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The Impact of Prenatal Depressive Symptoms, Intimate Partner Relationship, and Immune Status on Postpartum Depression

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THE IMPACT OF PRENATAL DEPRESSIVE SYMPTOMS, INTIMATE PARTNER RELATIONSHIP, AND IMMUNE STATUS ON POSTPARTUM DEPRESSION

DISSERTATION

A dissertation submitted in partial fulfillment of
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By
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ABSTRACT OF DISSERTATION

THE IMPACT OF PRENATAL DEPRESSIVE SYMPTOMS, INTIMATE PARTNER RELATIONSHIP, AND IMMUNE STATUS ON POSTPARTUM DEPRESSION

The prevalence of depression during pregnancy in the U. S. is approximately 13%. Poor quality of the intimate partner relationship is significantly correlated with depression during pregnancy. The adverse effects of antenatal depression have been widely documented. The relationship between the intimate partner relationship and depression during pregnancy has not been well delineated in the literature. Little data exist regarding the impact of prenatal immune status on risk for postpartum depression. Due to limited evidence, there is a critical need to examine the relationship among trimester specific cytokines, quality of the intimate partner relationship, and antenatal depressive symptoms on risk for postpartum depression. Examining this relationship is a crucial aspect in understanding the holistic aspects of depression during pregnancy.

The purpose of this dissertation was to examine the impact of the quality of the intimate partner relationship and immune status in early pregnancy on risk for postpartum depression. This was done in three ways: a critical review and analysis of the current state of measurement of antenatal depression via four instruments; a psychometric assessment of the Autonomy and Relatedness Inventory (ARI) during pregnancy; and an examination of the impact of trimester specific cytokines on depressive symptoms and the quality of the intimate partner relationship.

The critical review and analysis of the current state of measurement of four antenatal instruments measuring depression indicated similar results in detecting depression during pregnancy. The Postpartum Depression and Screening Scale (PDSS) performed more conclusively in detecting true cases of antenatal depression. In the next manuscript, psychometric assessment of the ARI revealed a 6 component model. Further, the ARI was significantly inversely correlated with depressive symptoms in the first trimester. For the final manuscript, first trimester serum MMP-8 levels were significant in predicting depression in the third trimester of pregnancy.

The findings of this dissertation study indicate that measuring and predicting pregnancy associated depression continues to be confounded by multitudinous factors. A comprehensive approach is warranted when screening for depression before, during, and after pregnancy. An emphasis on psychosocial, physical, immunological, and behavioral characteristics should be included when examining pregnancy associated depression in future research studies.

KEYWORDS: Postpartum Depression, Cytokines, Psychometric Properties of Postpartum Depression Screening Scales, Autonomy and Relatedness Inventory, Inflammation

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12/10/15

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This dissertation is dedicated to the first and best nurse educator I have ever known, my mother, Mary JoAnn Hall.

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Chapter I: Introduction

The primary purpose of this dissertation was to explore the impact of antenatal depressive symptoms, the quality of the intimate partner relationship, and immune status on third trimester depression. In addition to the introductory chapter, the dissertation is comprised of three manuscripts and a conclusion chapter that summarizes and links the findings of the three manuscripts. First, a critical review and analysis of the current state of measurement of antenatal depression of four instruments was conducted to identify an accurate screening tool for depressive symptoms at several time points in pregnancy and in the postpartum period. Second, a psychometric assessment of the Autonomy and Relatedness Inventory (ARI) was conducted via exploratory factor analysis and hypothesis testing using the Norbeck (1981) social support model in a sample of women in the first trimester of pregnancy. Third, the impact of immune status on depressive symptoms in the third trimester was examined.

A wide body of evidence demonstrating the detrimental consequences of postpartum depression (PPD) for the woman, her family, and society at large exists (Robertson, Grace, Wallington, & Stewart, 2004). The etiology of PPD is not clearly understood, but is thought to be related to the interaction among neurobiological, psychosocial, neurochemical, and neuronal circuit integrity (Moses-Kolko & Roth, 2004). The incidence and prevalence of postpartum depression (PPD) when defined as depression occurring during pregnancy and/or the first year after delivery has been estimated to affect 8-15% of women in the U. S. (Banti et al., 2011; Gavin et al., 2005). This is the definition of PPD used in this dissertation.

The long-term effects of PPD are immeasurable including altered maternal-infant attachment, problems with marital relationships, altered cognitive and emotional effects

on the infant, and altered family relationships (Murray & Stein, 1989; Burke, 2003). Specific effects of PPD include depressed mood, hopelessness, anxiety, excessive fatigue, psychomotor agitation, appetite and sleep disturbances, and guilt or feelings of inadequacy concerning the ability to meet the needs of the infant (O'Hara, 1997). Women who have suffered from PPD are twice as likely to relapse in the 5 years following the birth as compared to women who have never experienced PPD (Cooper & Murray, 1995). The most serious outcomes of PPD are suicide and infanticide (Moses-Kolko & Roth, 2004).

Numerous risk factors have been associated with PPD. Prevalent risk factors gleaned from the literature include: maternal anxiety, life stress, history of depression, lack of social support, unintended pregnancy, Medicaid insurance, domestic violence, lower income, lower education, smoking, single status, and poor relationship quality (Beck, 2001; Lancaster et al., 2010). Screening for pregnancy associated depression, the quality of the intimate partner relationship, and the impact of immune status on PPD was the focus of this dissertation.

In the U. S., the financial cost of PPD has not been studied and reported. The Post and Antenatal Depression Association (PANDA) was commissioned to assess the cost of perinatal depression in Australia. For 2012, the estimated cost of healthcare expenditures, forgone taxation, and loss of productivity for PPD was $433 million. The report included both maternal and paternal PPD in the estimates (PANDA, 2012). The population of the U. S. is considerably greater at an estimated 318.8 million in 2014 (U. S. Census Bureau, 2015) when compared to that of Australia at an estimated 23.1 thousand (Australian

Bureau of Statistics, 2015). These estimates provide evidence that if the cost of PPD was estimated for the United States, the cost would be considerably substantial.

Chapter Two presents a critical review and analysis of the literature examining four instruments used to measure PPD. The purpose of the review was to present a critical review and analysis of the current state of measurement of antepartum and postpartum depression and to provide direction in recommending a self-report instrument with strong psychometric properties for use in future research studies. Four instruments, two of which are tailored to postpartum depression and two that measure depression based on the Diagnostic and Statistical Manual of Mental Disorders-V (DSM-V) criteria, were examined. Choosing a valid and reliable instrument when measuring PPD in research studies is of the utmost importance to accurately glean evidence and recommend interventions to help alleviate PPD. Recommendations for choosing a reliable and valid instrument when measuring PPD in research studies are presented in this chapter.

Chapter Three presents a psychometric assessment of the ARI in a sample of first trimester pregnant participants. Exploratory factor analysis and hypothesis testing using Norbeck's (1981) social support model were conducted. The model provides a framework for guiding research and incorporating social support into clinical practice. The nursing process and the four components of nursing practice theories: person, environment, health-illness, and nursing actions, are incorporated in this social support theory. Women who report adequate support report positive health outcomes; whereas, those who report inadequate social support are more likely to experience negative health outcomes. Interventions that address or target inadequate social support should be implemented in an attempt to produce positive health outcomes (Norbeck, 1981).

Data from a sample of 397 women in the first trimester of pregnancy was used. Construct validity was examined with hypothesis testing and factor analysis. The Edinburgh Postnatal Depression Scale (EPDS) was correlated with the ARI as part of the hypothesis testing. These measures were designated and their psychometric properties evaluated. Clinical recommendations are delineated.

Chapter Four explores the relationship among eight serum cytokine levels and third trimester depressive symptoms. A shift in the awareness and understanding between the role of depression and inflammation has occurred in the last 20 years. In the past, inflammation was considered to be a risk factor for depression. Currently, the information and evidence suggest that inflammation is the trigger for depression (Schiepers, Wichers, & Maes, 2005) and the core risk factor for all other documented risk factors (Kendall-Tackett, 2007). Elucidating a biomarker to predict inflammation has the potential to tackle depression and other risk factors on an entirely new level. If clinicians know which biomarker or biomarkers to assess in early pregnancy, then early interventions, monitoring, and treatment can occur to prevent worsening of the conditions or prevent others from arising. Baseline data from 82 outpatient women in antenatal clinics were used to assess associations among sociodemographic characteristics and immune status on third trimester depressive symptoms. Appropriate t-tests, chi-square analyses were conducted and then logistic regression was performed and evaluated. Research and clinical recommendations are discussed.

Chapter Five provides a synopsis of Chapters Two through Four, integrates the findings of the three manuscripts, and summarizes research and practice indications and recommendations based on the three manuscripts.

Chapter II: Critical Review and Analysis of Four Measures of Postpartum Depression

Overview of the Significance of Postpartum Depression

Postpartum depression (PPD) can be an extremely debilitating disease that leads to irreversible sequelae for the mother, child, father, family, and society at large. The etiology of PPD is not clearly understood, but is thought to be related to the interaction among neurobiological, psychosocial, neurochemical, and neuronal circuit integrity (Moses-Kolko & Roth, 2004). Postpartum depression is considered to be a hidden illness because of a debate as to whether the disease is a separate diagnosis or a manifestation of clinical depression (Bennett & Indman, 2003).

The occurrence of PPD is estimated at approximately 12% for major and 19% for minor depression (Beck & Gable, 2001a). More recently, Gavin et al. (2005) conducted a systematic review of 28 studies investigating the prevalence and incidence of PPD. They found the incidence of PPD as defined by depressive episodes that begin during pregnancy and/or up to the first year postpartum to be 15%. The accuracy of these estimates may be low as many women do not seek treatment and subsequently receive the diagnosis of PPD. Ramsey (1993) estimated that up to 50% of the true PPD cases go undetected. Another caveat is that many clinicians do not routinely screen for PPD at well baby or postpartum visits. They cite either not having received proper training in screening or high workloads that do not allow time for screening. Moreover, the studies used in eliciting the prevalence and incidence of PPD used a variety of tools and time periods to assess depression which further complicates the true picture of PPD (Beck & Gable, 2001a; Gavin et al., 2005).

The long-term effects of PPD are immeasurable including altered maternal-infant attachment, problems with marital relationships, altered cognitive and emotional effects on the infant, and altered family relationships (Murray & Stein, 1989; Burke, 2003). Specific effects of PPD include depressed mood, hopelessness, anxiety, excessive fatigue, psychomotor agitation, appetite and sleep disturbances, and guilt or feelings of inadequacy concerning the ability to meet the needs of the infant (O'Hara, 1997). Women who have suffered from PPD are twice as likely to relapse in the 5 years following the birth as compared to women who have never experienced PPD (Cooper & Murray, 1995). The most serious outcomes of PPD are suicide and infanticide (Moses-Kolko & Roth, 2004).

Numerous instruments have been used to measure PPD in various settings. Given the seriousness of PPD, instruments in clinical and research settings should accurately measure the presence of PPD. While the Diagnostic and Statistical Manual of Mental Disorders-V (DSM-V) is considered the "gold standard" in diagnosing PPD, the instrument is difficult to administer in research and many outpatient settings because the interviewer must be trained and skilled in administering the exam. Further, the DSM-V clumps PPD under the category of major depression. Therefore, many researchers and clinicians suggest that PPD is separate and unique diagnosis and should be treated as such (Dennis & Hodnett, 2009; Gavin et al., 2005; O'Hara & McCabe, 2013). Currently, there is no agreement in the literature as to which instrument is recommended in screening for PPD in research studies. Further, the gold standard, DSM-V criteria is criticized in effectively targeting the actual case of PPD in clinical settings. The purpose of this paper is to present a critical review and analysis of the current state of measurement of

antepartum and postpartum depression and to provide direction in recommending a self-report instrument with strong psychometric properties for use in future research studies. Four instruments, two of which are tailored to postpartum depression and two that measure depression based on the DSM-V criteria will be examined.

Conceptual Definition of Postpartum Depression

Beck (2002) performed a metasynthesis of 18 qualitative studies on the subject of postpartum depression. She identified the following four overarching themes: incongruity between expectations of the mother and the reality of motherhood, pervasive loss, spiraling downward, and making gains. The most widely accepted operational definition for depression is from the DSM-V's criteria for major or clinical depression. To be diagnosed with a major depressive episode, a person must exhibit five or more of the following symptoms for two weeks or more as follows: "depressed mood most of the day, nearly every day, loss of interest or pleasure in most activities, significant weight loss or gain, sleeping too much or not being able to sleep nearly every day, slowed thinking or movement that others can see, fatigue or low energy nearly every day, feelings of worthlessness or inappropriate guilt, loss of concentration or indecisiveness, or recurring thoughts of death or suicide. In addition, at least one of the symptoms must be depressed mood or loss of interest or pleasure." (American Psychiatric Association [APA], 2013 pp. 160-162).

Although the DSM-V does not recognize antepartum and postpartum depression (PPD) as separate diagnoses, women who develop depression during pregnancy (peripartum) and/or the 4 weeks following delivery and who meet the criteria for a major depressive episode are considered to exhibit PPD. PPD is treated as a specifier of major

depression (APA, 2013). Consequently, many researchers, clinicians, and victims, and survivors of PPD argue that PPD extends into 6 months to a year after delivery. Further, these groups recommend that the APA consider including this criterion in the DSM (Dennis & Hodnett, 2009; Gavin et al., 2005; O'Hara & McCabe, 2013).

Search Strategy

All studies presented in this paper were gleaned from Pub Med, CINAHL, PsycInfo, and Google searches. The rationale for selecting four screening instruments for PPD is discussed under each heading designated for the particular instrument in this paper. The instruments are presented in Table 1. The search terms utilized were postpartum depression screening instruments, Center for Epidemiologic Studies Depression Scale **(**CES-D), Edinburgh Postnatal Depression Scale (EPDS), Postpartum Depression Screening Scale (PDSS), Beck Depression Inventory (BDI-II) antepartum, postpartum, postpartum depression, psychometric properties, factor analysis, reliability, and validity. Fourteen studies were selected from over 1,000 potential articles for use in this paper. The articles were selected due to the use of the instruments selected for review in this paper, reports of psychometric properties, and the use of the instruments in the antepartum and postpartum populations. The 14 articles are presented in Table 2.

Description of Four Existing Instruments that Measure Postpartum Depression

The Center for Epidemiologic Studies Depression Scale (CES-D)

The CES-D was chosen to review in this paper because the tool has been widely used to measure PPD in many previous research studies examining both antenatal and postpartum depression (Campbell & Cohn, 1991; Beeghly et al., 2003; Mosack & Shore, 2006; Ko, Yang, & Chiang, 2008; Canaday, Stommel, & Holzman, 2009). The self-

report CES-D is a 20-item tool derived from previously validated depression scales that model the DSM criteria for major and minor depression. The items focus on the affective component of depressed mood. The tool was initially developed for use in the general population (Radloff, 1977).

Subjects are asked to rate their responses based on how often they have felt over the last seven days. The items are scored from 0 (less than one day) to 3 (all of the time) and total scores range from 0-60.The tool takes approximately 5-10 minutes to complete (see Table 1). The instrument is written at the 2nd grade reading level as determined by the Fry Readability Graph (Fry, 1968; Logsdon & Hutti, 2006). Sixteen of the items represent negative symptoms and four items are worded positively. These four items are reverse coded to indicate lack of wellbeing. A score of 16 has been used as a standard threshold indicating possible clinical depression (Radloff, 1977; Weissman, Sholomskas, Pottenger, Prusoff, & Locke, 1977). The CES-D has been cited as demonstrating both content and construct validity in many studies and populations (Canady, Stommel, & Holzman, 2009; Radloff, 1977; Weissman et al., 1977).

Radloff (1977) reported the Cronbach's alpha between .85-.90 and the split half reliability at .87 among general and clinical samples demonstrating strong internal consistency. To assess construct validity, principal components factor analysis (PFA) was conducted. Four eigenvalues were greater than one. The four dimensions accounted for 48% of the total variance. Then, normal varimax rotation was examined. The four dimensions were readily identified as depressed affect, positive affect, somatic and retarded activity, and interpersonal.

Carelton et al. (2013) performed Confirmatory Factor Analysis (CFA) on the CES-D using five different samples of undergraduate college students (n= 948), community members (n= 254), tertiary rehabilitation clients (n= 522), clinically depressed clients (n = 84), and the National Health and Nutrition Examination Survey (NHANES) (n= 2,814). Cronbach's alpha's for the final model were .87, .92, .90, .80, and .83 respectively among the samples indicating strong support for internal consistency. The final model was a 3-subscale (somatic symptoms, negative affect, and anhedonia) 14-item model.

Researchers have begun using the CES-D to measure PPD in antepartum and postpartum samples (See Table 2). Campbell and Cohn (1991) found that in a sample of 1,007 married, middle class, primiparous women, the Cronbach's alpha was .81 indicating strong internal consistency. The CES-D exhibited a sensitivity of 60% and a specificity of 92% with a cut-off score of 16. The CES-D is likely to miss 40% of women with true PPD in this sample. Actual cases of PPD were diagnosed with a modification of the Research Diagnostic Criteria (RDC) where they had to report six symptoms of minor depression for a minimum of two weeks in the postpartum period. Conversely, Ko et al. (2008) found that a cut-off score of 15 among 79 Taiwan postpartum women yielded a sensitivity of 92% and a specificity of 91%. Strong internal consistency was reported via Cronbach's alpha of .81.

Beeghly et al. (2003) showed support for internal consistency of the CES-D in a sample of 163 Black postpartum mothers. At several different time points in the postpartum period, the CES-D was administered. All Cronbach's alpha coefficients were $\geq$ .80 (.83 at 2 months, .89 at 3 months, .87 at 6 months, .88 at 12 months, and .86 at 18

months) indicating strong internal consistency. Concurrent validity was supported when the CES-D scores were correlated with the Brief Symptom Index (BSI). The BSI's General Symptom Index (GSI) and the Depression Subscale were also included (GSI: mean r[163] = .76,; Depression subscale: mean r[163] = .72,).

Mosack and Shore (2006) demonstrated similar results in a sample of 98 pregnant and postpartum women. The CES-D was compared with the Edinburgh Postnatal depression Scale (EPDS). The Cronbach's alpha for the CES-D was .87 and for the EPDS was .86 indicating strong internal consistency for both instruments. The CES-D and the EPDS were strongly correlated at .81. Conversely, the two instruments veered in detecting women exhibiting depressive symptoms. The CES-D identified 17 more women than the EPDS with depressive symptoms. There was no mention of a follow-up Structured Clinical Interview for Depression (SCID) or other diagnostic test to confirm that the women were indeed truly depressed. The authors cite the possibility of the CES-D being prone to false positives or the EPDS being prone to missing true positives for the discrepancy.

Specific to the antepartum population, Canady et al. (2009) conducted CFA on the CES-D among 750 matched White and African American pairs. The final model elucidated a 2-dimensional (depressive symptoms and positive affect) 19-item instrument. One item "everything was an effort" had an item total correlation < .3 which is considered inadequate (Nunnally & Bernstein, 1994). While the final model suggested for future use was the 19-item version, the authors concluded that since the correlations exceeded .99 in both racial groups, the use of the original 20-item CES-D introduces no racial bias and that both models were a good fit.

Edinburgh Postnatal Depression Scale (EPDS)

The EPDS was selected -for review based on - two reasons: 1. -, the EPDS is the most widely used scale for measuring PPD; and 2. the EPDS is specifically developed to target depression in the postpartum period and is also modeled to capture the DSM criteria for major and minor depression. The EPDS is a 10-item self-report scale that was developed specifically for screening for PPD in community settings. Subjects are asked to rate their responses based on how they have felt during the last seven days. The items are scored from 0 (never or not at all) to 3 (yes, most of the time, quite a lot, or as much as I always could) and total scores range from 0-30. The test is easy to administer and takes approximately 5-10 minutes to complete (Cox, Holden, & Sagovsky, 1987). The reading level of the EPDS is at 3rd grade via the Fry Readability Graph (Fry, 1968; Logsdon & Hutti, 2006). The instrument is available via paper and computer versions and can be administered via the telephone (Le, Perry, & Sheng, 2009).

The original suggested threshold or cut-off score for major depression was 9-10. The sensitivity and specificity was found to be 85% and 77% in that order and the positive predictive value (PPV) was 83%. The Cronbach's alpha was calculated at .87 and the split half reliability was .88 demonstrating evidence of strong internal consistency (Cox et al., 1987). Support for construct validity of the EPDS has been demonstrated in a wide range of populations, languages, ethnicities, etc. and has been highly correlated with the Structured Clinical Interview for Depression (SCID) (Beck & Gable, 2001b; Cox et al., 1987; Eberhard-Gran, Eskild, Tambs, Opjordsmoen, & Samuelsen, 2001).

Consequently, the sensitivity and specificity can vary significantly depending on the cut-off score used by the researchers to indicate depressive symptoms (Chaudron et

al., 2010). Eberhard-Gran et al. (2001) examined 18 studies that used the EPDS to assess PPD and found wide variation in the sensitivity and specificity. The scores for sensitivity and specificity ranged from 65-100% to 49-100% correspondingly. They also reported a lower PPV in normal populations as opposed to validation study samples.

Logsdon, Usui, and Nering (2009) examined the psychometric properties of the EPDS in a sample of adolescent mothers. Internal consistency was strongly supported with a Cronbach's alpha .88. A mid-level correlation at .77 was demonstrated between the EPDS and the CES-D indicating support for criterion validity. Further, Principle Components Analysis (PCA) revealed a bi-dimensional (anxiety and depressive symptoms) model of the EPDS that explained 60% of the variance providing evidence of construct validity. This reflection of anxiety measured by the EPDS has been a criticism of the tool. Some authors argue that the EPDS measures both depression and anxiety which causes issues when targeting the measurement of PPD (Beck & Gable, 2001a; Boyd, Le, & Somberg, 2005).

Logsdon and Meyers (2010) then compared the EPDS with two versions of the CES-D in a sample of 59 postpartum adolescents. In addition to the traditional 20-item CES-D and 10-item EPDS, a 30-itme CES-D was administered. The 30-item CES-D includes the original 20 questions with 10 questions aimed at the adolescent population. Previously, the psychometric properties of the 30-item CES-D had not been released in the literature. The gold standard for diagnosis of depression in adolescents, the Schedule for Affective Disorders and Schizophrenia for School Age Children-Present and Lifetime Version (KSADS-PL), was also employed in this study (Kaufman et al., 1997).

The Cronbach's alpha's for the EPDS, CES-D20, CES-D30 were .85, .84, and .85 respectively indicating strong internal consistency among the three instruments in this sample. Convergent validity was supported as the three instruments were correlated as reported via Spearman Rho correlations. The EPDS with CES-D20 and CES-D30 was (r_s = .631, .623,) respectively and the CES-D20 with the CES-D30 (r_s =.928,). However, none of the instruments correlated with the KSADS-PL as follows: EPDS (r_s = .189,), CES-D20 (r_s = .152, ,), and the CESD-30(r_s =.127, providing no evidence of concurrent validity. Since the Spearman Rho correlations are < .20, the information may not be consequential or may be a result of the small sample size. Further, the Receiver Operating Characteristic (ROC) analysis proceeded by the computed area under the curves (AUC) revealed that the CES-D was the most accurate in screening for depression, followed by the CES-D20, and finally the CES-D30, but not significantly so (Logsdon & Meyers, 2010).

Beck Depression Inventory (BDI-II)

The self-report BDI-II is a revision of the original BDI. Changes were made to the original instrument to reflect the DSM-IV's diagnostic criteria for major depression. The instrument still contains 21-items; however, the themes of weight loss, body image change, work difficulty, and somatic preoccupation were purged and replaced with agitation, worthlessness, concentration difficulty, and loss of energy (Beck, Steer, Ball, & Ranieri, 1996). Both the BDI and the BDI-II are scored the same way with the exception that the BDI-II asks subjects to rate their mood based on the last two weeks as opposed to the last seven days as with the BDI. The tool takes approximately 5-10 minutes. The reading level of the BDI-II is estimated to be at the 5th grade via the Fry Readability

Graph (Fry, 1968; Logsdon & Hutti, 2006). Use of the tool requires consent of the authors. Each item is scored on a 4-point scale where 0 (lowest or do not exhibit that symptom) to 3 (highest or expression of that mood most of the time). The range of scores is 0-63 (Beck et al., 1996).

Initially, Steer and Clark (1997) reported Cronbach's alpha as .93 among college students and Beck et al. (1996) reported a Cronbach's alpha of .92 among psychiatric outpatients; thereby, providing evidence of strong internal consistency. In a fairly homogenous sample of 150 postpartum women, when the cut-off score for depression was 20 for major depression, the sensitivity and specificity of the BDI-II was found to be 56-100%; while the PPV and negative predictive values (NPV) were 100-93% respectively. In contrast, when the cut-off score was lowered to 14 to reflect major and/or minor depression, the sensitivity dropped to 57% and the specificity increased to 97% and the PPV and NPV changed to 90-83% respectively (Beck & Gable, 2001b).

Few studies have examined the BDI-II solely in postpartum samples as a standalone measure. When the BDI-II is utilized in postpartum samples, the tool is habitually used to correlate with other measures to demonstrate evidence of validity among those tools (Beck & Gable, 2001a; Chaudron et al., 2010; Le, Perry, & Ortiz, 2010). One exception is the study by Mahmud, Awang, Herman, and Mohamed (2004) where the psychometric properties of the Malaysian version of the BDI-II were examined. Stage I of the study consisted of the translation of the BDI-II to the Chinese. Face validity was addressed by administering the Malaysian version to 20 postpartum Malaysian women, two psychiatrists, two physicians, and a general practitioner. No revisions were necessary.

In Stage II, the Malaysian versions of the EPDS and the BDI-II were administered to 60 postpartum women. Furthermore, all the women were subsequently assessed with the clinical interview schedule (CIS) and the 17-item Hamilton Rating Scale for Depression (HRSD-17). Diagnoses of depression were predicated on the 10th edition of the International Classification of Disease to provide evidence for concurrent validity. The Cronbach's alpha of the Malaysian version of the BDI-II was .89 and the unequal length Spearman-Brown Coefficient was .84 indicating strong internal consistency. With a cut-off score of 9.5, the sensitivity, specificity, and PPV of the Malaysian BDI-II were 100%, 98.15%, and 87.5% respectively providing evidence of concurrent validity. Further, the Malaysian BDI-II demonstrated convergent validity with good correlations with the Malay version of the EPDS (Spearman's rho = .72) and the HRSD-17 (Spearman's rho = .75). Divergent validity was reported when the significant differences were noted between the depressed and non-depressed groups (Mann Whitney U: 2 tailed p value < .01) (Mahmud et al., 2004).

In the final stage of the study, Mahmud et al. (2004) performed principal components analysis (PCA). A sample of 354 postpartum women was recruited. Three subscales emerged and were labeled as affective, somatic, and cognitive domains. The Cronbach's alpha's were .80, .75, and .68 correspondingly. The inter-item correlations ranged .37-.75 indicating no redundancy of the 21 items and a moderate correlation.

Manian, Schmidt, Bornstein, and Martinez (2013) conducted EFA and CFA of the BDI with 953 postpartum women from ethnically diverse backgrounds. Cronbach's alpha was .91 supporting strong internal consistency. Both EFA and CFA yielded a 3 factor structure of the BDI-II (cognitive, somatic, and affective domains) in this sample as was

the case with the Mahmud et al. (2004) sample. During EFA, the 953 subjects were examined. When maximum likelihood CFA was performed, 478 of the participants were used for analysis. The Cronbach's alpha's for each dimension were .81 for the cognitive domain, .77 for the somatic domain, and .82 for the affective domain indicating moderate to strong internal consistency within the domains. No items were deleted due to factor loadings above .35 as was the documented standard for this study.

Convergent validity was supported when the current 3 Factor structure was compared to other studies of postpartum women with similar findings (Bos et al., 2009; Mahmud et al., 2004). Multiple fit indices indicate that the 3 Factor structure accounts for 50% of the variance. Unique to this study was the finding that somatic symptoms accounted for less of the variance as compared to the cognitive and affective domains. However, the factor mean was highest for the somatic domain signifying that somatic symptoms are part of the postpartum depression experience. Concurrent validity was addressed by performing binomial logistic regression based on a subsample of depressed women diagnosed by the SCID and a BDI-II score > 12. These women were more likely to exhibit higher somatic and affective scores on the BDI-II as compared to their non-depressed counterparts. These findings suggest that the somatic aspect of the BDI-II cannot be abandoned without further testing. (Manian et al., 2013). This is somewhat in contrast to the argument that some measures of PPD exhibit problematic findings due to the somatic items contained within the BDI-II (Beck & Gable, 2001a; Boyd et al., 2005).

The Postpartum Depression Screening Scale (PDSS)

The PDSS was selected for review in this paper due to the uniqueness of the instrument in asking participants to identify how they rate their responses taking into

consideration that they have recently become new mothers (Beck & Gable, 2000). The PDSS was derived from Beck's (1992, 1993, 1996) qualitative work on PPD. The preliminary self-report version of the PDSS contained 7 dimensions with 8 items each for a total of 56 items. The most recent version of the PDSS consists of 35 times with the same 7 dimensions with 5 items per dimension. The seven dimensions in the PDSS are sleeping/eating disturbances, anxiety/insecurity, emotional/lability, cognitive impairment, loss of self, guilt/shame, and contemplating harming oneself. Further, the items were quotes elucidated from the participants statements and themes gleaned from the above mentioned qualitative works. Subjects are asked to rate how strongly they disagree, 1 to how strongly they agree, 5. The range of scores is 35-175. The suggested cut-off scores are 35-59 indicating normal adjustment, 60-79 indicating significant symptoms of PPD, and 80-175 indicating positive screen for major depressive disorder (MDD) (Beck & Gable, 2000). The instrument is written at the 7th grade reading level (Beck & Gable, 2000). However, Logsdon and Hutti (2006) determined the reading level to be at the 4th grade level according to the Fry Readability Graph (Fry, 1968).

Initially, the PDSS was administered to 525 new mothers who were predominantly Caucasian, married, in their earlier twenties, with some college education, first time mothers, 6 weeks postpartum, and with no reported history of depression. Internal consistency reliabilities were reported as high with some items indicating redundancy; therefore, 3 items were deleted from each dimension of the scale rendering the current 35-item version of the scale. The final version of the PDSS demonstrated high correlations among the dimensions ranging from .56-.80. The dimension Cronbach's alpha's if item deleted ranged from .78-.93 indicating strong support that alpha would not

increase if the item were deleted (Beck & Gable, 2000).

CFA was conducted to assess for construct validity in this population (Beck & Gable, 2000). Cabrera-Nguyen (2010) suggest the utilization of multiple fit indices when estimating a model when conducting CFA. In this sample, the Tucker-Lewis index was .87, the standardized weights for the 5 items in each of the 7 dimensions ranged from .57-.92 with a minimum *t* value of 14.79, and the root mean square residual (RMR) of .05 were determined to support the fit of the model by the authors (Beck & Gable, 2000). However, a Tucker-Lewis index of $\geq$ .95 is the recommended level proposed in the literature (Tucker & Lewis, 1973). In contrast, the standardized weights for each item were high and the RMR were at the recommended level of $\leq$ .80 (Hu & Bentler, 1999). Finally, no rationale was provided as to Beck and Gable's (2000) decision to proceed with CFA when exploratory factory analysis (EFA) is recommended when a new scale's validity is assessed (Cabrera-Nguyen, 2010).

Beck and Gable (2001a) further assessed the construct validity of the PDSS in a sample of 150 new mothers. The PDSS was compared along with the EPDS, BDI-II, and the SCID. The Cronbach's alphas for the seven subscales of the PDSS ranged from .80-.91, for the BDI-II was .91, and for the EPDS was .89 indicating strong internal consistency for all three measures. The PDSS was strongly correlated with the BDI-II ($r = .81$, $p < .0001$) and the EPDS ($r = .79$, $p < .0001$) thus providing evidence of construct validity. Incremental validity indicated the BDI accounted for 38% ($p < .0001$) of the variance in group classification. Then, the EPDS accounted for an increase by 3% ($p = .039$) of the variance. Finally, the PDSS accounted for an additional 9% ($p < .0001$) of the variance in depression scores. For minor depression based on DSM-IV criteria, a cut-off

score of 60 on the PDSS will yield a sensitivity of 91%, a specificity of 72%, and a PPV of 59%. Conversely, for major depression, a cut-off score of 80 yields a sensitivity of 94%, a specificity of 98%, and a PPV of 90%. All of these metrics indicated that the PDSS demonstrates moderate to strong concurrent validity.

Le et al. (2009) examined the viability of using the PDSS to assess for postpartum depressive symptoms via the internet. Like the other studies described in this paper, the Cronbach's alpha was .97 for the total score on the PDSS indicating strong internal consistency. The Cronbach's alphas for the 7 subscales ranged from .77-.95 indicating moderate to strong internal consistency. The EPDS was also administered and the Cronbach's alpha was .87 indicating strong internal consistency. Convergent validity was supported when the internet version of the PDSS was correlated with the internet version of the EPDS (r = .80, p = .01). The authors also compared the internet sample to the sample from the Beck and Gable (2001a) study (r = .79, p = .01). The sample was relatively small with 141 women and there was no verification of true versus false positives in this sample; therefore, concurrent validity was not addressed.

Le, Perry, and Ortiz (2010) examined the prevalence of PPD and the psychometric properties of the Spanish version of the PDSS in a sample of 155 Latina immigrant workers classified as El Salvador (n = 91), Other Central American (n = 40), and Mexico (n = 24). The authors compared the 35-item PDSS with the BDI-II, CESD-D, and a 7-item version of the PDSS. The 7-item PDSS used one question from each of the 7 subscales of the original PDSS. Cronbach's alpha's for the 7 subscales on the 35-item PDSS ranged .56-.97 and the total was .97 indicating moderate to strong internal consistency for the subscales and strong internal consistency for the total scale.

Cronbach's alpha for the 7-item PDSS was .83. The subscale internal consistencies were not reported for the 7-item PDSS, BDI-II, or the EPDS. Convergent validity was supported with the Pearson's correlation between the 35-item Spanish version of the PDSS and the Spanish version of the BDI-II (r = .54, p <.001). The 7-item and 28 (minus the 7 items in the 35-item version)-item Spanish versions of the PDSS were also highly correlated (r = .91, p <.001).

McCabe et al. (2012) examined the psychometric properties of the PDSS in a sample of 111 postpartum mothers with infants in the neonatal intensive care unit (NICU). The Cronbach's alpha's among the 7 subscales ranged from .72-.89. The Cronbach's alpha for the total scale was .95 again providing strong support for excellent internal consistency for the total scale and moderate to strong for the subscales. Construct validity was reported via bivariate correlations among the subscale scores. The R^2 correlation ranged from .37-.74 with two subscales sharing 70% or more of the variance with the remaining subscales. However, the R^2 statistic is limited and cannot explain a complete picture of the variance or goodness of fit of the model.

Comparison of Strength and Weaknesses of the Measures

All four of the instruments encompass the DSM-IV diagnostic criteria for a major and minor depressive episode. All four are brief and easy to administer and/or for subjects to complete. Most studies have utilized the paper versions of the instruments, but one author has used the EPDS and PDSS via the internet with evidence of strong internal consistency (Le et al., 2009). The sample size was relatively small; therefore, generalizability of these findings is limited. Further, the BDI-II and the CES-D have not been studied via the internet with postpartum samples. They all have demonstrated strong

internal consistency reliability with Cronbach's alpha's ranging from .83-.97 for the total scales. The higher alphas potentially could indicate item redundancy, but that has not been a consistent theme when item-total correlations have been examined by some authors (Canady et al., 2009; Carelton et al., 2013; Logsdon et al., 2009; Mahmud et al., 2004; Manian et al., 2013; Radloff, 1977).

All four instruments have been validated in many studies with varying sample populations. However, the psychometric properties suffer depending on the cut-off scores used to signify depression or when the samples become more heterogeneous and/or small sample sizes are used. Nonetheless, the BDI-II and the PDSS are fairly new tools that have not been as extensively studied in the postpartum populations when compared to the EPDS and CES-D (Beck & Gable, 2001 a/b; Chaudron et al., 2010). As discussed previously, all have demonstrated moderate to high sensitivity and specificity in accurately screening for PPD. In contrast to most of the studies, Logsdon and Meyers (2010) found no correlation between the gold standard interview in diagnosing depression in adolescents using the EPDS, CES-D20, or CESD-30. The lack of a relationship could have been a result of a small sample size. The EPDS was the instrument that performed the best in this sample. However, the BDI-II and the PDSS have not been examined with the adolescent postpartum population.

Further, both the EPDS and the BDI-II have been cited as overestimating depression due to the nature of some of the somatic items (Boyd et al., 2005). While some authors have found the BDI-II to be valid, there is some agreement that the BDI-II tends to err on the side of false positives. Also, the BDI-II is not as reliable when compared to other screening tools like the EPDS and PDSS among patients exhibiting the

unique signs and symptoms of PPD versus the DSM criteria for major and minor depression (Beck & Gable, 2001a/b). Beck and Gable (2000) state that the PDSS is unique in that the seven subscales both represent the DSM criteria, although not by design, and items that are specific to PPD. Furthermore, the PDSS is the only instrument that asks subjects to rate their responses taking into consideration that they are new mothers. The PDSS has been criticized as most of the studies reporting the reliability and validity are generated by the original authors. Another criticism of the PDSS is that the reading level has been determined to exist between the 4-7th grades (Beck & Gable, 2000; Logsdon & Hutti, 2006). Some subjects with low levels of literacy could have problems understanding some of the items and subsequently report invalid responses (Boyd et al., 2005).

The EPDS and the PDSS were specifically designed to screen for PPD; whereas, the CES-D and the BDI-II were designed for the general population. Therefore, the EPDS and in a more robust manner, the PDSS, may be more precise in determining the unique characteristics of PPD. However, since the diagnosis of PPD is a subset of the DSM criteria and three of the tools (PDSS) were modeled to include the diagnostic criteria for major depression, then any impediments in screening accurately for PPD may not be so perceptible among the EPDS, BDI-II, and the CES-D. This has been cited as a strength by Beck in her numerous articles and psychometric assessments of the PDSS. Another problem with all four instruments is that they are all self-report measures requiring the subjects to report how they have felt over the last 1-2 weeks. Recall always has the potential to cause problems as respondents can rate how they feel in the moment or the last few days as opposed to the entire 1-2 weeks. Finally, there is controversy as to when

PPD should be assessed. Depending on when the tools are administered can also be problematic if none of the subjects are depressed at the time of administration. Many of the studies do not follow up with a gold standard SCID to confirm whether or not the instruments are truly measuring the PPD construct. Also, there has been no optimal time frame suggested in the literature as to when PPD is likely to occur or when best to assess for PPD. While none of the three instruments should serve as a replacement for the SCID, they all have been shown to be valid and reliable in screening for PPD in the outpatient setting and for use in research studies.

Future Direction in Measurement of Postpartum Depression

In the last 40 years, there has been an explosion of research and new information gathering in the area of PPD. Regrettably, a comprehensive picture of the disease has not been elucidated. Despite the increase in knowledge and a slow and steady attempt to increase awareness and decrease the stigma associated with PPD, many women will not seek care and/or will not be accurately diagnosed. This is due to a multitude of reasons as some practitioners are not comfortable discussing the issue or may be inundated with high patient loads and perceive screening for PPD as something that can be skipped in lieu of assessing for more pressing physiological matters (Beck, 2001; Ramsay, 1993). Further, there are few studies that have confirmed that universal screening is useful, necessary, or would impact the outcomes of women suffering from PPD (Gaynes et al., 2005). This is definitely an area rich for further examination.

Many instruments have shown promise in measuring and screening for PPD in the literature; however, there is no clear set of guidelines that direct clinicians and researchers in selecting a particular tool at a certain time period in pregnancy and/or the

postpartum period (Gaynes et al., 2005). Although new to the literature, the PDSS shows the most promise in detecting those women who are truly depressed in the postpartum period (Beck and Gable 2001a). Selection of a specific instrument may depend on the population under scrutiny. For instance, the EPDS would be recommended at this point in adolescent samples as demonstrating superior performance when compared to two versions of the CES-D. Further, the EPDS has been more extensively studied in the adolescent population (Logsdon & Meyers, 2010; Logsdon et al., 2009). The CES-D has been studied most extensively in urban samples with strong internal consistency and support for validity and is recommended in this population at this time (Beehly et al., 2003; Canaday et al., 2009). All of the instruments discussed in this paper would be better served with more studies comprised of larger populations and conducted in a variety of settings.

In summation, future research studies examining PPD should clearly delineate the definition of PPD, examine the effectiveness of identifying PPD on the trajectory of those women affected by PPD, and select the particular instrument that has been shown to be reliable and valid in a specific population or setting. Overall, the PDSS is recommended for screening for PPD in the antenatal and postpartum periods from this critical review of the current evidence.

Table 2.1: Description of 4 Instruments Measuring Postpartum Depression

Instrument (Year)	No. Items	Response Options	Scoring and Range	Suggested Cut-off Scores	Time Required to Complete
Center for Epidemiologic Studies Depression Scale (Radloff, 1977)	16 Positive items; 4 Negative items	Over the past week, indicate how often you felt this way. 0 (less than 1 day) to 3 (all of the time)	Responses from the items are summed (4 items are reverse scored) Range = 0-60	≥ 16 = significant or mild depression	5-10 minutes
Edinburgh Postnatal Depression Scale (Cox, Holden, &Sagovsky, 1987)	7 Negative items; 3 Positive items	Over the last 7 days, rate how often you have felt this way. 0 (never or not at all) to3 (yes, most of the time, quite a lot, or as much as I always could)	Responses from the items are summed (7 items are reverse scored) Range = 0-30	≥10 = MDD/MnDD	5-10 minutes
Beck Depression Inventory-II ((Beck, Steer, Ball, &Ranieri, 1996).	21 items	Based on the last 2 weeks, rate how often you have felt this way. 0 indicates that the subject is not demonstrating depressive symptoms at any time, while 3 indicates the subject demonstrates the highest level of symptoms most of the time.	Responses from the items are summed Range 0-63	0-13 = minimal depression 14-19 = mild depression 20-28 = moderate depression 29-63 = severe depression	5-10 minutes
Postpartum Depression Screening Scale (Beck & Gable, 2000)	35 Positive items	Based on the last 2 weeks, rate on a Likert Scale of 1(strongly disagree) to 5 (strongly agree) the degree to which you agree or disagree with the symptoms of PPD	Responses from the items are summed. Range 35-175	35-59 = normal adjustment 60-79 = significant symptoms of PPD 80-175 = positive screen for MDD	5-10 minutes

Abbreviations: MDD, Major Depressive Disorder; MnDD, Minor Depressive Disorder; PPD, postpartum depression

Table 2.2: Psychometric Properties of 4 Measures of Postpartum Depression in Antepartum and Postpartum Samples

First Author (Year)	Purpose	Design	Sample	Time Frame	Reliability	Evidence of Validity	Cut-off Score
CES-D							
Campbell and Cohn (1991**)**	To describe the prevalence of PPD in first time mothers	Longitudinal	N = 1,007	6-8 weeks postpartum	Not reported	With a cut-off score of 16, the sensitivity was 60% and the specificity was 92%	CES-D $\geq$ 16
Beeghly et al. (2003)	To evaluate the prevalence and stability of high levels of maternal depressive symptoms and examine the relationship between socio-demographic risk factors and the mother's depressive symptoms during the first 18 months after delivery	Prospective, longitudinal	N = 163 Black adult postpartum mothers	Data were collected at 3, 6, and 18 months after delivery	Cronbach's alpha for the CES-D 2 months = .83 3 months = .89 6 months = .88	Concurrent validity was supported when the CES-D was correlated with concurrent scores on the BSI and the Depression Subscale of the GSI	CES-D $\geq$ 16

Table 2.2 (continued): Psychometric Properties of 4 Measures of Postpartum Depression in Antepartum and Postpartum Samples

First Author (Year)	Purpose	Design	Sample	Time Frame	Reliability	Evidence of Validity	Cut-off Score
CES-D							
Mosack and Shore (2006)	To examine depressive symptoms with the CES-D and the EPDS among first time mothers at three time points (antenatal, early postpartum, and late postpartum) and to compare the utility of the two instruments	Cross sectional	N=98 pregnant and postpartum women	Pregnancy at 28 weeks and beyond, early postpartum (within 6 months of deliver), and late postpartum (beyond 6 months)	For the CES-D, Cronbach's's alpha was .87 and for the EPDS, Cronbach's's alpha was .86	Convergent validity was supported: the CES-D and the EPDS were strongly correlated $r(96) = .81$ $p < .01$	CES-D $\geq$ 16 EPDS $\geq$ 12
Ko, Yang, & Chiang (2008)	To evaluate fatigue and depression among Taiwan postpartum women before and after the implementation a low intensity exercise program	Cross sectional	N=79 postpartum women	Baseline after delivery and then 3 weeks later at the completion of the exercise program	Cronbach's's alpha = .81	Convergent validity was supported when using a cut-off score of 15, the sensitivity was 92%, the specificity was 91%	The Chinese version of the CES-D $\geq$ 15

Table 2.2 (continued): Psychometric Properties of 4 Measures of Postpartum Depression in Antepartum and Postpartum Samples

First Author (Year)	Purpose	Design	Sample	Time Frame	Reliability	Evidence of Validity	Cut-off Score
CES-D							
Canady, Stommel, and Holzman (2009)	To examine the psychometric properties and assess racial bias of the CES-D between African American and White American pregnant women	Cross sectional	N=750 pregnant women (375 Black and 375 White matched pairs)	Between the 15th and 27th week of pregnancy	20 items (Cronbach's alpha = 90 for Whites .87 for Blacks) 19 items (Cronbach's alpha for Whites = .90 and for Blacks = .88)	CFA revealed 2 dimensions of the CES-D with 19-items with a good fit; however, the 20-item CES-D did not demonstrate significant ethnical bias	CES-D $\geq$ 16
EPDS							
Cox, Holden, & Sagovsky, 1987)	To validate the 10-item EPDS	Cross sectional	N = 84	Approximately 3 months post delivery	EPDS Cronbach's alpha = .87 Split half reliability = .88	Evidence of concurrent validity was supported when the EPDS was correlated with the RDC. With a cut-off score of 9/10 the sensitivity was 85%, specificity was 77%, and the positive predictive value was 83%	EPDS $\geq$ 9/10

Table 2.2 (continued): Psychometric Properties of 4 Measures of Postpartum Depression in Antepartum and Postpartum Samples

First Author (Year)	Purpose	Design	Sample	Time Frame	Reliability	Evidence of Validity	Cut-off Score
EPDS							
Logsdon, Usui, and Nering (2009)	To examine the psychometric properties of the EPDS in a sample of adolescent mothers	Descriptive	N = 149	4-6 weeks postpartum	EPDS Cronbach's alpha = .88	Criterion validity was demonstrated between the EPDS and the CES-D with a mid level correlation .77 Principle components analysis supported two subscales of the EPDS	EPDS $\geq$ 12
Logsdon and Myers (2010)	To examine the psychometric properties of 2 versions of the CES-D and the EPDS in and adolescent sample	Cross sectional	N=59 adolescent postpartum adolescents	4-6 weeks postpartum	CES-D20 Cronbach's alpha = .84 CES-D30, Cronbach's alpha = .85 EPDS Cronbach's alpha = .85	Convergent validity was supported in that all three instruments were correlated; however none of the instruments correlated with the SCID indicating that concurrent validity was not supported ROC analysis indicated that the EPDS was the most accurate instrument	CES-D20 $\geq$ 16 CES-D30 $\geq$ 24 EPDS $\geq$ 12

Table 2.2 (continued): Psychometric Properties of 4 Measures of Postpartum Depression in Antepartum and Postpartum Samples

First Author (Year)	Purpose	Design	Sample	Time Frame	Reliability	Evidence of Validity	Cut-off Score
BDI-II							
Mahmud, Awang, Herman, and Mohamed (2004)	To ascertain validity, reliability, and factor structure of the BDI-II in postpartum Malaysian women	Cross sectional	Stage I N = 20 Stage II N= 61 Stage III N=35 postpartum Malaysian women	4-12 weeks postpartum	Performed in Stage II on 61 women Cronbach's alpha = .89 Split half coefficient = .84	Face, content, concurrent, convergent, divergent, and factor validity were supported	BDI-II $\geq$ 9-10
Manian, Schmidt, Bornstein, and Martinez (2013)	To examine factoral dimensions of the BDI-II in a diverse sample of ethnically diverse postpartum women	Cross sectional	N = 953	4-20 weeks postpartum	Cronbach's alpha .91	Evidence of concurrent, convergent, and factor validity supported	BDI-II $\geq$ 12

Table 2.2 (continued): Psychometric Properties of 4 Measures of Postpartum Depression in Antepartum and Postpartum Samples

First Author (Year)	Purpose	Design	Sample	Time Frame	Reliability	Evidence of Validity	Cut-off Score
PDSS							
Beck and Gable (1999)	To discuss the development and description of the psychometric properties of the PDSS	Cross sectional	N= 525	2 weeks-6 months postpartum	Cronbach's alpha for the 7 subscales ranged from .83-.94	Evidence of content and construct validity was supported.	PDSS ≤59 = normal adjustment 60-79 = significant symptoms of PPD 80-175 = positive screen for MDD
Beck and Gable (2001a)	To assess the construct and incremental validity, sensitivity, specificity, and predictive values of the PDSS	Cross sectional	N = 150	2-12 weeks postpartum	Cronbach's alpha for the 7 subscales on the PDSS ranged .80-.91 Cronbach's alpha for the BDI-II was .91 Cronback alpha for the EPDS was .89	Convergent validity: the PDSS was strongly correlated with both the BDI-II and the EPDS Incremental validity was demonstrated	ROC curves and the DSM-IV criteria suggest 80 for major and 60 for minor depression

Table 2.2 (continued): Psychometric Properties of 4 Measures of Postpartum Depression in Antepartum and Postpartum Samples

First Author (Year)	Purpose	Design	Sample	Time Frame	Reliability	Evidence of Validity	Cut-off Score
PDSS							
Le, Perry, and Sheng (2009)	To examine the possibility of screening for PPD via the internet	Cross sectional	N = 141 women	Up to a year post delivery	PDSS Cronbach's alpha = .97 (.77-.95 among the 7 subscales) EPDS Cronbach's alpha = .87	Construct validity was supported when the PDSS was correlated with the EPDS (r = .80, p\ .01)	PDSS ≤59 = normal adjustment 60-79 = significant symptoms of PPD 80-175 = positive screen for MDD EPDS ≥ 9/10
Le, Perry, and Ortiz (2010)	To examine the reliability and validity of the original PDSS, and a shortened 7-item version of the PDSS and the prevalence of postpartum depressive symptoms of the Spanish version of the PDSS in a sample of Central American mothers	Cross sectional time point from a longitudinal study	N = 217 who were categorized by region El Salvador (n = 91) Other Central American (n = 40) Mexico (n = 24)	6-8 weeks postpartum	Cronbach's alpha for the 7 subscales on the 35-item PDSS ranged .56-.97 and the total was .97 Cronbach's alpha for the 7-item PDSS was .83 The subscale internal consistencies were not reported for the 7-item PDSS, BDI-II, or the EPDS	Concurrent validity was demonstrated in a partial manner when one subject scored 115 on the PDSS and met criteria for MDD via the Mood Screener, the BDI-II, and the CES-D (screened during pregnancy), and a history of depression. Evidence of construct validity was supported.	Not specified for either version of the PDSS or the BDI. The CES-D was used as a screen for depression during pregnancy as part of the longitudinal aspect of the study. A cut-off score of ≥ 16 was used

Table 2.2 (continued): Psychometric Properties of 4 Measures of Postpartum Depression in Antepartum and Postpartum Samples

First Author (Year)	Purpose	Design	Sample	Time Frame	Reliability	Evidence of Validity	Cut-off Score
PDSS							
McGabe et al. (2012)	To examine the internal consistency of the PDSS in a sample of mothers with infants in the NICU	Cross sectional	N = 111	≥ 14 days postpartum	Cronbach's alpha Total PDSS = .95 and .72-.89 for the seven subscales	Evidence for construct validity was demonstrated via bivariate correlations The R^2 correlations ranged from .37-.74 with two subscales sharing 70% or more of the variance with the remaining subscales	PDSS ≤59 = normal adjustment 60-79 = significant symptoms of PPD 80-175 = positive screen for MDD EPDS ≥ 9/10
Combination Study							
Chaudron et al (2010)	To assess the sensitivity, specificity, and operating characteristics of the BDI-II, the EPDS, and the PDSS	Cross sectional	N=198 low income urban postpartum mothers	The instruments were administered between 2 weeks and14 months after delivery	Not reported	Concurrent validity was supported as all three instruments were compared to the SCID. Convergent validity was supported as all three instruments performed equally for MDD and MDD/MnDD, with AUC of ≥ .8	BDI-II ≥ 14 MDD ≥11MDD/MnDD EPDS ≥ 9 MDD ≥7MDD/MnDD PDSS ≥ 80 MDD ≥77MDD/MnDD

Chapter III: Psychometric Assessment of the Autonomy and Relatedness Inventory (Ari) in the First Trimester of Pregnancy

Background and Purpose

The purpose of this study is to examine the psychometric properties of the Autonomy and Relatedness Inventory (ARI) in a sample of pregnant women in their first trimester. The importance of intimate partner relationships during pregnancy cannot be overstated. For instance, Norbeck and Anderson (1989) found that women with the highest levels of stress and the lowest levels of reported intimate partner support reported the highest levels of anxiety (M = 45) as measured by the State Trait Anxiety Inventory (STAI). Correspondingly, women who reported low social support as compared to women who reported adequate support were more likely to report an increased incidence of poorer health during pregnancy, start prenatal care later in gestation, seek medical assistance more often, and report higher levels of depressive symptoms in the postpartum period (Webster et al., 2000).

Similarly, Robertson, Grace, Wallington, and Stewart (2004) conducted a meta-analysis and found that the strongest antenatal predictors in developing depression in the postpartum period and the corresponding Cohen's d effect sizes were as follows: depression during pregnancy (d = .75), anxiety during pregnancy (d =.68), life events (d =.61), social support (d =-.64), and previous history of depression (d =.58). Neuroticism and marital relationship were considered moderate predictors with a Cohen's effect size d =.39. Finally, a small predictive effect size was demonstrated for socioeconomic status at -.14 and obstetric complications at .26 (Cohen, 1988).

Lancaster et al. (2010) demonstrated similar findings in a systematic review of the literature. In addition to the Robertson et al. (2004) findings, Lancaster et al. (2010)

added Medicaid insurance, unintended pregnancy, lower income, smoking, single status, and poor relationship quality, and domestic violence as moderate correlates in the development of antenatal depression. These findings suggest a fairly moderate to strong interplay among these variables. However, the mechanism(s) in which all of these factors work in concert is not well understood. In particular, poor intimate partner relationship quality is difficulty to define and to examine in research studies. Further, instruments used to examine the quality of intimate partner relationships in research studies are rarely used or validated in the literature (Robertson et al., 2004; Lancaster et al., 2010).

The ARI is a measure of the quality of intimate partner relationships. Originally developed by Schaefer and Edgerton (1982), the 23-item, Marital Autonomy and Relatedness Inventory (MARI), is unique in that women are first asked to identify the most important person in their life and then answer the questions on the instrument based on their current perceptions of their identified intimate partner's (e.g., spouse, partner, mother, father, friend, etc.) behavior. Further, the MARI also addresses negative aspects of social support. Many social support instruments only address the positive qualities of social support and many experts have demonstrated and argued for the need to assess and report all aspects of the social support relationship (Hutchison, 1999). Hall (1983) added nine items to the MARI which was named the ARI. The additional items strengthened the positive relationship subscales.

To date, this author knows of no research studies that have used the ARI in a sample of pregnant women. Since the intimate partner relationship plays an integral, while not completely elucidated role in the development of antenatal depression,

measures to assess the quality of the relationship need to be validated in an effort to explore this phenomenon further.

Theoretical Framework

We chose Norbeck's Social Support Model (1981) to provide the framework for this paper. Norbeck extensively examined decades of literature on social support. She surmised that adequate social support as defined by the perception of the individual had many positive protective health outcomes. Conversely, an individual's perception of inadequate social support was significantly correlated with negative health outcomes. Because stress and support are moderately to strongly correlated with social support, every effort should be made to assist persons with inadequate support to either increase social support or maximize any available support and resources. Norbeck's model syncs with the foundation of the ARI in that both take into account the negative and positive aspects of social support from the perspective of the respondent (Norbeck, 1981). The model also provides the foundation for the discussion specific to the aims and hypotheses of this paper.

Specific Aims

The specific aims of this study were to:

1. Assess the internal consistency reliability of the ARI;
2. Examine the dimensionality of the ARI; and
3. Evaluate construct validity of the measure by testing the following hypotheses:

   H_1: The ARI will not be significantly associated with sociodemographic characteristics of women in the first trimester.

H_2: The ARI will be inversely related to the Edinburgh Postnatal Depression Scale.

Methods

Design

Data for this cross-sectional study came from a prospective multicenter study of a culturally and ethnically diverse sample of pregnant women using a repeated measure design. Data were collected in the first trimester between 8-13 weeks gestation, second trimester between 14-26 weeks gestation, third trimester between 27-36 weeks gestation, and the postpartum period at 6 weeks (Center for Biomedical Research Excellence (COBRE: 5P20GM103538). In this paper we examined first trimester data only, as this is a midpoint analyses of a larger, ongoing study.

Sample and Setting

Subjects were recruited from three outpatient obstetric clinics in northern, central, and western Kentucky over a four year period from 2009 to 2013. There were two cohorts, women with a history of previous preterm birth and women with no history of preterm birth. Women were eligible for enrollment if they were greater than 18 years of age with a singleton gestation. Exclusion criteria included history of Type 1 and Type 2 diabetes, heart disease, current history of illegal or prescription drug use, second trimester diagnosis of bacterial vaginosis or sexually transmitted infections, autoimmune disease, HIV or women with multifetal pregnancies. Data from 397 women were available for analyses.

Measures

Intimate partner relationships. The quality of the intimate partner relationship was measured with the ARI. The ARI is a 32-item scale. There are a total of eight subscales within the ARI with four items in each subscale. There are five subscales that examine the positive side of the intimate partner relationship as follows: Acceptance, Autonomy, Listening, Relatedness, and Support. The remaining three subscales examine the negative aspects of the intimate partner relationship. The three negative subscales are Detachment/Rejection, Control, and Hostile Control. There are no cutoff scores for quality of the relationship; however, higher scores are associated with a higher quality relationship (Schaefer & Edgerton; 1982; Hall, 1983).

Administration of the ARI first asks respondents to identify the most important person in their life. The answer to this question is considered the identified intimate partner, but is not part of the scoring of the scale. Then, the respondents rate the quality of their current perception of the intimate partner's behavior towards them for each item. The responses range as follows: very little like (1), somewhat like (2), much like (3), very much like (4), and very much like (5) the intimate partner (Hall & Kiernan, 1992). Both, a total score and subscale scores can be calculated. The negative items are reverse coded. To form the total score, all ratings are summed, and then 32 is subtracted from the total sum, so that the minimum score is 0; therefore, the potential range of scores is 0-128. Subscale scores are calculated by summing their corresponding items, and then four is subtracted from the total sum of the subscale. Although there are no agreed upon cutoff scores for the quality of the relationship, the higher the score, the more positive the

intimate partner relationship is reported by the respondent and vice versa (Hall & Kiernan, 1992).

The ARI has been reported to be a valid and reliable tool in samples of women of childbearing age. The psychometric properties of the ARI was examined in a sample of 213 mothers of 5-6 year old children (Hall & Kiernan, 192). The ARI was used in a study that examined self-esteem as a mediator of the effects of stressors and social resources on postpartum depressive symptoms in a sample of 738 postpartum women. Cronbach's alpha for the ARI was .93 (Hall, Kotch, Browne, & Rayens, 1996). A Spanish version of the ARI (ARI-S) was recently validated in a sample 100 Hispanic women. Cronbach's alpha was .92 for the total scale (Linares, Hall, & Ashford, 2015). These findings indicate excellent internal consistency, but Cronbach's alphas larger than .90 in the previous studies could indicate some item redundancy in those samples (Hall & Kiernan, 1992).

To provide evidence for construct validity of the ARI, Hall and Kiernan (1992), hypothesized that the ARI would not be significantly correlated with sociodemographic characteristics. There were no significant correlations with any of the sociodemographic variables. In regards to dimensionality of the ARI, the authors performed principal components analysis with Varimax rotation was performed and a two factor model prevailed. The first factor was termed "Support/Positive Regard" with all positive and positively worded items and the second factor was "Dominance/Control" with all negative and negatively worded items.

To demonstrate divergent validity, the ARI was assessed with the Center for Epidemiologic Studies Depression Scale (CES-D). The ARI demonstrated divergent validity when principal components analysis revealed a three factor structure among all

of the items from the ARI and the CES-D. The first two factors contained the items from the ARI as described previously; while, all the items on the third factor belonged to the CES-D. The same held true when the same procedure was applied with the ARI and the Health Opinion Survey which is a measure of psychosomatic symptoms. There were no cross-loaded items in either case. Finally, evidence for convergent validity was supported when the ARI correlated with items from the Dyadic Adjustment Scale which is another instrument that measures marital satisfaction (Hall & Kiernan, 1992).

Depression. The Edinburgh Postnatal Depression Scale (EPDS) is a 10-item instrument that was developed for utilization in the postpartum period in the community settings. Respondents are asked to rate their responses over the past week based on how often they have felt this way from less than one day (0) to all of the time (3). Four items are reversed scored. The range of scores is 0-60 (Cox, Holden, & Sagovsky, 1987). The Cronbach's α has been reported to range .85-.87 in several studies (Cox et al., 1987; Logsdon & Meyer, 2010; Logsdon, Usui, & Nering, 2009) and the split half reliability was .88 (Cox et al., 1987) providing evidence for strong to excellent internal consistency. However, the Cronbach's alpha for the sample in this study was .32 indicating poor internal consistency of the EPDS in this sample.

Procedures

Institutional review board approval was obtained for the study. Informed consent was obtained and participants completed the questionnaires in their respective outpatient obstetric clinics. While waiting for their obstetric appointments, participants completed the surveys via Survey Monkey on Apple IPads, but were offered pen and paper upon request. A research assistant described the instruments to the participants and answered

any questions they may have in regards to any of the instruments. After the questionnaires were completed, the information was de-identified and became part of the COBRE data base. Women received a $20 gift card for their participation in the study at the first trimester.

Statistical Analysis

Descriptive statistics were used to summarize the demographic and personal characteristics of the participants. Cronbach's alphas were calculated for each measure to assess internal consistency. Split half reliability via the Spearman-Brown Coefficient was calculated for the ARI. Construct validity was explored via hypothesis testing using correlational analysis. Principal component analysis was conducted on the ARI to evaluate the dimensionality of the scale. Data were analyzed with the Statistical Package for Social Sciences (SPSS) Version 22.0 (SPSS Inc., Chicago, IL).

Results

Sample Characteristics

Demographic characteristics of the sample are summarized in Table 1. The total sample was 397, all females in their first trimester of pregnancy. The participants comprised a fairly diverse sample. The majority were either married or living with a partner (69%). The mean age was 26 years (*SD* = 5). Most of the women reported greater than a high school education. More than a third of the women reported an income level of less than $20,000 annually (37%). Finally, more women reported working part or full-time as opposed to being unemployed (48%).

Psychometric Assessment of the ARI

Internal consistency reliability. Descriptive statistics and internal consistency reliabilities for the total ARI and its subscales are shown in Table 2. In this sample, the women identified their husband, boyfriend, or partner (65%), their mother (20%), other kin including father, sister, brother, and mother-in-law (11%), and finally other (4%). For this sample, the total ARI mean was relatively high (M = 106, SD = 10). Cronbach's alpha obtained for the ARI total scale was .77 and the Spearman-Brown Coefficient of .83 indicating evidence of acceptable internal consistency (Ponterotto & Ruckdeschel, 2007). The Cronbach's alphas for the subscales range from .30 to .84.

The three negative subscales of the ARI, Detachment/Rejection, Control, and Hostile Control demonstrated weak correlations via Pearson's correlation at -.11 to -.14 with the total ARI. The negative subscales were positively correlated amongst themselves with correlations ranging from .41 to.67. The Cronbach's alpha for the subscale, Detachment/Rejection was .30, for Control was .67, and for Hostile Control was .68. In regards to the Detachment/Rejection subscale, only two inter-item correlations were at .24, while other remaining inter-item correlations were < .20 within the subscale. In addition, three items displayed corrected item total correlations <.20. However, no major change in the alpha is gained with deletion of any items within the subscale. The two remaining negative subscales did not demonstrate any problematic inter-item correlations or corrected item total correlations with their respective content subscales, nor would any major increase in alpha occur with the deletion of any of their respective items. See Table 2.

Conversely, the five remaining positive subscales demonstrated very strong correlations with the total ARI with correlations ranging .74 to .81. In addition, the positive subscales correlations ranged from .57 to .76 among themselves indicating strong positive relationships among themselves. No low inter-item correlations or problematic corrected item total correlations were noted among any of the five positive subscales. Finally, no significant increase in alpha would occur with the deletion of any of the items in respect to their content subscales. See Table 2.

Construct validity

Dimensionality of the ARI. The 32 items of the ARI were subjected to principal components analysis. The significant Bartlett's test ($p < .001$) indicates the adequacy of the correlation matrix, while the high Kaiser-Meyer-Olkin (KMO) index (.94) indicates that the sample was suitable for this type of analysis. On the basis of the size of the eigenvalues and using a cutoff of greater than one, six primary components were elucidated.

The eigenvalue of the first component was 12 and explained approximately 38% of the variance. The second component's eigenvalue was a little over 2 and explained an additional 7% of the variance. The remaining four components demonstrated eigenvalues > 1 and explained an additional 14% of the variance. The six component model explains a total of 59% of the variance. All items exhibited moderate to strong loadings on their respective components. Accordingly, the ARI displayed a 6 component model in this sample.

Eleven items loaded on component one and were all from the positive subscales, Support (4 items), Relatedness (3 items), Listening (3 items), and Acceptance (1 item).

The Cronbach's alpha for component one was .91. Seven items loaded on component two from the positive subscales, Autonomy (4 items) and Acceptance (3 items). The Cronbach's alpha for component two was .87. Eight items loaded on component three from the negative subscales, Control (4 items), Hostile Control (3 items), and Detachment/Rejection (1 item). The Cronbach's alpha for component three was .78.Two items loaded on component four from the positive subscales, Relatedness (1 item) and Listening (1 item). The Cronbach's alpha for component four was .78. Three items loaded on component five from the negative subscales, Detachment/Rejection (2 items) and Hostile Control (1 item). The Cronbach's alpha for component five was .50. Finally, one item loaded on component six from the negative subscale, Detachment/Rejection. A Cronbach's alpha cannot be calculated for component six due to the component consisting of only one item.

Sociodemographic characteristics. The relationship among sociodemographic characteristics and the ARI were evaluated via *t* tests and correlational analyses. The ARI was not significantly correlated with age (r = .08, p = .12) or income level (r = .24, p = .64). A two samples *t* test revealed a significant difference in the ARI score between those who were employed (M = 112) and those who were not (107) $t(274) = -2.33$, p = <.02. Similarly, there were differences in education for those with less than a high school degree (M = 102) and those with high school or greater (M = 111) $t(273) = -3.71$, p = <.001. There were significant difference for those who categorized themselves as other than white (M= 93) and for those who were white (M = 114) $t(239) = -3.73$, p = <.001. Finally, there were significant differences in women who reported being in a relationship

(M = 111) and for those who were not in a relationship (M = 103) $t(274) = -3.15$, $p = <.002$.

Edinburgh Postnatal Depression Scale (EPDS). Next, to further assess construct validity of the ARI, the scale was correlated with the EPDS using the Spearman's rho statistic. The ARI demonstrated a moderate to strong negative correlation with the EPDS (*rho* =-.42, p = .01). This is an expected finding as women with higher depression scores are more likely to report an inadequate amount of or to be dissatisfied with their available support (Burke, 2003; Logsdon, McBride, & Birkimer, 1994). The cut off score for depression was $\geq$ 10; therefore, 21% (M = 5.69, SD = 4.97) of the women in this study met the criteria for depressive symptoms (Lagerberg, Magnusson, & Sundelin, 2011). Since four-fifths of participants were below the cutoff for high depressive symptoms, the high average ARI score in this sample is not unexpected.

Discussion

In this study, internal consistency reliability and validity of the ARI was examined in sample of women in the first trimester of pregnancy. While poor quality of intimate partner relationships has been found to be associated with many deleterious consequences for women in the antenatal period, no instrument has been recommended for use in assessing the intimate partner relationship during pregnancy or specifically in the first trimester (Lancaster, et al., 2010; Norbeck & Anderson, 1989; Robertson et al., 2004; Webster et al., 2000). These results demonstrate that the ARI exhibited acceptable internal consistency, reliability, and validity.

However, the three negative subscales of the ARI did not correlate with the total ARI which is in contrast to the Hall and Kiernan (1992) findings in new mothers. This

difference may be due to the different sample. These were pregnant women in the first trimester; whereas, in the Hall and Kiernan (1992) study, the women were 5-6 years after delivery. Perhaps, pregnancy provides a buffering effect on the negative aspects of the intimate partner relationship. Consistent with the Hall and Kiernan (1992) findings, the three negative subscales were negatively correlated with the positive subscales with correlations ranging from -.35 to -.53 indicating a weak to strong relationship with the positive subscales. The negative subscales did correlate with one another and the remaining positive subscales.

These findings of the factor analysis are in contrast to that of Hall and Kiernan (1992) where a two component model emerged after the ARI was subjected to principle components analysis and Varimax rotation. As discussed previously, the authors termed the two components, "Support/Positive Regard" and "Dominance/Control." For the purposes of this paper, component one encompasses many of the items from Hall and Kiernan's (1992) factor, "Support/Positive Regard;" therefore, the term will be applied to component one. Component two is termed "Autonomy/Acceptance." Component three consists of many of the items from Hall and Kiernan's (1992), "Dominance/Control" and will be used to denote the respective factor. Component four is termed "Relatedness/Listening." Component five is termed Detachment/Rejection." Finally, since component six consists of one item, "says I'm a big," which is an item from the Detachment/Rejection subscale, this component is termed "Subjugation." Perhaps the item, "says I'm a big problem" is another aspect of the negative side of social support not originally gleaned from the studies among new mothers. This factor could potentially be unique to pregnancy.

Study Limitations

A few limitations of the current study are important to note. There was no other instrument or "gold standard" assessment utilized to conclusively denote the quality of the participants' relationships with their intimate partners. Therefore, there was no way to examine concurrent validity of the ARI in this sample of women in the first trimester of pregnancy. The instruments in this study were self-report in nature which can limit the validity of the instrument. Cross sectional data analyses limit the study findings as well in that the assessment of the quality of the intimate partner relationship is captured at this one shot in time and the relationship may vacillate over time. Further, stability of the instruments cannot be assessed. A final limitation is the nature of secondary data analysis which can limit the author's intentions for the study as the primary author may have not designed the study to meet the needs and desires of the second author (Smith, et al., 2011).

Conclusions

The findings of this secondary data analysis provide support for the reliability and validity of the ARI for assessment of the intimate partner relationship in women in their first trimester of pregnancy with the exception of one dimension where the Cronbach's alpha could not be calculated. Poor quality of the primary intimate partner relationship remains a significant issue for women throughout pregnancy. The ARI could be used as a screening to tool in earlier pregnancy to identify the quality of the intimate partner relationship. Those women who score low on the ARI should be targeted for interventions to optimize the quality of existing positive relationships. A social services consult may help the woman to identify community and financial sources of support. The

use of doulas in the first trimester could improve the woman's perceptions of support as they have been found to increase positive health outcomes during labor and the postpartum period (Hodnett, Gates, Hofmeyr, & Sakala, 2013). Marital/couples counseling and parenting classes are some of other viable options to improve the quality of the intimate partner relationship (Doss, Thum, Sevier, Atkins, & Christensen, 2005).

This the first study to measure the quality of intimate partner relationships using the ARI in the first trimester of pregnancy. Further research is warranted in all trimesters of pregnancy to further examine the intimate partner relationship with the ARI and other instruments measuring both the negative and positive aspects of the intimate partner relationship (Hutchinson, 1999).

Table 3.1: Sample characteristics of participants, n = 397

Characteristic	n	Frequency (%) Or mean ± SD
Race		
Not Caucasian	113	28.5%
Caucasian	214	53.9%
Missing	70	17.6%
Marital Status		
Single	54	13.6%
Living with partner/married	275	69.3%
Missing	68	17.1%
Age	394	25.95 ± 5
Missing	3	
Education		
< high school	61	15.4%
≥ High school	267	67.3%
Missing	69	17.4%
Income		
< $20,000	147	37%
$20,000-$39,999	70	17.6%
≥ $40,000	103	25.9%
Missing	77	19.4%
Employment		
Unemployed	137	34.5%
Employed part or full-time	192	48.4%
Missing	68	17.1%

Table 3.2: Intercorrelations of the Autonomy and Relatedness Inventory total score and the subscales, n = 397

Scale/Subscale	Total ARI	Autonomy	Listening	Acceptance	Support	Relatedness	Detachment Rejection	Control	Hostile Control
Autonomy	.74**								
Listening	.79**	.69**							
Acceptance	.78**	.73**	.83**						
Support	.74**	.57**	.74**	.70**					
Relatedness	.81**	.63**	.76**	.74**	.70**				
Detachment/Rejection	-.12*	-.39**	-.44**	-.39**	-.42**	-.36**			
Control	-.11*	-.41**	-.52**	-.53**	-.39**	-.35**	.41**		
Hostile Control	-.14**	-.47**	-.47**	-.53**	-.38**	-.39**	.41**	.67**	
Mean±SD	105.61±9.6	12.7±3.3	13.8±2.8	13.5±2.7	14.37±2.3	13.1±2.8	1.4±1.9	2.1±2.5	2.1±2.4
Cronbach's alpha	.77	.80	.84	.80	.77	.71	.30	.67	.68

*p ≤ .05; **p ≤ .01

Table 3.3: Rotated component matrix of the Autonomy and Relatedness Inventory (ARI)

Items on the ARI (Subscale)	Component 1	Component 2	Component 3	Component 4	Component 5	Component 6
13. Is willing to help when I need it (Support)	**.76**	.16	-.19	.12	-.11	
5. Is there when I need him/her (Support)	**.73**					
29. Tries to comfort me when things go wrong (Support)	**.67**	.11	-.18		-.18	
9. Is always thinking of things to please me (Relatedness)	**.62**	.36	-.18	.17	.17	
31. Wants me to tell him/her about things (Listening)	**.60**	.29	-.20	.34	-.18	-.14
17. Has a good time with me (Relatedness)	**.58**	.35			-.30	-.25
15. Thinks I am worth listening to (Listening)	**.58**	.43	-.17	.23	-.17	-.12
21. Does what he/she can to make things easy for me (Support)	**.58**	.38	-.19	.17	-.14	.18
25. Asks me to share things he/she enjoys (Relatedness)	**.55**	.42		.13	-.12	
23. Makes me feel I can tell him/her anything (Listening)	**.54**	.40		.29	-.33	-.12
3. Respects my opinions (Acceptance)	**.46**	.38	-.24	.36		-.12
32. Lets me do anything I want to do (Autonomy)	.19	**.74**	-.13			-.11
8. Gives me as much freedom as I want (Autonomy)	.23	**.73**	-.26			
24. Thinks it's ok if I disagree (Autonomy)	.33	**.58**		.23	-.25	

Table 3.3 (continued): Rotated component matrix of the Autonomy and Relatedness Inventory (ARI)

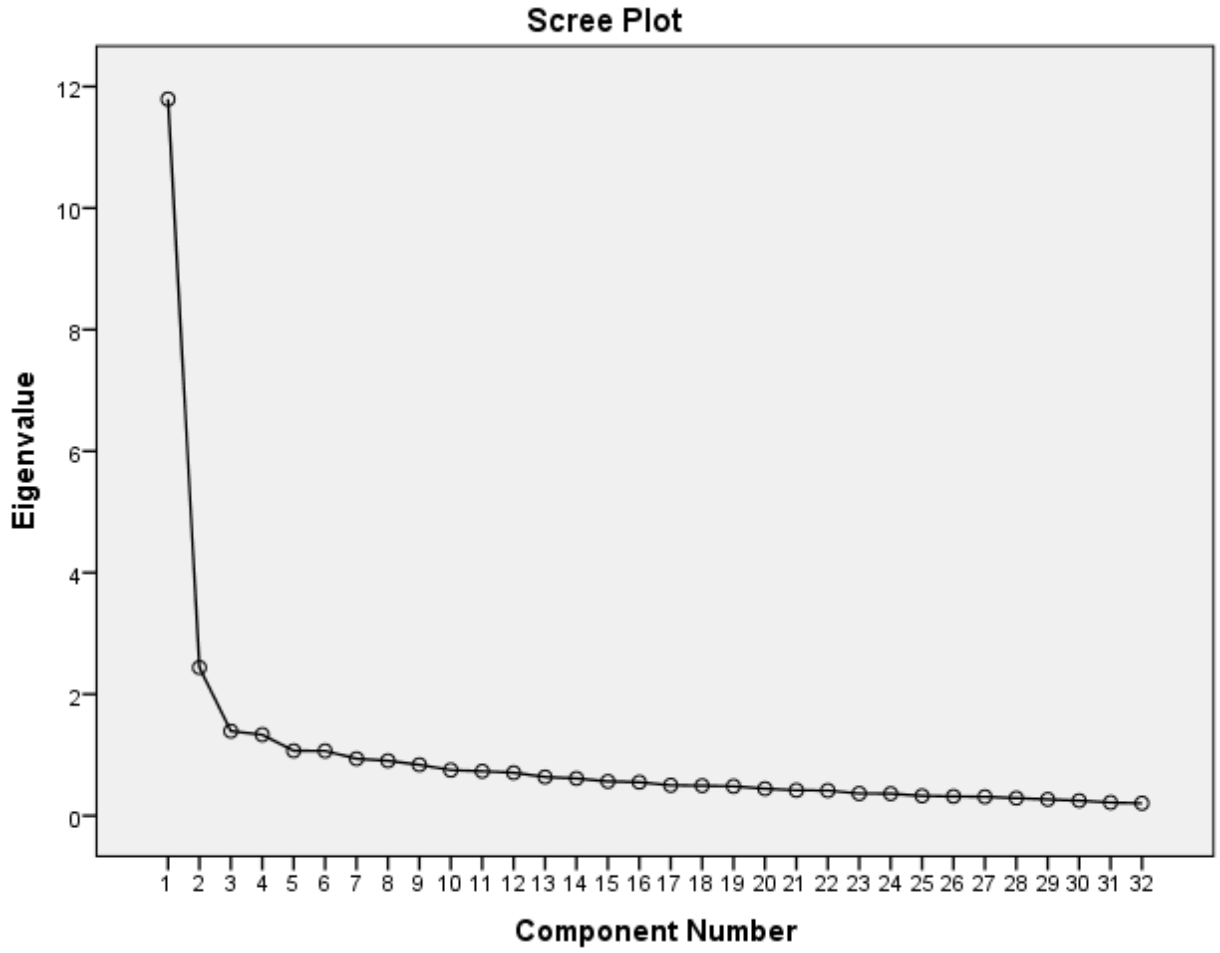
Items on the ARI (Subscale)	Component 1	Component 2	Component 3	Component 4	Component 5	Component 6
16. Lets me make up my own mind (Autonomy)	.42	**.58**	-.13		-.32	-.17
27. Considers my point view (Acceptance)	.47	**.53**	-.26	.28		
11. Encourages me to follow my interests (Acceptance)	.42	**.53**	-.25	.28		
19. Happy to go along with my decisions (Acceptance)	.43	**.43**	-.32	.32		
14. Wants to have last word on how we spend our time (Control)		-.14	**.72**		.28	
10. Argues back no matter what I say (Hostile Control)	-.18	-.16	**.68**			
22. Expects me to do everything his/her way (Control)	-.29		**.67**	-.11		
18. Wants to control everything I do (Hostile Control)	-.20	-.36	**.61**	.19	.13	.12
26. Finds fault with me (Hostile Control)	-.28		**.60**	.16		.37
6. Won't take no for answer when he/she wants something (Control)	.22	-.34	**.57**	-.28	.21	
12. Makes fun of me (Detachment/Rejection)			**.51**	-.31		
30. Acts as if he/she doesn't know me when he/she's angry (Control)	-.26		**.39**	-.37	.27	
1. Talks over his/her problems with me (Relatedness)	.34	.17		**.67**		-.17
7. Tries to understand how I see things (Listening)	.41	.39	-.28	**.54**		

Table 3.3 (continued): Rotated component matrix of the Autonomy and Relatedness Inventory (ARI)

Items on the ARI (Subscale)	Component 1	Component 2	Component 3	Component 4	Component 5	Component 6
2. Trying to change me (Hostile Control)		-.41	.37		**.41**	.30
28. Doesn't think about me much (Detachment/Rejection)	-.19			-.13	**.68**	-.13
4. Acts as though I am in the way (Detachment/Rejection)	-.24	-.30	.17		**.64**	.20
20. Says I'm a big problem (Detachment/Rejection)			.12	-.16		**.87**
Eigenvalue	11.79	2.44	1.39	1.33	1.07	1.07
Explained variance (%)	38.85	7.62	4.35	4.17	3.34	3.33
Cronbach's alpha	.91	.87	.78	.60	.50	

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

Figure 3.1: Scree Plot of the ARI



Chapter IV: Impact of Immune Status and Sociodemographic Characteristics in Predicting Depressive Symptoms in the Third Trimester of Pregnancy

Background and Purpose

The incidence and prevalence of postpartum depression (PPD) when defined as depression occurring during pregnancy and/or the first year after delivery has been estimated to affect 8-15% of women (Banti et al., 2011; Gavin et al., 2005). This is the definition of PPD used in this paper. The consequences associated with PPD are numerous and can be catastrophic for the woman, her offspring, her family, and society.

Further, immune status plays a critical role in the development and progression of PPD. A shift in the knowledge and understanding between the role of depression and inflammation has occurred in the last 20 years. In the past, inflammation was considered to be a risk factor for depression. Currently, the evidence suggests that inflammation is the trigger for depression (Schiepers, Wichers, & Maes, 2005) and the core risk factor for all other documented risk factors (Kendall-Tackett, 2007). Consequently, the interplay between PPD and inflammation is not well understood and worthy of further investigation.

Osborne and Monk (2013) conducted a systematic literature review on perinatal depression, anxiety, and inflammation. Seventeen studies were included in the review and were organized as: antenatal, mixed antenatal and postpartum, and postpartum only studies. Four studies examined inflammatory markers during the antenatal period only. Five studies used the mixed antenatal and postpartum period and eight in the postpartum period only. The serum inflammatory markers found to be statistically significant and consistent with measures of depression during the antenatal period were Interleukin-6 (IL-6), Interleukin-10 (IL-10), and Macrophage Migration Inhibitory Factor (MIF). In the

mixed studies, Clare Cells-16 (CC-16) IL-6, Interleukin-1ra (IL-1ra), leukemia inhibitory factor receptor (LIFR), Interleukin 6r (IL-6r), and C-Reactive Protein (CRP) were found to be significant with measures of mood and anxiety. In the postpartum period, serum tumor necrosis factor alpha (TNF-α), IL-6, IL-8, IL-13, IL-18, IFN-γ, total lymphocytes, and T cells were found to be significant.

Coussons-Read, Okun, Schmitt, and Giese (2005) found that women who reported high levels of stress exhibited higher levels of pro-inflammatory cytokines, IL-6 and TNF-α, while the anti-inflammatory marker, IL-10 was decreased. Further, Coussons-Read, Okun, and Nettles (2006) found that increased levels of reported stress in early, mid, and late pregnancy were associated with increased production of IL-1β and IL-6 in the third trimester and the onset of complications like pre-eclampsia and preterm birth. Increased stress in mid pregnancy and low levels of social support in late pregnancy were associated with increased levels of CRP. In addition, increased stress in early and late pregnancy was associated with increased IL-6 and decreased IL-10 in early pregnancy. Simhan and Krohn (2009) found that the pro-inflammatory cytokines IL-1α, IL-1β were decreased, and IL-6 and the anti-inflammatory cytokines IL-4, IL-10, and IL-3 were increased in cervico-vaginal (CVF) of women who delivered prior to 34 weeks gestation. The odds ratio was 7.7 (95% CI, 4.9-9.1, P = .01). Finally, Nien et al. (2006) reported amniotic MMP-8 was elevated in both women in the absence of intra-amniotic infection who delivered prematurely and in women who had active intra-amniotic infections. The likelihood ratios of the women to deliver within 48 hours, 7 days, or 14 days were 17.5 (95% CI, 9-33.9), 61.3 (95% CI, 15.1-20), and 50 (95% CI 12-96) respectively.

Wide variability exists among the cytokines measured, the medium (amniotic fluid, placental tissue, saliva, serum, CVF, etc.) used, and the time point during pregnancy or the postpartum period when examining immune status and pregnancy outcomes. Unfortunately, many of the cytokines under investigation have not been examined in conjunction with a measure of PPD; therefore, data on these associations are limited. The focus of the parent study was to examine the specified cytokines IL-1α, IL-1β, IL-6, IL-8, IL-10, CRP, TNF-α, and MMP-8 in saliva, serum, and CVF at trimester specific time points. The three mediums were chosen as they are less invasive when compared to obtaining amniotic fluid or placenta tissue samples. For the purpose of this paper, only serum cytokines were examined.

The purpose of this paper is to determine the impact of prenatal immune status on the risk for late pregnancy depression. The specific aims are:

1. Determine the association between prenatal immune status (serum IL-1α, IL-1β, Il-6, Il-8, Il-10, TNFα, MMP=8 and CRP) and depressive symptoms in each trimester of pregnancy.
2. Determine the impact of prenatal immune status on serum IL-1α, IL-1β, Il-6, Il-8, Il-10, TNFα, MMP=8 and CRP on risk for third trimester depressive symptoms.

Methods

Design

The current study was a preliminary assessment from a repeated measures, prospective, cross-sectional, multicenter study from a culturally and ethnically diverse sample using a repeated measures design. The primary purpose of the parent study was to examine the relationship among preterm birth and increased levels of prenatal

inflammatory markers in whole saliva, serum and CVF. Data were collected in the first trimester between 8-13 weeks gestation, second trimester between 14-26 weeks gestation, third trimester between 27-36 weeks gestation, and the postpartum period at 2- 6 weeks (Center for Biomedical Research Excellence (COBRE: 5P20GM103538).

Sample and Setting

Subjects were recruited from three outpatient obstetric clinics in northern, central, and western Kentucky over a four year period that spanned from 2009-2013. There were 487 women approached, 301 enrolled, and 203 women completed both the first and third trimester Edinburgh Postnatal Depression Scale (EPDS) survey. Two cohorts of women were recruited: women with a history of previous preterm birth, and women with no history of preterm birth. Women were eligible for enrollment if they were greater than 18 years of age with a singleton gestation. Exclusion criteria included history of Type 1 and Type 2 diabetes, heart disease, current history of illegal or prescription drug use, second trimester diagnosis of bacterial vaginosis or sexually transmitted infections, women with multifetal pregnancies, and multigravid women with no previous history of preterm delivery. For the present study, women who completed the first and third trimester EDPS and had serum cytokine data available were included.

Measures

Depression. The Edinburgh Postnatal Depression Scale (EPDS) is a 10-item instrument initially developed for utilization in the postpartum period in community settings (Cox, Holden, & Sargovsky, 1987).The EPDS is a reliable and valid tool consistently for measuring depressive symptoms during and after pregnancy (Gibson et al., 2009). For instance, the EPDS has been used with women during all trimesters of

pregnancy, with fathers, and with grandparents (Cox, Chapman, Murray, & Jones, 1996; Edmondson, Psychogiou, Vlachos, Netsi, & Ramchandani, 2010). Subjects were asked to rate their responses over the past week based on how often they have felt this way from less than one day (0) to all of the time (3). Four items are reversed scored. The range of scores is 0-60 (Cox et al, 1987). For this study, the EPDS was categorized as not demonstrating depressive symptomatology with a total score of $\leq$ 9 and demonstrating depressive symptomatology with a total score of $\geq$ 10.

Cytokines, CRP and MMP 8. Maternal serum cytokines (IL-1a, IL-1b, IL-2, IL-6, IL-8, IL-10, TNFa, CRP and MMP 8) were measured using multiplex beadlyte assay on a Luminex IS-100. Cytokines were collected at four time points during the study via saliva, serum, and CVF. The cytokines examined in the parent study were selected based on previous studies examining their association with preterm birth, stress, and/or depression as described in the background and significance section. Due to the limited data on salivary fluid and CVF, only the serum samples are reported in this paper. Blood was collected using standard venipuncture. For long term storage, blood samples were centrifuged, pipetted into aliquots, and stored at -80°c. Prior to analysis, the samples were slowly thawed. For CRP, the samples were diluted 1:5000, and for MMP-8 the samples were diluted 1:50. The cytokines were analyzed undiluted. All samples were run in duplicate according to the manufactures' protocols. All of the cytokines were stratified into three categories with high, medium, and low values due to their non-normal distribution. The International Business Machines (IBM) Statistical Package for Social Science (SPSS) software version 22.0 was used for data management and analysis (SPSS Inc., Chicago, IL).

Procedures

Institutional review board (IRB) approval was obtained for the parent study. Informed consent was obtained from potential subjects. Once consented, participants completed the questionnaires in their respective outpatient obstetric clinics. The majority of participants completed the surveys via Apple IPads at their respective obstetrical antenatal and postpartum visits. Pen and paper were made available upon request. A research assistant described the surveys to the participants and answered individual study questions. The survey took approximately 20 minutes to complete. After the survey was completed, biomarkers were collected. All data were stored on RedCap, a secure web-based data management system managed through the University of Kentucky Clinical and Translational Research Center.

Statistical Analysis

All statistical analyses were performed using the IBM SPSS (SPSS Inc., Chicago, IL). Descriptive analyses of the demographic characteristics of the sample were conducted including means and standard deviations. Cronbach alphas were calculated for each measure to assess internal consistency. Split half reliability was performed on the EPDS via the Spearman-Brown Coefficient.

Group comparisons between those with high EPDS versus low EPDS scores were conducted. Independent samples t-tests were conducted on age to compare those to third trimester depression scores. Likewise, chi square comparisons were performed on the remaining sociodemographic variables of race, obesity, smoking, education, and marital status against depressive symptoms in the third trimester of pregnancy. The decision to use these particular variables was based on previous research where significant

association were reported (Allen, Prince, & Dietz; Beck, 2001; 2009; Burke, 2003). In addition, Mann Whitney U statistics were conducted on all of the serum cytokines in all three trimesters of pregnancy and correlated with the third trimester depression score. Finally, logistic regression analysis was used to test whether any sociodemographic variables or significant cytokines predicted the participants' reported depressive levels in the third trimester of pregnancy. The alpha level was set at .05 throughout.

Results

Sociodemographic Characteristics

As the primary study is ongoing, complete data on all instruments and biomarkers are not available. In this study, 203 participants completed both first and third trimester EDPS survey. See table 1 for sample characteristics. Overall, the participants mean age in years was 25 for depressed and 27 for non-depressed women. The sample is culturally diverse with 24% indicating their race as African American, Hispanic, Asian, and other. The majority of participants are living with a partner or married and educated with a high school degree or higher. Fifty percent of the depressed women in this sample were smokers and 13% were obese. Smoking status (p = .001) and educational level (p = .001) were statistically different among women with and without third trimester depression.

EPDS

For the EPDS, the Cronbach α has been reported to range .85-.87 in several studies (Cox et al., 1987; Logsdon & Meyer, 2010; Logsdon, Usui, & Nering, 2009) and the split half reliability was .88 (Cox et al., 1987) providing evidence for strong internal consistency. The Cronbach α for this sample is .87 and the Spearman-Brown coefficient was .86 further supporting evidence for strong internal consistency in this sample. Only

19% of the subjects in this sample reported depressive symptoms in the postpartum period as defined by the cut off score of $\geq$ 10.

Third Trimester Depression and Immune Status

Table 2 displays the bivariate associations among serum levels of cytokines during the three trimesters of pregnancy and the third trimester depression score. The cytokines are stratified into tertiles with low, medium, and high levels. The top third levels are categorized in the high tertile, the middle third levels are categorized in the medium tertile, and the lower third levels are categorized in the low tertile. In the first trimester, IL-8 levels $U = 1297$, $p = .031$, $r = .18$ and MMP-8 levels $U = 287$, $p = .002$, $r = .31$ were higher among women who reported depression in the third trimester. In the second trimester, IL-6 levels $U = 1143$, $p = .018$, $r = .19$ were higher among women who reported depression in the third trimester. In the third trimester, again IL-8 levels $U = 1749$, $p = .036$, $r = .17$ and MMP-8 levels $U = 594$, $p = .051$, $r = .19$ levels were higher among women who reported depression in the third trimester.

Table 3 displays the variables in the logistic regression model. The logistic regression was conducted to assess the impact of prenatal immune status via serum cytokines and the risk for third trimester depressive symptoms (n = 82). In the final logistic model, only women with complete first trimester serum cytokine levels and third trimester depression scores were included. Smoking, race, age, and first trimester serum IL-8 and MMP-8 were entered in one block which was significant ($p = .004$), and accounted for 20.6 to 35.4% of the variance. The model was a good fit (Hosmer and Lemshow Test, chi-square 2.65, df = 8, $p = .955$. The sensitivity of the model in predicting third trimester depression was 30.8%. The specificity in predicting those who

did not display third trimester depression was 98.6%. Only first trimester MMP-8 (p = .004) was a significant predictor of depression in the third trimester. For every tertile increase of MMP-8, the likelihood of depression increased by 554% (OR = 5.54).

To test for differences between completers and non-completers, sociodemographic differences between subjects with complete and incomplete cytokine data (IL-8 and MMP-8) were compared. Among participants with complete and incomplete data, significant sociodemographic differences with smoking status (p =.008) and race (p =.024) existed. Smoking and race were included in the final model; therefore, no adjustments were necessary.

Discussion

First trimester serum MMP-8 was predictive of third trimester depression during pregnancy. To date, prenatal MMP 8 has been primarily associated with preterm labor and/or delivery (Nien et al., 2006) and not depression. The lack of any significant second trimester biomarkers predicting depressive symptoms has been supported in other studies. The concept that an immunological flux exists with distinct trimester-specific phases throughout pregnancy has been gaining popularity. Specifically, a pro-inflammatory state is heightened in the first and early second trimester. Whereas, during mid-pregnancy, a more stable anti-inflammatory environment is needed to promote fetal growth and development. In the third trimester, a strong inflammatory response returns to induce parturition. Thus, the second trimester is often considered a more stable time during pregnancy when the risk of miscarriage, nausea, vomiting, and other first trimester discomforts have resolved (Coussons-Read et al., 2006).

Psychosocial wellness has also been reported to flux throughout pregnancy. Heron, Connor, Evans, Golding, and Glove (2004) found that anxiety and depression across trimesters was significant in predicting PPD. However, anxiety in the third trimester (measured at 32 weeks) was the strongest predictor of postnatal depression (OR = 3.22). This lends support that identifying anxiety and depression in the third trimester is important in identifying subsequent depression in the postpartum period.

While limited studies have examined the relationship between antenatal depression and immune status, these findings contrast with previous findings. Specifically, only first trimester MMP-8 levels were found to be significant in this sample; whereas, serum IL-6, IL-10, and MIF were found to be significantly correlated with antenatal depression in a recent review of literature (Osborne & Monk, 2013). Further, Coussons-Read et al. (2006) found the pro-inflammatory cytokine, IL-β and IL-6, increase in response to increased stress across pregnancy trimesters.

The contrast in findings may be a result of the varying methodology among the studies. In the parent study, all instruments and biomarkers were obtained at the trimester specific time frames. Some studies use arbitrary collection times during and after pregnancy. Further, there is wide variability in the types of mediums (serum, salivary, cervico-vaginal, etc.) that are used in the studies. This inconsistency can make interpreting the results problematic (Kendall-Tackett, 2007; Osborne & Monk, 2013).

Limitations

There are limitations to this study. First, this was preliminary secondary data analysis which can limit the quality of the data and analyses as the purpose of the current study was not the primary objective of the primary investigators (Smith et al., 2011). The

small sample size limited the analyses as there were only 39 subjects reporting depressive symptoms in the third trimester time frame. In addition, there was incomplete cytokine data in the first trimester. The lack of cytokine data was primarily explained by a delay in laboratory analyses. To address the issue with missing data, a comparative analysis between subjects with complete and incomplete data (IL-8 and MMP-8) was performed. Sociodemographic differences in participant smoking and race were noted. Therefore, the findings of the study cannot be generalized to the wider population of childbearing women. Another limitation was the self-report of depressive symptoms versus clinical diagnosis. Finally, the study may have been limited by the exclusion of the biomarkers, IL-13, IL-18, IFN-γ, total lymphocytes, and T cells as these were found to be significant in previous studies examining the relationship between immune status and PPD (Osborne & Monk, 2013).

Conclusions

In this study, first trimester serum MMP-8 levels were predictive of maternal depressive symptoms in late pregnancy. This is also one of the first studies to examine the relationship between MMP-8 and maternal depression during pregnancy. However, due to limited sample size and lack of generalizability, more studies examining the impact of inflammation on depression during pregnancy are warranted.

Future studies examining serum cytokines and MMP-8 in the first trimester as well in the preconception period, second trimester, third trimester and postpartum period in relation to maternal depression are justified. Further research should use prospective, trimester specific time frames as the inflammatory milieu during pregnancy greatly varies. Other studies should include both psychosocial and biological data to provide a

more holistic approach to attain evidence regarding the impact of MMP-8 and other biomarkers function in the presence of pregnancy associated depression. Such evidence may potentially yield new diagnostic tools for early detection of depressive and other psychosocial conditions that can adversely impact maternal and neonatal health. Consequently, larger samples sizes are recommended to further generalize the results of these studies. Finally, future studies examining more cytokines like IL-13, IL-18, IFN-γ, total lymphocytes, and T cells with a variety of mediums may afford researchers and clinicians with a clearer picture of how immune status functions in the development and progression of antenatal depression.

Table 4.1: Comparison of Sociodemographic Characteristics by Third Trimester Depression Scores (n=203)

Characteristic	Depressed (*n* = 39) *n* (%)	Not Depressed (*n* =164) *n* (%)	P value
Marital Status			
Partner-Yes	28 (80)	122 (89)	.16
No Partner-No	7(20)	15 (11)	
Race			
White/Non-Hispanic	23 (66)	107 (78)	.13
Other	12 (34)	30 (22)	
Education			
High school or above	23 (66)	125 (91)	<.001
Less than high school	12 (34)	12 (9)	
Obesity			
Yes	5 (13)	9 (6)	.16
No	34 (87)	148 (94)	
Smoker			
Yes	18 (50)	31 (19)	<.001
No	18 (50)	130 (81)	
Age			
Mean ± SD	25.31 ± 5.78	26.68± 5.25	.43

Table 4.2: Bivariate associations among serum levels of cytokines and depression during pregnancy

	1st Trimester		2nd Trimester		3rd Trimester	
	% Depressed	*p*	% Depressed	*p*	% Depressed	*p*
IL-1α		.44		.30		.44
Low	33.3%		23.1%		41%	
Medium	12.8%		10.3%		23.1%	
High	25.6%		30.8%		28.2%	
IL-1β		.97		.16		.42
Low	30.8%		20.5%		30.8%	
Medium	17.9%		15.4%		25.6%	
High	23.1%		28.2%		35.9%	
IL-6		.10		.02		.18
Low	15.4%		10.3%		28.2%	
Medium	20.5%		17.9%		25.6%	
High	35.9%		35.9%		38.5%	
IL-8		.03		.08		.04
Low	15.4%		10.3%		20.5%	
Medium	20.5%		28.2%		33.3%	
High	35.9%		25.6%		38.5%	
IL-10		.50		.92		.62
Low	17.9%		23.1%		33.3%	
Medium	28.2%		15.4%		17.9%	
High	25.6%		25.6%		41%	
TNF-α		.60		.66		.73
Low	15.4%		15.4%		30.8%	
Medium	33.3%		25.6%		23.1%	
High	23.1%		23.1%		38.5%	
MMP-8		.00		.72		.05
Low	2.6%		7.7%		5.1%	
Medium	7.7%		7.7%		25.6%	
High	25.6%		10.3%		20.5%	
		.56		.79		.29
CRP						
Low	23.1%		20.5%		30.8%	
Medium	35.9%		28.2%		41%	
High	12.8%		15.4%		20.5%	

Note: *p value* from Mann-Whitney U test

Table 4.3: Logistic Regression of Selected Model Variables on PPD (n = 82)

Variable	*b*	SE	Likelihood Ratio Statistic	*P*	Odds Ratio	CI
Smoking Status	1.34	.83	2.63	<.105	3.83	.76-19.44
Race	-1.02	.92	1.22	<.269	.36	.06-2.20
Age	-.06	.06	.96	<.328	.94	.83-1.06
1st Trimester Serum IL-8	-0.37	.51	.54	<.463	.70	.26-1.86
1st Trimester Serum MMP-8	1.71	.59	8.53	<.004	5.54	1.76-17.47
Constant	-1.68	1.96				

Chapter V: Discussion and Conclusions

The purposes of this dissertation were to: (1) critically review and analyze the literature on four instruments that have been used to measure pregnancy associated depression; (2) evaluate the psychometric properties of the Autonomy and Relatedness Inventory (ARI) in a sample of pregnant women in the first trimester; and (3) examine the influence of first trimester serum inflammatory markers on third trimester depressive symptoms.

Synthesis of Findings and Implications

In Chapter Two, four instruments that examine pregnancy associated depression were examined: the Center for Epidemiologic Studies Depression Scale (CES-D), the Edinburgh Postnatal Depression Scale (EPDS), the Beck Depression Inventory (BDI-II), and the Postpartum Depression Screening Scale (PDSS). While the PDSS emerged as the instrument that detected the greatest amount of true PPD cases, the instrument is fairly new. The EPDS has been used most extensively and demonstrated reliable and valid results within the adolescent and postpartum populations; whereas, the CES-D has similar findings with the urban population.

Consistent with the finding that the EPDS is the most widely used screening tool for pregnancy associated depressive symptoms, the EPDS was used in the sample of 397 women in the first trimester from Chapter three (Lagerberg, Magnusson, & Sundelin, 2011). In assessing the psychometric properties of the Autonomy and Relatedness Inventory (ARI), the ARI was hypothesized to be inversely associated with the EPDS. This hypothesis was derived from evidence that supports that the higher the quality of the intimate partner relationship, the lower the depressive symptoms reported by women (Burke, 2003; Logsdon, McBride, & Birkimer 1994). The hypothesis was supported in

this sample of women via the Spearman's rho statistic. The final principal components analysis yielded a 6 dimension structure in this sample of women. Finally, in Chapter Four only first trimester serum MMP-8 was found to be significant in predicting third trimester depressive symptoms.

These findings support the difficulty in understanding the interplay of relationships among pregnancy, depressive symptoms, the intimate partner relationship, and immune status (Moses-Kolko & Roth, 2004. This author attempted to evaluate and elucidate some of those relationships and concluded that more research is warranted in this area to further glean knowledge and understanding of these phenomena.

Suggested Instruments to Measure Pregnancy Associated Depression in Research Studies

There are various instruments used in measuring pregnancy associated depression. Some of the problems identified in measuring postpartum depression (PPD) and/or pregnancy associated depression include: not delineating a clear definition of PPD to guide research studies, wide variability in the use of numerous instruments, no defined time points to measure depression in the antenatal and postnatal periods, and finally, no clear cut guidelines exist in recommending one instrument over another (Beck & Gable, 2001; Gavin et al., 2005).

Chapter Two addressed these issues by examining four commonly used instruments employed in research studies that measure PPD. The major implication of this critical review and analysis was that certain instruments performed better depending on the type of population under scrutiny. Overall, the PDSS performed well in predicting true cases of PPD. However, the PDSS is a fairly new instrument and has been used the least among the four instruments (Beck & Gable, 2001). The CES-D performed well in

urban populations (Beehly et al., 2003; Canaday, Strommel, & Holzman, 2009). The EPDS is not only the most widely studied and validated instrument among various populations, the EPDS was shown to identify true cases of PPD in adolescents (Logsdon & Meyers, 2010; Logsdon, Usui, & Nering, 2009).

The main conclusions of this study were that the operational definition of PPD needs to be clearly stated in future research studies, care should be taken in selecting an instrument to measure pregnancy associated depression in regard to the type of population under study, more studies are needed to investigate the impact of interventions and treatments for PPD as identified via these instruments, and more studies are needed to further validate the PDSS in a variety of populations and settings. Finally, all four of the instruments CES-D, BDI-II, EPDS, and the PDSS all need further validation of their psychometric properties.

Psychometric Assessment of the ARI

Pregnancy associated depression, social support, and the quality of the intimate partner relationship have been found to be interconnected. For instance, women with the highest levels of stress and the lowest levels of reported intimate partner support reported the highest levels of anxiety (M = 45) as measured by the State Trait Anxiety Inventory (STAI) (Norbeck & Anderson, 1989). Correspondingly, women who reported low social support as compared to women who reported adequate support were more likely to report an increased incidence of poorer health during pregnancy, begin prenatal care later in gestation, seek medical assistance more often, and report higher levels of depressive symptoms in the postpartum period (Webster et al., 2000).

A meta-analysis found the strongest antenatal predictors in developing depression in the postpartum period and the corresponding Cohen's *d* effect sizes were as follows: depression during pregnancy (*d* = .75), anxiety during pregnancy (*d* =.68), life events (*d* =.61), social support (*d* =-.64), and previous history of depression (*d* =.58). Neuroticism and marital relationship were considered moderate predictors with a Cohen's effect size *d* =.39. Finally, a small predictive effect size was demonstrated for socioeconomic status at -.14 and obstetric complications at .26 (Robertson, Grace, Wallington, & Stewart, 2004; Cohen, 1988).

Clearly, the association between PPD and the quality of the intimate partner relationship is an integral facet in the understanding of the trajectory of PPD. However, there are few instruments that have examined the quality of the intimate partner relationship during pregnancy. The ARI was adapted from the Marital Autonomy, and Relatedness Inventory (MARI) (Schaefer & Edgerton, 1982). The ARI includes the 23 items from the MARI and an additional nine items which strengthened the positive relations subscales. The ARI examines both negative and positive aspects of the intimate partner relationship (Hall, 1983).

In order to further examine the quality of the intimate partner relationship, the ARI was examined in a sample of 397 women in the first trimester of pregnancy. Overall, the ARI was found to demonstrate acceptable internal consistency, reliability, and validity. Cronbach's alpha obtained for the ARI total scale was .77 and the Spearman-Brown Coefficient of .83 indicating evidence of acceptable internal consistency (Ponterotto & Ruckdeschel, 2007). The Cronbach's alphas for the subscales range from .30 to .84. Principal components analysis yielded a six dimension model for this sample.

As hypothesized, the ARI demonstrated a moderate to strong negative correlation with the EPDS (*rho* =-.42, *p* = .01). This finding indicates that women who reported higher depressive scores also reported lower scores on the ARI which indicates a poorer quality of the intimate partner relationship. A two samples *t* test revealed a significant difference in the ARI score between those who were employed (M = 112) and those who were not (107) *t*(274) = -2.33, *p* = <.02. Similarly, there were differences in education for those with less than a high school degree (M = 102) and those with high school or greater (M = 111) t(273) = -3.71, *p* = <.001. There were significant differences for those who categorized themselves as other than white (M= 93) and for those who were white (M = 114) *t*(239) = -3.73, *p* = <.001. Finally, there were significant differences in women who reported being in a relationship (M = 111) and for those who were not in a relationship (M = 103) *t*(274) = -3.15, *p* = <.002. These findings indicate that employed women, women with more education, non-Caucasians, and women who were in a relationship reported an increased quality of intimate partner relationship. These findings are consistent with previous research where these relationships have been associated with the quality of the intimate partner relationship (Burke, 2003; Hall, 1983).

Impact of Immune Status on Third Trimester Depressive Symptoms

The importance of predicting certain conditions among vulnerable populations is a very relevant topic. An emerging area of research in this area is focused on linking biomarkers with certain conditions in order to predict, target treatments, and better understand how those conditions or diseases manifest (Schiepers, Wichers, & Maes, 2005). Chapter Four focused on the role of immune status and pregnancy associated depression in the third trimester.

In the final logistic regression model, 82 women with complete serum biomarker data were included in the analyses. First trimester MMP-8 (p = .004) was highly predictive of third trimester depressive symptoms. For every tertile increase of MMP-8, the likelihood of depression increased by 554% (OR = 5.54). There were no significant differences noted with depression and immune status in the other trimesters.

While few research studies have examined the relationship between antenatal depression and immune status, these findings are in contrast with previous findings. Only first trimester MMP-8 levels were found to be significant in this sample; whereas, serum IL-6, IL-10, and MIF were found to be significantly correlated with antenatal depression in a review of literature (Osborne & Monk, 2013). Further, Coussons-Read et al. (2006) found the pro-inflammatory cytokine, IL-β and IL-6, increase in response to increased stress across pregnancy trimesters.

The contrast in findings may be a result of the varying methodology among the studies. In the parent study, all instruments and biomarkers were obtained at trimester specific time frames. Some studies use arbitrary collection times during and after pregnancy. Further, there is wide variability in the types of mediums (serum, salivary, cervico-vaginal fluid, etc.) that are used in the studies. This inconsistency can make interpreting the results problematic (Kendall-Tackett, 2007; Osborne & Monk, 2013).

This is one of the first studies to examine MMP-8 levels and pregnancy associated depression. Future studies with larger sample sizes are needed. Further research should use prospective, trimester specific time frames as the inflammatory milieu during pregnancy greatly varies. Other studies should include both psychosocial and biological

data to provide a more holistic approach to attain evidence regarding the impact of MMP-8 and other biomarkers function in the presence of pregnancy associated depression.

Pregnancy associated depression presents a challenge for health care workers in that some women will not seek treatment until the symptoms become severe or many opt never to seek care (Gavin et al., 2005). Screening for antenatal and postnatal depression is recommended in all trimesters of pregnancy and several times in the postpartum period. The quality of the intimate partner relationship should also be assessed during and after pregnancy. In addition, the ARI and other instruments that examine the quality of the intimate partner relationship should be validated in larger samples in all trimesters of pregnancy and the postpartum period. Future research studies are recommended to examine psychosocial and biological data to further expand on the current state of knowledge on pregnancy associated depression.

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Curriculum Vitae

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Education

Dates	Institution/Location	Degree/Field of Study
Aug. 1998 – May 2004	University of Kentucky College of Nursing Lexington, KY	MSN, Nursing
Aug. 1988 – Dec. 1992	Eastern Kentucky University College of Health Science, Richmond, KY	BSN, Nursing

Licensures and Certifications

January 1993 – present Nurse Registration, Kentucky Board of Nursing

Professional Experience

Academic

Aug. 2003 – present University of Kentucky College of Nursing, Clinical Instructor/Lecturer

Clinical/Other

Jan. 1993 – Jan. 2004 UK HealthCare, Lexington, KY, UK Birthing Center Staff Nurse

Honors and Awards

1997, 1999, 2003 Clinical Nurse Excellence Award
Spring 2010 Teachers Who Made a Difference
2014-Present Faculty Fellows Program

Scholarly Work

Presentations

Spring 2015 State Perinatal Conference

Professional Memberships

Sigma Theta Tau 1991-Present
AWHOHNN 2005-Present

Service

Professional
Delta Psi Faculty Advisor & Governance Council Chair, Summer 2011-Summer2013

University
Spring 2013-Present Transitions of Care Curriculum Committee
2014-present IPE Faculty Facilitator

College
2007-Present UPC member
2013-presnet Computer Task Force member
2014-2015 UPC chair
2014-HESI Task Force member
2014-Influenza Vaccination Policy Task Force member

Public/Community
Summer 2015-Governor's Minority Awareness Program Simulation