not a significant proportion, meaning that stress and attachment avoidance did not account for significant variance in birth weight when controlling for risk factors, R square change = .02, F change $(2, 148) = 1.73$, $p = .18$. The interaction term entered at Step 3 did not account for significant variance, R square change = .01, F change $(1, 147) = 1.50$, $p = .22$. The interaction term was not statistically significant, *beta* = -.10, $p = .22$.

With mean Apgar score as the outcome variable, the risk factors in Step 1 accounted for 4% of the variance. Stress and attachment avoidance were added at Step 2; this model accounted for 5% of the variance, $F(3, 145) = 2.24$, $p = .09$, which is not significant. Stress and attachment avoidance did not account or significant proportion of variance in Apgar scores when controlling for risk factors, *R* square change = .01, *F* change (2, 145) = .38, $p = .69$. The interaction term entered at Step 3 did not account for significant variance, *R* square change = .01, *F* change (1, 144) = 2.06, $p = .15$. The interaction term was not statistically significant, *beta* = -.12, $p = .15$.

Hypothesis IIc. Hierarchical multiple regression analyses were used to assess the ability of stress, attachment anxiety, attachment avoidance, and social support to predict birth outcomes, after controlling for the effects of risk factors for adverse birth outcomes. The results are presented in Table 21. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity, and homoscedasticity.

Insert Table 21

With gestational age as the outcome variable, risk factors were entered at Step 1; they explained 17% of the variance. After stress (PSS10), attachment anxiety (ECR-S Anxiety), attachment avoidance (ECR-S Avoidance), and social support (SPS) were entered at Step 2, the total variance explained by the model as a whole was still 17%, *F* (5, 117) = 4.91, $p < .001$. Stress, attachment anxiety, attachment avoidance, and social support did not account for significant proportion of variance when controlling for risk factors, *R* square change = .004, *F* change (4, 117) = .12, $p = .97$.

With birth weight as the outcome variable, the risk factors entered at Step 1 accounted for 14% of the variance. PSS, ECR-S Anxiety, ECR-S Avoidance, and SPS were entered at Step 2, which resulted in the model explaining 16% of the variance, *F* (5, 117) = 4.54, $p = .001$. This was not a significant proportion of the variance after controlling for risk factors, *R* square change = .02, *F* change (4, 117) = .75, *p* = .56.

With Apgar mean scores as the outcome variable, the risk factors entered at Step 1 accounted for 4% of the variance. When PSS, ECR-S Anxiety, ECR-S Avoidance, and SPS were entered at Step 2, the total variance explained by the model was 5%, *F* (5, 114) = 1.10, *p* = .37, which was not a significant proportion of variance, *R* square change = .01, *F* change (4, 114) = .19, *p* = .94.

Additional Analyses

Further investigation was conducted into the potential role of black race in the study's findings. This was of particular interest given the high rates of black race in the sample, the finding that black race was a predictor of adverse birth outcomes, and the finding that attachment avoidance and social support levels varied between black and white participants. In order to investigate if black race (the covariate risk factor) influenced the study's predictor variables, all regression analyses were conducted a second time with black race removed from the covariates. There were no changes in the results. The data were then split by race and the analyses were run a third time with black race removed from the covariates; again, no changes in the results were found.

CHAPTER 5

DISCUSSION

The purpose of this study was to examine the relationship among prenatal stress, social support, attachment levels, and birth outcomes in a sample of women with high-risk pregnancies. Previous research has demonstrated that stress during normal pregnancy can exacerbate or even cause adverse birth outcomes through vascular and endocrine mechanisms (Gennaro & Hennessy, 2003; Hobel & Culhane, 2003), but this association had not been investigated in high-risk pregnancies. Furthermore, social support has been shown to buffer the physiological sequelae of stress (Uchino, 2006), and attachment levels are known to affect social support (Ditzen et al., 2008). This study created a biopsychosocial model of adverse birth outcomes that accounted for all of these factors and tested its applicability in a sample of women who had been hospitalized for pregnancy complications. This population was selected because it could benefit greatly from further research on risk and protective factors related to adverse birth outcomes. The following sections examine the study's findings and propose ways in which they may reflect this unique population.

Preliminary Analyses

Compared to the general population of Dallas County, this sample was highly educated. It also reflected an under-representation of Hispanic women, and an over-representation of black women with respect to the county. The high proportion of black women in this sample is to be expected, however, given that black race is one of the primary risk factor for pregnancy complications. This demographic skew is therefore consistent with the population of antepartum units (Institute of Medicine, 2007).

All participants in this study were hospitalized for medical complications during pregnancy that increased their risk of adverse health outcomes. As such, an integral component of this study was to identify and control for the effects of participants' risk factors. After identifying the known maternal and fetal risk factors through literature review, the researcher then coded all participants' medical conditions to evaluate the degree to which they were associated with birth outcomes, as well as the degree to which they fit with the risk factors identified in the literature. Six risk factors were associated with birth outcomes in this sample; all six had been previously identified as risk factors in the literature (see Table 4; Collins & David, 2009; Comstock, 2011; Davis et al., 1990; Ekwo et al., 1992; Kiely, 1998; Newman et al., 2008). Black race was the most common risk factor, followed by cervical abnormality, multifetal gestation, ruptured membranes, uterine abnormality, and lastly placental abnormality. There was little to no correlation among the six identified risk factors, suggesting that each condition uniquely contributed to birth outcomes. There were no differences in birth outcomes according to whether the risk factors were maternal and/or fetal in origin, which indicates that in this sample, categorizing risk factors in this manner is not predictive of birth outcomes.

Participants completed self-report measures of stress, social support, and attachment anxiety and avoidance levels. The mean self-report survey scores were generally consistent with research on other samples of pregnant women. Attachment avoidance and social support levels varied significantly by race, education, and marital status: higher attachment avoidance was associated with black race, lower education, and being single. The finding that black participants had higher levels of attachment avoidance than white participants is consistent with previous research, and is thought to reflect multiple factors associated with the construct of race, including socialization and socioeconomic factors (Wei, Russell, Mallinckrodt, & Zakalik, 2004). By contrast, higher social support was associated with white race, higher education, and being married. Neither attachment anxiety nor perceived stress levels varied by demographic group.

Follow-up data were collected after participants gave birth. Approximately half of the participants had preterm birth and/or low birth weight. These figures are disproportionately high when compared to the general population (see Table 13), but are to be expected from a high-risk antepartum sample (Martin et al., 2015). The timespan between when participants completed the self-report surveys and when they delivered had no effect on subsequent analyses.

Before turning to the primary analyses of this study, a series of preliminary correlations was conducted to assess the strength of the relationships among the psychosocial and physiological variables. By design, the risk factor variables correlated with birth outcomes in this sample. However, neither the risk factors nor the birth outcomes correlated with stress, social support, or attachment levels.

The finding that stress, in particular, did not correlate with birth outcomes diverges from literature on stress in general-population pregnancies (Giscombe & Lobel, 2005; Littleton, et al., 2010). As discussed in the literature review, two physiological mechanisms of stress are understood to exacerbate and potentially cause preterm birth and low birth weight. First, stress increases CRH levels, which can induce preterm labor through the release of ACTH and glucocorticoids, and can also increase susceptibility to infection (which itself can induce preterm labor; Hobel & Culhane, 2003). Second, stress increases cytokine levels, which can initiate preterm labor through prostaglandin-induced cervical changes (Gennaro & Hennessy, 2003). These physiological processes explain the well-documented association between stress and adverse pregnancy outcomes in the general population (Cardwell, 2013). However, this study found that there was no association between stress and birth outcomes in this sample of women with high-risk pregnancies.

Participants' medical complications presented profound risk for adverse birth outcomes; so profound that the effects of stress were negligible. By thus deviating from the literature on normal pregnancies, this finding suggests that stress is less relevant to the physiological outcomes of high-risk pregnancies.

Primary Analyses

Hypothesis Ia, which proposed that stress levels predict birth outcomes, was not supported. As expected from the lack of correlation between stress levels and birth outcomes, hierarchical multiple regression analyses revealed that stress did not predict any of the birth outcomes. Instead, risk factors for adverse birth outcomes explained the variance, and stress levels were not additive to the model.

Hypothesis Ib predicted that stress and social support levels would be inversely associated. This was supported by correlation analysis, which found that participants with higher stress levels had lower social support levels, and vice versa. This is consistent with previous research on antepartum populations, in which women who are hospitalized with high-risk pregnancies have been shown to have reduced stress in the presence of high social support (Kent et al., 2015). Of course, causality cannot be determined from these associations: high social support may help lessen stress, and high stress may drive away social support. Nonetheless, a clear association was demonstrated in the present sample, reflecting the inverse association between stress and social support in women with high-risk pregnancies.

Hypothesis Ic was that social support moderates the association between stress and birth outcomes; this was not supported. A series of hierarchical multiple regression analyses was conducted to examine each of the three birth outcomes. In each analysis, the risk factors for adverse birth outcomes were the only significant predictors of the birth outcome. Neither stress nor social support accounted for variance in birth outcomes over and above these risk factors.

Hypothesis IIa, that stress would be positively associated with attachment anxiety and attachment avoidance levels, was supported. There was a large, positive correlation between perceived stress and attachment anxiety, and a small, positive correlation between perceived stress and attachment avoidance (see Table 17). This indicates that higher levels of stress were associated with higher levels of attachment anxiety and (to a lesser, but still significant extent) attachment avoidance. As previously discussed, high attachment levels can be understood as insecure attachment style (Brennan et al., 1998). The finding that participants with insecure attachment style tend to report high levels of stress is consistent with previous literature documenting how attachment systems are activated under stress (Fraley & Shaver, 2000). The present study contributes to this existing body of research by documenting a relationship among heightened stress and attachment levels in a sample of women hospitalized for high-risk pregnancies.

Hypothesis IIb was that attachment anxiety and avoidance levels would moderate the association between stress and birth outcomes. This was not supported, which was to be expected from the preliminary finding that there was no association between stress or attachment levels and birth outcomes. As with other hierarchical multiple regressions in this study, this analysis revealed that the risk factors were significant predictors of birth outcomes, and that psychosocial variables were not additive to the relationship.

Hypothesis IIc, that stress, attachment levels, and social support together predict birth outcomes, was not supported. Hierarchical multiple regression analyses found that risk factors were the sole predictors of birth outcomes; psychosocial variables did not contribute to the model.

Additional analyses were conducted to investigate the potential role of race in the study's findings. After removing black race (an identified risk factor) from the covariates and splitting the data by race, no significant differences were found in the study's results.

Overall, the study found that stress was associated with social support (hypothesis Ib), attachment anxiety (hypothesis IIa), and attachment avoidance (hypothesis IIa): participants with more stress reported lower levels of social support and higher levels of attachment anxiety and avoidance. Demonstrating the associations between these psychosocial variables in a sample of women with high-risk pregnancies is additive to the field of antepartum studies, as little research has been conducted on the psychosocial experience of women who are hospitalized for pregnancy complications. This lays the groundwork for future research on psychosocial interventions in this population.

An unintended finding of this study was that participants were more likely to have avoidant attachment and low social support if they had black race, lower education, and/or were single. Further investigation into the impact of race revealed no additional effects on the study's models.

The remaining hypotheses were premised on a presumed association between stress and birth outcomes, since the mechanisms and strength of this relationship have been well documented in normal pregnancies (Cardwell, 2013). However, in this sample of high-risk pregnancies, no association was found between stress and birth outcomes, or between any psychosocial variable and birth outcome. As such, no moderated relationships between psychosocial variables and birth outcomes were found.

The finding that stress was not associated with birth outcomes raises some important questions about this study's sample. In this sample of high-risk pregnancies, women who experienced more stress had other psychosocial problems (less social support and more insecure attachment styles), but the stress did not impact the physiological outcomes of their pregnancies. Instead, medical risk factors were powerful predictors of adverse birth outcomes: so powerful, in fact, that psychosocial variables had no additive effects. This is likely explained by the high-risk nature of the sample. Recall that 53.2% of the sample had preterm birth, compared to 11.4% of the general population (Martin et al., 2015). 47.3% of the sample had low birth weight, which is almost five times the national average of 8.0% (Martin et al., 2015). The staggeringly high rates of adverse birth outcomes in this sample – which, again, are to be expected from the antepartum hospital unit – suggest that these participants' medical risk factors were so powerful that the measured psychosocial variables could not overpower them.

There is perhaps a threshold of organic injury beyond which psychological variables are negligible to physical outcomes. A pregnant woman with massive abdominal trauma would be at high risk of adverse birth outcomes no matter how secure her attachment, how strong her social support, and how low her stress levels. The present study suggests that the women in an inpatient antepartum unit may have crossed the same threshold; the physical outcomes of their high-risk pregnancies were not susceptible to psychosocial variables.

Because the psychosocial variables of this study had no bearing on the biological outcomes, a biopsychosocial model may not be the best way to approach this population. Psychosocial interventions in this population may be most effective if they target psychosocial, rather than biological, outcomes. Psychologists may not be able to significantly affect these patients' physical birth outcomes, but more research is needed on the other ways in which they can help women with high-risk pregnancies. For example, because stress was associated with social support and attachment levels, this study suggests that stress-reduction interventions in this population would be most effective if they accounted for individual differences in social support and attachment style.

Limitations and Directions for Future Research

The population sampled for this study was unique in that it was at very high risk for adverse birth outcomes. This was an intentional choice because the population would benefit greatly from further research on biopsychosocial factors affecting their birth outcomes. However, sampling from only one hospital unit limited the study's generalizability.

The sample also underrepresented Hispanic women, which may have been due to the protocols only being available in English. Using questionnaires that had been validated in Spanish would have increased the generalizability of the study. This study attempted to record participants' primary language in order to assess the role of language comprehension in survey results. Primary language was extracted from participants' electronic medical records; however, all participants' records listed English as the primary language. Anecdotally, some participants had accents suggesting that English may not have been their primary language. This appears to reflect an error in the medical records. As such, it was not possible to analyze the effects of primary language on comprehension. Although this study inquired about participants' educational attainment and used questionnaires with low reading level requirements, it did not administer reading level assessments and therefore could not account for participants' actual reading levels.

An incidental finding of this study was that participants' attachment avoidance and social support levels varied by race, education, and marital status. In this sample, participants were more likely to have avoidant attachment and low social support if they were black (as opposed to white), had a lower education level, and were single (versus married). These same demographic variables did not account for any variability in attachment anxiety or stress levels, however. Previous research suggests that these demographic disparities may reflect socialization and socioeconomic factors (Wei et al., 2004), neither of which were accounted for in this study. Future research should therefore investigate cultural and economic factors that may particularly affect attachment avoidance and social support scores.

An important limitation of this study is that some participants had incomplete protocols. One reason for this was that the social support measure (SPS) was added to the protocol after data collection initiation. As such, fewer participants completed the social support measure than the other psychosocial measures. This should not have affected sampling, however, because there was no systematic difference between participants who were approached before and after this measure was added.

Additionally, some participants were missing birth outcome data. The lack of birth outcome data in participants' electronic medical records could mean one of two things: either they eventually delivered at a non-Baylor University Medical Center location, or their pregnancies ended in fetal demise. These are very disparate possibilities that could have affected the birth outcome data quite differently. However, in the interest of minimizing participant burden – especially for those who may have lost pregnancies – this researcher chose not to follow up with participants whose birth outcome data was missing. Future researchers could consider non-intrusive ways to inquire with formerly pregnant women about the outcomes of their pregnancies.

Although this study tracked participants from survey completion to delivery, future studies could also consider a more longitudinal approach in which mother-infant dyads are assessed during pregnancy and again after delivery. This could yield additional data about maternal-fetal attachment (Alhusen, 2008) and the development of attachment in young children.

It should also be noted that gestational age, one of the primary outcomes of this study, is usually an estimate, since the date of conception is often unknown. Additionally, some gestational ages are altered by scheduled cesarean deliveries. However, cesarean deliveries would be unlikely to influence the delivery timing in this sample due to the high-risk nature of the pregnancies. Nonetheless, future studies could examine the method of delivery to determine any effects that it may have on birth outcomes.

These methodological considerations highlight the complicated nature, but importance, of further research on high-risk pregnancies. It is recommended that more research be conducted on prenatal interventions that may decrease psychosocial burden in this population.

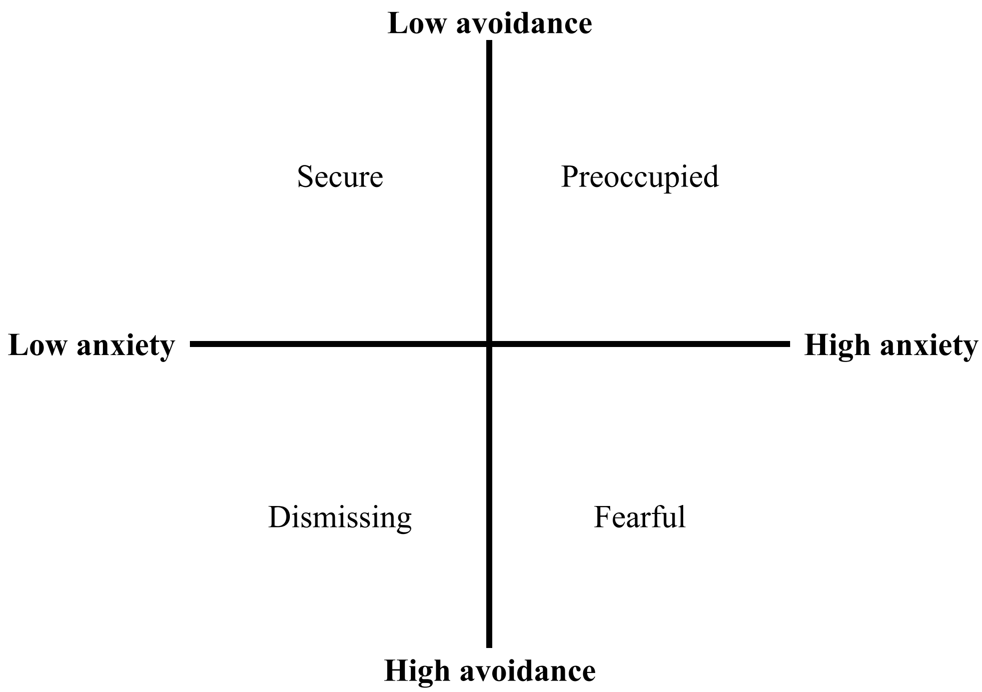

FIGURE 1. Dimensional and categorical conceptualization of adult attachment (Brennan et al., 1998).

FIGURE 2. Hypothesis Ia.

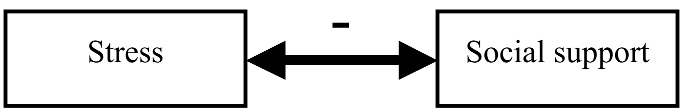

FIGURE 3. Hypothesis Ib.

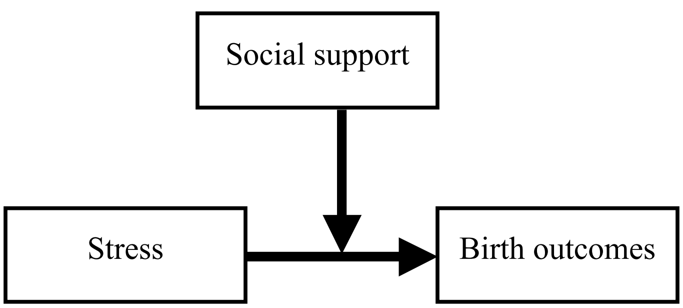

FIGURE 4. Hypothesis Ic.

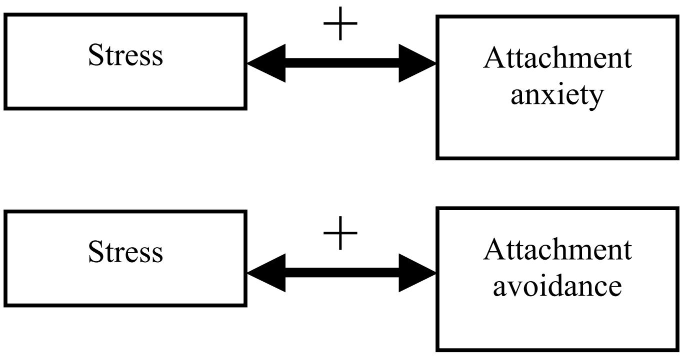

FIGURE 5. Hypothesis IIa.

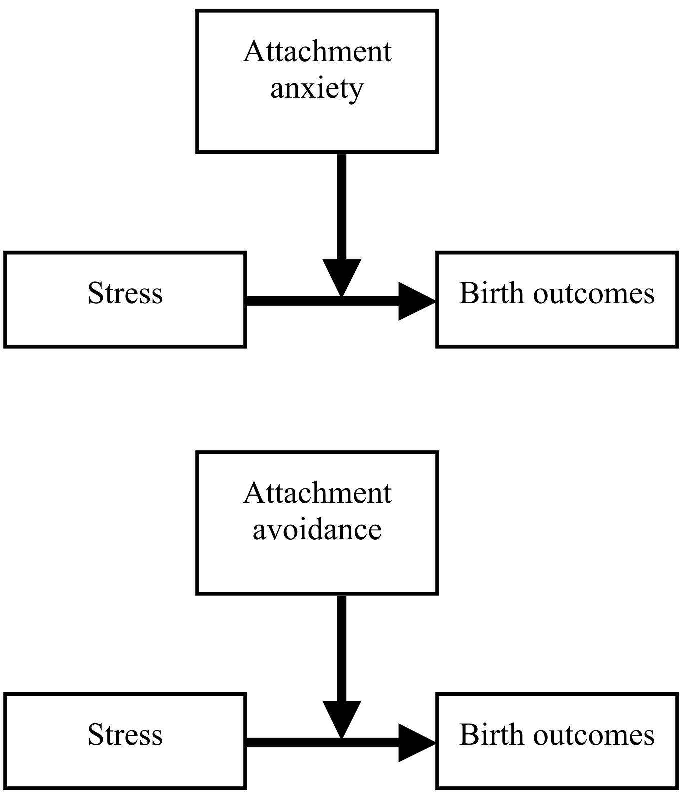

FIGURE 6. Hypothesis IIb.

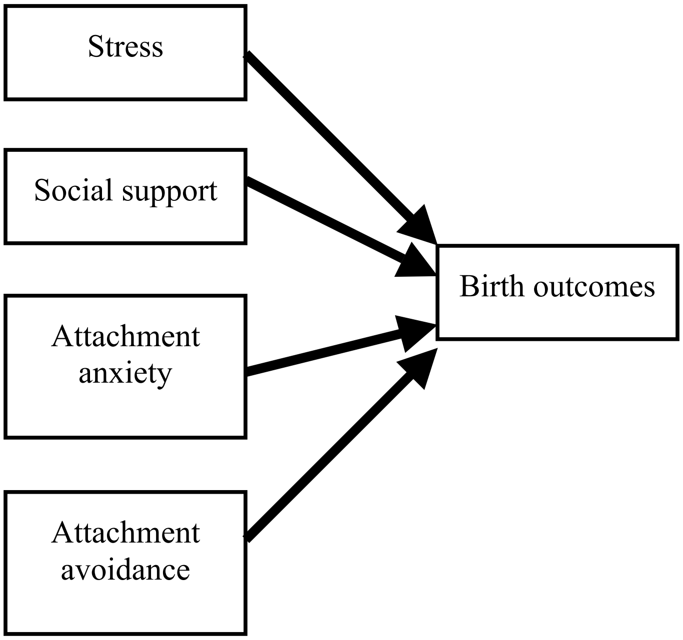

FIGURE 7. Hypothesis IIc.

TABLE 1

Risk Factors for Adverse Birth Outcomes Identified in the Literature

Maternal risk factors		Fetal risk factors
Pre-existing	Pregnancy-specific	
- Advanced maternal age - Anemia in early pregnancy - Black race - Chronic hypertension - Cigarette smoking - Diabetes mellitus - History of 2nd trimester pregnancy loss/abortion - History of cervical surgery - History of preterm delivery - Infection (e.g., sexually transmitted, systemic, urogenital, vaginal, bacterial, periodontal) - Renal insufficiency - Substance abuse - Vascular disease	- Cervical abnormality (e.g., premature dilation, effacement, short length, incompetence) - Gestational diabetes - Eclampsia - Preeclampsia - Uterine abnormality (e.g., distension, leiomyoma, fibroids, diethylstilbestrol-induced changes, excessive contractility) - Vaginal bleeding in 1st trimester - Weight gain outside of recommended range	- Amniotic fluid abnormality (e.g., oligohydramnios, polyhydramnios) - Fetal/congenital anomaly - Fetal growth restriction - Multifetal gestation - Placental abnormality (e.g. placenta accreta, abruption, praevia) - Ruptured membranes

TABLE 2

Summary of Participant Recruitment

Recruitment Step	n	%
Total screened for eligibility	***485***	
Not approached due to ineligibility	**180**	**37.1**
Postpartum	128	
Not English-speaking	14	
Under 18 years old*	13	
Consented in previous hospital admission	9	
Fetal demise	9	
Visitors restricted by nursing staff	6	
Actively psychotic	1	
Not approached due to other factors	**28**	**5.8**
Busy with visitors	11	
Asleep	10	
Not in hospital room	5	
Busy with nursing staff	2	
Total approached	***277***	***57.1***
Incompletely approached	**13**	**4.7**
Requested to be re-approached at later time; unavailable (discharged or postpartum) at follow-up	9	
Consented but discharged before began surveys	4	
Approached and declined	**76**	**27.4**
Approached and consented	**188**	**67.9**

*One patient was ineligible due to being both under 18 and also postpartum; counted here as under 18.

TABLE 3

Coding Criteria for Risk Factors in this Sample

Risk factor	Coding criteria
Black race:	EMR lists race as black or African-American.
Cervical abnormality:	EMR lists diagnosis of cervical anomaly, cervical effacement, cervical incompetence, incompetent cervix, or short cervix.
Multifetal gestation:	EMR lists diagnosis of multifetal gestation, twins, triplets, quadruplets, or other multiple.
Ruptured membranes:	EMR lists diagnosis of ruptured membranes of preterm premature ruptured membranes.
Placental abnormality:	EMR lists diagnosis of low lying placenta, placenta accreta, placenta percreta, placenta previa, or placental abruption.
Uterine abnormality:	EMR lists diagnosis of bicornuate uterus, diethylstilbestrol-induced changes of uterus, ectopic pregnancy, endometrial ablation, endometriosis, endometriosis removal, fibroids, fibroid removal, leiomyoma, myomectomy, uterine ablation, uterine distension, uterine polyps, uterine polypectomy, or vasa previa.

TABLE 4

Risk Factors in this Sample Arranged by Type

Maternal risk factors		Fetal risk factors
Pre-existing	Pregnancy-specific	
- Black race	- Cervical abnormality (e.g., premature dilation, effacement, short length, incompetence) - Uterine abnormality (e.g., distension, leiomyoma, fibroids, diethylstilbestrol-induced changes, excessive contractility)	- Multifetal gestation - Placental abnormality (e.g., placenta accreta, abruption, praevia) - Ruptured membranes

TABLE 5

Demographic Characteristics, N *= 188 (2014 Dallas County, TX, Census Percentages in Parentheses)*

Characteristic	n	%	(General population %)
Race			
American Indian/Alaska Native	4	2.2	(1.1)
Asian	2	1.1	(5.9)
Black/African-American	82	44.1	(23.1)
White	98	52.7	(68.0)
Ethnicity			
Hispanic/Latina	28	14.9	(39.3)
Not Hispanic/Latina	160	85.1	(60.7)
Education level completed			
Less than 9th grade	2	1.1	(11.5)
9th to 12th grade, no diploma	11	5.9	(11.1)
High school diploma or equivalent	52	28.0	(23.0)
Some college	49	26.3	(25.7)
4-year college degree	35	18.8	(18.4)
More than 4-year college degree	37	19.9	(10.1)
Marital status			
Married	94	50.0	(43.5)
Never married	83	44.1	(32.8)
Divorced	8	4.3	(12.6)
Widowed	3	1.6	(7.5)
Pregnancy trimester at survey			
1st	7	3.7	
2nd	56	29.8	
3rd	125	66.5	

TABLE 6

Summary of the Correlations between Risk Factors and Birth Outcomes

	Black race	Cervical abnormality	Multifetal gestation	Ruptured membranes	Placental abnormality	Uterine abnormality
Gestational age	-.19*	-.43***	-.20*	-.31***	-.04	-.20*
Birth weight	-.21*	-.32***	-.20*	-.25*	.04	-.15
Apgar 1 minute	-.03	-.20*	-.03	-.06	-.28*	-.13
Apgar 5 minute	-.10	-.36***	-.11	-.02	-.14	-.21*

*$p < .05$. ***$p < .001$.

TABLE 7

Risk Factors for Adverse Birth Outcomes in this Sample

Characteristic	n	%
Black race	82	44.1
Cervical abnormality	41	21.8
Multifetal gestation	31	16.5
Ruptured membranes	26	13.8
Placental abnormality	13	6.9
Uterine abnormality	15	8.0

TABLE 8

Psychometric Properties of the Major Study Variables

				Range	
Variable	n	M	SD	Potential	Actual
Attachment anxiety (ECR-S Anxiety)	187	2.94	.10	1-7	1-5.7
Attachment avoidance (ECR-S Avoidance)	187	2.22	1.09	1-7	1-5.2
Stress (PSS10)	187	15.52	7.94	0-40	1-37
Social support (SPS)	153	85.39	9.41	24-96	50-96

Note. The variation in sample size is due to the variation in the number of participants who completed different versions of the self-report battery.

TABLE 9

Summary of ANOVA between Race and Self-Report Measures

	Race			
	Black	White		
Variable	M (SD)	M (SD)	F	Eta^2
Attachment anxiety	3.05 (1.05)	2.88 (.97)	1.01	.02
Attachment avoidance	2.46 (1.11)	2.00 (1.05)	3.04*	.05
Stress	16.93 (8.55)	14.28 (7.34)	1.90	.07
Social support	82.81 (10.35)	87.60 (8.15)	3.85*	.07

*$p < .05$.

TABLE 10

Summary of ANOVA between Education and Self-Report Measures

	Education			
	Lower	Higher		
Variable	M (SD)	M (SD)	F	Eta^2
Attachment anxiety	2.96 (1.10)	3.00 (.99)	1.65	.04
Attachment avoidance	2.61 (1.23)	1.79 (.81)	3.60*	.09
Stress	18.55 (9.09)	16.67 (8.95)	.99	.02
Social support	78.10 (8.50)	81.09 (10.95)	8.33***	.22

*p < .05. ***p < .001.

TABLE 11

Summary of ANOVA between Marital Status and Self-Report Measures

	Marital Status			
	Single	Married		
Variable	M (SD)	M (SD)	F	Eta^2
Attachment anxiety	3.01 (1.04)	2.81 (.96)	2.54	.04
Attachment avoidance	2.27 (1.11)	1.78 (.93)	12.58***	.17
Stress	16.49 (8.66)	14.18 (6.70)	2.895	.05
Social support	82.76 (10.88)	88.14 (6.88)	4.18*	.08

*p < .05. ***p < .001.

TABLE 12

Birth Outcome Characteristics of Sample

	n	M	SD
Completed gestational age (weeks)	154	34.64	4.15
Birth weight (grams)	154	2339.62	908.79
Apgar score at 1 minute	150	7.37	1.98
Apgar score at 5 minutes	151	8.38	1.56

TABLE 13

Adverse Birth Outcomes of Sample (2013 U.S. General Population Percentages in Parentheses)

	n	%	(General population %)
Preterm birth (<37 weeks gestation)	100	53.2	(11.4)
Low birth weight (≤2,500 grams)	89	47.3	(8.0)

TABLE 14

Correlations between Self-Report Measures and Risk Factors

	Black race	Cervical abnormality	Multifetal gestation	Ruptured membranes	Placental abnormality	Uterine abnormality
Perceived stress	.17*	-.01	.03	-.05	-.01	-.03
Social support	-.26*	.10	.01	.05	.09	.14
Attachment anxiety	.09	-.08	-.01	-.01	.06	-.08
Attachment avoidance	.21*	-.18*	-.12	-.01	.04	-.14

*p < .05. ***p < .001.

TABLE 15

Correlations between Self-Report Measures and Birth Outcomes

	Gestational age	Birth weight	Apgar mean
Perceived stress	-.06	-.05	-.08
Social support	.04	.04	-.01
Attachment anxiety	-.01	.001	-.02
Attachment avoidance	-.02	-.12	.01

*p < .05. ***p < .001.

TABLE 16

Hierarchical Multiple Regression Analyses Predicting Birth Outcomes from Stress

	Gestational age		Birth weight		Apgar score	
Predictor	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	.17***		.14***		.04*	
Risk factors						
Step 2	.001		.001		.01	
Stress		-.04		-.03		-.07
Total R^2	.17		.14		.05	

*p < .05. ***p < .001.

TABLE 17

Correlations between Stress, Social Support, and Attachment Levels

	Stress
Social support	-.37***
Attachment anxiety	.52***
Attachment avoidance	.26***

***p < .001.

TABLE 18

Hierarchical Multiple Regression Analyses Predicting Birth Outcomes from Stress and Social Support

	Gestational age		Birth weight		Apgar score	
Predictor	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	.17***		.14***		.04*	
Risk factors						
Step 2	.002		.002		.01	
Stress		-.02		-.01		-.09
Social support		.03		.03		-.04
Step 3	.002		.002		.01	
Stress × social support		.04		-.05		.09
Total R^2	.17		.14		.06	

*$p < .05$. ***$p < .001$.

TABLE 19

Hierarchical Multiple Regression Analyses Predicting Birth Outcomes from Stress and Attachment Anxiety

	Gestational age		Birth weight		Apgar score	
Predictor	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	.17***		.14***		.04*	
Risk factors						
Step 2	.001		.001		.01	
Stress		-.04		-.03		-.08
Attachment anxiety		.01		.01		.02
Step 3	.000		.003		.01	
Stress × attachment anxiety		-.02		.06		-.10
Total R^2	.17		.14		.06	

*$p < .05$. ***$p < .001$.

TABLE 20

Hierarchical Multiple Regression Analyses Predicting Birth Outcomes from Stress and Attachment Avoidance

	Gestational age		Birth weight		Apgar score	
Predictor	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	.17***		.14***		.04*	
Risk factors						
Step 2	.003		.02		.01	
Stress		-.02		.01		-.07
Attachment avoidance		-.04		-.14		.01
Step 3	.01		.01		.01	
Stress × attachment avoidance		-.11		-.10		-.12
Total R^2	.18		.17		.06	

*$p < .05$. ***$p < .001$.

TABLE 21

Hierarchical Multiple Regression Analyses Predicting Birth Outcomes from Stress, Attachment Anxiety, Attachment Avoidance, and Social Support

	Gestational age		Birth weight		Apgar score	
Predictor	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	.17***		.14***		.04*	
Risk factors						
Step 2	.004		.02		.01	
Stress		-.03		-.02		-.09
Attachment anxiety		.02		.05		.01
Attachment avoidance		-.04		-.16		-.01
Social support		.02		-.02		-.04
Total R^2	.17		.16		.05	

*$p < .05$. ***$p < .001$.

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