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Gestational Diabetes, Depression, and the Impact on Maternal Child Health Outcomes

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GESTATIONAL DIABETES, DEPRESSION, AND THE IMPACT ON MATERNAL CHILD HEALTH OUTCOMES

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Knowing is not enough; we must apply. Willing is not enough; we must do.

–Johann Wolfgang von Goethe

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ABSTRACT

Antenatal depression occurs in about 20% of all pregnancies and gestational diabetes occurs in up to 14% of all pregnancies. Although there is sufficient information on (1) depression during pregnancy and (2) depression and diabetes, there is little information about depression and gestational diabetes. This comparative, longitudinal research study was done to better understand the relationship between gestational diabetes and depression. The study aims were the following: (1) to determine whether women with gestational diabetes had more depression than women without gestational diabetes, (2) to determine whether factors predictive of depression in pregnant women with gestational diabetes were different from women without gestational diabetes, and (3) to determine if minorities were more at risk for depression during pregnancy than Caucasians. The sample included 135 pregnant women between 24 and 40 weeks' gestation, of which 65 had gestational diabetes (GDM) and 70 had no gestational diabetes (NGDM). Depression, anxiety, stress, and social support were measured using self-report questionnaires completed during a prenatal care visit. Delivery outcomes were collected from the electronic medical record. Using the CES-D, 28% of the entire sample had depression and 32% of women with GDM had depression compared to 24% of women with NGDM, although the difference was not statistically significant. However, women with GDM were 2.7 times more likely to have depression (OR=2.72, 95% CI, 1.04, 7.13, p =.041).

Also, women with GDM were 3.07 times as likely to have a history depression (OR=3.07, 95% CI, 1.01, 9.49, p = .05). Trait anxiety was found to be a significant predictor of prenatal depression ($p<.001$). No significant difference was found between race and depression. There were no clinically significant findings in delivery outcomes between women with and without GDM or between women with and without depression. This study may improve the prenatal care of women with depression and gestational diabetes during pregnancy.

CHAPTER ONE

PROBLEM STATEMENT

Depression affects approximately 121 million people and is the leading cause of disability worldwide (World Health Organization, 2009). Depression is more common in women than in men and is the leading cause of disease burden in developed and developing countries for women between the ages of 15 and 44 (World Health Organization, 2009). Since these are the childbearing years for women, the risk of depression for women during pregnancy and the postpartum period increases. Although many people believe that women are resistant to becoming depressed during pregnancy, at least 20% of women are depressed during pregnancy (Bonari et al., 2004). Some studies have reported depression rates as high as 45% during pregnancy (Lindgren, 2001; S. Orr, Blazer, & James, 2007; S. T. Orr, Blazer, & James, 2006). Depression during pregnancy is often called antenatal depression or prenatal depression. An increase in the percentage of antenatal depression has been reported in women with low social support (C. Anderson, Roux, & Pruitt, 2002; Glazier, Elgar, Goel, & Holzapfel, 2004; Records & Rice, 2007; Sleath et al., 2005; Westdahl et al., 2007), low socioeconomic status (C. Anderson et al., 2002; T. Field et al., 2002; Glazier et al., 2004; Lindgren, 2001), lower education levels (Glazier et al., 2004; Lindgren, 2001; Marcus, Flynn, Blow, & Barry, 2003; Rubertsson, Waldenstrom, Wickberg, Radestad, & Hildingsson,

2005; Westdahl et al., 2007), and younger age (Glazier et al., 2004; Lindgren, 2001; S. T. Orr et al., 2006; Rubertsson et al., 2005). During pregnancy, there is a heightened inflammatory response and an increase in stress hormones, such as, cortisol (Dayan et al., 2006). Interestingly, increased cortisol and inflammation markers are also found in persons with depression (Black, 2006), suggesting a possible physiological mechanisms for antenatal depression.

Depression is defined and diagnosed clinically according to the DSM-IV. To make this diagnosis, at least five of the following symptoms must be present during the same two week period: (1) depressed mood most of the day, nearly every day; (2) markedly diminished interest or pleasure in all or almost all activities; (3) significant weight loss when not dieting or significant weight gain, or decrease or increase in appetite nearly every day; (4) insomnia or hypersomnia; (5) psychomotor agitation or retardation; (6) fatigue or loss of energy; (7) feelings of worthlessness or excessive or inappropriate guilt; (8) diminished ability to think or concentrate, or indecisiveness; and (9) recurrent thoughts of death, suicidal ideation without a specific plan, or suicide attempt or a specific plan for committing suicide (American Psychiatric Association, 1994). Also, one of the two symptoms, (1) depressed mood or (2) loss of interest or pleasure must be included in the five symptoms (American Psychiatric Association, 1994). The symptoms of depression are similar among pregnant and non-pregnant women. However, pregnant women with depression are less likely to report intense feelings of suicide and guilt, have less difficulty falling asleep, and are more likely to

have slowed movement or speech (Manber, Blasey, & Allen, 2008). Although it is necessary to use the DSM-IV criteria to make a diagnosis of depression, many research studies use self-report measures to classify participants as depressed.

Postpartum Depression

Postpartum depression is common and occurs in 13% of postpartum women (O'Hara & Swain, 1996). A meta-analysis of 141 articles on postpartum depression indicated that low social support, low self-esteem, life stress, fatigue, and a history of prenatal depression are risk factors for developing postpartum depression (C. T. Beck, 2008a). Another meta-analysis of 59 studies found similar risk factors, but had poor marital relationship as an additional risk factor (O'Hara & Swain, 1996). Postpartum depression was found to have a negative effect on mother-infant interactions during the first year of life (C. T. Beck, 2008b). Also, postpartum depression has a negative effect on cognitive and emotional development in children (C. T. Beck, 2008b). Postpartum depression and prenatal depression occur at different points during the birth process and although related, they are different concepts. Postpartum depression has been extensively studied and thus, is not the focus of this study (C. T. Beck, 2008a).

Gestational Diabetes

Gestational diabetes is a significant problem in the United States, occurring in about 7% of all pregnancies (American Diabetes Association, 2010b). However, gestational diabetes has been found in up to 14% of all pregnancies (Jovanovic & Pettitt, 2001). Recently, it has been documented that there are more than 200,000 pregnancies

which are complicated by gestational diabetes each year (American Diabetes Association, 2010b). Also, there was a 122% increase in the prevalence of gestational diabetes between 1989 and 2004 (Getahun, Nath, Ananth, Chavez, & Smulian, 2008). Other studies have shown an increase in gestational diabetes between 16% and 127% in different races over the past 20 years (Ferrara, 2007). The increase in gestational diabetes may be attributed to a modification in the diagnosis standards. These modifications include an increase in the number of women screened for gestational diabetes and the lowering of the plasma glucose threshold needed to make a diagnosis of gestational diabetes (Ferrara, 2007). However, with such a large increase in the prevalence of gestational diabetes, the increase in obesity has been suggested as a valid reason for the increase in gestational diabetes (Ferrara, 2007).

Gestational diabetes is defined as glucose intolerance found for the first time during pregnancy (Buchanan, Xiang, Kjos, & Watanabe, 2007). During pregnancy, the maternal body goes through many changes. Increased maternal adiposity in early pregnancy and increased insulin resistance in late pregnancy are physiological reasons for a woman developing gestational diabetes (Barbour et al., 2007). In gestational diabetes, the pancreatic β-cells are not able to increase insulin secretion to meet the demands of the insulin resistant pregnant woman (Buchanan et al., 2007). Gestational diabetes is diagnosed based on the result of an oral glucose tolerance test. Criteria to interpret elevated results of the glucose tolerance test are used to diagnosis gestational diabetes (O'Sullivan, 1980; O'Sullivan & Mahan, 1964).

Parity, maternal obesity, advanced maternal age, and race are risk factors for developing gestational diabetes (Casey, Lucas, McIntire, & Leveno, 1997; Ferrara, 2007; Getahun et al., 2008). Women with gestational diabetes are more likely to deliver a baby with macrosomia and have an increased risk of a shoulder dystocia during delivery (Jovanovic & Pettitt, 2001). Also, stillbirth and infant hypoglycemia are increased in women with gestational diabetes (Getahun et al., 2008).

Women with gestational diabetes were more likely to have a cesarean section (46%) compared to women without gestational diabetes (32%) (Wier, Witt, Burgess, & Elixhauser, 2010). Also, the hospital costs related to delivery of infants were 18% more expensive (about $4,500) for women with gestational diabetes than for women without gestational diabetes (Wier et al., 2010).

The increased state of insulin resistance in pregnancy that contributes to the diagnosis of gestational diabetes may also predispose a woman to develop depression. Lower insulin sensitivity was found in depressed patients, and insulin resistance improved with depression treatment indicating that increased insulin resistance may be connected to depression (Lustman, Penckofer, & Clouse, 2007; Okamura et al., 2000). Hyperglycemia, a complication that occurs with gestational diabetes, has also been found to be related to depression (Lustman, Anderson, Freedland, de Groot, & Carney, 2000). Therefore, the combination of increased insulin resistance and hyperglycemia that occurs with gestational diabetes may increase the chance of depression occurring in women with gestational diabetes.

The combined effects of gestational diabetes and depression in pregnant women increases the chance of multiple complications in mothers and infants. Although there is potential for increased risk, there has been limited research to study the relationship between gestational diabetes and depression.

Purpose

The purpose of this study was to determine if women with gestational diabetes are more likely to suffer from depression. Depression and gestational diabetes are common occurrences during pregnancy; however, the relationship between the two has not been extensively studied. Depression occurs in 25% of persons with type 1 and type 2 diabetes (Lustman et al., 2000). Whether there is more depression in women with gestational diabetes is unknown. If women with gestational diabetes have more depression, it would seem that they would be at even greater risks for complications because of their co-morbid depression. The factors that predict depression (anxiety, stress, age, income, and marital status) in both women with and without gestational diabetes were also assessed to determine if women with gestational diabetes have different predictive factors of depression than women without gestational diabetes. Lastly, a potential difference in the prevalence of depression between White and minority women was investigated.

Theoretical Framework

The biopsychosocial model developed by George Engel (1977) was used to guide the study. This model includes the biological, psychological, and sociological effects incorporated with disease. In the biopsychosocial model, the biological, psychological,

and sociological components of a person are all equally important when treating an illness (Engel, 1977). The biopsychosocial model is holistic in that it explains how a person can be understood as a whole including the interaction between the components (Molina, 1983).

The components of the biopsychosocial model are (1) the concept of multicausality of illness, (2) illness as a dynamic process, (3) holistic understanding of the human being, and (4) the concept of vulnerability of systems (Molina, 1983). The concept of multicausality of illness is the idea that an illness is caused by the interaction of several factors. For example, depression is caused by both biological factors (neurotransmitters dysfunction) and psychological (learned helplessness or negative thinking) (Molina, 1983). Illness is a dynamic process rather than a steady state and changes constantly as biological, psychological, and sociocultural factors interact with each other and the environment (Molina, 1983). Holistic understanding of the human being is the belief that body and mind are not separate entities, and that there is complex interaction between body and mind. These complex interactions need to be considered when caring for the person as a whole (Molina, 1983). The human being is considered an open system of complex relationships with the internal and external environment, which defines the concept of vulnerability. The biological and psychosocial systems interact with each other and can be affected by a change in the internal or external environment (Molina, 1983).

A benefit of the biopsychosocial model is that it allows the researcher or clinician to consider the person as a whole including quality of life, social role performance, and emotional status during evaluation of a patient (Fava & Sonino, 2008). The biopsychosocial model has been used to study depression (Covinsky & Landefeld, 1996) and diabetes (Peyrot, McMurry, & Kruger, 1999). The factors examined in this study include psychological, sociological, and biological variables and will be thoroughly described in Chapter 2. The psychological variables were as follows: depression, history of depression, anxiety, stress and social support. The sociological variables were as follows: socioeconomic status, race, ethnicity, and marital status. The biological factors were as follows: body mass index (BMI), oral glucose tolerance test results, gravida and parity, presence of delivery complications, type of delivery (vaginal or cesarean section), gestational age at delivery, Apgar (Appearance, Pulse, Grimace, Activity, Respiration) scores, and infant weight.

Figure 1 illustrates the biopsychosocial model used for this study.

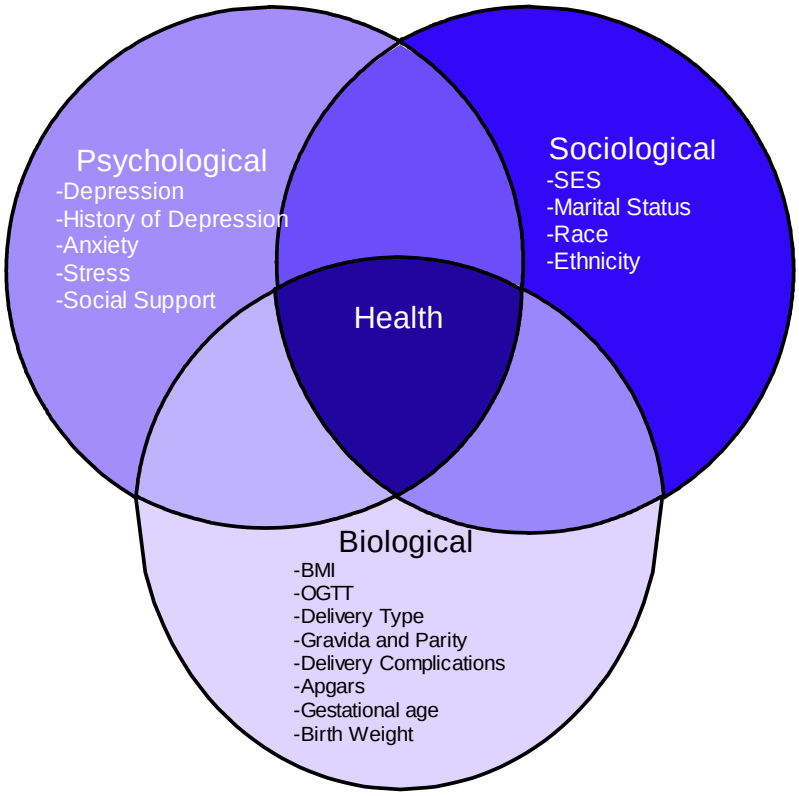


Figure 1: The Biopsychosocial Model for the Study of Depression and Gestational Diabetes

Specific Aims

The primary aims for this study were (1) to determine whether women with gestational diabetes had more depression than women without gestational diabetes and (2) to determine whether factors predictive of depression in pregnant women with gestational diabetes were different from women without gestational diabetes.

Hispanic and African American women are at greater risk for developing gestational diabetes than Caucasians. One study has found African Americans are more likely to be depressed during pregnancy (S. T. Orr et al., 2006). However, other studies

have not shown race to be a significant risk factor for depression during pregnancy findings (Diego, Field, & Hernandez-Reif, 2005; Marcus et al., 2003; Sleath et al., 2005; Westdahl et al., 2007). If women with gestational diabetes have more depression, race may be a significant factor. Therefore, it is important to study these minority populations in order to determine if a health disparity exists. Thus, an exploratory aim for this study was to determine if minorities were at more at risk for depression than Caucasians.

In summary, depression and gestational diabetes are common during pregnancy. There is a known link between type 1 and type 2 diabetes and depression. A possible relationship between gestational diabetes and depression exists due to the increased insulin resistance and occurrence of hyperglycemia. However, the relationship between gestational diabetes and depression has not been extensively studied. The biopscyhosocial model was the theoretical framework used to guide the study. The study had three aims: (1) to determine whether women with gestational diabetes had more depression than women without gestational diabetes, (2) to determine whether factors predictive of depression in pregnant women with gestational diabetes were different from women without gestational diabetes, and (3) to determine if minorities were at more at risk for depression than Caucasians.

CHAPTER TWO

LITERATURE REVIEW

This chapter addresses the biopsychosocial variables that contribute to depression and gestational diabetes. In order to gain an understanding of these variables, a literature search was completed. Using CINAHL, Medline, and PsychInfo, articles studying depression during pregnancy were examined. The time frame from 2002 onward was selected as this was the time that most literature on depression during pregnancy was published. The keywords used in the search were as follows: depression, pregnancy, antepartum, and prenatal. A librarian was also consulted to aid in the search to insure that the most relevant articles were found. Approximately 120 articles were found in the search, about 45 articles were included in this literature review. Articles not included were (1) not written in English, (2) editorials, or (3) focused on postpartum depression. Most articles excluded were those that focused on postpartum depression which was not the intent of this study. Eight literature review papers were found on the topic of depression during pregnancy. The articles included in the review will be summarized and organized according to risk factors for developing depression during pregnancy, factors related to maternal health, and factors related to infant health. Evidence from the literature suggests that depression is a common problem during pregnancy and has an impact on the health of the mother and infant. It is important that this evidence be known, so practice can change and the care given to pregnant women improved.

Risk Factors

The literature review revealed four risk factors most often associated with depression during pregnancy: (1) decreased social support, (2) low income or socioeconomic status, (3) low education, and (4) younger age. Race as a risk factor was found to be inconclusive and will be discussed as well.

The relationship of social support, emotional distress, and stress were examined in a large cross-sectional, descriptive study (n=2052) (Glazier et al., 2004). Healthy pregnant women between 15 and 18 weeks' gestation were requested to complete the following tools: Perceived Social Support, the Center for Epidemiologic Studies Depression Scale (CES-D), and the State-Trait Anxiety Inventory (STAI). Results showed that depression was inversely correlated with education ($r=-.21$, $p<.01$) and income ($r=-.24$, $p<.01$), and similar relationships were found with anxiety. Low social support was related to depression ($r=-.32$, $p<.01$) and anxiety ($r=-.27$, $p<.01$). Stress was also significantly related to low social support and having more symptoms of anxiety and depression. Limitations to this study were the lack of information regarding the racial distribution of the sample and the cross-sectional design.

Social support and social conflict have been examined as predictors of prenatal depression (Westdahl et al., 2007). One prospective, longitudinal study examined social support and social conflict as it relates to depression in women during their second trimester of pregnancy and followed them to one year postpartum. Social conflict and social support were found to account for 34% of the variance for depression during

pregnancy. Although education and relationship status with the infant's father were the only socio-demographic variables found to be significant, they accounted for only 5% of the variance for depression. Women with less education, who were not in a relationship with the father of the baby, were more likely to be depressed. Low social support and high social conflict predicted depression and social conflict was more strongly related to depression ($r=.58$, $p<.01$) than social support ($r=-.45$, $p<.01$). The finding that social conflict was a greater predictor of depression suggests that social support may be an important risk factor when studying depression. One strength of the study included a diverse sample (80% African American and 13% Hispanic participants); however, its generalizability to White participants was limited.

Depression and social support have been examined relative to ethnicity (Sleath et al., 2005). In a study of 73 pregnant women (23 Hispanic, 25 Black, and 25 White) between 12 and 32 weeks' gestation, women with lower quality of social interactions as measured by the Quality of Social Interactions Scale had significantly more depression (Mean=11.64) than those who did not have low social interactions (Mean= 5.53, $p<.001$). No significant difference in the incidence of depression (moderate or severe depression measured by the Beck Depression Inventory-II (BDI-II)) among the ethnic groups of African Americans (24%), Hispanics (13%), and Whites (20%) was found. Limitations of the study included the small sample and the lack of an operational definition of quality of social interactions which made the results difficult to interpret.

Depression and support were also studied by Anderson, Roux, & Pruitt (2002). In a sample of 31 women between 32 and 39 weeks' gestation, 29% of the sample scored higher than a 12 on the Edinburgh Postpartum Depression Scale (EPDS) which indicated depression. Significant relationships between depression and marital dissatisfaction (r=.378, p=.02), partner satisfaction (r=-.584, p=.001), partner support (r=-.578 p=.001), partner closeness (r=-.663, p=.000) and partner love (r=-.506, p=.004) were found. Researchers also found that women with lower education levels (Tau=-.290, p=.027) and lower socioeconomic status (Tau=-.362, p=.019) were also found to have higher depression scores. A limitation to this study was the small and predominately White (84%) sample. Another potential limitation was the use of a tool developed by the researchers to measure social support; although the Cronbach's alpha of .85 indicated it was a reliable measure.

Records & Rice (2007) conducted a study focusing on depression and social support in 139 women during the third trimester of pregnancy. Thirty-eight percent of the sample was found to have depressive symptoms (CES-D≥16). Intermittent negative mood states, social support, marital satisfaction, and gravida accounted for 46% of the variance in depression during the third trimester. In this model, social support accounted for 6% of the variance of depression and brief, intermittent negative mood states accounted for 24% of the variance. Although this study was unique in that it focused on women in the third trimester, the Postpartum Depression Predictor Inventory-Revised Scale (which includes 12 items to measure social support) was used to measure social

support. In addition, the reliability of this tool was not reported, which is a limitation of this study.

Depression in relation to life circumstances was studied in a large, cross-sectional study of 1,321 women between 16 and 26 weeks' gestation (Holzman et al., 2006). Life circumstances were defined as life stressors relating to physical or sexual abuse, economic problems, substance abuse in a loved one, and legal problems. For the analysis, the participants were divided into three groups: teenagers, women older than 20 years and on Medicaid (disadvantaged), and women older than 20 years and not on Medicaid (advantaged). Depression was found in 46% of the teens, 47% of the disadvantaged group, and 23% of the advantaged group. Depression was higher in women who had problems with abuse, economics, and illegal substance use in someone close in the past six months for all three groups of women. Overall, disadvantaged women and teens consistently had higher depression scores when compared to advantaged women.

Another study was conducted in which the primary aim was to determine risk factors associated with prenatal depression (Leigh & Milgrom, 2008). Depression, anxiety, self-esteem, and social support were measured in a sample of 367 pregnant women (between 26 and 36 weeks' gestation). Depression was measured using the Beck Depression Inventory (BDI) and anxiety was measured using the Beck Anxiety Inventory (BAI). To measure social support, the Social Provisions Scale was used and the Rosenberg Self-Esteem Scale was used to measure self-esteem. Using a cutoff score of

16.5 of the BDI to determine depression, 16.9% of the sample had prenatal depression. Multiple regression analysis indicated that the significant predictors of prenatal depression were as follows: low self-esteem (β= -.34, p<.001), antenatal anxiety (β= .32, p<.001), social support (β= -.18, p<.001), income (β= -.05, p=.04), history of abuse (β= .06, p=.03), major life events (β= .07, p=.01), and negative cognitive style (β= .11, p<.001). The regression model explained 78% of the variance in prenatal depression. Interestingly, age, education, and depression history were not found to be significant predictors. However, these factors were reported to be significantly correlated with antenatal depression (although the correlation coefficients and corresponding p values were not provided). Limitations to this study include that only 1.6% (n=6) reported being without a partner, all other participants were married or with a significant other. Also, 87.5% of the sample was from Australia (where the study was conducted) which decreases generalizability of findings.

Social support, education, and income were found to be significant factors related to perinatal depression (C. Anderson et al., 2002; Glazier et al., 2004; Marcus et al., 2003; Records & Rice, 2007; Westdahl et al., 2007). However, race as a risk factor was inconclusive. In a study with a sample of 3,472 women (73% White and 13.3% Black) the CES-D was used to measure depression, but race was not related to depression (Marcus et al., 2003). Only 20% of the sample was found to be depressed. The sample was largely White which may have affected the findings regarding race. This study did find that women with a history of depression were 4.9 times more likely to have antenatal

depression ($p<.05$). Also, poorer health ($\beta=.39$, $p<.001$), greater alcohol use ($\beta=.211$, $p<.001$), smoking ($\beta=.13$, $p<001$), lower education achievement ($\beta=-.10$, $p=.04$), unemployment (β-.30, $p=.01$), and not being married ($\beta=-.56$, $p<.001$) were significant predictors of depression during pregnancy. A limitation of this study was the cross-sectional design, and the large variability of gestational age (3 to 41 weeks, Mean=25 weeks).

Another study of 112 minority women in the second trimester of pregnancy (54% Hispanic, 46% Black) did not find a relationship between race and depression (T. Field et al., 2002). However, differences were found in depression and socioeconomic status: the women with higher socioeconomic status had lower levels of depression. Women in the low socioeconomic status group had a mean CES-D score of 13.78 and women in the higher socioeconomic status group had a mean score of 9.16 ($p=.006$). Because this study only included minority women, a true comparison by race was not able to be examined.

Another study of minority women compared Latina women in the United States ($n=108$) to Latina women in Mexico ($n=117$) and did not find significant racial differences (Lara, Le, Letechipia, & Hochhausen, 2009). This study reported that 32.4% of Latinas from the U.S with depression compared with 36.8% of Latinas from Mexico using the cutoff score of 16 on the CES-D. Also, the mean CES-D score for U.S. Latinas was 12.9 and it was 14.7 for Latinas in Mexico; however, these differences were not statistically significant.

A similar study, which also used the CES-D, but had a sample size of 252

women between 20 and 40 weeks' gestation (77% White, 13% Black, 10% other) and reported that minority women had higher depression scores than White women (Lindgren, 2001). However, it was not reported if the differences in depression scores between races were statistically significant. This study also found that younger women ($r=-.26$, $p<.05$), less education ($r=-.34$, $p<.05$), and lower income ($r=-.38$, $p<.05$) were related to depression. Perhaps the larger sample accounted for the ability to detect race as a factor related to depression.

Orr, Blazer, and James (2006) reported differences between races and incidence of depression in 1,163 pregnant women in their first or second trimester of pregnancy (70% Black and 30% White). Although the age range of patients was not provided, 21.8% of the sample was younger than 20 and 78.2% was older than 20. The CES-D was used to measure depression and 44% of the sample had depression based on a CES-D score of greater than or equal to 16. The mean CES-D score for Black women was 17.37 and was 13.65 for White women—which was significantly different, indicating Blacks were more depressed than Whites. Black women had a 50% greater prevalence rate of depression even after adjustment for age, education, and marital status. However, socioeconomic status, which has been associated with depression, was not controlled for (T. Field et al., 2002; Marcus et al., 2003). Also, approximately 67% of the sample was enrolled in Medicaid (of which 72% of were Black). Because Blacks were more likely to be on Medicaid, the difference found in depression scores between races may be more attributable to socioeconomic status instead of race.

Social support was found to be related to depression in all of the articles reviewed. All of the articles that had a cross-sectional design measured social support and depression during the pregnancy, but the time was quite variable (between 3 to 41 weeks' gestation). Only one study included pregnant women during the first trimester and all other studies focused on the second and third trimesters of pregnancy. Regardless of the time when depression and social support were measured, women with more social support had less depression. Many of these studies also included measurements of age, socioeconomic status and education. Overall, it was noted that pregnant women who were younger had lower socioeconomic status, and those with less education were more likely to be depressed. Although all studies agreed on the risk factors of age, low social support, education, and socioeconomic status, race as a risk factor to depression was not conclusive. Race as it relates to depression needs to be studied further while controlling for the risk factors of age, low social support, education, and socioeconomic status in order to determine if it is a risk factor to depression.

Maternal Health Factors

Overall Health

Pregnant women with depression are more likely to report having poor health. Women with a poor health status may require more complex prenatal care or they may elicit poor self-care behaviors which would suggest they are less likely to adhere to a complex prenatal care plan. Women with a psychiatric diagnosis were reported to have poor prenatal care (Kelly et al., 1999). Orr, Blazer, James, and Reiter (2007) studied

depression and maternal health status during pregnancy in a cross-sectional study of 1,163 women in their second trimester (70% White, 30% Black). Forty-four percent of the sample was found to have a score greater than 16 on the CES-D, indicating depression. A total of 16.9% of the sample reported fair or poor health. It was found that women with higher depression scores had twice the risk of poorer health (OR=1.74, CI= 1.27-2.39) even when age, marital status, smoking, education, type of insurance, trimester, and race were accounted for. The large, diverse sample size was a strength of the study. However, with a 68% of the sample on Medicaid, the results may not be generalizable.

Marcus et al., (2003), also found a relationship between overall health status and depression in a large, cross-sectional study (n=3742) of women between 3 to 41 weeks' gestation. Approximately twenty percent of the sample was found to be depressed. As discussed earlier in this paper, there was a significant relationship between depressive symptoms and marital status, education level, employment status, history of depression, self-rated overall health, smoking, and alcohol and substance abuse. A strength of this study was the large sample size.

Anxiety

Many women with depression also report feelings of anxiety. This relationship has also been reported in pregnancy (Breitkopf et al., 2006; Hart & McMahon, 2006). Hart & McMahon (2006) analyzed relationships between depression, anxiety, and psychological adjustment in 53 women between 20 and 38 weeks' gestation using a

cross-sectional design. Psychological adjustment was described as including two concepts: maternal representation of herself as a mother and a positive relationship with the fetus. Maternal representation of self was described as the mother being competent and confident in mothering behaviors and her role as a mother (Hart & McMahon, 2006). Relationship with the fetus was defined as the attachment developed between mother and fetus. This attachment is represented by maternal behaviors such as healthy eating, talking to the fetus, stroking the belly, abstaining from cigarettes and alcohol, buying baby clothes and furniture, reading about child development, and attending antenatal classes. Nine percent of the sample was found to score above 13 on the EPDS indicating depression. Scores on the EPDS and the STAI were significantly correlated ($r=.77$ and .63, respectively, for state and trait anxiety, $p<.001$). Relationship with the fetus and maternal fetal attachment was measured using the Maternal Antenatal Attachment scale. Mean STAI scores were significantly higher for women with low attachment scores ($p=.015$ for state anxiety and $p=.038$ for trait anxiety). However, mean EPDS scores were not significantly different between women with high and low attachment scores (Mean EPDS 7.52 for women with low attachment scores and 5.57 for women with high attachment scores, $p=.078$). Although depression was not found to be significantly related to maternal-fetal attachment, there was a trend indicating exploration of this relationship is needed. However, the significant relationship between anxiety and depression suggests that it may be beneficial to measure anxiety when researching

antenatal depression. Because this study was conducted in Australia, there may be limitations in the generalizability of the findings to U.S. women.

Breikopf et al. (2006), examined the relationship between anxiety and depression symptoms in a group of pregnant, postpartum, and non-pregnant women. The sample consisted of 807 women (36% pregnant, 23% postpartum, and 41% non-pregnant). The measurements were done between 24 and 36 weeks' gestation for the pregnant women and between 2 and 8 weeks postpartum for the postpartum group. Twenty-eight percent of the sample was found to have depression symptoms. The Beck Depression Inventory (BDI-II) was administrated (recommended cutoff score of 16 for use in pregnant women), but the cutoff score was 14 because the sample included non-pregnant women (Holcomb, Stone, Lustman, Gavard, & Mostello, 1996). Pregnant women had the highest depression scores with a mean value on the BDI-II of 11.5. The mean values on the BDI-II were 8.1 and 10.6 for postpartum and non-pregnant women, respectively. A significant difference in mean scores was found between pregnant and postpartum women ($p<.001$), but not between pregnant and non-pregnant women ($p=.66$). Depression scores were found to increase as anxiety scores increased. Regression analysis suggested that anxiety scores would increase by 5.81 points ($p<.001$) in women reporting mild depression compared with women reporting minimal depression symptoms. Anxiety scores would increase by 17.53 points ($p<.001$) for women reporting severe depression symptoms compared with women reporting minimal depression symptoms. A history of depression and anxiety, as well as current depressive symptoms, were found to be significant

predictors of anxiety. The strengths of this study were the diverse (50% Hispanic, 25% African American, 21% White, and 3% other) and large sample as well as use of a non-pregnant comparison group. A limitation of this study was the use of a lower cutoff value to determine depression which may have increased the number of women classified as depressed and potentially biased the results.

Obstetric Complications

Women with depression have been reported to have an increase in obstetric complications. Larsson et al. (2004), reported that in a sample of 518 participants, women who were depressed (17.4% of the sample) were more likely to be multiparous and single. The multiparous women in the depressed group were more likely to have had a previous pregnancy with complications when compared with the multiparous women without depression. Complications of pregnancy (acute or elective cesarean sections, instrument delivery, perineal tears, excessive bleeding, premature contractions, back pain, or preeclampsia) were more often found in the depressed group. Depressed women were also more likely to have premature contractions, back pain, and shorter gestational length by one week. A limitation to this study was that only p values were reported in the analysis section making it difficult to interpret the strength of the relationships found in the study.

Another study, which also analyzed obstetric complications, used medical records and a much larger sample of 32,156,438 deliveries between the years of 1998 and 2005 (Bansil et al., 2010). This study found that women with a depression diagnosis were 1.2

to 2.8 more times likely to experience maternal and fetal complications including: preterm labor, preeclampsia, diabetes, cesarean section, anemia, placental abnormalities, urinary tract infections, infections during labor, fetal growth restriction, fetal abnormalities, fetal distress, and fetal death. This study was a cross-sectional study and so it is impossible to determine causality. Although the use of medical records allowed for a very large sample size, the use of diagnosis codes to determine cases of depression may have resulted in some cases of depression being missed. The researchers believed that only the most severe cases of depression would be coded because it is the most severe cases that would be likely to interfere with the routine care of a pregnant woman (Bansil et al., 2010); therefore the less severe cases of depression may not have been coded and included in the analysis.

Preeclampsia is a serious obstetric complication that usually occurs during the third trimester of pregnancy where delivery of the infant is the only cure. A prospective study of 623 Finnish women enrolled in the study between 8 and 17 weeks' gestation found that depression (OR 2.5, CI 1.2-5.3) and anxiety (OR 3.2, CI 1.4-7.1) in early pregnancy increased the risk of preeclampsia (Kurki, Hilesmaa, Raitasalo, Mattila, & Ylikorkala, 2000). This study also reported that 30% of the sample was found to be depressed and that older age (greater than 30 years) was another risk factor (OR 3.4, CI 1.3-8.8) in developing preeclampsia. The BDI was modified for this study; no information was provided on its reliability or validity. Another limitation was the use of one item to measure anxiety.

Recurrent spontaneous abortions are another obstetric complication that can be challenging for health care providers to treat. Two studies reviewed this complication and reported conflicting results (Bergant et al., 1997; Sugiura-Ogasawara et al., 2002). Depression was found to be related to recurrent spontaneous abortions in a prospective study of 61 women (Sugiura-Ogasawara et al., 2002). This study recruited women who had a history of two recurrent spontaneous abortions and followed them longitudinally to see if there were differences in women that had another abortion and women that were able to conceive. The participants entered the study at an average of ten months after their last miscarriage. Out of the 61 women included in the study, 45 became pregnant again and ten of them had another subsequent spontaneous abortion. Using the Symptom Checklist-90 to measure mental status, only the depression subscale was found to be a significant predictor of the subsequent pregnancy outcome, where women with depression were more likely to have a subsequent spontaneous abortion. However, no specific statistics were reported, which is a limitation of this study. The study was done in Japan with a small sample size which may decrease the generalizability of the findings.

Bergant et al. (1997), compared women with a history of two recurrent spontaneous abortions (n=36) to women without a history of recurrent spontaneous abortions (n=36). Women with recurrent spontaneous abortions all desired children and entered the study at six to eight weeks after their last miscarriage. These women were followed for two years. Those without a history of recurrent abortions were randomly selected from a sample of women that attended a hospital for a preventive checkup.

Their desire for children was unknown. There was no difference between groups in depression scores on the BDI. The sample size may be the reason for the non-significant findings. This study was done in Germany and may decrease the generalizability of the findings to U.S. women.

Poor Prenatal Care

Women with a psychiatric diagnosis are more likely to have poor prenatal care. Kelly et al. (1999), used five psychiatric disorders to study this relationship: (1) substance-related disorder, (2) schizophrenic disorders, (3) mood disorders, (4) anxiety disorders, and (5) other psychiatric disorders. Women were determined to have a psychiatric diagnosis by International Classification of Diseases, 9th Revision (ICD-9) codes documented in the California Health Information for Policy Project (CHIPP) database. Poor prenatal care was defined as initiating prenatal care after the fourth month of pregnancy and/or attending less than 50% of recommended visits. Women with a psychiatric diagnosis were 2.3 times (CI 2.23-5.50, $p<.001$) more likely to delay initiation of prenatal care and 2.18 times (CI 2.06-2.31, $p<.001$) more likely to receive inadequate prenatal services after controlling for potential confounding demographic variables. Chi square analysis indicated that women without private insurance, of single marital status, of lower educational status, having one previous delivery, at a younger age, and of Hispanic and Native American race were more likely to receive poor prenatal care. Although this study suggests that Hispanics and Native Americans are more likely to have a diagnosis of psychiatric disorder, it did not provide any specific information about

the number of participants with depression compared to the other psychiatric diagnosis which limits the interpretation of the findings.

In another study, poor prenatal care was not found to be significantly related to a psychiatric disorder (H. G. Kim et al., 2006). Similar to the study discussed above, poor prenatal care was defined as initiating prenatal care after the fourth month of pregnancy and/or attending less than 50% of recommended visits. This Primary Care Evaluation of Mental Health Disorder Patient Health Questionnaire was used to determine the psychiatric diagnosis of 154 participants. Participants were given the questionnaire while attending prenatal care visits; the mean gestational age when interviewed was 28 weeks. After the women had delivered the infant, the medical chart was reviewed to determine the number of prenatal care visits attended. A benefit of this study is that it indicated that of the 29% of participants who had a psychiatric disorder, 26% had major or minor depression. Inadequate prenatal care was significantly related to domestic abuse in the past year, but not with current psychiatric disorder, alcohol abuse, age, primiparity, marital status, government assistance, or unplanned pregnancy. Another difference with this study was the use of a questionnaire instead of ICD-9 codes to determine a psychiatric diagnosis. A limitation of this study is that all women were interviewed during a prenatal care visit which may confound the results since these women were already receiving prenatal care.

Postpartum Depression

Postpartum depression is serious and may lead to postpartum psychosis, a serious mental illness where suicide, infanticide, and homicide may result. Suicide is a risk of untreated depression and 86% of maternal deaths were related to psychiatric illness where 68% of deaths were due to suicide (Oates, 2003). Women with prenatal depression are more likely to suffer from postpartum depression. Heron et al. (2004), conducted a large (n=8,323), prospective, longitudinal study. Women were assessed for depression using the EPDS at 18 and 32 weeks' gestation and 8 weeks and 8 months postpartum. Women who had depression at 32 weeks' gestation were found to be six times (OR=6.55, CI 4.68-9.17) more likely to have postpartum depression. Also, 43.7% of women with postpartum depression reported elevated depression symptoms during pregnancy. The strengths of this study were the large sample and the longitudinal design to examine the relationship between prenatal and postpartum depression. This study was done in England, which may decrease the generalizability of the findings because of socialized medicine.

Another longitudinal study reported that 39% of women (n=2,674) who had depression during pregnancy also had postpartum depression (Rubertsson et al., 2005). Women were assessed for depression using the EPDS sometime during their prenatal care (16 weeks' gestation was the average gestational age) and then at two months postpartum. A significant positive correlation ($r=.52$, $p<.01$) between antenatal depression and postpartum depression was reported. Unemployment (RR 2.8, CI 2.6-

5.8), younger age (RR 1.7, CI 1.2-2.5), single marital status (RR 3.9, CI 2.6-5.8), and less education (RR 2.1, CI 1.3-3.3) were associated with antenatal depression. Although the study had a large sample and used the EPDS to determine the relationship between prenatal and postpartum depression, it was conducted in Sweden, which may decrease its generalizability.

Infant Health Factors

Depression has been found to be related to many infant factors including: preterm birth (A. Beck & Steer, 1996; Dayan et al., 2006; Steer, Scholl, Hediger, & Fischer, 1992), maternal-fetal attachment (Lindgren, 2001), negative infant reactivity (Davis et al., 2007; Davis et al., 2004; Diego et al., 2005; Huot, Brennan, Stowe, Plotsky, & Walker, 2004; Steer et al., 1992), fetal heart rate (Allister, Lester, Carr, & Liu, 2001), infant colic (Sondergaard et al., 2003) and developmental delay (Deave, Heron, Evans, & Emond, 2008). It is important for health care providers to be aware and understand the impact of depression on the fetus and infant, and more importantly to recognize and treat depression to prevent poor infant outcomes.

Preterm Birth

Dayan et al. (2006), examined the relationships between depression, anxiety, and spontaneous preterm birth in a prospective cohort study (n=681). The EPDS was used to assess for depression and the STAI to assess for anxiety between 20 and 28 weeks' gestation. Preterm birth (defined as birth before 37 weeks' gestation) was assessed using medical records. Depression was found to be significantly related to preterm birth, where

9.7% of women with high depression scores had a preterm delivery compared to 4.0% of non-depressed women (p=.023). There was not a significant relationship found between anxiety and preterm birth. This study took place in France, which may limit the generalizability of the findings to U.S. women.

Steer et al. (1992), also found a relationship between preterm birth and depression. This prospective study used the BDI to measure depression at 28 weeks' gestation in 389 adults (greater than 18 years of age) and 323 teens. In this study, low birth weight was defined as a baby weighing less than 2500 grams, small for gestational age was defined as having a birth weight below the tenth percentile for that gestational age, and preterm delivery was defined as delivering before the 37th week gestation. For adult participants with a score higher than 16 on the BDI, indicating depression, there was an increased risk for delivery of a low birth weight infant (OR 2.86, CI 2.73-2.99), a small for gestational age infant (OR 2.32, CI 2.21-2.43), or delivering a preterm infant (OR 2.53, CI 2.42-2.65). All odds risk ratios were adjusted for ethnicity, low pre-pregnancy body mass index, inadequate pregnancy weight gain, smoking, and history of complications. The risk of a low birth weight infant rose approximately 5% to 7% for each point the total score on the BDI increased ($p < .05$). This study did not find a relationship between depression and low birth weight, preterm delivery, or small for gestational age infants in the teen population, which may suggest that the BDI may not be an appropriate tool for the teen population.

Maternal-Fetal Attachment

Lindgren (2001) examined the relationship between depression, maternal-fetal attachment, and health practices in 252 pregnant women between 20 and 40 weeks' gestation, in which 44% had depression defined as scoring 16 or higher on the CES-D. Women who had more children ($r=.14$, $p<.05$), were younger ($r=-.26$, $p<.05$), less educated ($r=-.34$, $p<.05$), lower income ($r=-.38$, $p<.05$), single (.$r=30$, $p<.05$), and from the inner city ($r=.25$, $p<.05$) had higher depression scores. After controlling for age, income, and education there was a significant relationship between increased depression and less maternal-fetal attachment (measured by the Maternal Fetal Attachment Scale). However, depression explained only three percent of the variance in maternal-fetal attachment.

Negative Infant Reactivity

Depression and anxiety during pregnancy have been found to have negative effects on the infant (Davis et al., 2004). Maternal depression and anxiety were measured in women at 32 weeks' gestation and 8 weeks postpartum. Forty-two percent of the sample was found to have scores greater than 16 on the CES-D indicating depression at 32 weeks' gestation. Infant behavioral reactivity was assessed at four months of age using the Harvard Infant Behavioral Reactivity Protocol. To measure infant behavioral reactivity, various stimuli were used to elicit a response. The type of response such as movement and crying are recorded as a negative response. The measures of anxiety and depression were highly correlated ($r=.74$, $p=.0001$) at 32 weeks' gestation. Prenatal

anxiety accounted for 20% and prenatal depression accounted for 27% of the variance in negative infant behavioral reactivity. Postnatal measurements of anxiety and depression did not contribute significantly to infant behavioral reactivity. This finding suggests that it is important to intervene during prenatal care to detect and treat depression symptoms, in order to prevent negative infant reactivity.

Maternal depression during pregnancy has been found to impact infant temperament at six months (Huot et al., 2004). This study included 123 mother-infant pairs. Women were assessed for depression using the BDI sometime during pregnancy and postpartum; however, exact times of measurement were not reported and this is a limitation of the study. Women who were assessed during the first or second trimester were combined into one group for analysis because there was a smaller number of women during these times compared to women assessed in the third trimester. Higher BDI scores during the first two trimesters of pregnancy (but not the third trimester) were significantly related to negative infant affect (R^2=0.11, p=.02). There was no significant relationship found between postpartum scores on the BDI and negative infant affect. The results indicate the importance of detecting and treating antenatal depression to improve infant health outcomes.

The effects of depression during pregnancy and cortisol levels on infant temperament were studied by Davis et al. (2007), in a longitudinal study of 247 mother-infant pairs. Maternal assessments of depression using the CES-D and anxiety using the STAI were done between 18 and 20 weeks' gestation, 24 and 26 weeks' gestation, 30 and

32 weeks' gestation, and 2 months postpartum. Depression scores on the CES-D and cortisol levels were found to be higher during pregnancy compared to the postpartum period. At 30 to 32 weeks' gestation, higher cortisol levels were found to be significantly related to negative infant reactivity ($r=.20$, $p<.01$). However, postpartum cortisol levels were not found to be significantly related to negative infant reactivity. Prenatal anxiety ($r=.17$, $p<.01$) and depression ($r=.18$, $p<.01$) were also found to be related to negative infant reactivity. The effects of prenatal depression and cortisol levels on negative infant reactivity remained significant after controlling for postpartum depression and anxiety. These findings indicate that anxiety and depression during pregnancy have an impact on infant behavior regardless of postpartum depression and anxiety; and again, this supports the importance of diagnosing and treating prenatal depression and anxiety. This study was unique because cortisol levels to determine a relationship between stress, depression, and anxiety were measured, and few studies have included physiologic markers. Future studies may want to include measures of stress hormones to confirm the findings of this study.

Diego et al. (2005), also reported a relationship between infant behavior and maternal depression. This prospective, longitudinal study of 80 women used the CES-D to measure depression between 23 and 27 weeks' gestation and then 2 weeks postpartum. When infants of mothers with prenatal depression were compared to infants of mothers without prenatal depression, women with prenatal depression had infants who spent more time crying and fussing (14% compared to 3%, $p<.05$), exhibited more stress behaviors

(9% compared to 5%, p<.05), and spent less time awake and alert (5% compared to 16%, p<.05) than infants of women without prenatal depression. Also, women with both prenatal and postpartum depression had infants with lower mean motor scores (3.45 compared to 4.59, p <.05) and mean orientation scores (3.36 compared to 4.99, p<.05) as measured by Brazelton Neonatal Behavior Scale. Similar to the other studies on infant behavior, this study reported findings that are consistent with the need to treat prenatal depression to improve infant outcomes.

Fetal Heart Rate

Fetal heart rate is a measure of fetal well-being. Allister et al. (2001), reported a relationship between fetal heart rate and prenatal depression in a cross-sectional study of 20 women (10 with depression, 10 without depression) between 32 and 36 weeks' gestation. Depression was measured using the BDI and fetal heart rate was measured using a fetal heart monitor. After a baseline fetal heart rate was obtained, a vibroacoustic stimulus was given. Vibroacoustic stimulation applies an auditory stimulus to the maternal abdomen to stimulate the fetus. Women with depression had higher baseline fetal heart rates (Mean FHR 145 bpm compared to 136 bpm), had smaller heart rate accelerations after the stimulus (Mean acceleration 6 bpm compared to 12.5 bpm), and required a longer amount of time to return to baseline after the stimulus (6 min. compared to 2.5 min.) than women without depression. For the depressed group, a smaller acceleration suggested a slower response to the environment, and a longer time period to return to baseline suggested an inability to adjust to the external stimuli (Allister et al.,

2001). The inability to adjust to external stimuli may be related to an immature autonomic nervous system or an abnormality in the overall well-being of the fetus (Allister et al., 2001). A weakness of this study is the small sample size and the use of a cutoff score of ten on the BDI, which is lower than the recommended cutoff score of 16 for the pregnant population (Holcomb et al., 1996), which may have classified more of the women as depressed.

Developmental Delay

Depression during pregnancy has been found to be related to child developmental delay at 18 months of age (Deave et al., 2008). Women (n=14,062, 96% White) were screened four times for depression (18 and 32 weeks' gestation and 8 weeks and 8 months postpartum). Fourteen percent of women were found to be depressed at least once during pregnancy (but not postpartum), 4.8% were depressed at least once during postpartum (but not during pregnancy), and 1.4% were found to be depressed at least once both during pregnancy and postpartum. Nine percent of children were reported to be developmentally delayed. For women who had depression during both prenatal measurements, their child was 1.24 times (CI 1.04-1.49) more likely to be delayed. Once smoking, maternal age, and life events were adjusted for, the risk of delay for their child increased to 1.34 times (CI 1.11-1.62). This relationship between depression and delay remained significant after controlling for postpartum depression. A limitation of the study was the small number of women reported to have depression during pregnancy and

postpartum. A strength of the study was the large sample size; however, the sample was predominately White, limiting the generalizability of the findings.

Sudden Infant Death Syndrome (SIDS)

SIDS is the most common cause of infant death in the first year of life (Howard, Kirkwood, & Latinovic, 2007). A retrospective, case control study (n=831) was conducted to determine if there was relationship between antenatal depression and SIDS (Howard et al., 2007). Antenatal depression was defined as a diagnosis of depression by an ICD-9 code during the year before birth. Women who had an infant death related to SIDS (n=169) were compared to women without an infant death (n=662). There were no differences in substance use or alcohol consumption between groups. However, smoking was more common in the women with cases of SIDS. Also, depression during the year before birth was found to be associated with SIDS (OR=4.93, 95% CI 1.10-22.05). Postpartum depression was not associated with SIDS, indicating the importance of diagnosis of depression during pregnancy. A limitation to this study was that women in the depression group were determined to have depression at some point during the year before birth but not necessarily during pregnancy. The racial distribution of the sample was not reported and the study was done in England, which may also make generalizability of the findings problematic.

Antenatal Depression Treatment

Only one research article was found studying a treatment program for depressed women during pregnancy (Spinelli & Endicott, 2003). A review paper on treatments for

depression during pregnancy cited the Spinelli & Endicott paper as the only intervention study to meet the criteria to be included in the paper (Dennis, Ross, & Grigoriadis, 2007). Spinelli & Endicott (2003) conducted a controlled clinical trial in a sample of 50 pregnant women to compare a 16 week Interpersonal Therapy (IPT) treatment to a parenting education control. Women began the IPT treatment or the parenting education class at about 21 weeks' gestation. Depression was measured by the Hamilton depression scale (HDS), the BDI, the EPDS, and the Structured Clinical Interview for DSM-IV Axis I Disorder. Mood improved in both groups; however, mood improved significantly more in the IPT treatment group compared to the parenting education group on all measurements of mood (HDS: $p<.03$, BDI: $p<.02$, EPDS: $p=.005$). This study was unique in testing an intervention treatment for prenatal depression. A strength of the study was that it included minority women with more than half having an annual income of less than $25,000 a year. Another strength of the study was the use of a structured interview for depression and the randomized study design.

Synthesis of the literature indicates there are multiple health risks to the mother and infant when the mother has depression during pregnancy. Many of the longitudinal studies found that depression during pregnancy, but not in the postpartum period, had a significant impact on the health of the infant, indicating the importance of continued research in the area of antenatal depression. Almost all of the studies used self-report measures to determine depression, which is a limitation to this body of research. The results of the studies using only self-report measures would be strengthened if there had

been a diagnostic interview to validate the findings of the self-report questionnaires. Many of the studies included women in the second or third trimester, so it may be beneficial for future studies to include women in early pregnancy to determine when depression is most prevalent and its impact on the health of the mother and infant.

Most studies used a sample of women that were already receiving prenatal care. Because depressed women may be more likely to receive poor prenatal care and miss prenatal care visits, many of the studies could be missing a large population of depressed women. Also, many studies did not have diverse samples. Future studies should target women who are at risk for receiving poor prenatal care and include racially diverse samples.

Depression and Diabetes

There is a known link between diabetes and depression. Depression is more commonly found in women with type 2 diabetes (28%) than in men with type 2 diabetes (18%) (R. Anderson, Freeland, Clouse, & Lustman, 2001). Whether the neuroendocrine changes in depression cause hyperglycemia or the effects of hyperglycemia cause depression is yet to be determined. However, three meta-analyses have indicated that depression may predispose the onset of type 2 diabetes (Lustman et al., 2000; Lustman et al., 2007; Musselman, Betan, Larsen, & Phillips, 2003). It has been shown that depression-induced changes in neurotransmitter functions may negatively affect glycemic control by causing hyperglycemia (Von Kanel, Mills, Fainman, & Dimsdale, 2001).

Also, depression has been found to be significantly related to hyperglycemia in both type 1 and type 2 diabetes (Lustman et al., 2000).

The effects of hyperglycemia have been known to cause depression because insulin resistance has been related to depression. Insulin sensitivity was found to be significantly lower in depressed patients when compared to non-depressed people and insulin resistance improved with treatment of depression (Lustman et al., 2007). Also, the pathophysiological relationship between insulin resistance and psychological stress may be due to the exposure to the stress hormones, the catecholamines and corticosteroids, the proinflammatory cytokines, and the free fatty acids acting in combination to cause increased insulin resistance (Black, 2006).

Although the hyperglycemia and insulin resistance that occur during diabetes has been related to depression, the relationship between gestational diabetes and depression has not been extensively researched. Hyperglycemia is also a complication of gestational diabetes and is related to increased stillbirths and increased infants born with macrosomia (Dudley, 2007; Metzger et al., 2008). Whether hyperglycemia during pregnancy is associated with increased incidence of depression is unknown and is an area for future research.

Gestational Diabetes and Depression

Despite the association between depression and type 1 and 2 diabetes, there is little known about gestational diabetes and depression. During the literature review, only five studies were found that examined depression and gestational diabetes.

A cross-sectional, descriptive study of 90 high risk pregnant women between 34 and 36 weeks' gestation to determine if a high risk pregnancy was associated with depression and maternal fetal attachment was conducted by Chazotte, Freda, Elovitz, & Youchah (1995). The CES-D was used to compare the following groups: (1) women with gestational diabetes (n=30), (2) women at risk for a preterm delivery (n=30), and (3) women with an uncomplicated pregnancy (n=30). Fifty-seven percent of the gestational diabetics, 70% of the women at risk for preterm delivery, and 33.3% of the uncomplicated pregnant women were found to be depressed (≥ 16 on the CES-D). Although the pregnant women with gestational diabetes had a greater incidence of depression than women with an uncomplicated pregnancy, this difference was not statistically significant. The researchers suggested that this lack of difference may have been due to the small sample size, thus insufficient power necessary to find significant differences between the groups. Most of the sample consisted of minority women (94%), therefore, it is unknown if these findings would be generalizable to White women.

A similar study examined health-related quality of life and depressive symptoms in pregnant women (n=90). Here a prospective, longitudinal study compared women with hypertension (n=18), gestational diabetes (n=11), preterm birth (n=32), and healthy pregnant women (n=29) (Mautner et al., 2009). The EPDS was used to measure depression at three times throughout the perinatal period (24-37 weeks' gestation, 2-5 days postpartum, and 3-4 months postpartum). No significant differences in depression scores were found between women with gestational diabetes and women without

gestational diabetes. However, the highest rates of depressive symptoms occurred during late pregnancy (24-37 weeks' gestation). In addition, women with preterm delivery followed by women with hypertensive disorder reported the greatest number of depressive symptoms. The only significant difference in depressive symptoms was found between women with preterm delivery and women with healthy pregnancies. Limitations to this study included the small sample of women with gestational diabetes who were from one hospital located in Austria.

The diagnosis of gestational diabetes and its impact on emotional adjustment was studied by Langer & Langer (1994). In this study, 206 women with gestational diabetes and 95 non-diabetic pregnant women between 37 and 38 weeks were assessed for depression using the Profile of Mood States-Bipolar (POMS-B). No differences in depression scores were noted between gestational diabetics and non-diabetics. However, the study reported that the mean score on the POMS-B was in the normal range for both groups with the mean score of 45 for the women with gestational diabetes and 44 for the women without diabetes on the elated-depressed subscale (Langer & Langer, 1994). This study was unique because it classified the women with gestational diabetes by the type of treatment (diet or insulin therapy) and by their level of glycemic control (good control or poor control). In this study, good control was defined as a mean glucose <105 mg/dL and poor control was a mean glucose ≥ 105 mg/dL. Also, the target range was defined as an overall mean blood glucose of 90-100 mg/dL, fasting blood glucose of 60-90 mg/dL, and postprandial blood glucose less than 120 mg/dL. Participants were

classified as having good control if their average blood glucose was less than 105 mg/dL and women were said to have poor control if their average blood glucose was greater than 105 mg/dL. Intense treatment for gestational diabetes (insulin therapy and close monitoring of blood glucose) was not related to increased depression symptoms. However, women with good control of their diabetes were less distressed than women in poor control. Twenty-one percent of the variance in the average mood disturbance score was explained by the number of glucose readings in the normal range, number of glucose readings above the target range, marital status, and maternal age. A limitation of this study is that the number of women with depression was not reported, and there may have not been a sufficient number of women with depression to find differences between women with and without depression. Finally, the use of the POMS-B has not been widely used in pregnancy and the reliability and validity of the tool was not reported for this study.

Kim, Brawarsky, Jackson, Fuentes-Afflick, & Haas (2005) examined health status in pregnant women with gestational diabetes (n=64), pregnancy induced hypertension (PIH) (n=148), or uncomplicated pregnancy (n=1233). Although the focus of this cohort study was not depression, it was assessed using the CES-D between 12 and 20 weeks' gestation and between 8 and 12 weeks postpartum. Although women were measured between 12 and 20 weeks' gestation, they were asked to answer questions regarding the month prior to conception. Therefore, perceived depression before pregnancy was assessed rather than actual antenatal depression. Depression was present in 7.8% of

women with gestational diabetes, 10.1% of women with PIH, and 11.6% of unaffected women. Group differences were not significant for depression; however, researchers reported that women with gestational diabetes had poorer self-rated health in the third trimester (20%) compared to women without gestational diabetes (9.2%). The researchers suggested the study may not have been powered sufficiently to detect significant differences for depression. Differences in self-rated health during the third trimester were reported but it is unclear how this was measured. A weakness of this study is that women were asked to recall feelings of depression and health the month prior to conception at 12 to 20 weeks' gestation which may have measurement error due to recall bias.

A recent study reported that women with diabetes during pregnancy were more likely to have depression (Backes Kozhimannil, Pereira, & Harlow, 2009). A large sample (n=11,024) using a retrospective cohort design used medical records from New Jersey's Medicaid administrative claims database and ICD-9 codes to determine women with diabetes and depression. After controlling for age, race, and preterm birth, 15.2% of women with diabetes during pregnancy had depression compared to 8.5% of women without diabetes (OR 1.85, 95% CI 1.45-2.36). This study also reported that women with diabetes but no depression during pregnancy were more likely to develop postpartum depression (OR 1.69, CI 1.27-2.23). The strength of this study was the large sample size. However, one weakness was that women with gestational diabetes, type 1 diabetes, and type 2 diabetes were grouped together in the study.

These five studies were the only studies found that examined depression and gestational diabetes. Four studies did not show that pregnant women with gestational diabetes are at greater risk for depression; however, all four of the studies had small sample sizes and inadequate power (Chazotte, Freda, Elovitz, & Youchah, 1995; C. Kim, Brawarsky, Jackson, Fuentes-Afflick, & Haas, 2005; Langer & Langer, 1994; Mautner et al., 2009). One large study reported a difference in depression between women with diabetes compared to women without diabetes. However, this large study studied women with type 1, type 2, and gestational diabetes making it difficult to make conclusions specifically about gestational diabetes. Therefore, a gap in the literature exists and the need for a study with a large sample and adequate power to determine if women with gestational diabetes are more at risk for depression is needed.

A relationship between depression and poor self-care in people with diabetes has been established (Lin et al., 2006). Women who are depressed during pregnancy were more likely to smoke, use alcohol, miss prenatal care visits, or delay initiation of prenatal care (Kelly et al., 1999; Marcus et al., 2003). Pregnant women with depression and gestational diabetes may find it difficult to perform all the self-care behaviors necessary to effectively manage the diabetes. Future studies may want to include measurements of self-care to determine if women with depression and gestational diabetes are more at risk for complications.

The relationship between hyperglycemia, increased insulin resistance, and depression has been documented in type 2 diabetes and suggests that depression may

cause gestational diabetes. However, this has not been established through research in the area of gestational diabetes. Future studies may find it beneficial to measure insulin resistance, hyperglycemia, and depression in a prospective study beginning in the first trimester of pregnancy before the diagnosis of gestational diabetes is made later in the third trimester. This study would provide evidence as to whether depression is a risk factor for developing gestational diabetes.

Electronic Medical Record

The electronic medical record (EMR) is defined as a digital collection of patient data that is accessible to multiple authorized users and is exchanged and stored securely. It includes retrospective, current, and prospective information and has the primary purpose of providing efficient and high quality health care (Hayrinen, Saranto, & Nykanen, 2008). Although the EMR is primarily used for clinical purposes, it may also be used for research. When using the EMR for research, it is important to consider the quality of the retrieved data information. Information quality includes the concepts of completeness, accuracy, and reliability.

A review paper analyzed the information quality in 299 studies using the EMR as a data source (Hayrinen et al., 2008). This paper reported that of the 299 studies reviewed, 55 reported on the completeness of the data in the EMR. Completeness is a measure of the amount of missing data. Many of the studies (n=31) found that documentation by the health care provider was more complete and included more details in the EMR than in another data source. Data accuracy is a measure of how accurate the

data in the EMR is compared to another data source. A review of data accuracy was included in 29 of the papers and it was found that data in the EMR was accurate. Another study involving respiratory illness in an emergency department compared electronic data to data retrieved from a paper chart and found the electronic data to be accurate (Townes et al., 2004). When the electronic data was compared to a dictated clinical note, it was found that 95% of the notes included a history of one respiratory symptom or an objective sign of a respiratory tract infection on physical examination.

Reliability is a measure of how often the data shows the same results over multiple measurements. Electronic medical records have been found to produce reliable data (Hayrinen et al., 2008). Reliability and accuracy of EMR's were analyzed in a study on the amount of prescribed medication to the elderly for osteoarthritis in general practitioners' offices (Vandenberghe et al., 2005). In this study, the general practitioner had the option of using a semi-automatic data extraction system from an EMR or data collection with paper registration sheets. Semi-automatic data extraction was completed by the EMR software developers creating a data extraction software program to extract the necessary data for the study. Once the necessary data was extracted from the chart, the general practitioner had the ability to review the data and modify data or add missing data. This step allowed the general practitioner to improve the quality of the data. The data collected from the charts included age, sex, diagnosis and location of osteoarthritis, treatment type (medication, physiotherapy, diet, surgery, other, or none), and prescribed medications for osteoarthritis (paracetamol, NSAID, or other painkillers). The analysis

included 222 general practitioners who collected data on 4,231 patients using paper sheets and 146 general practitioners who collected data on 3,055 patients using EMR. Although there were fewer practitioners using EMR, they were able to collect data on more patients indicating the ease and timely manner in which data can be collected using EMR. This study also found that the proportion of patients who were prescribed drugs to treat osteoarthritis was almost twice as high for the general practitioners recording data on paper sheets (64%) when compared to the general practitioners using EMRs (36%). One possible explanation for this difference is that the general practitioners wrote the prescriptions on paper and did not record them in the EMR. Another possibility is that the prescriptions were recorded in a different place in the EMR and the semi-automatic extraction was not able to capture the total number of patients on medications.

Missing data and problems with data entry are two weaknesses that may be found when using EMR as a data source. Missing values can be found in any large database (Cios & Moore, 2002). The missing value may be due to an oversight or intentionally due to a technical, economic, or ethical reason (Cios & Moore, 2002). Missing values may be substituted with the most likely value, with all possible values, or with a likely range of possible values (Cios & Moore, 2002). A statistician who is familiar with large data sets may be needed to assist in methods to replace missing data. Data entry problems can also occur because many terms are used to describe the same conditions (Cios & Moore, 2002). An example of this would be terms for high blood pressure during pregnancy which include the following: hypertension, pregnancy induced

hypertension, and preeclampsia. All three diagnoses include high blood pressure occurring during pregnancy, so when studying the complication of high blood pressure during pregnancy, it is important to search the EMR for all three terms. Similarly, when health care providers document this problem in the chart, they may use one or all three of these terms, also creating a challenge for accurate data extraction for research.

One of the strengths of using EMR as a data source is the ability to collect a large amount of data on many people in a short time. For example, a large study using EMR as a data source found that hypertension was under-diagnosed in the pediatric population (Hansen, Gunn, & Kaelber, 2007). This study had a sample size of 14,187 patients and data was collected for 53,911 patient visits over seven years. The author reported that the study took about 100 hours of work time, and was completed without significant resources as compared to a study of this magnitude that did not use EMR that would have required many hours and cost hundreds of thousands of dollars. Another strength of using the EMR as a data source is that preliminary data can be generated to provide support for a possible intervention study.

Use of the electronic medical record systems has the ability to transform research and may change the way research is conducted in the future. However, it will be important to assess and understand the data quality issues (completeness, accuracy, and reliability) that may occur or may be inherent with electronic documentation so that these can be controlled in study design. Assurances of high quality data is essential for research to be conducted using new and different methods of automated data captured at

the point of care and aggregated across patient populations (Thiru, Hassey, & Sulllivan, 2003).

CHAPTER THREE

METHODOLOGY

This chapter addresses the study design, sampling criteria, recruitment strategies, enrollment procedures, and data collection methods (including all measurements). As stated previously, the purpose of the study was to determine if women with gestational diabetes were more likely to suffer from depression. Although depression and gestational diabetes are common occurrences during pregnancy, the relationship between the two has not been extensively studied. The study aims were as follows: (1) to determine whether women with gestational diabetes had more depression than women without gestational diabetes, and (2) to determine whether factors predictive of depression in pregnant women with gestational diabetes were different from women without gestational diabetes. An exploratory aim to determine if minorities were more at risk for depression during pregnancy than Caucasians was also examined.

Design

This study used a comparative, longitudinal design. It was comparative because women with gestational diabetes were compared to women without gestational diabetes (Nieswiadomy, 1998). It was longitudinal because data was collected in the antepartum period from the mother and information regarding infant and maternal outcomes was collected following delivery. The study explored whether having depression or gestational diabetes impacts

health outcomes in the mother and infant when compared to pregnant women who do not have depression or gestational diabetes. The psychological factors (depression, history of depression, anxiety, perceived stress, and social support), biological factors (body mass index (BMI)), oral glucose tolerance test results, type of delivery, complications during delivery, Apgar scores, gestational age at delivery, and infant birth weight), and sociological factors (socioeconomic status, race, marital status, and medical history) were studied.

Setting

The study was conducted primarily in outpatient clinics of a large, urban, Midwestern medical center (99% women). Because data collection was slower than anticipated, another outpatient clinic approximately five miles from the primary site was also used (1% women). Data collection occurred over a period of one year (January 2010 to 2011). Both data collection sites serve the ethnically and economically diverse population of the greater Chicago area.

Sample

The sample was a convenience sample of pregnant women who met selected inclusion and exclusion criteria. The sample inclusion criteria were as follows: women who received prenatal care at the research sites, between 24 and 40 weeks' gestation, spoke and read English, and older than 18 years. The exclusion criteria were as follows: women under the age of 18 because expression of symptoms of depression varies with developmental stage and some adolescents may have difficulty identifying and describing

mood states (Bhatia & Bhatia, 2007). Also, women who did not read or speak English were excluded because of insufficient funds to pay for translation. In order to classify women as having gestational diabetes, the results of the three-hour oral glucose tolerance test, an ICD-9 code of gestational diabetes, and/or a one-hour OGT greater than 200 mg/dL (see measurement section for how women with gestational diabetes was defined) were used.

To determine the sample size needed for statistical significance, a power analysis was conducted. Using the data from Chazotte et al. (1995), there was an incidence of significant depressive symptoms (CES-D $\geq$ 16) in women with gestational diabetes of 57% and of 33% in women without gestational diabetes. Using G-Power, in order to detect a difference between groups using these percentages with an alpha of 0.05, power of .80, and one-sided tail distribution, 58 women per group are needed. Thus, 120 women were needed to determine whether women with gestational diabetes had more depression than women without gestational diabetes. To determine whether psychological (anxiety, stress), biological (gestational diabetes, age), and sociological (social support, marital status, socioeconomic status) factors were predictive of depression in pregnant women with and without gestational diabetes, a conservative rule of 10 to 15 subjects per major variable, or a total of 80 to 120 subjects, was required. Thus, a sample of 147 women was recruited in order to account for missing data.

Recruitment of Study Participants

Participants were recruited from outpatient obstetrics offices. The investigator approached pregnant women while they were attending a routine prenatal care visit. After the nurse or technician had completed the patient vital signs and the patient was in the exam room, the nurse or technician asked the patient for permission for the investigator to come in and discuss the study. If the patient agreed, the investigator went in the room to explain the study and determine if the patient was interested. If the patient agreed to participate, the investigator explained the informed consent document and the self-report questionnaires (Appendix A). The participant had the option of signing the informed consent document and completing the self-report questionnaires while at the visit or take them home and return them in a pre-paid envelope or at another scheduled visit. The investigator also recruited gestational diabetics who had a scheduled visit with the dietician. The process was the same: the dietician would ask permission for the investigator to talk about a study and if the patient agreed, the investigator would approach the patient and explain the study, the informed consent document, and the self-report questionnaires. All participants were made aware that by signing the consent they were giving the investigator permission to access their electronic medical record. A flyer (Appendix B) was also posted around the clinics and institution regarding participation; however this method of recruitment did not lead to any participants.

Collection of Data

Data was collected using self-report questionnaires and medical records. EpicCare (Epic) is a common type of EMR and was used at the institution where most of the data was collected. The use of Epic began in the ambulatory care setting in 2004 and in the inpatient setting in 2007 and has been successfully used in documenting patient information and providing quality care. At the other data collection site, information was collected using paper medical records. These records were only from the outpatient obstetric clinic; the inpatient hospital records were not accessed.

The self-report questionnaire included the following: the depression score measured by the CESD and the EPDS, the anxiety score, the perceived stress scale, the social support scale, and demographic and health information (including age, race, marital status, socioeconomic status, depression history, other chronic conditions, estimated date of delivery, list of current medications, gravida, and parity) (Table 1). Data taken from the EMR included the following: weight, height, gravida, parity, ethnicity, race, results of oral glucose tolerance test, gestational age at delivery, type of delivery, complications during delivery, perineal tears, infant birth weight, and Apgar scores (at one, five, and ten minutes) (Table 1).

Table 1: Data Collection Methods

Variable	Data Collection Method
Depression (CESD and EPDS scores) Anxiety (STAI score) Stress (Perceived Stress Scale) Social Support (MSPSS score) Age Race & Ethnicity Marital Status Socioeconomic Status Depression History Chronic Conditions Current Medications Estimated Date of Delivery Gravida & Parity	Self-report questionnaire
Result of OGT test Infant Birth Date Infant weight Infant Length Apgar Scores Gestational Age at Delivery Type of Delivery Delivery complications EPDS Scores Maternal Height Maternal Weight Perineal Tears & Episiotomy Maternal Height & Maternal Weights Infant Hypoglycemia	Electronic Medical Record

Other variables extracted from the EMR for a possible secondary analysis included the following: past medical history, current medical diagnoses, depression scores measured by the EPDS (done at four time points: 28 weeks' gestation, time of delivery, two weeks postpartum, and six weeks postpartum), history of tobacco, alcohol or illegal substance, type of anesthesia used during delivery, occurrence of induction, plan to breastfeed, infant size (average for gestational age (AGA), small for gestational age (SGA), or large for gestational age (LGA)), and infant blood glucose levels to determine episodes of hypoglycemia.

The self-report questionnaire booklet (Appendix A) took participants about 15 to 30 minutes to complete. Upon successful completion, the participants were given a $10 gift card. Participants who took the self-report questionnaire booklets home were sent the $10 gift card once the booklet was received in the mail. The phone number and address of patients who took the questionnaire booklet home was obtained and the gift card was mailed once the completed booklet was received. If patients had not returned the booklet within a couple of weeks, the investigator called the patient to remind them to complete and mail back the booklet.

After the patient had completed and returned the self-report questionnaire booklet, data was collected from the EMR (electronic medical record) of both the mother and the infant. Data extracted from the EMR of the mother included the following: weight, height, gravida, parity, ethnicity, race, results of oral glucose tolerance test, gestational age at delivery, type of delivery, complications during delivery, and perineal tears. The

data to be extracted from the infant EMR included the following: infant birth weight and Apgar scores (at one, five, and ten minutes). See Appendix C for variables collected from the EMR.

Data collection from the EMR occurred in two stages. The first stage entailed the investigator accessing the EMR to obtain the participant OGTT results, gravida, and parity. The second phase was done using a template to extract variables from the EMR. The template was created specifically for the study by an informatics specialist. This template was created as a way to expedite data retrieval from the EMR. To create the template, the investigator worked with the informatics specialist to determine what variables should be extracted from the chart. The medical record numbers of the participants were given to the informatics specialist. The informatics specialist then entered the numbers into the template and the variables collected from the EMR were automatically pulled and provided in a word document. The template for this research study included the following maternal variables: maternal height and weight, past medical history, gravida, parity, type of delivery, perineal tears, episiotomy, and substance abuse. The template included the following infant variables: date of birth, Apgar scores (at one, five, and ten minutes), birth weight, birth length, and any results for a blood glucose level for the infant.

Only information which could be documented as a discrete variable in the EMR was provided on the template. Therefore, to collect information which was only contained in physician notes (such as complications during delivery), the investigator

accessed the EMR of all participants. The information provided in the template was also checked to ensure that accurate information was being recorded. This check was done by reading four notes in the maternal EMR: the history and physical admission note when the participant began prenatal care, the history and physical admission note when the participant was admitted to the hospital for delivery, the delivery summary note, and the discharge note. Also, two notes were read in the infant EMR: the admission note to the nursery and the discharge summary note.

Measurements

The measurements were organized using the biopsychosocial model previously discussed in Chapter 1 (see Table 2). See Appendix A for a copy of all the measurement tools used.

The psychological factors assessed included depression, social support, anxiety and stress. For depression, the CESD and EPDS instruments were used to measure depression and were included in the self-report questionnaire booklet. The EPDS is a ten-item tool in which each item is scored on a four-point scale (0-3). The score from each item is then summed to give a total score ranging from 0-30.

Table 2: Variables and Measurements of Study

	Variable	Measurement
Psychological Factors	Depression	EPDS score CESD scores History of Depression
	Social support	MSPSS
	Anxiety	STAI
	Stress	PSS
Biological Factors	Maternal Health Factors	BMI OGTT Results Gravida and Parity Current medications Type of Delivery Delivery Complications
	Infant Health Outcomes	Apgar scores Gestational age Birth weight
Sociological Factors	Socioeconomic Status	Income
	Demographic	Maternal Age Race Ethnicity Marital Status

Higher scores indicate more depressive symptoms in the individual. The recommended cutoff score to indicate prenatal depression is 12/13 resulting in a sensitivity of 64% and specificity of 95% (Murray & Cox, 1990). In the study, a cutoff score of 12 was used to indicate depression. The EPDS was developed for use in the postpartum population but has been validated for use during pregnancy (Murray & Cox, 1990). In addition, reliability has been established (Cox, Holden, & Sagovsky, 1987). The EPDS for the current study had a Cronbach's alpha of .91.

The CES-D was developed by Radloff (1977) and is a 20-item tool that has items scored on a scale of 0 to 3 and then summed to give a total score ranging from 0 to 60. A higher score indicates more depressive symptoms. A score equal to or greater than 16 indicates depression (Radloff, 1977). Similar to the EPDS, the CES-D asks the individual to answer the items based on his or her feelings in the past week. The CES-D has established reliability in pregnancy (Maloni, Seunghee, Anthony, & Musil, 2005). In the current study the Cronbach's alpha of the CES-D was found to be .90.

For anxiety, the Speilberger State Trait Anxiety Inventory (STAI) scale is a 40-item tool which measures both a person's current level of anxiety (state anxiety) and a person's general and long standing anxiety (trait anxiety). The measure of state anxiety includes 20 items using a four point Likert scale (1=not at all to 4=very much so), with a total score ranging from 20-80. Another four point Likert scale (1=not at all to 4=almost always) is used to measure trait anxiety in 20 items, again with the total score ranging from 20-80. Higher scores on the STAI indicate higher levels of anxiety. The STAI has

been frequently used in pregnant populations (Allister et al., 2001; Bergant et al., 1997; Breitkopf et al., 2006; Davis et al., 2004; Dayan et al., 2006; Glazier et al., 2004; Hart & McMahon, 2006) with acceptable reliability for state and trait anxiety (Dayan et al., 2006). In the current study, the Cronbach's alpha for the state anxiety was .93 and .94 for trait anxiety.

The Multidimensional Scale of Perceived Social Support (MSPSS), a 12-item tool, was used to measure social support (Zimet, Dahlem, Zimet, & Farley, 1988). Each item is scored on a 7-point Likert scale (1=very strongly disagree to 7=very strongly agree). To compute a total social support scale, the mean of all items are used with higher scores indicating more social support (with total scores ranging from 1-7). There are three subscales to the tool including significant other support (item numbers 1, 2, 5, 10), family support (item numbers 3, 4, 8, 11), and friend support (item numbers 6, 7, 9, 12). The tool has established reliability and validity in the pregnant population (Zimet, Powell, Farley, Werkman, & Berkoff, 1990). In the current study, the Cronbach's alpha was .94 for the total scale and for the subscales, .95 for significant other support, .90 for family support, and .97 for friend support.

To measure stress, the Cohen's Perceived Stress Scale (PSS) was used. This is a commonly used 10-item tool to measure a person's amount of stress. Each item is scored on a 5 point Likert scale (0=never to 4=very often) and then scores are summed with higher scores indicating higher levels of stress. This tool has established reliability (Cohen & Williamson, 1988). In the current study, the Cronbach's alpha was .92.

For the history of depression and chronic conditions, the self-report questionnaire asked women if they had a history of depression by the question: “Have you ever been diagnosed with depression?” The women were also asked if they had a current diagnosis of asthma, diabetes, hypertension, depression, bipolar disorder, or schizophrenia. Women had the option to write in any other current diagnosis. Women who had a positive history of depression were not excluded. Women with type 1 or type 2 diabetes were excluded.

The biological factors assessed included maternal health and infant factors. For the mother, body mass index (BMI), gravida and parity, oral glucose tolerance test results, current medications, type of delivery, and complications of delivery were assessed. For BMI, weight (lbs) and height (in) at the time of the prenatal care visit when the patient filled out the self-report questionnaire was extracted from the EMR. To calculate BMI, the formula 703 times the weight divided by the height squared was used. Gravida was recorded as the number of times a woman has been pregnant. Parity consisted of the results of those pregnancies and included full term deliveries, preterm deliveries (infants born between 20 and 37 weeks’ gestation), abortions (including spontaneous and miscarriages), and current living children. In the self-report questionnaire, women were asked to report their gravida and parity. This information was also extracted from the EMR.

Women were routinely screened for gestational diabetes with an oral glucose tolerance test to diagnose gestational diabetes. Typically, to make a diagnosis of

gestational diabetes two OGTT were done: a one-hour test and a three-hour test. For the one-hour OGTT, women were given a 50-gram glucose drink to ingest and then a blood glucose reading was obtained one hour later. The American Diabetes Association and the American College of Obstetricians and Gynecologists accept either value (130 mg/dL or 140 mg/dL) as an abnormal value on the one-hour OGTT that indicates further testing for gestational diabetes by a three-hour OGTT (Turok, Ratcliffe, & Baxley, 2003). The three-hour OGTT involves the ingestion of a 100-gram glucose drink followed by glucose testing at one, two, and three hours after the ingestion of the drink. The results of the three-hour OGTT were used to determine a diagnosis of gestational diabetes based on criteria for abnormal results for the three-hour OGTT. There are two sets of criteria that can be used to make a diagnosis of gestational diabetes. The American Diabetes Association suggests the following criteria with two of the following values being met or exceeded: fasting 95 mg/dL; one hour 180 mg/dL; two hour 155 mg/dL; three hour 140 mg/dL (American Diabetes Association, 2003). However, in the current study, the following criteria were used, any two of the four blood glucose values being met or exceeded: fasting 90 mg/dL; one hour 165 mg/dL; two hour 145 mg/dL; three hour 125 mg/dL (O'Sullivan, 1980; O'Sullivan & Mahan, 1964).

For this study, if the one-hour test result was greater than 130 mg/dL , a three-hour OGTT was typically done. The result of the one-hour OGTT was recorded in the EMR for all patients who were screened for gestational diabetes. If the result of the one-hour OGTT is greater than 130 mg/dL, the glucose results of the three-hour glucose test

were also recorded in the EMR. Therefore, almost all women had glucose results of the one-hour test documented in the EMR. If a woman did not have a result for a gestational diabetes screen by a one-hour OGTT or a diagnosis of gestational diabetes, she was excluded from the sample, because it was impossible to classify her as a gestational diabetic or non-gestational diabetic. Women who had an abnormal one-hour OGTT had results for the three-hour OGTT. The results of the three-hour OGTT were used to define gestational diabetes in women for the present study.

Anyone who had a one-hour OGTT result greater than 200 mg/dL was diagnosed with gestational diabetes without further testing. In this study, women with a one-hour OGT result greater than 200 mg/dL, an ICD-9 code of gestational diabetes, a diagnosis of gestational diabetes written by the health care provider in the EMR, and/or abnormal results on the three-hour OGTT (as described above), were defined as having gestational diabetes. The results of the glucose tests were extracted from the EMR.

For maternal outcomes following delivery, the type of delivery, complications during pregnancy, and medications were assessed. Deliveries were documented in the EMR using the following terms: Spontaneous Vaginal Delivery, Cesarean, Low-forceps Delivery, Mid-forceps Delivery, Forceps Outlet, Vacuum, Breech Assisted, or Breech Extraction. This information was extracted from the EMR. A history of cesarean section was also extracted. For complications during delivery, the following were noted: shoulder dystocia, presence of meconium, nuchal cord, postpartum hemorrhage, chorioamnionitis, prolonged rupture of membranes, partial abruption, or maternal fever.

Presence of perineal tears were documented according to the degree of the tear (1^{st}, 2^{nd}, 3^{rd}, or 4^{th}) and were extracted. Although the use of a vacuum may be recorded when the type of delivery was recorded, the health care provider has the option of writing in the use of a vacuum as a complication. If the health care provider chose to write in the use of a vacuum, it was classified as a vacuum delivery.

For medication, participants were asked to list medications currently being taken in the self-report questionnaire. The following medications were categorized for data analysis purposes: insulin, oral diabetes medications, anti-depressants, and anti-anxiety medications.

For the infant outcomes, the Apgar scores, gestational age at delivery, and weight were used. Apgar scores were routinely measured at one, five, and ten minutes after birth to reflect the health of the infant. Apgar scores can range from zero to ten: a score of zero, one, or two are assigned to each of the five aspects of the score (Appearance, Pulse, Grimace, Activity, Respiration) and then summed to provide a total score. Therefore, three Apgar scores were extracted for the study (scores at one, five, and ten minutes). Gestational age at delivery was extracted in "weeks" from the EMR. Finally, infant birth weight was recorded in grams and was taken from the infant EMR.

The sociological factors that were assessed included socioeconomic status, race, ethnicity, marital status, and planned pregnancy. For socioeconomic status, a question regarding income was included on the demographic questionnaire administered in the self-report questionnaire booklet. For race and ethnicity, participants were asked to

report their race as: Alaska Native, Native American, Asian, Black, White, Native Hawaiian or Other Pacific Islander, Preference not Indicated, or Other. Non-Hispanic or Hispanic were the choices available for ethnicity in the self-report questionnaire. This information was also extracted from the EMR. For marital status, a question regarding marital status was included in the self-report questionnaire booklet. Participants had to pick one of the following categories: married, divorced, separated, single and not living with partner, and single and living with partner. For planned pregnancy, women were asked in the self-report questionnaire booklet if the pregnancy was planned or unplanned.

Human Subjects Protection

The involvement of human subjects involved the completion of the self-report questionnaires that were completed by the participant. Also, medical data (maternal and infant) was collected from the EMR. Characteristics of the sample were women older than 18 years of age who could read and speak English. Women younger than 18 years of age were excluded from the sample due to the differences in depression symptom expression for adolescents. It was necessary to study pregnant women, because it is not possible to conduct a study on gestational diabetes without including pregnant women.

Sources of materials were the data collected from the self-report questionnaire booklet and the data extracted from the EMR. These variables have been previously delineated.

There were very few potential risks to this study. However, upon completion of study tools, there was potential for participants to report feelings of anxiety and/or

depressive symptoms during the antepartum visit. Since all prenatal patients are given the EPDS screening during their regular prenatal care visit and there is a protocol for treatment established at the institution where data collection occurred, patients were encouraged to discuss their feelings with their health care provider. The consent stated that if the patient expressed "the thought of harming myself has occurred to me" on the EPDS, the health care provider was notified. Data was also collected from the EMR and the informed consent stated that the medical record will be accessed and information obtained.

To ensure adequate protection against risks to the participants, proper recruitment techniques and informed consent documents were obtained. Participants were recruited from the outpatient obstetrics clinic. Before recruitment began, permission for recruitment at the clinic was provided by Dr. John Gianapoulos. Women attending the outpatient obstetric clinic for routine prenatal care between 24 and 40 weeks pregnant were approached for participation in the study by the investigator. Informed consent was obtained by all participants (See Appendix D for a copy of the informed consent).

In order to protect participants against risks, participants were informed of the possibility of experiencing depressive or anxious feelings while filling out the self-report questionnaires in the informed consent document. If participants informed the investigator of feelings of depression or anxiety, they were encouraged to share these feelings with the health care provider they were seeing in the clinic. If participants shared feelings of harming oneself on the EPDS questionnaire, this information was

shared with the health care provider of the participant. Participants were informed of the possibility of sharing this information with the health care provider in the informed consent. Loyola University has an established protocol for patients who report feelings of harming oneself on the EPDS. The protocol was followed by informing the health care provider of the participant's feelings.

Collected data was kept in a locked file cabinet. Only members of the research team had access to this data. During data entry patient identifiers were not recorded, assuring participant anonymity. Participants were informed that there were no identifiers recorded in the informed consent. This research study involved pregnant women because pregnancy is necessary to study gestational diabetes. However, because of the design of this study and information collected, there was no increased risk to the mother, fetus, or neonate.

At this point there are no known benefits to human subjects or others. However, if women with gestational diabetes were found to be at increased risk for depression, the care provided to them could be improved. Also, with significant results, future studies to test an intervention that would improve depression symptoms in this population could be conducted which would provide benefit.

Important knowledge may be gained at the completion of this study. If women with gestational diabetes were found to be more at risk for depression, the care provided to this population would be improved. Recognizing depression during pregnancy will

help improve the outcome of maternal and infant health and could decrease the effects of postpartum depression. These benefits outweigh the minimal risk of this study.

It was necessary to include women in the study; however, children were not included. This study involved gestational diabetes and pregnancy, therefore only women were included. Children and adolescents were not included because expression of symptoms of depression varies with developmental stage and some adolescents may have difficulty identifying and describing mood states (Bhatia & Bhatia, 2007). The sample had a good representation of minority women: about 23% of the sample was African American, 33% was Hispanic, and 11% of the sample was of another minority group.

CHAPTER FOUR

RESULTS

This chapter addresses the findings from the study. First, the description of the sample and all study variables is provided. Second, the results of the study aims are delineated. As previously stated, there were three aims to this study. The primary aim was to determine if women with gestational diabetes mellitus (GDM) had more depression than women without GDM. The secondary aim was to determine if the factors predictive of depression in women with GDM were different than factors predictive of depression in women without GDM. The exploratory aim was to determine if minority women were more at risk for prenatal depression than White women.

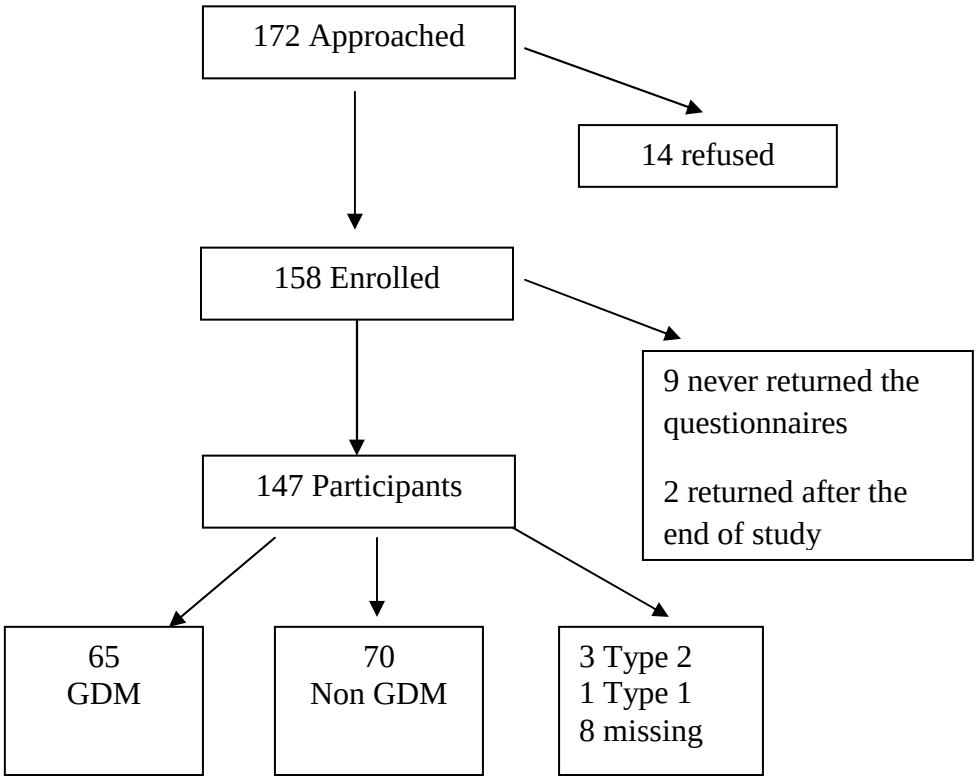
Description of the Sample

One hundred and seventy two women were approached and asked to participate in the study (See Figure 2 for enrollment diagram). Of these, 14 women refused and therefore 158 women were enrolled in the study. Of the 158 women enrolled, 147 women completed the self-report questionnaires. Of those 147, eight had no results in the chart of their oral glucose tolerance test or a diagnosis of GDM, three had type 2 diabetes, and one had type 1 diabetes. The final sample included a convenience sample of 135 women (65 with gestational diabetes and 70 without gestational diabetes).

The majority of the sample was non-Hispanic (66.7%), married (65.2%), had an unplanned pregnancy (52.6%), had no history of depression (84.4%), and had an average

age of 29.7 years. The average gestational age at the time participants completed the self-report questionnaire booklet was 31.3 weeks' gestation. The race of the sample was evenly distributed with 32.6% being White, 32.6% Hispanic, 23.0% Black, and 11.9% other (Table 3). T-tests were done to determine if there were differences in age, and gestational age at when participants filled out the questionnaire booklet. Women with GDM were significantly older ($p<.001$). Chi-square tests were done to determine if there were differences between groups in marital status, income, and history of depression. Although women with GDM had higher incomes and more were married, these were not significantly different than women without GDM according to the chi-square results.

Figure 2: Enrollment Flow Diagram



However, women with GDM were more likely to have a history of depression (χ^2=5.40, *p*=.02). See Table 3 for differences in the demographic variable between gestational diabetics and non-gestational diabetics. The 12 women who were not included in the final sample because of missing results to an oral glucose tolerance test or a diagnosis of type 1 or type 2 diabetes had demographics similar to the women included in the sample (see Table 3). The ethnic and racial makeup of the sample is representative of the population where the sample was collected.

Table 3: Description of Sample

Variable	Total Sample N=135 (%)	GDM N=65 (%)	Non-GDM N=70 (%)	Excluded
Age* Mean (SD) Range	29.7 (6.02) 18-47	32.12 (5.53) 18-47	27.36 (5.55) 18-41	26.25 (7.65) 18-36
Gestational Age Mean (SD) Range	31.3 (3.90) 24.1-39.3	31.8 (3.77) 24.1-38.3	30.86 (4.00) 24.1-39.3	31.63 (4.08) 26.5-39.3
Gravida Mean (SD) Range	3.0 (2.0) 1-9	3.0 (2.0) 1-8	3.0 (2.0) 1-9	3.0 (2.0) 1-7
Ethnicity Hispanic Non-Hispanic	45(33.3%) 90 (66.7%)	25 (38.5%) 40 (61.5%)	20 (28.6%) 50 (71.4%)	4 (33.3%) 8 (66.7%)
Race White Black Hispanic Other	44 (32.6%) 31 (23.0%) 44 (32.6%) 16 (11.9%)	20 (38.5%) 11 (16.9%) 25 (38.5%) 9 (13.8%)	24 (34.3%) 20 (28.6%) 19 (27.1%) 7 (10%)	1 (8.3%) 6 (50%) 4 (33.3%) 1 (8.3%)
Marital Status Married Divorced Separated Single, not living with partner	88 (65.2%) 3 (2.2%) 2 (1.5%) 15 (11.1%)	48 (73.8%) 2 (3.1%) 1 (1.5%) 6 (9.2%)	40 (57.1%) 1 (1.4%) 1 (1.4%) 9 (12.9%)	5 (41.7%) 1 (8.3%) N/A 4 (33.3%)

Single, living with partner	26 (19.3%)	7 (10.8%)	19 (27.1%)	2 (16.7%)
Income				
Less than $5,000	23 (17.0%)	9 (13.8%)	14 (20%)	5 (41.7%)
$5,000-$9,999	4 (3.0%)	1 (1.5%)	3 (4.3%)	N/A
$10,000-$19,999	16 (11.9%)	8 (12.3%)	8 (11.4%)	2 (16.7%)
$20,000-$29,999	23 (17.0%)	9 (13.8%)	14 (20.0%)	2 (16.7%)
$30,000-$39,999	19 (14.1%)	9 (13.8%)	10 (14.3%)	N/A
$40,000-$49,999	10 (7.4%)	5 (7.7%)	5 (7.1%)	N/A
$50,000-$59,999	9 (6.7%)	5 (7.7%)	4 (5.7%)	1 (8.3%)
$60,000-$69,999	9 (6.7%)	4 (6.2%)	5 (7.1%)	N/A
Over $70,000	15 (11.1%)	12 (18.5%)	3 (4.3%)	1 (8.3%)
Planned Pregnancy				
Yes	63 (46.7%)	32 (49.2%)	31 (44.3%)	1 (8.3%)
No	71 (52.6%)	32 (49.2%)	39 (55.7%)	11 (91.7%)
History of				
Depression*	21 (15.6%)	15 (23.1%)	6 (8.6%)	1 (8.3%)
Yes	114 (84.4%)	50 (76.9%)	64 (91.4%)	11 (91.7%)
No				

* Significant differences between GDM and non-GDM ($p<.05$)

Data Entry

All data from the self-report questionnaires and EMR was de-identified and entered into a statistical software database (SPSS Windows Version 16.0, SPSS, Chicago, IL). Data was then manually checked and corrected for any entry errors. Once the raw data had been entered, only assigned ID numbers were used to analyze the data.

Missing Data

After data entry was complete, data was assessed for missing data. There was very limited missing data in the self-report questionnaires (see Appendix E). This is because all booklets were examined upon completion for missing data. If an item was missing, the participant was asked if the item was accidently skipped or left blank on purpose. If the participant desired to leave an item blank it was accepted. Missing data

on the self-report questionnaires was replaced with the individual mean for that specific instrument. There was limited missing data from self-report questionnaires that could not be replaced with the individual mean (one marital status item, one pregnancy planned item, and seven income items). Many participants when asked about income desired to leave this blank or were unsure of the annual income because the spouse was the primary wage earner.

There was also missing data from the EMR templates provided by the informatics expert. When missing data was encountered on the template, the EMR was accessed and examined to see if missing information could be found (Appendix E). This included reading through the following physician notes: the admission history and physical note, the delivery summary note, and the discharge summary note in the maternal EMR. Also, the infant admission to the nursery and discharge summary notes were read. When missing data was found, it was entered into the database. There were six participants that did not deliver at the institution where data was collected and therefore all delivery data is missing from these six people. See Appendix E for amount of missing data encountered from the EMR. The variable with the most missing data was the Apgar score at ten minutes. There were six participants with missing results for the one-hour OGTT gestational diabetes screen; however, all six of these participants had a diagnosis of gestational diabetes in their charts. The most common reason for the missing one-hour OGTT results was because patients had transferred from other institutions and this data was not available.

Comparability of Data from Different Sources

Only information which could be documented as a discrete variable in a flow sheet was provided on the template. Data such as the complications during delivery were only written in physician notes. Therefore, physician notes were consulted to retrieve information not provided on the template and to find missing data. Once the physician notes were read, discrepancies were found between the information retrieved using the EMR template and the physician notes in the EMR (Appendix F). The physician notes from the maternal EMR that were reviewed included the following: the history and physical note at the start of prenatal care, the history and physical note at the time of admission to the hospital for delivery, the delivery summary note, and the discharge summary note. Physician notes from the infant EMR that were reviewed included the following: admission to the nursery and the discharge summary. Usually, the information found in the physician note was entered into the database, because it was believed that the physician note would be more accurate than flow sheet documentation.

Data Analyses of Key Study Variables

First, data was analyzed for normality and outliers. Normality was assessed by examining histogram plots. The outcome variables found to be positively skewed were the CES-D scores, the EPDS scores, the state anxiety scores, and the trait anxiety scores. Social support was found to be negatively skewed. Lastly, perceived stress was found to be normally distributed. Age and the gestational age when the self-report questionnaires were completed were also found to be normally distributed. Although some variables

were skewed, the scores represent scores expected for this sample and consistent with the literature. After consultation with the statistician and given that the distribution of scores was expected for this sample, transformation of scores was not done. Normality is not an assumption for correlations and if dichotomous variables are used, normality is not a necessary assumption.

The next step in data analysis was to analyze the descriptive statistics and frequency distributions for all major outcome variables (gestational diabetes, depression, anxiety, stress, and social support). A detailed analysis of each outcome variables is provided next, starting with gestational diabetes.

Gestational Diabetes

For almost all participants (n=129), a one-hour OGTT test was done (as mentioned previously, six women had these results missing but had a diagnosis of GDM). These results are included in Table 4. If the OGTT at one hour was abnormal, patients had further testing with a three-hour OGTT and these results are also presented in Table 4. The presence of gestational diabetes was determined based on the results of the three-hour OGTT. In order to make a diagnosis of gestational diabetes, two of the following four levels had to be abnormal: fasting>90 mg/dL, one hour >165 mg/dL, two hour >145 mg/dL, and three hour >125 mg/dL. The mean one-hour glucose for women with GDM was 170.46 mg/dL (SD±33.34) and for women without GDM was 113.16 mg/dL (SD±23.50), which were significantly different [$t(127) = -11.40$, $p<.001$].

Table 4: Oral Glucose Tolerance Results*

Variable	Mean (SD)	Range
One-Hour OGTT (N=129)	139.36 (40.29)	65-300
3-Hour OGTT: fasting (N=61)	88.36 (9.56)	68-113
3-Hour OGTT: 1 hour(N=61)	182.44 (28.70)	108-233
3-Hour OGTT: 2 hour (N=61)	159.75 (33.70)	67-249
3-Hour OGTT: 3 hour (N=61)	130.41 (30.72)	64-208

*n=61 because four women had OGTT results missing but had a diagnosis of GDM in the chart

Depression

There were two self-report instruments used to assess depression (the CES-D and the EPDS) and one question regarding history of depression. The CES-D is a 20-item tool with four items (4, 8, 12, 16,) being reverse-coded before sum scores were calculated. The EPDS is a 10-item tool with 7 items (3, 5, 6, 7, 8, 9, 10) being reverse-coded before sum scores were calculated. The question "Do you have a history of depression?" with response choices of "yes" or "no" was included in the self-report questionnaire booklet.

For the CES-D the mean score for the entire sample was 12.73 (SD±9.8). The women with GDM had a mean score of 12.97 (SD±10.66) and the women without GDM had a mean score of 12.5 (SD±9.0) (Table 5). Using the recommended cutoff score of 16 or greater to suggest depression, 28% of the entire sample had depression, 32% of the women with GDM had depression, and 24% of the women without GDM had depression.

Table 5: Mean Depression Scores

Variable	Entire Sample Mean (SD)	GDM Mean (SD)	Non-GDM Mean (SD)
CESD	12.73 (9.80)	12.97 (10.66)	12.51 (9.00)
EPDS	6.26 (5.72)	6.45 (6.21)	5.90 (5.25)

For the EPDS the mean score for the entire sample was 6.26 (SD±5.72). Women with GDM had a mean score of 6.65 (SD±6.2) and women without GDM had a mean score of 5.9 (SD±5.25) (Table 5). Using the recommended cutoff score of 12 or greater to suggest depression, 16% of the entire sample had depression. Also, 20% of women with GDM had depression, compared with 13% of women without GDM. Table 7 displays the individual item mean responses on the EPDS. For women without GDM, the two items with the highest mean scores were numbers 4 and 6. For women with GDM, the item with the highest mean score was number 4 followed by items 3 and 6 which both had the same mean. Items 1 and 10 had the lowest mean scores for both women with and without GDM.

Table 6 displays the mean item responses on the CES-D. For both women with and without GDM, the two items with the highest mean were numbers 7 and 11 and the items with the lowest means were numbers 15 and 19.

Table 6: Item Means on the Center for Epidemiologic Studies Scale (CES-D)

Item	Sample Mean (SD)	GDM Mean (SD)	Non-GDM Mean (SD)
1. I was bothered by things that usually don't bother me	.81(.88)	.71(.84)	.91(.91)
2. I did not feel like eating; my appetite was poor	.47(.74)	.46(.81)	.49(.68)
3. I felt that I could not shake off the blues even with the help from my family or friends	.45(.83)	.46(.81)	.44(.85)
4. I felt I was just as good as other people*	.87(1.13)	.97(1.17)	.79(1.09)
5. I had trouble keeping my mind on what I was doing	.76(.92)	.68(.87)	.84(.96)
6. I felt depressed	.52(.85)	.55(.87)	.49(.85)
7. I felt that everything I did was an effort	1.24(1.10)	1.20(1.13)	1.29(1.08)
8. I felt hopeful about the future*	.87(1.05)	.89(1.08)	.84(1.03)
9. I thought my life had been a failure	.30(.66)	.31(.61)	.30(.71)
10. I felt fearful	.48(.74)	.55(.71)	.41(.77)
11. My sleep was restless	1.31(.95)	1.29(1.00)	1.33(.91)
12. I was happy*	.66(.79)	.74(.87)	.59(.71)
13. I talked less than usual	.59(.84)	.63(.88)	.56(.81)
14. I felt lonely	.56(.85)	.65(.86)	.49(.85)
15. People were unfriendly	.29(.69)	.29(.74)	.29(.64)
16. I enjoyed life*	.59(.84)	.66(.89)	.51(.79)
17. I had crying spells	.59(.80)	.52(.75)	.64(.83)
18. I felt sad	.61(.79)	.60(.79)	.61(.80)
19. I felt that people dislike me	.18(.53)	.20(.56)	.16(.50)
20. I could not get "going"	.57(.74)	.60(.75)	.54(.74)

* Reverse-coded items

Table 7: Item Means on the Edinburgh Postpartum Depression Scale (EPDS)

Item	Sample Mean (SD)	GDM Mean (SD)	Non-GDM Mean (SD)
1. I have been able to laugh and see the funny side of things	.30 (.59)	.32 (.56)	.27 (.61)
2. I have looked forward with enjoyment to things	.33 (.61)	.37 (.65)	.30 (.57)
3. I have blamed myself unnecessarily when things went wrong*	.91 (.88)	.98 (.89)	.84 (.88)
4. I have been anxious or worried for no good reason	.96 (.99)	1.05 (1.04)	.87 (.95)
5. I have felt scared or panicky for no very good reason*	.74 (.87)	.80 (.97)	.70 (.77)
6. Things have been getting on top of me*	.92 (.81)	.98 (.86)	.86 (.77)
7. I have been so unhappy that I have had difficulty sleeping*	.61 (.84)	.75 (.94)	.49 (.72)
8. I have felt sad or miserable*	.77 (.79)	.77 (.84)	.77 (.75)
9. I have been so unhappy that I have been crying*	.64 (.79)	.55 (.75)	.73 (.82)
10. The thought of harming myself has occurred to me*	.07 (.37)	.06 (.35)	.07 (.39)

* Reverse-coded items

Anxiety

The Spielberger State-Trait Anxiety Index (STAI) was used to measure state and trait anxiety. It is a 40-item tool which measures both a person's current level of anxiety (state anxiety) and a person's general and long standing anxiety (trait anxiety). There are 20 items (1-20) to measure state anxiety and 20 items (21-40) to measure trait anxiety. Nineteen of the items were reverse-coded when computing the sum score for state and trait anxiety. These items included numbers: 1, 2, 5, 8, 10, 11, 15, 16, 19, 20, 21, 23, 26, 27, 30, 33, 34, 36, and 39. Higher scores on the STAI indicate higher anxiety.

On the STAI, the mean score for state anxiety of the entire sample was 35.67 (SD±11.62 and for trait anxiety the mean score was 36.25 (SD±11.57). For women with GDM, the mean state anxiety score was 36.98 (SD±12.28) and for women without GDM the mean state anxiety score was 34.44(SD±10.93). On trait anxiety, women with GDM had a mean score of 38.22(SD±12.77) and women without GDM had a mean score of 34.43(SD±10.08) (Table 8). Table 9 and Table 10 display the means for individual items for both state and trait anxiety. Due to copyright regulations, only the first five items are written completely while the rest of the items are abbreviated to not violate the copyright laws. For state anxiety, the items with the highest mean for the entire sample were numbers 5 and 19. For women without GDM, items 5 and 15 had the highest means. For women with GDM, items with the highest means were 5 and 16. Items 13 and 18 had the lowest means for everyone (entire sample, women with GDM, and women without GDM). Regarding trait anxiety, items 26 and 34 had the highest mean scores for the entire sample and women with GDM. For women without GDM, items 26 and 27 had the highest mean scores. For all groups (the entire sample, women with and without GDM) the lowest mean scores were items 25 and 31.

Table 8: Mean Anxiety Scores

Variable	Entire Sample Mean (SD)	GDM Mean (SD)	Non-GDM Mean (SD)
State Anxiety	35.67 (11.62)	36.98 (12.28)	34.44 (10.93)
Trait Anxiety	36.25 (11.57)	38.22 (12.77)	34.43 (10.08)

Table 9: Item Means on the State Anxiety Scale

Item	Sample Mean (SD)	GDM Mean (SD)	Non-GDM Mean (SD)
1. I feel calm*	1.73 (.80)	1.82 (.75)	1.64 (.83)
2. I feel secure*	1.61 (.78)	1.63 (.70)	1.59 (.86)
3. I am tense	1.87 (.85)	1.94 (.85)	1.80 (.87)
4. I feel strained	1.77 (.88)	1.80 (.91)	1.74(.86)
5. I feel at ease*	2.11 (.98)	2.18 (.95)	2.06 (1.02)
6. Upset	1.52 (.85)	1.51 (.83)	1.53 (.86)
7. I am presently worrying	1.78 (.92)	1.92 (.91)	1.64 (.92)
8. Satisfied*	1.97 (.95)	2.08 (.94)	1.87 (.95)
9. Frightened	1.53 (.76)	1.51 (.71)	1.54 (.81)
10. Comfortable*	1.98 (.97)	1.98 (1.00)	1.97 (.95)
11. Self-confident*	1.87 (.90)	1.91 (.91)	1.83 (.90)
12. Nervous	1.87 (.90)	1.92 (.94)	1.83 (.87)
13. Jittery	1.33 (.67)	1.40 (.66)	1.27 (.68)
14. Indecisive	1.52 (.82)	1.62 (.82)	1.43 (.81)
15. Relaxed*	2.07 (.96)	2.11 (.94)	2.04 (.98)
16. Content*	2.04 (.95)	2.20 (.97)	1.89 (.91)
17. Worried	1.78 (.90)	1.88 (.91)	1.69 (.89)
18. Confused	1.39 (.72)	1.45 (.77)	1.34 (.68)
19. Steady*	2.09 (.92)	2.17 (.91)	2.01 (.92)
20. Pleasant*	1.84 (.85)	1.97 (.88)	1.72 (.81)

* Items that were reverse-coded when computing the sum score

Table 10: Item Means on the Trait Anxiety Scale

Item	Sample Mean (SD)	GDM Mean (SD)	Non-GDM Mean (SD)
21. Pleasant*	1.84 (.87)	1.92 (.91)	1.77 (.82)
22. Nervous, restless	1.86 (.81)	2.02 (.78)	1.71 (.82)
23. Satisfied with self*	1.83 (.91)	1.92 (.89)	1.74 (.93)
24. Happy as others	1.86 (.96)	2.03 (1.00)	1.70 .(89)
25. Like a failure	1.36 (.65)	1.40 (.68)	1.31 (.63)
26. Rested*	2.51 (.96)	2.62 (.98)	2.41 (.94)
27. “calm, cool, and collected.”*	2.10 (.92)	2.18 (.92)	2.03 (.93)
28. Difficulties are piling up	1.62(.79)	1.71 (.82)	1.54 (.76)
29. Worry too much	1.80 (.88)	1.88 (.93)	1.73 (.83)
30. Happy*	1.74 (.86)	1.88 (.91)	1.61(.80)
31. Disturbing thoughts	1.41 (.74)	1.45 (.73)	1.37 (.77)
32. Self-confidence	1.53 (.84)	1.65 (.86)	1.41 (.81)
33. Secure*	1.81 (.89)	1.92 (.92)	1.70 (.86)
34. Decisions easily*	2.13 (.88)	2.26 (.96)	2.00 (.80)
35. Inadequate	1.45 (.68)	1.49 (.69)	1.41 (.67)
36. Content*	2.00 (.95)	2.11 (.97)	1.90 (.93)
37. Unimportant thoughts	1.81 (.87)	1.88 (.88)	1.74 (.86)
38. Disappointments	1.88 (.91)	1.97 (.95)	1.80 (.86)
39. Steady person*	1.96 (.91)	2.06 (.98)	1.87 (.83)
40. State of tension	1.76 (.84)	1.88 (.86)	1.64 (.82)

* Items that were reverse-coded when computing the sum score

Stress

Stress was measured using the Cohen Perceived Stress Scale (PSS). It had a total of ten items scored on a scale of 0-4. Four items were reverse-coded when computing the sum score (items 4, 5, 7, 8). Higher scores on the instrument indicate higher levels of stress. The mean score for the entire sample was 15.07 (SD±8.40). The women with GDM had a mean score of 16.11 (SD±8.49) and women without GDM had a mean score of 14.11 (SD±8.25) (Table 11).

Table 11: Mean Perceived Stress Scores

Variable	Entire Sample Mean (SD)	GDM Mean (SD)	Non-GDM Mean (SD)
Perceived Stress	15.07 (8.40)	16.11 (8.49)	14.11 (8.25)

Table 12 displays the means for individual items on the PSS. For the entire sample and women with and without GDM, items 1 and 3 had the highest mean scores. For the entire sample the items 4 and 5 had the lowest mean scores. For women without GDM, items 4 and 10 had the lowest mean scores. For women with GDM, items 4 and 7 had the lowest mean score.

Table 12: Item Means on the Perceived Stress Scale

Item	Sample Mean (SD)	GDM Mean (SD)	Non-GDM Mean (SD)
1. Have you been upset because of something that happened unexpectedly?	1.81 (1.06)	1.94 (1.09)	1.69 (1.03)
2. Have you felt that you were unable to control the important things in your life?	1.48 (1.21)	1.62 (1.21)	1.36 (1.20)
3. Have you felt nervous or "stressed"?	2.04 (1.10)	2.20 (1.11)	1.89 (1.07)
4. Have you felt confident about your ability to handle your personal problems?*	1.19 (1.09)	1.17 (.96)	1.20 (1.21)
5. Have you felt that things were going your way?*	1.29 (1.02)	1.37 (.99)	1.21 (1.05)
6. Have you found that you could not cope with all things you had to do?	1.51 (1.19)	1.62 (1.10)	1.41 (1.21)
7. Have you been able to control irritations in your life?*	1.30 (1.02)	1.32 (.94)	1.27 (1.02)
8. Have you felt that you were on top of things?*	1.37 (1.02)	1.45 (1.12)	1.30 (.92)
9. Have you been angered because of things that were outside of your control?	1.73 (1.11)	1.86 (1.09)	1.60 (1.12)
10. Have you felt difficulties were piling up so high that you could not overcome them?	1.37 (1.24)	1.57 (1.25)	1.19 (1.21)

* Items that were reverse-coded when computing the sum score

Social Support

Social support was measured by the Multidimensional Scale of Perceived Social Support (MSPSS). The tool consisted of 12 items and contained three subscales. The three subscales included the following: significant other support, family support, and friend support. Items in the significant other subscale included numbers 1, 2, 5, and 10. The family support subscale consisted of numbers 3, 4, 8, and 11. Lastly, the friend support subscale included items, 6, 7, 9, and 12. Each item is scored on a seven point Likert scale ranging from "very strongly disagree" (1) to "very strongly agree" (7). There were no items that were reverse-coded for this tool. The items are averaged to compute a sum score. Higher scores suggest higher levels of social support. The mean score for overall social support in the entire sample was 6.00 (SD±1.10), the mean was 6.30(SD±1.18) for significant other support, 6.11(SD±1.16) for family support, and 5.59(SD±1.55) for friend support. For women with GDM the means for the total and subscales were as follows: for overall social support 6.03(SD±1.03), for significant other support 6.27(SD±1.10), for family support 6.06(SD±1.11), and for friend support 5.77(SD±1.38). For women without GDM the means were as follows: 5.97(SD±1.17) for overall support, 6.27(SD±1.26) for significant other support, 6.15(SD±1.20) for family support and 5.42(SD±1.69) for friend support (Table 13). Table 14 displays the item means for the MSPSS. For the entire sample and the women without GDM, items 1 and 10 had the highest means, and items 6 and 7, the lowest means. For women with GDM, items 3 and 10 had the highest means and items 7 and 8 had the lowest means.

Table 13: Mean Overall Social Support and Subscale Scores

Variable	Entire Sample Mean (SD)	GDM Mean (SD)	Non-GDM Mean (SD)
Overall Support	6.00 (1.10)	6.03 (1.03)	5.97 (1.17)
Significant Other Support	6.30 (1.18)	6.27 (1.10)	6.32 (1.26)
Family Support	6.11 (1.16)	6.06 (1.11)	6.15 (1.20)
Friend Support	5.59 (1.55)	5.77 (1.38)	5.42 (1.69)

Table 14: Item Means on the Multidimensional Perceived Social Support Scale

Item	Entire Sample Mean (SD)	GDM Mean (SD)	Non-GDM Mean (SD)
1. There is a special person who is around when I am in need	6.22 (1.39)	6.12 (1.41)	6.31 (1.37)
2. There is a special person with whom I can share my joys and sorrows	6.27 (1.24)	6.25 (1.24)	6.30 (1.24)
3. My family really tries to help me	6.26 (1.23)	6.29 (1.17)	6.23 (1.30)
4. I get the emotional help and support I need from my family	6.17 (1.24)	6.14 (1.26)	6.20 (1.22)
5. I have a special person who is a real source of comfort to me	6.25 (1.29)	6.26 (1.16)	6.24 (1.41)
6. My friends really try to help me	5.61 (1.66)	5.86 (1.44)	5.39 (1.83)
7. I can count on my friends when things go wrong	5.45 (1.69)	5.60 (1.60)	5.31 (1.77)
8. I can talk about my problems with my family	5.90 (1.49)	5.74 (1.55)	6.04 (1.43)
9. I have friends with whom I can share my joys and sorrows	5.67 (1.56)	5.85 (1.35)	5.50 (1.73)
10. There is a special person in my life who cares about my feelings	6.44 (1.14)	6.45 (.97)	6.43 (1.29)
11. My family is willing to help me make decisions	6.10 (1.31)	6.06 (1.16)	6.14 (1.45)
12. I can talk about my problems with my friends.	5.62 (1.63)	5.77 (1.46)	5.49 (1.77)

Medication Use and Chronic Conditions

In the self questionnaire booklet, participants were asked to list any medications they were taking. These medications were coded into the following groups: (1) antidepressant, (2) anti-anxiety, (3) insulin, (4) oral diabetes medication, (5) antidepressant and anti-anxiety, (6) oral diabetes medication and antidepressant, and (7) oral diabetes medication and insulin. There were only 25 women taking medications according to these categories (Table 15). Only five women were taking antidepressants and 22 were taking medications to treat their GDM. As for chronic conditions, participants were asked if they had been diagnosed with asthma, diabetes, hypertension, bipolar disorder, or schizophrenia (Table 16). No women had bipolar disorder or schizophrenia, only 10 (7.4%) had hypertension, and 14 (10.4%) had asthma.

Table 15: Medication Use

Medication Category	N (%)
Antidepressant	2 (1.5%)
Anti-anxiety	0 (0%)
Insulin	2 (1.5%)
Oral Diabetes Medication	16 (11.9%)
Antidepressant and Anti-anxiety	1 (0.7%)
Oral Diabetes Medication and Antidepressant	2 (1.5%)
Oral Diabetes Medication and Insulin	2 (1.5%)

Table 16: Chronic Conditions

Chronic Condition	N (%)
Asthma	14 (10.4%)
Diabetes	42 (31.1%)
Hypertension	10 (7.4%)
Bipolar Disorder	0 (0%)
Schizophrenia	0 (0%)

Interestingly, out of the 65 women who had a diagnosis of gestational diabetes, only 42 marked down that they had diabetes. This may be due to the fact that the question asked about “diabetes” and not “gestational diabetes”.

Correlations

The relationships between the variables (GDM, age, race, marital status, planned pregnancy, income, gravida, BMI, depression, anxiety, stress, and social support) were analyzed using Pearson correlations (r). Gestational diabetes was found to be significantly related to age (r =.397, p<.001), marital status (r =-.217, p=.01), income (r =.197, p=.03), gravida (r =.174, p=.04), and BMI (r =.265, p<.001). The relationship between marital status and GDM was negative, meaning that more people with GDM were married. Income and gravida were positively correlated with GDM, meaning that women with GDM had higher incomes and more pregnancies. Depression was correlated with marital status (r = .182, p = .04), if the pregnancy was planned (r = .227, p <.001), and with income (r = -.177, p = .05).—indicating that women who were not married, had an unplanned pregnancy, and had lower incomes had more depression. Regarding the self-report instruments, the expected relationships were found with a positive correlation between depression, anxiety, and stress. Also, a negative relationship was found between social support, depression, anxiety and stress (Table 17). The strongest relationship was found between state and trait anxiety (r =.871, p<.001), as expected. The weakest relationship was found between gravida and GDM (r = .174, p<.04). The two depression

measures (CES-D and EPDS) were also found to be strongly positively correlated (r=.791, p<.001), as would be expected.

Table 17: Correlations between Key Variables

	Age	Race	Marital Status	Plan	Income	Gravida	BMI	CESD	Social Support	State Anxiety	Trait Anxiety	Stress	EPDS
GDM	**.397****	.109	**-.217***	-.057	**.197***	**.174***	**.266****	.023	.030	.110	.164	.119	.065
Age		-.037	**-.429****	**-.266****	**.610****	**.343****	**.178***	-.078	.023	-.056	.012	.007	-.026
Race			-.129	-.007	-.029	.098	.095	.082	-.060	.166	.140	.122	.133
Marital Status				**-.490***	**-.482****	-.047	-.135	**.182***	-.101	.026	.054	.125	.092
Plan					**-.365****	.127	.064	**.227****	**-.188***	.132	**.176***	**.218***	**.178***
Income						-.021	-.004	**-.177***	**.191***	**-.204***	**-.185***	-.130	**-.206***
Gravida							**.331****	.103	**-.245****	.109	**.191***	**.199***	.134
BMI								-.038	.061	.031	.045	.042	.102
CESD									**-.556****	**.712****	**.805****	**.757****	**.791****
Social Support										**-.520****	**-.599****	**-.577****	**-.587****
State Anxiety											**.871****	**.769****	**.805****
Trait Anxiety												**.855****	**.861****
Stress													**.844****

**Significant correlations at the p<.001 level, *Significant correlations at the p<.05 level.

Data Analysis for Study Aims

The primary aim of this study was to determine if women with GDM had more depression than women without GDM. The secondary aim was to determine if the factors predictive of depression in women with GDM were different than factors predictive of depression in women without GDM. The third aim was to determine if minority women were more at risk for prenatal depression than White women. In the next section, the analysis for each aim will be described.

Data Analysis: Aim 1

The first aim of the study was to determine if women with GDM have more depression than women without GDM. The analysis for this aim was done three ways: one-tailed Fisher's exact test, an independent t-test, and logistic regression. To present the results of the data for the primary aim, the assumptions of each analysis will be discussed followed by the results.

A Fisher's exact test is done to test the relationship between two categorical variables. The Fisher's exact test is usually done when there are two variables and both variables are dichotomous so a 2 x 2 table can be created (A. Field, 2009). There are two assumptions associated with the Fisher's exact test: (1) there must be independence of data and (2) the expected frequency of each variable must be greater than five (A. Field, 2009). In this analysis, both of these assumptions were met. The variables of presence of GDM and presence of depression were independent of each other and there were more than five cases present in each category.

The one-tailed Fisher's exact test was done (since the hypothesis was directional) to assess the difference in the proportion of depressed women (with and without GDM) using the recommended cutoff score on the CES-D ≥ 16 and on the EPDS ≥ 12 to indicate women who had depression. The results shown in Table 18 display that there were no significant differences in the frequency of depression between women with and without GDM when using the CES-D (p=.199). Similarly, there were no significant differences in the frequency of depression found among women with and without GDM when the EPDS was used (p=.187) (Table 19).

Table 18: Fisher's Exact Test for Depression (CES-D)

	CES-D<16 (Not Depressed) N (%)	CES-D≥ 16 (Depressed) N (%)
GDM	44 (67.7%)	21 (32.3%)
No GDM	53 (75.7%)	17 (24.2%)

p value for Fisher's Exact test =.199

Table 19: Fisher's Exact Test for Depression (EPDS)

	EPDS<12 (Not Depressed) N (%)	EPDS≥ 12 (Depressed) N (%)
GDM	52 (80%)	13 (20%)
No GDM	61 (87.1%)	9 (12.9%)

p value for Fisher's Exact test =.187

Independent t-tests compared mean depression scores between women with and without GDM. There are four assumptions made when performing independent t-tests: (1) the sampling distribution is normal, (2) data is measured at the interval level or greater, (3) there is homogeneity of variance, and (4) scores are independent of each other (scores come from separate people) (A. Field, 2009). Three of the four assumptions were

met for this analysis (Appendix G). Data was collected at the interval level or greater, depression scores between women with GDM and without GDM were independent of each other, and there was homogeneity of variance among the two groups. The normal distribution of the sample was the only assumption not met (Appendix F); however, the scores generated were consistent with what has been published in the literature. Also, both independent t-tests and regression analyses are relatively robust to moderate deviations from the normal distribution; therefore, transformation of the data was not done (Box & Watson, 1962).

Independent t-tests indicated that mean scores on the CES-D were slightly higher for women with GDM (M=12.97, SE=1.32) when compared with women without GDM (M=12.51, SE=1.08), but not statistically significant [t (133) = .269, p =.789 (Table 20)]. Similarly on the EPDS, women with GDM (M=6.65, SE=.77) had slightly more depression than women without GDM (M=5.90, SE= .63), which was also not statistically significant [t(133)= .755, p = .451 (Table 20)].

Table 20: Independent T-Tests for Depression Measures

Variable	Group	Mean	Standard Error	Df	t statistic	p value
CES-D	GDM	12.97	1.32	133	.269	.789
	Non-GDM	12.51	1.07			
EPDS	GDM	6.65	.771	133	.755	.451
	Non-GDM	5.90	.628			

Although independent t-tests are robust, a Mann-Whitney analysis (non-parametric test of comparison of means) was done to determine if the non-normality of

the data impacted the findings (A. Field, 2009). This test was also not significant for both depression measures. Results for the CES-D (U=2212.00, p = .781) and for the EPDS (U=2206.50, p = .762) indicated that the non-normality of the data did not affect the ability to detect significant findings.

Logistic regression is done to predict which group a participant is likely to belong to, based on known information (A. Field, 2009). In the logistic regression analysis, the outcome variable must be dichotomous. In the current study, the outcome variable of depression was dichotomized in two ways. The first was done using a score on the CES-D≥ 16 to classify women as depressed and a score <16 to classify women as not depressed. The second analysis was done using a score on the EPDS≥ 12 to classify women as depressed and an EPDS score <12 to classify women as not depressed. In logistic regression, covariates may be at the nominal to ratio level of measurement (Munro, 2005). In the analysis age, income, and marital status were used as covariates because these have been demonstrated in the literature to be related to depression. The assumptions associated with logistic regression include the following: (1) linearity, (2) independence of errors, and (3) multicollinearity. The assumption of linearity assumes that there is a linear relationship between the continuous predictors and the logit of the outcome variable. There was one covariate which was continuous in this analysis (age), and to test this assumption, the logistic regression was run using the interaction between the variable and the log of itself (A. Field, 2009). When the model was run this way the interaction terms were not significant, therefore this assumption was met. The second assumption of independence of errors is the same as the independence assumption

discussed with the independent t-test. As mentioned previously, the assumption has been met. The last assumption of multicollinearity indicates that predictor variables should not be highly correlated (correlation coefficient>.8). To test this assumption, a linear regression was done with the analysis of the collinearity diagnostics option (A. Field, 2009). These results indicate that relationships between age, income, marital status, and GDM were not highly correlated and this assumption was met.

To continue the analysis between groups of women with and without GDM, logistic regression analysis was done. According to the CES-D, there was not a significant relationship between depression and GDM when controlling for age, income, and marital status. Although women with GDM were more likely to have depression, it was not statistically significant (OR=2.00, 95% CI, .84, 4.75, *p*=.115) (Table 21).

Table 21: Gestational Diabetes Predicting Depression (CES-D)*

	95% CI for Odds Ratio			
	b (SE)	Lower	Odds Ratio	Upper
Constant	-2.16 (1.27)			
GDM	.69 (.44)	.84	2.00	4.75

*Covariates were age, marital status, and income

Similar results were found for the second logistic regression using the EPDS. When controlling for age, income, and marital status, women with GDM were more likely to have depression but the findings were not statistically significant (OR=2.33, 95% CI, .80, 6.81, *p*=.12) (Table 22).

Table 22: Gestational Diabetes Predicting Depression (EPDS)*

	95% CI for Odds Ratio			
	b (SE)	Lower	Odds Ratio	Upper
Constant	-2.59 (1.51)			
GDM	.85 (.55)	.80	2.33	6.81

*Covariates were age, marital status, and income

Depression has been found to be related to higher BMI in women (Keddie, 2011; Zhao et al., 2009). Although no articles were found on BMI and prenatal depression, BMI has been found to be related to postpartum depression (LaCoursiere, Baksh, Bloebaum, & Varner, 2006; LaCoursiere, Barrett-Connor, O'Hara, Hutton, & Varner, 2010). Also, a relationship between gravida and depression has been documented (Larsson, Sydsjo, & Josefsson, 2004; Lindgren, 2001; Records & Rice, 2007). The logistic model was run to include these covariates. After controlling for age, income, marital status, BMI, and gravida, women with GDM were 2.7 times more likely to have depression (OR=2.72, 95% CI, 1.04, 7.13, p =.041) using the CES-D (Table 23). Using the EPDS and controlling for age, income, marital status, BMI, and gravida, although women with GDM were 2.36 times more likely to have depression (OR=2.36, 95% CI, .79, 7.06, p = .126), it was not statistically significant (Table 24).

Table 23: Gestational Diabetes Predicting Depression (CES-D)*

	95% CI for Odds Ratio			
	b (SE)	Lower	Odds Ratio	Upper
Constant	-1.09 (1.73)			
GDM	1.00 (.49)	1.04	2.72	7.13

*Covariates were age, marital status, income, BMI, and gravida

Table 24: Gestational Diabetes Predicting Depression (EPDS)*

	95% CI for Odds Ratio			
	b (SE)	Lower	Odds Ratio	Upper
Constant	-2.59 (1.51)			
GDM	.86 (.56)	.79	2.36	7.06

*Covariates were age, marital status, income, BMI, and gravida

When analyzing the descriptive statistics, more women with GDM were found to have a history of depression than women without GDM (Table 4). To analyze these differences further, a chi-square analysis and a logistic regression analysis were done. Chi-square results indicated that women with a history of depression were significantly more likely to have GDM (χ^2=5.40 (1), *p*=.02). In the logistic regression analysis, when controlling for age, marital status, and income, women with a history of depression were also significantly more likely to have GDM (OR=2.95, 95% CI, .98, 8.82, *p*=.05) (Table 25). Results suggest that women with GDM are about three times as likely to have a history of depression. Once the covariates of gravida and BMI were added, they were 3.07 times as likely to have a history of depression (OR=3.07, 95% CI, 1.01, 9.49, *p* = .05) (Table 26).

Table 25: History of Depression Predicting Gestational Diabetes

	95% CI for Odds Ratio			
	b (SE)	Lower	Odds Ratio	Upper
Constant	-2.49 (1.57)			
GDM	1.08 (.56)	.98	2.95	8.82

*Covariates were age, marital status, income

Table 26: History of Depression Predicting Gestational Diabetes

	95% CI for Odds Ratio			
	b (SE)	Lower	Odds Ratio	Upper
Constant	-3.07 (2.09)			
GDM	1.12 (.57)	1.01	3.07	9.36

*Covariates were age, marital status, income, BMI, and gravida

The results for the primary aim of this study indicate that women with GDM do have higher depression scores as measured by both the CES-D and the EPDS; however, the differences between groups were not statistically significant (using Fisher's exact test and the independent t-tests). However, logistic regression indicated that women with GDM were two times more likely to have depression on both the CES-D and the EPDS when controlling for age, marital status, and income. Gravida and BMI were found to be related to depression in the literature, therefore, these variables were added into the analysis. Once controlling for age, marital status, income, BMI, and gravida, women with GDM were 2.7 times likely to have depression (when the CES-D was used) and this was statistically significant. In addition, this is a clinically significant finding. Also, as discussed in the descriptive statistics section, there was a significant difference between women with and without GDM and a history of depression. Logistic regression also indicated that women with a history of depression were 3.07 times more likely to have GDM when controlling for age, marital status, income, gravida, and BMI.

Data Analysis: Aim 2

The second aim of this study was to determine the predictive factors of depression and to determine if these factors differ between women with and without GDM. The following variables: state anxiety scores, trait anxiety scores, age, marital status, and

socioeconomic status which were based upon the literature were used as the predictors for the multiple linear regression analyses.

Multiple regression is done to predict an outcome variable from several predictor variables (A. Field, 2009). In the current study, depression is the outcome variable, while anxiety, stress, gestational diabetes, age, marital status, and socioeconomic status were predictor variables. There are nine assumptions associated with multiple regression. These include the following: (1) variable types, (2) non-zero variance, (3) multicollinearity, (4) predictors which are not correlated with external variables, (5) homoscedasticity, (6) independent errors, (7) normally distributed errors, (8) independence, and (9) linearity. These assumptions were met to allow for the testing to be done (Appendix G).

First, the predictive factors (state anxiety, trait anxiety, GDM, age, marital status, and socioeconomic status) were entered into the model using the forced entry method. In the forced entry method, all predictors are entered into the model at the same time (A. Field, 2009). Predictor variables are chosen based on theory and published research; however, the order in which the predictor variables are entered into the model is not determined. In the first analysis, the CES-D score was the outcome variable and in the second analysis the EPDS score was the outcome variable. The analysis was also run using social support as a predictor variable instead of marital status because the analysis suggested that the effect of the marital status and social support were very similar. Only the models using marital status are displayed because marital status had a greater effect when analyzing the interaction effects between the variables. First, the regression

analyses using the CES-D score as the outcome variable will be presented followed by the regression analyses using the EPDS as the outcome variable.

The predictors (state anxiety, trait anxiety, GDM, age, marital status, and socioeconomic status) explained 71% of the variance in depression as measured by the CES-D [R^2= .71, Adjusted R^2=.69, F (7, 119) = 40.87, p < .001, Table 27]. Trait anxiety was the only statistically significant predictor, b=.61 (SE=.11), t=4.73, p<.001. This finding suggested that for every one unit increase in trait anxiety score there is a .61 increase in the depression score. Although this is a small increase, this finding was statistically significant. Perceived stress and marital status were two other predictors trending toward significance (Table 27).

Table 27: Multiple Regression with Depression (CES-D) as Outcome

Variable	B	SE B	β	t	p value
State Anxiety	.08	.09	.09	.86	.394
Trait Anxiety	**.51**	**.11**	**.61**	**4.73**	**<.001**
Perceived Stress	**.20**	**.12**	**.17**	**1.72**	**.088**
GDM	1.21	1.06	.06	1.14	.258
Age	-.04	.11	-.02	-.36	.723
Marital Status	**.64**	**.35**	**.10**	**1.83**	**.070**
Income	.21	.26	.06	.79	.429

To determine if women with GDM had different predictors of depression, multiple regression analyses were done including the predictor variables (state anxiety, trait anxiety, GDM, age, marital status, and socioeconomic status) and interaction effects. An interaction occurs when the influence of one predictor variable depends on the level

of another predictor variable. In the current study, the predictor variables of state anxiety, trait anxiety, perceived stress, age, marital status, and income may have an influence on the predictor variable of GDM. Therefore, regression analyses were run with the predictor variables and the interaction effects of the predictor variables for both depression measures (CES-D and EPDS).

Table 28: Multiple Regression with Interaction Terms for Depression (CES-D) as Outcome

Variable	B	SE B	β	t	p value
State Anxiety	.018	.12	.02	.15	.883
Trait Anxiety	**.44**	**.15**	**.53**	**3.02**	**.003**
Perceived Stress	**.40**	**.14**	**.35**	**2.77**	**.077**
GDM	-8.76	6.84	-.45	-1.28	.203
Age	-.18	.17	-.11	-1.05	.294
Marital Status	.08	.42	.01	.20	..519
Income	.28	.43	.07	.65	.249
GDM X State Anxiety	.12	.18	.25	.68	.496
GDM X Trait Anxiety	.20	.22	.44	.92	.362
GDM X Perceived Stress	**-.53**	**.24**	**-.54**	**-2.21**	**.029**
GDM X Age	.21	.23	.36	.95	.346
GDM X Marital Status	**-5.32**	**2.26**	**-.26**	**-2.36**	**.020**
GDM X Income	.20	.55	.07	.36	.718

In the model with predictor variables and interaction effects, 73% of the variance in depression measured by the CES-D was explained [R^2= .73, Adjusted R^2=.70, F (13, 113) = 23.41, p < .001]. In this model, there were two significant interaction terms: the interaction between GDM and perceived stress [b= -.54 (SE=.24), t= -2.21, p=.029] and the interaction between GDM and marital status [b= -.26 (SE=2.26), t= -2.33, p=.020] (Table 28). A significant interaction term indicates that the influence of the predictor variable on the outcome variable may depend on another predictor variable. According to these findings, the interaction effects of perceived stress and GDM and of marital status and GDM were significant, suggesting that perceived stress and marital status depend on the GDM variable. This means that the relationship between perceived stress and depression and the relationship between marital status and depression depend on whether women have GDM or not. Therefore, the predictor variables of perceived stress and marital status may differ for women with and without GDM. To further investigate these differences, a third regression analysis was done. To determine where these differences occurred, the file was split to compare women with and without GDM. In this model, only the predictor factors (state anxiety, trait anxiety, GDM, age, marital status, and socioeconomic status) were entered (no interaction effects were used). For women with GDM, the factors explained 75% of the variance in depression measured by the CES-D [R^2= .75, Adjusted R^2=.72, F (6, 54) = 27.18, p < .001] (Table 29). For women with GDM, trait anxiety [b=.81 (SE=.18), t=3.79, p=.001] and marital status [b=.29 (SE=.60), t=3.53, p=.001] were the significant predictors of depression. Also, for women without GDM, the factors explained 73% of the variance in depression measured

by the CES-D [R^2= .73, Adjusted R^2=.70, F (6, 59) = 26.21, p < .001] (Table 29). However, for women without GDM, trait anxiety [b=.50 (SE=.13), t=3.35, p=.001] and perceived stress [b=.40 (SE=.13), t=3.28, p=.002] were significant predictors of depression (Table 29). Thus, trait anxiety was a significant predictor for women with and without GDM. However, marital status was only a significant predictor for women with GDM and perceived stress was only a significant predictor for women without GDM.

Table 29: Predictors of Depression (CES-D) for Women with and without Gestational Diabetes

Group	Variable	B	SE B	B	t	p value
GDM	State Anxiety	.15	.14	.18	1.09	.282
	Trait Anxiety	**.67**	**.18**	**.81**	**3.79**	**<.001**
	Perceived Stress	-.17	.20	-.13	-.82	.416
	Age	.08	.16	.04	.50	.619
	Marital Status	**2.10**	**.60**	**.29**	**3.53**	**.001**
	Income	.55	.37	.14	1.51	.137
No GDM	State Anxiety	.01	.11	.01	.06	.955
	Trait Anxiety	**.44**	**.13**	**.50**	**3.35**	**.001**
	Perceived Stress	**.42**	**.13**	**.40**	**3.28**	**.002**
	Age	-.19	.15	-.12	-1.28	.206
	Marital Status	-.25	.39	-.05	-.65	.521
	Income	.19	.38	.05	.49	.629

When using the EPDS as the outcome variable, the predictive factors (state anxiety, trait anxiety, GDM, age, marital status, and socioeconomic status) explained 81% of the variance [R^2=.81, Adjusted R^2=.80, F (7, 119) = 73.04, p < .001, Table 30]. In this model, trait anxiety [b=.42 (SE=.051), t=4.05, p<.001] and perceived stress [b=.40 (SE=.06), t=4.96, p<.001] were statistically significant predictors of depression. These findings suggest that for every one unit increase in trait anxiety score, there is a .42

increase in the depression score. Also, for every one unit increase in perceived stress, there is a .40 increase in the depression score. Again, although small, these findings are statistically significant.

Table 30: Multiple Regression for Depression (EPDS) as Outcome

Variable	B	SE B	β	t	p value
State Anxiety	.06	.04	.12	1.41	.16
Trait Anxiety	**.21**	**.05**	**.42**	**4.05**	**<.001**
Perceived Stress	**.27**	**.06**	**.40**	**4.96**	**<.001**
GDM	.69	.50	.06	1.37	.17
Age	.03	.05	.03	.61	.54
Marital Status	-.01	.17	-.01	-.11	.91
Income	-.14	.13	-.06	-1.14	.26

Once again the next regression analysis was done to determine if women with GDM had different predictors of depression than women without GDM. This was done by a regression analysis with the predictor variables (state anxiety, trait anxiety, GDM, age, marital status, and socioeconomic status) and interaction effects. In this analysis, the factors explained 82% of the variance in depression measured by the EPDS [R^2=.82, Adjusted R^2=.80, F (13, 113) = 40.62, p < .001]. In this model, trait anxiety (b= .39 (SE=.07), t=2.74, p<.007] and perceived stress [b= .42 (SE=.07), t=4.20, p<.001] were statistically significant predictor variables (Table 31). However, unlike in the CES-D analysis there were no significant interaction effects. This suggests that there were no differences in predictor variables between women with and without GDM. In order to confirm this, a third regression analysis was done with a split file to compare women with

and without GDM. This analysis also indicates that significant predictive factors were the same for women with and without GDM. The significant predictor variables were trait anxiety and perceived stress for both women with and without GDM (Table 32). For women with GDM, the factors explained 89% of the variance in depression [R^2=.89, Adjusted R^2=.87, F (6, 54) = 70.57, $p < .001$]. For women without GDM the factors explained 74% of the variance in depression measured by the EPDS [R^2 = .74, Adjusted R^2=.71, F (6, 59) = 27.28, $p < .001$].

Table 31: Multiple Regression with Interaction Terms and Depression (EPDS) as Outcome

Variable	B	SE B	B	t	p value
State Anxiety	.05	.06	.09	.80	.43
Trait Anxiety	**.19**	**.07**	**.39**	**2.74**	**.007**
Perceived Stress	**.29**	**.07**	**.42**	**4.20**	**<.001**
GDM	-.82	3.27	-.07	-.25	.802
Age	.00	.08	.00	.03	.979
Marital Status	-.20	.20	-.06	-1.00	.322
Income	.02	.20	.01	.12	.908
GDM X State Anxiety	.05	.09	.16	.55	.587
GDM X Trait Anxiety	-.01	.11	-.03	-.08	.941
GDM X Perceived Stress	-.00	.11	-.01	-.03	.975
GDM X Age	.04	.11	.11	.36	.720
GDM X Marital Status	**-1.81**	**1.08**	**-.15**	**-1.68**	**.095**
GDM X Income	-.23	.26	-.13	-.88	.380

Table 32: Predictors of Depression (EPDS) for Women with and without Gestational Diabetes

Group	Variable	B	SE B	B	t	p value
GDM	State Anxiety	.09	.06	.18	1.69	.097
	Trait Anxiety	**.19**	**.07**	**.39**	**2.70**	**.009**
	Perceived Stress	**.28**	**.08**	**.39**	**3.51**	**.001**
	Age	.05	.06	.05	.80	.425
	Marital Status	.35	.24	.08	1.49	.143
	Income	-.22	.15	-.09	-1.51	.136
No GDM	State Anxiety	.05	.06	.10	.71	.482
	Trait Anxiety	**.19**	**.08**	**.37**	**2.48**	**.016**
	Perceived Stress	**.29**	**.08**	**.46**	**3.84**	**<.001**
	Age	.00	.09	.00	.01	.992
	Marital Status	-.23	.23	-.08	-.99	.327
	Income	.02	.22	.01	.07	.944

There were a total of six multiple regression analyses done to determine the predictor factors of depression in women with and without GDM. The first set of models determined predictive factors of depression in general. These models determined that when using the CES-D as the outcome variable, trait anxiety was the only significant predictive factor. However, when using the EPDS, only trait anxiety and perceived stress were significant predictors of depression.

The next set of analyses was done using interaction effects to determine if there were differences in predictive factors of depression between women with and without depression. In these models, it is the interaction effects that will determine what differences exist between groups. When using the CES-D, there were two interaction effects which were significant: the interaction effect between GDM and perceived stress and between GDM and marital status. This indicates that there are differences in stress

and marital status for women with and without GDM. To further investigate this, another regression model was done splitting the file into groups (women with and without GDM) to compare them. This regression analysis indicated that for women with GDM, trait anxiety and marital status were significant predictors. However, for women without GDM, trait anxiety and perceived stress were significant. Therefore, trait anxiety is a significant predictor regardless of whether a woman has GDM or not. Marital status is only a significant predictor if a woman has GDM. Women with GDM had significantly higher depression scores if they were not married. However, perceived stress was only a significant predictor for women without GDM where higher stress was related to higher depression scores.

The same analysis was done using the EPDS as the outcome variable. Similar to the CES-D model, there were two main effects which were significant; the trait anxiety and perceived stress. However, in this analysis there were no interaction effects which were statistically significant. Therefore according to the EPDS, there are no differences in predictors of depression regardless if a woman has GDM or not. The regression analysis that was done with the file split between women with and without GDM to compare the two groups confirms that the regression analysis done with the interaction terms. Therefore, both trait anxiety and perceived stress were significant predictors of depression for women with and without GDM.

Data Analysis: Exploratory Aim

The exploratory aim of this study was to determine if minority women were more at risk for depression than White women. To determine this, a chi-square analysis was

done. Women were classified into four groups: White, Black, Hispanic, and Other (included American Indian, Asian, and women who did not state a specific race). Two chi-square analyses were done: one using the recommended cutoff score on the CES-D ≥ 16 to categorize women as depressed and the second one using the EPDS ≥ 12 to indicate women who had depression. To further explore the impact of race on depression, two independent t-tests were done. In the t-test analyses the sample was grouped into White or non-White. In one analysis, the continuous CES-D score was used as the outcome variable and in the second analysis, the continuous EPDS score was used. The assumptions of the Pearson's chi-square test and the independent t-tests have been discussed previously.

According to the results with the CES-D, there was no significant relationship between race and depression (χ^2 (3) =2.231, p=.526). Also, no significant relationship was found when using the EPDS (χ^2 (3) =4.515, p=.211).

The independent t-tests also indicated no significant difference between race and depression. According to mean scores on the CES-D, White women (M=10.95, SE=1.38) had slightly less depression than non-White women (M=13.59, SE=1.05). However, this difference was not statistically significant [t (133) = -1.47, p =.143]. Similarly on the EPDS, White women (M=5.30, SE=.75) had slightly less depression than non-White women (M=6.73, SE= .63). Again, this difference was not statistically significant [t (133)= -1.36, p = .175] (Table 33).

Table 33: Independent T-Tests for Race (CES-D and EPDS)

Variable	Group	Mean	Standard Error	Df	t statistic	p value
CES-D	White	10.95	1.38	133	-1.47	.143
	Non-White	13.59	1.05			
EPDS	White	5.30	.75	133	-1.36	.175
	Non-White	6.73	.63			

To determine if there were differences in depression between race, both Pearson's chi-square and independent t-tests were done. Although the results indicated that White women had less depression, the differences between the groups were not statistically significant.

Data Analysis of Maternal and Infant Health Outcomes

Although not a specific aim of this study, the reviewed literature indicated that women with depression and gestational diabetes are more at risk for complications during delivery. Therefore, some delivery information was analyzed to determine if women with gestational diabetes were more at risk for complications and if women with depression were more at risk for complications. The variables analyzed were as follows: gestational age at delivery, type of delivery (vaginal, c-section, or instrument delivery), presence of lacerations during vaginal delivery, delivery complications (shoulder dystocia, presence of meconium, nuchal cord, maternal fever, postpartum hemorrhage, chorioamnionitis, prolonged rupture of membrane, and partial abruption), Apgar scores at one, five, and ten minutes, and infant birth weight. In order to analyze this, descriptive statistics and frequency tables were done for women with and without GDM (Table 34). The descriptive statistics and frequency tables were also completed for women with and

without depression according to the CES-D score (≥ 16 being categorized as depressed) and the EPDS score (≥ 12 being categorized as depressed) (Table 35). As mentioned in the Missing Data section, there are six women for whom delivery data is missing. These women delivered at an outside hospital where delivery information was unavailable. Unfortunately, most of the women with the missing data were in the GDM group, which may be a limitation in examining this data. Also, women with a twin pregnancy were excluded from this analysis because of their increased risk of a cesarean section, complications, and the inability to include more than one infant in the categories of birth weight and Apgar scores.

Table 34: Delivery Outcomes for Women with and without Gestational Diabetes

Variable	GDM N (%)	No GDM N (%)
Type of Delivery	N=56	N=65
Vaginal	27 (48%)	49 (72%)
C-section	26 (46%)	13 (20%)
Instrument	1 (2%)	4 (6%%)
VBAC	2 (4%)	1 (2%)
Lacerations	N=56	N=65
None	40 (71%)	23 (35%)
1st degree	6 (11%)	15 (23%)
2nd degree	8 (14%)	24 (37%)
3rd degree	N/A	1 (2%)
4th degree	1 (2%)	N/A
Sulcus Tear	1 (2%)	2 (3%)
Complications*	N=56	N=65
None	38 (68%)	48 (74%)
Shoulder dystocia	1 (2%)	2 (3.1%)
Meconium present	7 (13%)	11 (16.9%)
Nuchal cord	9 (16%)	6 (9.2%)
Maternal fever	2 (4%)	2 (3.1%)
Postpartum hemorrhage	2 (4%)	1 (1.5%)
Chorioamnionitis	3 (5%)	3 (4.6%)
Prolonged ROM	3 (5%)	5 (7.7%)
Partial abruption	N/A	1 (1.5%)
	GDM Mean (SD)	No GDM Mean (SD)
Gestational Age at Delivery	38.2 (1.67)	39.0 (1.25)
Apgar: 1 min	8.07 (1.32)	8.09 (1.58)
Apgar: 5 min	8.75 (.58)	8.83 (.45)
Apgar: 10 min	8.87 (.45)	8.93 (.31)
Birth Weight (grams)	3.42 (.62)	3.32 (.48)

*Complication category will not total 100% because some women experience more than one complication.

Table 35: Delivery Outcomes for Women with and without Depression

Variable	Depressed CES-D ≥ 16 N (%)	Not Depressed CES-D < 16 N (%)	Depressed EPDS ≥ 12 N (%)	Non-Depressed EPDS <12 N (%)
Type of Delivery	N=36	N=85	N=21	N=100
Vaginal	19 (52%)	55 (65%)	8 (38%)	66 (66%)
C-section	15 (42%)	24 (28%)	12 (57%)	27 (27%)
Instrument	1 (3%)	4 (5%)	1 (5%)	4 (4%)
VBAC	1 (3%)	2 (2%)	N/A	3 (3%)
Lacerations				
None	24 (67%)	39 (46%)	15 (72%)	48 (48%)
1st degree	7 (19%)	14 (16%)	3 (14%)	18 (18%)
2nd degree	4 (11%)	28 (33%)	3 (14%)	29 (29%)
3rd degree	N/A	1 (1%)	N/A	1 (1%)
4th degree	1 (3%)	N/A	N/A	1 (1%)
Sulcus Tear	N/A	3 (4%)	N/A	3 (3%)
Complications*				
None	26 (72%)	60 (71%)	17 (81%)	65 (65%)
Shoulder dystocia	3 (8%)	N/A	N/A	3 (3%)
Meconium present	5 (14%)	13 (15%)	2 (10%)	16 (16%)
Nuchal cord	4 (11%)	11 (13%)	2 (10%)	13 (13%)
Maternal fever	N/A	4 (5%)	N/A	4 (4%)
Postpartum hemorrhage	1 (3%)	2 (2%)	1 (5%)	2 (2%)
Chorioamnionitis	N/A	6 (7%)	N/A	6 (6%)
Prolonged ROM	2 (6%)	6 (7%)	N/A	8 (8%)
Partial abruption	N/A	1 (1%)	1 (5%)	N/A
	Depressed CES-D ≥ 16 Mean (SD)	Not Depressed CES-D < 16 Mean (SD)	Depressed EPDS ≥ 12 Mean (SD)	Non-Depressed EPDS <12 Mean (SD)
Gestational Age at Delivery	38.2 (1.98)	38.8 (1.21)	38.5 (1.18)	38.6 (1.56)
Apgar: 1 min	8.39 (.87)	7.95 (1.63)	8.10 (1.33)	8.08 (1.49)
Apgar: 5 min	8.86 (.35)	8.76 (.57)	8.90 (.30)	8.77 (.55)
Apgar: 10 min	9.00 (.27)	8.87 (.40)	9.00 (.00)	8.89 (.40)
Birth Weight (grams)	3.38 (.58)	3.36 (.53)	3.48 (.45)	3.34 (.56)

*Complication category will not total 100% because some women experience more than one complication.

To determine if there were any significant differences between groups (women with and without GDM and women with and without depression), independent t-tests were done for the continuous variables of the following: gestational age at delivery, Apgar at 1, 5, and 10 minutes, and birth weight. In order to do chi-square analyses, type of delivery was made a dichotomous variable where only vaginal delivery and cesarean section delivery were analyzed. The lacerations variable was also made dichotomous where no tears was considered a group and the presence of a tear (first degree, second degree, third degree, fourth degree, and sulcus tear) was considered a group.

According to the chi-square results, there was a significant difference in the type of delivery between women with and without GDM [χ^2 (1) =11.63, p=.001]. Women with GDM had significantly more cesarean sections than women without GDM. There was also a significant difference between groups in the presence of tears [χ^2 (1) =15.66, p<.001]. Women with GDM had significantly fewer tears than women without GDM. However, given that the women with GDM had more cesarean sections (and you can only have a vaginal tear if you deliver vaginally), it is not surprising that women with GDM had fewer vaginal tears.

Assumptions for the independent t-test analysis have also been discussed previously. The results of the independent t-tests indicate there are no differences in Apgar scores or birth weight between women with and without GDM (Table 36). However, there was a significant difference in gestational age at delivery: women with GDM delivered earlier. According to the mean gestational age at delivery, women with

GDM (M=38.23, SE=.22) delivered slightly earlier than women without GDM (M=38.97, SE=.16). This difference was significant [t (119) = 2.81, p =.006, Table 36].

Table 36: Independent T-Tests for Infant Outcomes in Women with and without Gestational Diabetes

Variable	Group	Mean	Standard Error	Df	t statistic	p value
Gestational Age	**GDM**	**38.23**	**.22**	**119**	**2.81**	**.006**
	Non-GDM	**38.97**	**.16**			
1 min Apgar	GDM	8.07	.18	119	.08	.938
	Non-GDM	8.09	.20			
5 min Apgar	GDM	8.75	.08	103	.84	.401
	Non-GDM	8.83	.06			
10 min Apgar	GDM	8.87	.07	105	.88	.381
	Non-GDM	8.93	.04			
Birth Weight	GDM	3.42	.09	115	-1.04	.302
	Non-GDM	3.32	.06			

The same chi-square analyses were done for women with and without depression. Women were classified as depressed based on their CES-D score (≥16 as depressed) and their EPDS score (≥12 as depressed). Type of delivery and presence of lacerations were also dichotomized as in the previous analysis. According to the CES-D there was no difference in the type of delivery between women with and without depression [χ^2 (1) =2.31, p=.129]. However, there was a significant difference in the presence of vaginal tears [χ^2 (1) =4.38, p=.036], where women without depression had more vaginal tears. When using the EPDS, there was a significant difference in the type of delivery between women with and without depression [χ^2 (1) =4.01, p=.045], where women with

depression had more cesarean sections. There were also significantly more vaginal tears in women without depression [χ^2 (1) =3.82, p=.051]. Again, because more women without depression had vaginal deliveries, they are more likely to have vaginal tears.

Independent t-tests were also done to analyze differences in gestational age at delivery Apgar scores (1, 5, and 10 minutes), and birth weight between women who were and were not depressed. Two separate independent t-test analyses were done: one with women who had a score ≥16 on the CES-D categorized as depressed and a second with women who had a score ≥12 on the EPDS categorized as depressed. According to the CES-D, there were no differences in gestational age at delivery, Apgar scores, or birth weight between women with and without depression (Table 37). Gestational age at delivery was trending towards significance where women with depression delivered slightly earlier than women without depression. There was also a trend toward significance with depressed women having an infant with a slightly higher ten minute Apgar score than women without depression.

When the EPDS was used to classify women as depressed or not depressed, similar results were found. In this analysis, the equality of variances was not met for Apgar scores at five and ten minutes. However, there were significant differences in the ten minute Apgar score between babies born to women who were and were not depressed. Babies born to women with depression (M=9.00, SE=.00) had higher Apgar scores at ten minutes than babies born to women without depression (M=8.89, SE=.04). This difference was significant [t (92) = -2.58, p =.012]. The adjusted degrees of freedom, t statistic, and p value have been reported in Table 38.

Table 37: Independent T-Tests for Infant Outcomes in Women with and without Depression (CES-D)

Variable	Group	Mean	Standard Error	Df	t statistic	p value
Gestational Age	Depressed	38.21	.33	46.50	1.69	.097
	Non-Depressed	38.81	.13			
1 min Apgar	Depressed	8.39	.15	119	-1.51	.133
	Non-Depressed	7.95	.18			
5 min Apgar	Depressed	8.86	.06	103	-1.13	.26
	Non-Depressed	8.76	.06			
10 min Apgar	Depressed	9.00	.05	70.72	-1.84	.069
	Non-Depressed	8.87	.05			
Birth Weight	Depressed	3.38	.10	115	-.21	.837
	Non-Depressed	3.36	.06			

Table 38: Independent T-Tests results for Infant Outcomes for Women with and without Depression (EPDS)

Variable	Group	Mean	Standard Error	Df	t statistic	p value
Gestational Age	Depressed	38.53	.26	119	.32	.752
	Non-Depressed	38.65	.16			
1 min Apgar	Depressed	8.10	.29	119	-.04	.965
	Non-Depressed	8.08	.15			
5 min Apgar	Depressed	8.90	.07	52	-1.58	.12
	Non-Depressed	8.77	.06			
10 min Apgar	**Depressed**	**9.00**	**.00**	**92**	**-2.58**	**.012**
	Non-Depressed	**8.89**	**.04**			
Birth Weight	Depressed	3.48	.10	115	-1.12	.266
	Non-Depressed	3.33	.06			

The results of the independent t-tests indicate that there are few very differences in maternal and infant health outcomes between women with and without GDM. In fact, only gestational age at delivery was significantly different with women with GDM delivering earlier than women without GDM. When comparing women with and without depression according to the CES-D there were no differences in delivery outcomes. However, when comparing women with and without depression on the EPDS, women with depression had more cesarean sections and babies born to women with depression had higher Apgar scores at ten minutes. These differences were significant, but it is important to note that there was very little difference between the means. In fact, the small difference does not suggest a clinical significance between ten minute Apgar scores. A larger sample size may produce different findings regarding differences between women with and without GDM and women with and without depression.

CHAPTER FIVE

DISCUSSION

This chapter discusses the study findings, implications for nursing, and recommendations for future research. Prenatal depression and gestational diabetes are common complications during pregnancy. Although evidence suggested that a potential relationship between prenatal depression and gestational diabetes exists, further research was needed. This study found that women with GDM had higher rates of depression as well as higher mean depression scores, but the results were not statistically significant. However, it was determined that women with GDM were 2.7 times more likely to suffer from depression than women without GDM when controlling for age, marital status, income, BMI, and gravida. This finding was both statistically significant and clinically significant. Also, women with a history of depression were 3.07 times more likely to have GDM (when controlling for age, marital status, income, BMI, and gravida). Trait anxiety was found to be a predictive factor of depression for both women with and without GDM. There were no differences in depression between races, suggesting that pregnant minority women were not at greater risk for depression. It was also determined that gestational diabetes had little impact on delivery outcomes although women with GDM delivered slightly earlier than women without GDM. There were very few

differences in delivery outcomes between women who did and did not have depression. When using the EPDS, women with depression had more cesarean sections and the ten minute Apgar score was found to be slightly higher. Also, for both measures (CES-D and the EPDS); women without depression were more likely to have vaginal tears.

The biopsychosocial model guided this study. This is a holistic model, in which the biological, psychological, and sociological components of a person are all equally important when treating an illness (Engel, 1977). The biopsychosocial model allows the researcher or clinician to consider many factors such as quality of life, social role performance, and emotional status during evaluation of a patient (Fava & Sonino, 2008).

There is a known relationship between depression and type 2 diabetes. Depression is more commonly found in women with type 2 diabetes (28%) than in men with type 2 diabetes (18%) (R. Anderson et al., 2001). Both hyperglycemia and insulin resistance which occur in type 2 diabetes have been related to depression. Hyperglycemia and insulin resistance are also present during gestational diabetes. However, the relationship between gestational diabetes and depression has not been extensively studied. This study was conducted to further investigate the possible relationship between gestational diabetes and depression.

Description of the Sample

This convenience sample had a mean age of 29.7 years and was ethnically diverse (33% White, 23% Black, 33% Hispanic, and 11% Other), which was representative of the population where the data was collected. The average age of a woman giving birth for the first time was 25 years in 2006 (Martin et al., 2009). The mean age in this sample

may be older due to the inclusion of multiparous women and the trend in the United States of older women having children (Martin et al., 2009). For the current study, participants were enrolled during routine prenatal care visits and the average gestational age at which participants filled out the self-report questionnaires was 31.1 weeks. Women with GDM were found to be significantly older (Mean= 32.12 years) compared with women without GDM (Mean=27.36 years). Advanced maternal age is a known risk factor for developing GDM, therefore these findings were not surprising (Casey et al., 1997; Jovanovic & Pettitt, 2001). In the current study, more women with GDM were married and had higher incomes than women without GDM; however, these differences were not statistically significant. Other studies have also not found significant differences in marital status and income between women with and without GDM (Casey et al., 1997; Jovanovic & Pettitt, 2001). The current study did not find differences in the prevalence of GDM between races. This is contradictory to other studies which have reported that GDM is more common in Black and Hispanic women (Getahun et al., 2008; Lawrence, Contreras, Chen, & Sacks, 2008). Both of these studies had very large sample sizes (over 100,000). The small sample size of the current study may be the reason that GDM was not more common in minority women.

Discussion of the Variables

Depression

In the current study, two tools were used to measure depression (the CES-D and the EPDS). To this researcher's knowledge, this is the first study to use both tools and to explore the relationship between the two commonly used prenatal depression measures.

Results varied depending upon which tool was used. Using the CES-D, 28% of women had depression when the recommended cutoff score of 16 was used. Thirty two percent of women with GDM were found to have depression compared with 24% of women without GDM. The items with the highest means on the CES-D for women with and without GDM were question 7 ("I felt that everything I did was an effort") and question 11 ("My sleep was restless"). This indicates that regardless of GDM, women during pregnancy felt that they had to use a lot of effort in their everyday lives and that they had problems with sleep. Other studies have reported that sleep deprivation and sleep disturbances are common for women during pregnancy (Da Costa et al., 2010; Facco, Kramer, Ho, Zee, & Grobman, 2010; Hall et al., 2009).

Rates of depression in this sample were compared with rates in studies examining prenatal depression (Chazotte et al., 1995; Davis et al., 2007; Davis et al., 2004; Diego et al., 2005; T. Field et al., 2002; Glazier et al., 2004; Holzman et al., 2006; C. Kim et al., 2005; Lindgren, 2001; Marcus et al., 2003; S. Orr et al., 2007; S. T. Orr et al., 2006; Records & Rice, 2007; Westdahl et al., 2007). In studies that used the CES-D in pregnant populations, rates of depression ranged from 7.8% to 70% (Table 39). Consistent with previous research, the women in this study (with and without GDM) were found to have rates of depression within this range. When comparing the mean scores on the CES-D from this study (12.73 for the entire sample, 12.97 for women with GDM, and 12.51 for women without GDM), they were within the range cited in previous work (6.5 to 21.9) (Table 39).

Table 39: Prenatal Depression Research (CES-D)

Author	Sample Size	Sample Characteristics	Percentage Depressed	Mean (SD)	Range
Chazotte, Freda, Elovitz, & Youchah (1995)	90 (30 GDM, 30 healthy, 30 preterm)	Average age 25.1 years 44% Black, 50% Hispanic, 6% White.	56.7% GDM, 70% at risk for preterm labor, 33.3% healthy	GDM-17.0 (9.1) PTL-20.9 (9.4) Healthy-13.7 (7.5)	Unknown
Davis et al. (2007)	247	Age unknown 49% White, 20% Hispanic, 11% African American, 9% Asian.	12.7%-17.8% (measured 3 times during pregnancy)	6.5 (4.8)-7.3 (5.5)	0-27
Davis et al. (2004)	22	Average age 28.0 years 68% White, 27% Hispanic, 5% Other.	42%	14.9 (10.2)	2-34
Diego, Field, & Hernandez-Reif, 2005	80	Average age 27 years 46% Hispanic, 27% Black, 16% White, 11% Asian.	Unknown	21.9 (6.34)	Unknown
Field et al. (2002)	112	Average age 30.7 years 54% Hispanic, 46% African American.	Unknown	11.5 (8.39)	Unknown
Glazier et al. (2004)	2,052	Average age 30.7 years Racial Distr. unknown.	Unknown	Unknown	Unknown
Holzman et al. (2006)	1,321	Average age unknown 69% White, 25% African American, 6% Other.	46% of teens 47% disadvantaged 23% advantaged	Teens-17.0 (10.3) Disad-17.3 (11.0) Advan-10.7 (8.7)	Unknown

Kim, C, et al. (2005)	1,445 (64 GDM, 148 PIH, 1,233 healthy)	Average age unknown In women with GDM 50% Hispanic, 25% White, 17% Black, 8% Asian/Other.	7.8% of GDM 10.1% Pregnancy Induced HTN 11.6% healthy	Unknown	Unknown
Lindgren, 2001	252	Average age 29.5 years 77% White, 13% Black, 10% Other.	44.4%	14.37 (9.62)	0-48
Marcus, et al. (2003)	3,742	Average age 28.6 years 73% White, 13% Black.	20.4%	Unknown	Unknown
Orr et al. (2006)	1163	Average age 24.1 70% Black, 30% White.	Unknown	16.2	0-55
Orr et al. (2007)	1163	Average age 24.7 70% Black, 30% White.	44%	16.2	0-55
Records & Rice, 2007	139	Average age 27 years 89% White, 1% African American, 4% Hispanic.	38%	Unknown	Unknown
Westdahl et al. (2007)	1,047	Average age 20.4 years 80% Black, 13% Hispanic, 7% White.	33%	12.74 (8.45)	1-43

According to the EPDS, 16% of this sample had depression using the recommended cutoff score of 12. For women with GDM, 20% were found to have depression compared with 13% of women without GDM. On the EPDS, items 4 and 6 had the highest mean scores for both women with and without GDM. Item 4 is "I have been anxious or worried for no good reason." Therefore, both women with and without GDM were feeling worried and anxious during their pregnancy. Item 6 is "things have been getting on top of me," suggesting that women with and without GDM are feeling like things are building up and may suggest feelings of stress during pregnancy. Other studies have reported that pregnant women have high amounts of daily stressors and feelings of anxiety (Hall et al., 2009; Reid, Power, & Cheshire, 2009).

In previous research, rates of depression ranged from 9% to 39% using the EPDS in pregnant women (C. Anderson et al., 2002; Dayan et al., 2006; Deave et al., 2008; Hart & McMahon, 2006; Heron et al., 2004; Larsson et al., 2004; Mautner et al., 2009; Rubertsson et al., 2005) (Table 40). In the current study, women with and without GDM had rates of depression within this range. In addition, the mean EPDS scores for this sample was 6.26 for the entire sample, 6.45 for women with GDM, and 5.9 for women without GDM, consistent with other studies which have reported scores ranging from 6.0 to 10.4 (C. Anderson et al., 2002; Dayan et al., 2006; Deave et al., 2008; Hart & McMahon, 2006; Heron et al., 2004; Larsson et al., 2004; Mautner et al., 2009; Rubertsson et al., 2005) (Table 40).

Table 40: Prenatal Depression Research (EPDS)

Author	Sample Size	Sample Characteristics	Percentage Depressed	Mean (SD)	Range
Anderson, Roux, & Pruitt, 2002	31	Average age 31.7 years 84% White, 10% Black, 3% Hispanic, 3% Other.	29%	8.71 (Unknown)	1-25
Dayan et al. (2006)	681	Average age 28.5 years Racial distribution unknown.	14.5% (>14)	7.2 (5.6)	0-28
Deave et al. (2008)	11,098	Average age 28 years 96% White.	14.1% (>12)	Unknown	Unknown
Hart & McMahon, (2006)	53	Average age 31.24 years Racial distribution unknown.	9% (>13)	6 (3.93)	0-16
Heron et al. (2004)	8,323	*	11% (>13)	Unknown	Unknown
Larsson et al. (2004)	518	*	17.4%	Unknown	Unknown
Mautner et al. (2009)	90	Average age 31.2 years Racial distribution unknown.	39% (>10)	GDM-7.55 (5.48) HTN-9.06 (5.33) Preterm Labor-10.41(4.79) Healthy-6.41(4.37)	Unknown
Rubertsson et al. (2005)	2,674	*	14.9%	Unknown	Unknown

* Average age and racial distribution unknown.

In the general population, 10% of women have depression (Center for Disease Control and Prevention, 2010). Therefore, pregnant women in this sample had higher rates of depression than the general population, but did have rates consistent with previous studies using the CESD and EPDS to measure depression in pregnant women. The results of the current study were also consistent with another study which reported that pregnant women had significantly higher depression scores when compared to non-pregnant women (Breitkopf et al., 2006).

When comparing the CES-D and the EPDS, the rates of depression and mean scores were higher when using the CES-D in both the current study and in previous research. Since the CES-D includes items that measure somatic symptoms of pregnancy such as restless sleep and appetite, this may be the reason for the increased rate of depression (Blaney et al., 2004; Holzman et al., 2006; S. T. Orr et al., 2006; Westdahl et al., 2007). Because one of the items with the highest mean score was “restless sleep”, this most likely contributed to the higher depression scores on the CES-D for the current study.

At the site for data collection, women are informed that depression screening is part of prenatal care and that the EPDS is used around 28 weeks’ gestation to screen for prenatal depression. When women were enrolled into this study, they were informed that the study was investigating moods during pregnancy. Thus, women may have recognized the EPDS as a depression screen when filling it out for the current study. It is possible that their familiarity with the tool may have impacted how they responded. It should be noted that for all women, the CES-D was administered first, with the EPDS administered

as one of the last questionnaires. Thus the ordering of the questionnaires may have contributed to the difference in the rates of depression and the mean depression scores.

History of depression was assessed in the self-report questionnaires with "Have you ever been diagnosed with depression?" A significant difference was found in that women with a history of depression were more likely to have GDM . This is a clinically significant finding because women with a history of depression may need to be screened earlier and monitored more closely for GDM. Depression as a risk factor for type 2 diabetes has been proposed in three meta-analyses (Lustman et al., 2000; Lustman et al., 2007; Musselman et al., 2003). It has been suggested that depression-induced changes in neurotransmitter functions may negatively affect glycemic control by causing hyperglycemia. This may be the physiological reason for depression predisposing a person to diabetes (Von Kanel et al., 2001). Also, depression has been found to be significantly related to hyperglycemia in both type 1 and type 2 diabetes (Lustman et al., 2000). The current study supports the importance and clinical significance of a history of depression being a risk factor for developing GDM.

Anxiety

In working women between the ages of 19 and 39, normal state anxiety scores have been reported with a mean of 36.17 (SD±10.96) and trait anxiety scores with a mean of 36.15 (SD±9.53) (Spielberger, Gorsuch, Jacobs, Lushene, & Vagg, 1983). For the current study, the state anxiety scores (M=35.67) and trait anxiety scores (M=36.25) were within 0.5 points of the normative scores. Women with GDM had about the same state anxiety scores (M=36.98); however, they had higher trait anxiety scores (M=38.22).

Lastly, women without GDM were found to have slightly lower state anxiety (M=34.44) and trait anxiety (M=34.43) scores when compared to the documented norm. Two studies using the STAI to measure anxiety reported that state and trait levels were about equal (Allister et al., 2001; Bergant et al., 1997). However, two other studies examining depression and anxiety using the STAI have found trait anxiety to be higher than state anxiety as was noted in the present study (Dayan et al., 2006; Hart & McMahon, 2006). The findings of the current study are consistent with previous research which found that women with GDM had higher state and trait anxiety scores shortly after diagnosis of GDM compared to women without GDM (Daniells et al., 2003).

Anxiety has been associated with prenatal depression (Allister et al., 2001; Breitkopf et al., 2006; Glazier et al., 2004; Hart & McMahon, 2006). The current study also found a relationship between depression and anxiety. State anxiety was correlated with both CES-D scores (r=.712, p<.001) and EPDS scores (r=.805, p<.001). Trait anxiety was also correlated with both CES-D scores (r=.805, p<.001) and EPDS scores (r=.861, p<.001). Therefore, the current study was consistent with previous research.

Stress

The perceived stress scale had a reported mean score of 16.14 (SD±7.73) in a large sample of women aged 40 and older (n=1032) (Cohen & Janicki-Deverts, in press). It was also reported that women had higher levels of stress than men and that stress was higher in younger people as well as individuals with lower income (Cohen & Janicki-Deverts, in press). In the current study, women with GDM (M= 16.11) reported similar stress levels. However, the sample as a whole (M=15.07) and women without

GDM (M=14.11) had slightly lower levels of stress than the documented norms. Although the current study noted that women with GDM were older, they had higher stress which was most likely due to the diagnosis of gestational diabetes. Another study found that women with GDM were found to have higher stress shortly after the diagnosis of GDM when compared to women without GDM (Daniells et al., 2003). Also, one study which used the PSS in a sample of pregnant women (n=247) reported much higher means on the scale (M= 26.7). However, that study used a different version of the scale (12 items) (Davis et al., 2007), making comparisons to the current study difficult.

The highest mean scores on the stress scale were the same for women with and without GDM. Item 1 ("Have you been upset because of something that happened unexpectedly?") and item 3 ("Have you felt nervous or "stressed"?") had the highest mean scores. Literature has reported that it is common for women to experience stress during pregnancy (Reid et al., 2009; Zust, Natwick, & Oldani, 2010).

Social Support

The mean overall social support in the current study was 6.0, which suggests that the women had high levels of social support. Similar findings have been documented in pregnant women (n=265) where the mean score on this tool was 6.01 (SD±.90) (Zimet et al., 1990). This tool included three subscales: significant other support, family support, and friend support. The mean scores in the current study for the three subscales were 6.3 for significant other support, 6.11 for family support, and 5.59 for friend support; findings consistent with the research by Zimet et al. (1990) (significant other support =6.39, family support=6.02, and friend support=5.64).

For women with GDM, item 3 (“My family really tries to help me.”) and item 10 (“There is a special person in my life who cares about my feelings.”) had the highest mean scores. Women without GDM also had item 10 as one of the highest mean item scores and item 1 (“There is a special person who is around when I am in need”). Because women with GDM had item 3 regarding help from family as a high item mean it appears that they get more assistance from their family than women without GDM. However, women without GDM had two items regarding their significant other which indicates most of the support for women without GDM comes from the significant other. The diagnosis of gestational diabetes may mean women require more support and therefore these women look to family in addition to their significant other to support them during their pregnancy. Other research has shown that women with gestational diabetes have greater compliance with their management of diabetes if they have more social support and fewer stressors (Ruggiero, Spirito, Bond, Coustan, & McGarvey, 1990).

Medications

Nineteen percent of women in the study were taking antidepressants, anti-anxiety, insulin, and oral diabetes medication. Four percent of women were taking an anti-depressant medication which is consistent with a large study (n=6,582) reporting that 4.5% of women used antidepressants during three months prior to pregnancy or until delivery (Alwan, Reefhuis, Rasmussen, Friedman, & National Birth Defects Prevention Study, 2011). For the current study, 66% of women were not taking medications for their diabetes. However, of those taking medication (35%), only two (1%) were taking insulin while the others were taking oral medication (glyburide). For the current study, the use

of medications for glycemic control was consistent with a previous study where 63% of women with gestational diabetes were diet controlled and 37% were treated with either oral medications or insulin (Kremer & Duff, 2004).

Discussion of Study Aims

Aim 1: Difference in Depression between Women with and without GDM

The primary aim of this study was to determine if women with GDM had more depression than women without GDM. Findings indicated that there were no statistically significant differences between women with GDM and without GDM in terms of the frequency of depression as well as the mean depression scores (both the CES-D and the EPDS). Although more women with GDM reported depression (32.3%) compared to women without GDM (24.2%), it was not statistically significant. Chazotte et al. (1995), also reported no differences in depression between healthy women without GDM (37%) and with GDM (57%) using the CESD-D). Although their study had higher rates of depression, the sample was much smaller (n=30 per group), and the participants were younger (M=26.6 years) and limited to women of 34 to 36 weeks' gestation. Both younger age (Glazier et al., 2004; Lindgren, 2001; S. T. Orr et al., 2006; Rubertsson et al., 2005) and the third trimester (Records & Rice, 2007) have been associated with higher levels of depression.

Although the current study reported that women with GDM had higher mean depression scores than women without GDM on the CES-D (12.97 vs. 12.51) and the EPDS (6.65 vs. 5.90), these findings were not statistically significant. Mautner et al. (2009), also reported that women with GDM had higher mean EPDS scores (M= 7.55)

when compared to women without GDM (M=6.41), but these differences were not statistically significant. Limitations of this study were the small number of gestational diabetics (n=11) and that the data was collected in Germany where generalizability to the current study may be difficult. Chazotte et al. (1995), also reported that women with GDM had a higher depression scores (mean CES-D=17) compared to women without GDM (mean CES-D=13.7) which was also not statistically significant. The possible reasons for the higher mean differences between the current study and Chazotte et al. (1995), have been previously addressed. The lack of statistically significant findings in all three studies may be attributed to the small sample sizes and inadequate power to detect statistically significant findings.

For the current study, logistic regression did reveal that after controlling for age, marital status, income, BMI, and gravida, women with GDM were 2.7 times more likely to have depression than women without GDM when using the CES-D. A similar analysis with the EPDS indicated that women with GDM were 2.3 times more likely to have depression when controlling for age, marital status, income, BMI, and gravida, but these findings were not statistically significant. The non-significant results with the EPDS may be attributed to the difference in the measurement tools. As discussed previously, the CES-D includes items which are somatic symptoms of pregnancy which may increase the depression scores on the CES-D and the percentage of depressed women in the sample, therefore impacting the logistic regression results.

The results of the current study are consistent with a research study with a sample of over 11,000 which reported that women with diabetes during pregnancy were 1.85

times more likely to have depression than women without diabetes (Backes Kozhimannil et al., 2009). The findings of the current study are clinically significant. Since women with GDM were at least two times more likely to be depressed than women without GDM, health care providers may want to screen women with GDM more frequently for depression during prenatal care visits.

Aim 2: Difference in Predictive Factors of Depression between Women with and without GDM

The second aim of this study was to determine predictive factors of depression and to examine whether women with GDM had different predictive factors of depression than women without GDM. The first regression analysis was done to determine which factors (state anxiety, trait anxiety, stress, GDM, age, marital status, and income) were predictive of depression in the entire sample. When using the CES-D, it was found that the model explained 71% of the variance in the depression scores and that trait anxiety was the only significant predictor of depression. Perceived stress and marital status were trending toward significance and also contributed to the amount of variance explained by the model. Anxiety (Leigh & Milgrom, 2008) and marital status (Marcus et al., 2003) have been found to be predictive of prenatal depression in previous research. Also, anxiety (C. T. Beck, 2001; Heron et al., 2004), stress (C. T. Beck, 2001), and marital relationships have been reported as significant predictors of postpartum depression (C. T. Beck, 2001).

It was also interesting that the other factors entered into the model (state anxiety, GDM, age, and income) were not significant predictors of depression. Some of the

reviewed literature has reported that age (Glazier et al., 2004; Holzman et al., 2006; Lindgren, 2001; S. T. Orr et al., 2006; Rubertsson et al., 2005; Steer et al., 1992; Westdahl et al., 2007), marital status (H. G. Kim et al., 2006; Lindgren, 2001; Marcus et al., 2003; S. T. Orr et al., 2006; Rubertsson et al., 2005; Westdahl et al., 2007), and income (Glazier et al., 2004; Holzman et al., 2006; Lindgren, 2001) impact depression. Studies had sample sizes ranging from 154 to 3,472 (Appendix H). Age, income levels, and marital status were varied in these studies. Other research has not found significant relationships between depression and age (Dayan et al., 2006; Diego et al., 2005; Hart & McMahon, 2006; Marcus et al., 2003) and marital status (Dayan et al., 2006; Diego et al., 2005). The sample sizes (53 to 3,472), ages, and marital status were also varied in these studies. However, two of these studies had smaller samples (<100) (Diego et al., 2005; Hart & McMahon, 2006). Although age, income, and marital status were associated with depression in most studies, there were some studies that indicated these factors were not related to depression, but these studies tended to have smaller samples. Therefore, the sample size may dictate whether a significant relationship between age, marital status, and income is found.

Regression was used to determine if predictive factors of depression were different in women with GDM when compared to women without GDM. Trait anxiety was a significant predictor for both groups. Trait anxiety is relatively stable and reflective of long-term anxiety levels. People with high trait anxiety have been reported to perceive stressful events as more unsafe (Spielberger et al., 1983). Previous research has reported a positive correlation between depression and anxiety when using the STAI

(Allister et al., 2001; Bergant et al., 1997; Davis et al., 2007; Davis et al., 2004; Dayan et al., 2006; Glazier et al., 2004; Hart & McMahon, 2006). One study examined the relationship between depression and anxiety, but only the state anxiety portion of the STAI was used (Breitkopf et al., 2006). Findings indicated that depression scores (measured by the Beck Depression Inventory) were predictive of state anxiety scores. However, the current study found that trait anxiety was predictive of depression which is consistent with longstanding anxiety as compared with state anxiety which is more temporary. A high state anxiety score would indicate that a person is anxious at the time, whereas a high trait anxiety score indicates that a person is more anxious over the long term. Because the depression measures asked how women felt in the past week (and not at the present time), it would be expected that the trait anxiety score would be the one that is predictive of depression compared to the state anxiety score. In addition, clinical practice has indicated that both anxiety and depression occur more often together rather than in isolation (Ballenger, 1999).

When using the CES-D differences in predictive factors of depression were found. Marital status was a significant predictor of depression for women with GDM and perceived stress was significant for women without GDM. Married women with GDM had lower depression scores than single women with GDM. The finding that married women had lower depression scores is consistent with previous research (Kelly et al., 1999; H. G. Kim et al., 2006; Lindgren, 2001; Marcus et al., 2003; S. T. Orr et al., 2006; Rubertsson et al., 2005; Westdahl et al., 2007). Still, being married did not have an impact of depression scores for women without GDM. This finding was consistent with

the research which did not show a relationship between marital status and depression (Dayan et al., 2006; Diego et al., 2005). Also, women without GDM had higher depression scores if they had higher stress scores. Two previous studies reported a positive relationship between prenatal depression and stress (Davis et al., 2007; Glazier et al., 2004). As discussed previously, marital status (Marcus et al., 2003), stress (C. T. Beck, 2001), and anxiety (C. T. Beck, 2001; Heron et al., 2004; Leigh & Milgrom, 2008) are known predictors of depression.

Regression was also used to determine predictive factors of depression using the EPDS. The first model showed that the factors explained 81% of the variance in depression. In this model, trait anxiety and perceived stress were the significant predictors of depression. As discussed previously, state anxiety, GDM, age, marital status, and income were not significant predictors of the model. Unlike the CES-D which found that marital status was predictive of depression for women with GDM and stress was predictive in women without GDM, the EPDS found that trait anxiety and perceived stress were significant predictors of depression for women with and without GDM.

Trait anxiety is a constant and significant predictor of depression when using the CES-D and the EPDS. If the patient has a diagnosis of an anxiety disorder or a history of an anxiety disorder, clinicians may want to screen for prenatal depression frequently during prenatal care.

There were differences in predictor variables based on which outcome variable (the CES-D or the EPDS) was used. This may be due to the fact that more women had

higher scores on the CES-D than on the EPDS. As discussed earlier, this may be related to the somatic symptoms of pregnancy items included on the CES-D.

Aim 3: Race and Depression

The third aim of this study was to determine if minority women were more at risk for depression than White women. Although this study had a good representation of minority women (32.6% White, 32.6% Hispanic, 23% Black, 11.9% Other), results indicated that race was not associated with depression. Other studies have reported similar findings (Diego et al., 2005; Marcus et al., 2003; Sleath et al., 2005; Westdahl et al., 2007) (Appendix H). Two studies, however, have reported that race is related to depression (Lindgren, 2001; S. T. Orr et al., 2006). Lindgren (2001) reported that non-White women had higher depression scores, but did not indicate if these differences were statistically significant. Orr et al. (2006), did indicate that Black women had significantly higher depression scores than White women. However, Blacks were more likely to be on Medicaid so the difference found in depression scores between races may be more attributable to socioeconomic factors than race. Other studies did not report the racial distribution of the sample or did not indicate if race was related to depression scores, making it difficult to compare the current study results to these studies (Glazier et al., 2004; Hart & McMahon, 2006; Rubertsson et al., 2005; Steer et al., 1992). The current study has results consistent with most research on prenatal depression and race which suggests that minority women do not appear to be at increased risk for depression (Diego et al., 2005; Marcus et al., 2003; Sleath et al., 2005; Westdahl et al., 2007).

Other Findings: Maternal and Infant Health Outcomes

Delivery and infant health information were extracted from the EMR to determine the impact of GDM on delivery complications and infant health. This was also analyzed in terms of depression status. The outcomes analyzed were as follows: gestational age at delivery, type of delivery, presence of lacerations, delivery complications (shoulder dystocia, presence of meconium, nuchal cord, maternal fever, postpartum hemorrhage, chorioamnionitis, prolonged rupture of membrane, and partial abruption), Apgar scores at one, five, and ten minutes, and infant birth weight.

When comparing women with and without GDM in terms of gestational age at delivery, it was found in that women with GDM delivered earlier (38.1 weeks) compared to women without GDM (38.8 weeks). Although this was statistically significant, it was not clinically significant. Women with GDM may have delivered slightly earlier because they are at greater risk for macrosomia, and induction at 38 weeks may reduce the rate of macrosomia (Nicholson et al., 2008). It should be noted that women with GDM had significantly more cesarean sections than women without GDM, which is consistent with previous research (Casey et al., 1997). Women without GDM were more likely to have vaginal tears; which would make sense, since they were more likely to deliver vaginally.

Women were also compared according to whether they had depression or not. This was done using the recommended cut scores for both tools (CESD-D and EPDS). A significant difference was found using the EPDS where infants born to depressed women had higher Apgar scores at 10 minutes (9.0) compared to non-depressed women (8.91). However, this was not a clinically significant finding. Also, when using the

EPDS, women with depression were significantly more likely to have cesarean sections than women without depression. This finding is consistent with previous research (Larsson et al., 2004). The last significant difference was found when using both the CES-D and the EPDS: women without depression were more likely to have vaginal tears; which would make sense, since they were more likely to deliver vaginally.

Data Quality of the Electronic Medical Record

There is an immense amount of information in the EMR that can be extracted and used for research purposes. However, when using the EMR for research purposes there are some aspects that are important to keep in mind. Hayrinen, Saranto, & Nykanen (2008) have reported that information found in the EMR should be complete, accurate, and reliable when compared to a paper medical chart. The current study did not compare information from the EMR to a paper chart, so it is impossible to determine if the EMR was more or less accurate, complete, and reliable than a paper chart. However, there were some variables extracted from the EMR which had missing data (Appendix E), suggesting that data from the EMR is not always complete. In the current study, it was often found that the data missing on the provided template was located in the physician notes. Information was not always consistent throughout the chart, which raises concerns of accuracy. There were differences found between information provided in the template and in the physician notes (Appendix F). For example, the gestational age at delivery was documented differently between the template and the physician notes and this made it difficult to determine which information was accurate and reliable. In the current study, when contradictory information was found between the template and physician

note, the information written in the note was used in the analysis, since the investigator believed this information would be more accurate and reliable than information documented in a flow sheet.

The current study also identified instances when data would have been missed or mis-classified based on the information provided in the template. For example, there were six participants for whom a diagnosis of GDM was written in a note in the chart but was not listed in the active problem list. The active problem list was provided on the template and was the list of active diagnoses the patient had at the time of delivery and a way to identify women with GDM. Had the lab results and notes not been accessed, the six women without GDM on the active problem list would never have been identified as GDM or they would have been classified as non-GDM, resulting in an error in analysis. Missing information on the template was also identified as a problem in a study which compared the amount of prescribed medication to the elderly between two data sources (Vandenberghe et al., 2005). This study compared a semi-automatic data extraction system from the EMR (similar to the template in the current study) to the amount of prescribed medication on the EMR to a paper chart (Vandenberghe et al., 2005). This study found that the proportion of patients who were prescribed drugs to treat osteoarthritis was almost twice as high for the general practitioners recording data on paper sheets (64%) when compared with the general practitioners using EMR (36%). Researchers in that study had two possible explanations for the difference in findings: (1) the general practitioners wrote the prescriptions on paper and did not record them in the EMR or (2) the prescriptions were recorded in a different place in the EMR and the semi-

automatic extraction was not able to capture the total number of patients on medications (Vandenberghe et al., 2005). The current study also found that information could be missing on the template, but was often recorded in a place in the chart which the template used for data retrieval was not able to capture. Although most data could be found when accessing the notes, checking all the information in the template against the notes in the chart was time-intensive and future studies may find it beneficial to develop a systematic approach to extract data from the EMR in order to decrease the amount of time it takes for data extraction. In the current study, a system was developed by the investigator. First, lab results were extracted to determine which women had a diagnosis of GDM and to ensure accurate classification of women with GDM. Next the information provided by the informatics specialist on the template was compared to the information written in the chart. To do the comparison, five notes in the chart were read. Three notes were read in the maternal EMR: the admission note at the start of prenatal care, the admission note at the time of delivery, and the discharge note. Two notes were read in the infant chart: the admission to the nursery note and the discharge summary note. The investigator found that by reading these five notes, most missing data could be retrieved and any inaccurate data on the template could be captured in one of these physician notes. The utilization of this systematic approach allowed for the information extracted from the EMR to be complete, accurate and reliable.

Summary of Major Findings

When analyzing the scores on the self-report questionnaires, the mean scores on the scales were similar to the normative scores. However, the standard deviations were

large and may be a reason that statistically significant differences were not found. Although women with GDM were found to have higher depression scores on both the CES-D and the EPDS and the rates of depression were higher among these women, it was not statistically significant. However, after controlling for age, marital status, income, BMI, and gravida, women with GDM were 2.7 times more likely to have depression (when measured by the CES-D), which was statistically and clinically significant. When using the EPDS, women with GDM were 2.4 times more likely to have depression (when controlling for age, marital status, income, BMI, and gravida), but the findings were not statistically significant. Another important finding was that women with a history of depression were more likely to have GDM. This finding suggests that a history of depression is a risk factor in development of GDM.

When determining predictive factors of depression, trait anxiety was the one factor that was significant in every analysis. Other significant predictive factors in some of the models were stress and marital status. No significance difference was found between race and depression in the current sample of women. When delivery outcomes were compared between women with and without GDM, women with GDM had more cesarean sections and were found to deliver earlier than women without GDM (but this was not clinically significant). When comparing delivery outcomes in women with and without depression, women with depression (on the EPDS) had more cesarean sections. Women with depression (as measured by the EPDS) had infants with slightly higher ten-minute Apgar scores, but again this was not clinically significant. Women without depression had more vaginal tears (when measured by both the CES-D and the EPDS).

The interpretation of these delivery outcomes must also be interpreted with caution because a Bonferroni correction was not utilized.

Study Limitations

There were limitations in this study based on threats to internal and external validity. The first threat to internal validity was selection bias. A convenient, non-random sample was used. Because of the sampling techniques, a significant difference in age was noted in that women with GDM were older. This difference in groups was accounted for in the analyses to address this impact of this limitation. The next threat to internal validity was the use of self- report questionnaires as the measure for depression. Depression self- report questionnaires do not always generate the same results as a clinical diagnosis of depression (Murray & Cox, 1990). Therefore, some women may have been classified as depressed based on the recommended cutoff score for the CES-D and the EPDS, but they may not have been clinically depressed based on the diagnostic criteria. The last threat to internal validity was the missing data. There was a limited amount of missing data from the self-report questionnaires. In order to reduce missing data, questionnaires were reviewed after they were completed by participants to reduce this error. In cases where data was missing, a conservative method was used for replacement where the individual's mean score was used.

There were also two external validity threats which pose limitations to the study. The first is that the study excluded non-English-speaking women and pregnant women less than 18 years of age. Results and conclusions may not be generalizable to teenagers and non-English-speaking women. Also, the sample size was small and was obtained

from the greater Chicagoland area. The results are not generalizable beyond the institution where data was collected. In addition, because women were recruited for the study at prenatal care visits, all study participants were receiving prenatal care at some point during their pregnancy. Therefore, women who did not receive prenatal care and who may be at more risk for depression and delivery complications were not represented in the study.

Nursing Implications

Nurses have a great deal of contact with patients during their prenatal care visits. It is important for nurses to know and understand the prevalence and symptoms of antenatal depression. Nurses need to be sensitive to women with prenatal depression and provide care to treat them appropriately. Often nurses provide education to the women diagnosed with gestational diabetes. It is imperative that nurses are aware that women with GDM are more likely to have a history of depression and are at least two times more likely to have antenatal depression. It may be desirable to include a depression screen in the diabetic teaching session. A psychosocial screen (such as a depression screen), is recommended for people with diabetes (American Diabetes Association, 2010a). However, a depression screen is not included in the recommended guidelines for treatment of gestational diabetes (American Diabetes Association, 2010b). Gestational diabetes education could include the symptoms of depression which may develop during pregnancy and the postpartum period. Also, involved family members or supportive people in the pregnant woman's life should be educated on the risk of depression and symptoms of depression. Women with prenatal depression may need some help in

identifying their depression and encouragement to seek help. If the family and support system of the woman are educated on depression, they may be more likely to help and encourage the woman to seek depression help and treatment. An Illinois Public Health Act (Public Act 095-0469), indicates that depression education should provided to all women receiving prenatal care. The act also encourages the inclusion of families in the education. The act does not mandate a prenatal depression screen, but does recommend that all women receiving prenatal care be given the option to complete a depression screen. At the data collection site, the recommendations of this act were followed and women were routinely screened for depression during prenatal care using the EPDS. The number of women with prenatal depression found in the current study supports the recommendations provided in the public act. Health care providers who are not currently screening for depression during routine prenatal care visits, should implement a depression screen in order detect and address depressive symptoms in pregnant women.

Women need to be reassured by nurses that depression is common and there is treatment in order to help them deal with the symptoms. Nurses should strive to provide understanding and sympathetic care while instilling hope that the depression symptoms will improve. Antidepressant medication is a possible treatment option for women with antenatal depression. Although there is research to suggest that antidepressants may be associated with an increased risk of fetal anomalies, there is also research to indicate that there is no association (Wisner et al., 2009). One study of pregnant women (n=238) between 20 and 36 weeks' gestation reported that although antidepressant use and untreated depression were not related to an increased risk of physical anomalies in the

infants, they were related to premature births (Wisner et al., 2009). Therefore, depression should be assessed and evaluated for treatment in the antenatal period because of the impact on the mother as well as on the unborn baby.

Another major finding of this study is that women with a history of depression were three times more likely to develop GDM. Therefore, a history of depression was found to be a risk factor in development of GDM. All health care providers should be aware of the relationship between the history of depression and GDM. Health care providers may want to consider earlier screening for GDM in women with a history of depression.

Future Research

Because many of the findings in the current study were trending toward significance, a larger study may be needed to determine if there are additional statistically significant differences in depression between women with and without GDM. This study indicated that 28% of women had depression according to the CES-D and 16% had depression using the EPDS. Because the CES-D includes items which are somatic symptoms of pregnancy, future research may want to use the EPDS or another measurement which does not include somatic symptoms of pregnancy.

Future intervention studies should be done to decrease the amount of depression and the depressive symptoms which occur during pregnancy. A meta-analysis paper reviewed 11 studies which included the treatment of prenatal and postpartum depression (Bledsoe & Grote, 2006). Of the 11 studies, only four were done during the prenatal period. Three of these four studies used interpersonal therapy (IPT) and one study used

an education intervention. Interpersonal therapy treats depression by addressing interpersonal problems related to the current depressive symptoms (Bledsoe & Grote, 2006). The meta-analysis paper did not indicate if the depression treatments during pregnancy were done on an individual basis or in groups (Bledsoe & Grote, 2006). Cognitive behavioral therapy (CBT) was used to treat postpartum depression in three of the studies and focuses on improving cognitive skills and changing negative thoughts (Bledsoe & Grote, 2006). The current study found that stress and anxiety were common symptoms which occurred with depression. Future intervention studies may want to use IPT or CBT to treat depression, stress, and anxiety at the same time. The successful treatment of prenatal depression, stress, and anxiety may improve the quality of life and health outcomes of the mother and baby.

Group CBT has been used to successfully treat depression and anxiety in women with type 2 diabetes (Penckofer et al., 2010). However, the use of group CBT has not been done during pregnancy. Group therapy may provide an economical approach to antenatal depression treatment. Also, pregnant women may like the aspect of a group treatment during pregnancy because they could provide support for each other during all the changes which occur in pregnancy.

Because women with GDM were more likely to have a history of depression and twice as likely to have antenatal depression, future studies may want to test an intervention that includes depression treatment incorporated into the gestational diabetic teaching. Similar to the CBT treatments described above, these could be specific to

women with GDM and could include treatment of depression and educational information on how to manage gestational diabetes.

APPENDIX A

SELF-REPORT QUESTIONNAIRES

Center for Epidemiologic Studies Depression Scale (CES-D)
Below is a list of ways you might have felt or behaved. Please tell me how often you have felt this way during the past week.

	Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of time (3-4 days)	Most or all of the time (5-7 days)
1. I was bothered by things that usually don't bother me	1	2	3	4
2. I did not feel like eating; my appetite was poor	1	2	3	4
3. I felt that I could not shake off the blues even with help from my family or friends	1	2	3	4
4. I felt I was just as good as other people	1	2	3	4
5. I had trouble keeping my mind on what I was doing	1	2	3	4
6. I felt depressed	1	2	3	4
7. I felt that everything I did was an effort	1	2	3	4
8. I felt hopeful about the future	1	2	3	4
9. I thought my life had been a failure	1	2	3	4
10. I felt fearful	1	2	3	4

11. My sleep was restless	1	2	3	4
12. I was happy	1	2	3	4
13. I talked less than usual	1	2	3	4
14. I felt lonely	1	2	3	4
15. People were unfriendly	1	2	3	4
16. I enjoyed life	1	2	3	4
17. I had crying spells	1	2	3	4
18. I felt sad	1	2	3	4
19. I felt that people dislike me	1	2	3	4
20. I could not get “going”	1	2	3	4

Multidimensional Scale of Perceived Social Support

Instructions: We are interested in how you feel about the following statements. Read each statement carefully. Indicate how you feel about each statement.

	Very Strongly Disagree	Strongly Disagree	Mildly Disagree	Neutral	Mildly Agree	Strongly Agree	Very Strongly Agree
1. There is a special person who is around when I am in need	1	2	3	4	5	6	7
2. There is a special person with whom I can share my joys and sorrows	1	2	3	4	5	6	7
3. My family really tries to help me	1	2	3	4	5	6	7
4. I get the emotional help and support I need from my family	1	2	3	4	5	6	7
5. I have a special person who is a real source of comfort to me	1	2	3	4	5	6	7
6. My friends really try to help me	1	2	3	4	5	6	7
7. I can count on my friends when things go wrong	1	2	3	4	5	6	7
8. I can talk about my problems with my family	1	2	3	4	5	6	7
9. I have friends with whom I can share my joys and sorrows	1	2	3	4	5	6	7
10. There is a special person in my life who cares about my feelings	1	2	3	4	5	6	7
11. My family is willing to help me make decisions	1	2	3	4	5	6	7
12. I can talk about my problems with my friends	1	2	3	4	5	6	7

Spielberger State-Trait Anxiety Scale (Only the first five items are printed so as not to violate copy right laws).

DIRECTIONS:

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you feel *right* now, that is, *at this moment*. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

	NOT AT ALL	SOMEWHAT	MODERATELY SO	VERY MUCH SO
1. I feel calm	1	2	3	4
2. I feel secure	1	2	3	4
3. I am tense	1	2	3	4
4. I feel strained	1	2	3	4
5. I feel at ease	1	2	3	4

Perceived Stress Scale

The questions in this scale ask you about your feelings and thoughts **during the last month**. In each case, you will be asked to indicate by circling *how often* you felt or thought a certain way.

	0 = Never	1 = Almost Never	2 = Sometimes	3 = Fairly Often	4 = Very Often
1. In the last month, how often have you been upset because of something that happened unexpectedly?	0	1	2	3	4
2. In the last month, how often have you felt that you were unable to control the important things in your life?	0	1	2	3	4
3. In the last month, how often have you felt nervous and "stressed"?	0	1	2	3	4
4. In the last month, how often have you felt confident about your ability to handle your personal problems?	0	1	2	3	4
5. In the last month, how often have you felt that things were going your way?	0	1	2	3	4
6. In the last month, how often have you found that you could not cope with all the things that you had to do?	0	1	2	3	4
7. In the last month, how often have you been able to control irritations in your life?	0	1	2	3	4
8. In the last month, how often have you felt that you were on top of things?	0	1	2	3	4
9. In the last month, how often have you been angered because of things that were outside of your control?	0	1	2	3	4
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	0	1	2	3	4

Edinburgh Postnatal Depression Scale (EPDS)

Are you pregnant or have recently had a baby? We would like to know how you are feeling. Please check the answer that comes closest to how you have felt in the past 7 days, not just how you feel today.

In the past 7 days:

1. I have been able to laugh and see the funny side of things
__As much as I always could
__Not quite so much now
__Definitely not so much now
__Not at all

2. I have looked forward with enjoyment to things
__As much as I ever did
__Rather less than I used to
__Definitely less than I used to
__Hardly at all

3. I have blamed myself unnecessarily with things went wrong
__Yes, most of the time
__Yes, some of the time
__Not very often
__No, never

4. I have been anxious or worried for no good reason
__No, not at all
__Hardly ever
__Yes, sometimes
__Yes, very often

5. I have felt scared or panicky for no very good reason
__Yes, quite a lot
__Yes, sometimes
__No, not much
__No, not at all

6. Things have been getting on top of me.
__Yes, most of the time I haven't been able to cope at all
__Yes, sometimes I haven't been coping as well as usual
__No, most of the time I have coped quite well
__No, I have been coping as well as ever

7. I have been so unhappy that I have had difficulty sleeping
__Yes, most of the time
__Yes, sometimes
__Not very often
__No, not at all

8. I have felt sad or miserable
__Yes, most of the time
__Yes, quite often
__Not very often
__No, not at all

9. I have been so unhappy that I have been crying
__Yes, most of the time
__Yes, quite often
__Only occasionally
__No, never

10. The thought of harming myself has occurred to me
__Yes, quite often
__Sometimes
__Hardly ever
__Never

Demographic and Health History Information

ID #_____ MRN#_____ Date_____

Please fill out the information below.

1. Age: _____

2. Ethnicity: (please circle one)
    1. Hispanic
    2. Non-Hispanic

3. Race: (please circle one)
    1. Alaska Native
    2. American Indian
    3. Asian
    4. Black
    5. White
    6. Native Hawaiian or Other Pacific Islander
    7. Preference not indicated
    8. Other

4. Marital Status: (please circle one)
    1. Married
    2. Divorced
    3. Separated
    4. Single, and not living with partner
    5. Single, and living with partner

5. Estimated Due Date: _____

6. Was your current pregnancy planned? YES NO

7. Please list any medications you are currently taking:

_____ _____

_____ _____

_____ _____

_____ _____

8. Have you ever been diagnosed with depression? YES NO

9. Please circle any of the following conditions you have been diagnosed with:

1. Asthma
2. Diabetes
3. High Blood Pressure
4. Depression
5. Bipolar Disorder
6. Schizophrenia
7. Other: _____

10. How many times have you been pregnant? _____

11. How many of those pregnancies did you deliver a full term (after 37 weeks) baby? _____

12. How many of those pregnancies did you deliver a preterm (between 20 and 37 weeks) baby? _____

13. How many miscarriages have you had? _____

14. How many abortions have you had? _____

15. How many living children do you have? _____

16. Have you ever had a cesarean section? YES NO

17. What is your annual income?

1. Less than $5,000 _____
2. $5,000 to $9,999 _____
3. $10,000 to $19,999 _____
4. $20,000 to $29,999 _____
5. $30,000 to $39,999_____
6. $40,000 to $49,999_____
7. $50,000 to $59,999_____
8. $60,000 to $69,999_____
9. Over $70,000____

APPENDIX B

PREGNANCY AND MOOD STUDY FLYER

Pregnancy and Mood Research Study

It is common for women to experience mood swings during pregnancy. It is also common for people with blood sugar fluctuations to experience mood swings.

This study is being conducted to gain a better understanding of the moods experienced during pregnancy and their relationship to gestational diabetes.

You may be eligible to participate in this study if you are between four and nine months pregnant and have gestational diabetes.

Women who participate in this study will be given a $10 gift card.

For more information, please call (888) LUHS-888 (888-584-7888) and ask for extension 6-9304.

www.LoyolaMedicine.org

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APPENDIX C

ELECTRONIC MEDICAL RECORD DATA COLLECTION FORM

Variables to be Collected From the EMR

ID # _____ Date _____

PREGNANCY DATA:

Maternal Date of Birth _____

Result of One Hour Glucose Tolerance Test _____ Date of test _____

Result of 3-hour Glucose Tolerance Test (only if 1 hour is greater than 130 mg/dl)

Fasting _____1_____ 2_____ 3_____ Date of test _____

Gestational Diabetes YES NO

Pre-pregnancy Weight _____lbs. Date of weight _____

Weight at appointment when questionnaire completed: _____lbs.

Height _____in

BP at appointment when questionnaire completed: _____

Gravida _____

Parity _____

EPDS SCORE @ 28 weeks gestation _____

DATA TAKEN FROM CHART AT TIME OF DELIVERY:

Weight at Delivery admission _____lbs.

History of abuse: YES NO
If yes: what (physical, emotional, sexual) and when _____

History of tobacco use: YES NO

If yes: how much (packs per day) _____

History of alcohol use: YES NO
If yes: how much _____

History of illicit drug use: YES NO
If yes: what drug and how much_____

Active Patient Problem List _____

Past medical History (including history of depression) _____

Current
medications_____

DELIVERY DATA:
Gestational age at delivery _____weeks

Sex of infant: Male Female

Infant weight _____ounces

Infant length_____inches

SGA AGA LGA

Induction of Labor: YES NO

Type of Delivery:

Spontaneous Vaginal Delivery Cesarean Low Forceps Delivery

Mid Forceps Delivery Forceps Outlet Vacuum

Breech Assisted Breech Extraction

History of Previous C-section: YES NO

Shoulder Dystocia: YES NO UNKNOWN

Delivery complications _____

Episiotomy: YES NO

Perineal Tear: YES NO

If yes, degree of laceration: 1 2 3 4

APGARS: 1 min _____ 5 min_____ 10 min_____

Infant Blood Glucose (from heel stick):

#1_____ #2_____ #3_____

EPDS Score at Delivery _____

Breastfeeding: YES NO

POSTPARTUM DATA:

EPDS Score at 2 weeks postpartum _____

EPDS Score at 6 weeks postpartum _____

Maternal weight at 6 weeks postpartum _____kg

Fasting Blood Glucose at 6 weeks postpartum _____mg/dL

APPENDIX D

INFORMED CONSENT DOCUMENT

IRB NUMBER: 202019121609

LOYOLA UNIVERSITY HEALTH SYSTEM

MAYWOOD, ILLINOIS

NIEHOFF SCHOOL OF NURSING

STRITCH SCHOOL OF MEDICINE

INFORMED CONSENT

(a copy of consent must be inserted in participant's file)

Participant's Name:_____

Project Title: "Pregnancy and Mood Study"

The project will undergo re-review on or before 6/16/2011.

Patient Information

PRINCPLES CONCERNING RESEARCH: You are being asked to take part in a research project. It is important that you read and understand the principles that apply to all individuals who agree to participate in the research project described below:

1. Taking part in the research is entirely voluntary.

2. You may not benefit from taking part in the research but the knowledge obtained may help health professionals understand the experiences of women with diabetes.

3. You may withdraw from the study at any time without anyone objecting and without penalty or loss of any benefits to which you are otherwise entitled.

The purpose of the research, how it is to be done, and your part in the research is described below. Also described are the risks, inconveniences, discomforts and other important information which you need to make a decision about whether or not you wish to participate. You are urged to discuss any questions you have about this research with the staff members.

PURPOSE OF RESEARCH: You are being asked to participate in this research because you are having a baby. There is evidence to indicate that pregnant women may experience hormonal fluctuations and have mood alterations during pregnancy. There is also evidence to indicate that fluctuations in blood sugar are associated with mood alterations. We are interested in studying whether the alterations in mood during pregnancy are greater in women who have gestational diabetes. Gestational diabetes is when a woman has high blood sugars that start or are first diagnosed during pregnancy. Thus, we will be comparing the health and well-being of women who have gestational diabetes with those who do not have gestational diabetes. The purpose of this study is to find out if women with gestational diabetes experience more mood alterations than women who do not have gestational diabetes.

Approximately 120 pregnant women will participate in this study. The information obtained from this study will be used to develop future research projects on pregnant women.

DESCRIPTION AND EXPLANATION OF PROCEDURES: If you agree to participate in this research you will be asked to complete a questionnaire booklet that will take about 20 to 30 minutes. The questionnaire booklet will ask you about your moods (depression, anxiety, and stress), your support systems, and your demographic and health history. We will also be obtaining information from your medical record that is part of your routine care during your pregnancy and delivery. In addition, we will be obtaining information from the medical record of your baby once it is delivered. .

POTENTIAL RISKS AND DISCOMFORTS: Because you will be filling out questionnaires related to your moods, you may experience feelings of sadness or anxiety. If you experience these feelings you should talk with the healthcare provider you are seeing at your appointment.

It is important that you understand that if you need assistance with the management of your emotions such as medication or counseling, you should talk to your health care provider about this. If you report feelings of harming yourself on the questionnaire, this information will be shared with your healthcare provider at the clinic.

All information taken from your medical record will be kept confidential. There will be no identifying information (name, birth date, or social security number).

POTENTIAL BENEFITS: We do not know if you will benefit from participating in this study**.** The information learned in this study may help others in the future.

ALTERNATIVES: You do not have to participate in this project if you do not want to. Your decision about participation will not affect your care in any way. If you are an employee of Loyola University, your decision about participation will not affect your evaluations or career or career opportunities in any way.

FINANCIAL INFORMATION: There are not costs associated with your participation in this research. You will be responsible for all costs associated with your care and treatment at Loyola.

You will be given a $10 gift card for participating in the study.

INFORMATION COLLECTED AND WHAT WILL HAPPEN TO IT: In order to meet the goals of the research study (see Purpose of Research section of this consent), we will collect information on you. The information will be collected by Mary Byrn, RN. All data will be stored in a locked file cabinet in the researcher's office. Only the research team will have access to those files.

The results of this research study may be published in a journal for the purpose of advancing medical knowledge. You will not be identified by name or by any other identifying information in any publication or report about this research.

The information we will collect includes:

X DEMOGRAPHIC INFORMATION (E.G., NAME, ADDRESS, PHONE NUMBER)

X QUESTIONNAIRES ABOUT YOUR MENTAL HEALTH INCLUDING MOOD AND FEELINGS

X INFORMATION TAKEN FROM YOUR MEDICAL RECORD (E.G., HEIGHT, WEIGHT, ORAL GLUCOSE TOLERANCE TEST RESULTS, DEPRESSION SCREENING SCORES, DELIVERY INFORMATION, SUBSTANCE ABUSE HISTORY, PLANS TO BREASTFEED)

This authorization expires when the sponsor has collected all of the data and the analysis is complete.

Consent for Loyola University Health System (LUHS) to use and disclose your information is required in order for you to participate in the study.

Withdrawal of Consent: Your consent to use and disclose your information for the purpose of this research study is completely voluntary. You can withdraw your consent for LUHS to use and disclose your information and your consent to participate in this study at any time without affecting your ability to receive care and treatment at LUHS unrelated to the research study. Withdrawal means that all study procedures and follow-up will stop and we will not send any more information about you. However, information already used and disclosed to the researcher prior to the time of your withdrawal from this study may continue to be used and disclosed by LUHS.

If you withdraw from the study we will ask that you sign the form attached to this consent and send it to Mary Byrn, RN. Your withdrawal from the study will not have any affect on any actions by LUHS taken before the attached form is received by LUHS.

Your study doctor, the Institutional Review Board/Independent Ethics Committee, the regulatory authorities, or Loyola University Chicago may terminate the study at any time with or without your consent.

CONSENT

I have fully explained to _____ the nature and purpose of the above described procedure and the risks that are involved in its performance. I have answered and will answer all questions to the best of my ability. I may be reached at 708-216-9304, Mary Byrn, RN.

_____ _____

(Signature) Date

Mary Byrn, RN, principal investigator for this study, will be available to answer any questions you may have. Sue Penckofer, PhD, RN can be reached at: 708-216-9303.

If you ever feel that you have been injured by participating in this study or if you have any questions concerning your rights as a research participant, you may contact Dr. Kenneth Micetich, Chairman, Institutional Review Board for the Protection of Human Subjects-Medical Center (708-216-4608).

You will receive a signed copy of this informed consent document.

You have been fully informed of the above-described research program with its possible benefits and risks. Your signature below indicates that you are willing to participate in this research study and agree to the use and disclosure of information about you as described above.

You do not give up any of your legal rights by signing this consent document.

_____Date:_____
(Signature: Patient)

_____Date:_____
(Signature: Witness)

REVOCATION OF AUTHORIZATION TO RELEASE

PROTECTED HEALTH INFORMATION (PHI)

I, _____, hereby revoke my consent to participate

in the "Pregnancy and Mood Study" at Loyola University Health System. I also revoke my consent to release information I provided to LUHS or allowed LUHS to use and disclose my information to Loyola University Chicago as outlined in the consent form, which I signed on _____. I understand that this revocation does not apply to any action LUHS has taken in reliance on the consent I signed earlier.

_____ _____

Patient Name or Personal Representative Date

Please return this form to:

Mary Byrn, RN
Professor, School of Nursing
Building 105, Room 2840
Loyola University Health System
2160 South First Avenue
Maywood, Illinois 60153
mbyrn@luc.edu

APPENDIX E

MISSING DATA

Self-Report Questionnaire Missing Data

ID#	Tool and Item	Individual Mean	Group Mean	Replaced
142	CESD #4	2.5	3.11	3
68	CESD #10	1.5	1.45	2
56	MDPSS #5	5.09	6.25	5
68	STAI #16	2.33	2.97	2
125	STAI #16	2.56	2.97	3
73	STAI #35	2.38	1.44	2
56	STAI #36	2.1	3.01	2
54	PSS #1	1.56	1.81	2
102	PSS #2	2.44	1.5	2
135	PSS #4	3	2.78	3
87	PSS #7	2	2.64	2
91	PSS #10	2.33	1.36	2

EMR Missing Data

Variable	Number of Missing Items
Height	1
One hour OGTT	6
Status of ruptured membranes	18
Apgar score at 1 min	6
Apgar score at 5 min	6
Apgar at 10 min	20
Infant birth weight	10
Infant birth length	18

APPENDIX F

COMPARABILITY OF DATA FROM DIFFERENT SOURCES

ID	Notes
2	Induction of Labor (IOL) said no on template and yes in note, entered yes.
3	Operative note says 1st degree perineal tear, template says 2nd degree, entered 1st degree.
11	LMP: 5/2/10 on template and 7/8/09 in note. Used the one in note. Delivery on template said vaginal, note said vacuum. Entered vacuum.
16	IOL said no on template and yes in note, entered yes.
36	Template says cesarean section delivery and clear membranes and note says vacuum and meconium membranes. Vacuum and meconium entered. Laceration says none on template and 2nd degree in note. Entered 2nd degree.
39	Templates says no to induction, note says yes. Entered yes for induction.
56	No diagnosis of GDM in list, but diagnosis in note. Entered GDM has a diagnosis.
58	No diagnosis of GDM in list, but diagnosis in note. Entered GDM has a diagnosis.
64	Template has induction as yes, but note says no. Entered no (patient was only 34 weeks).
70	Template has no for induction, but note says yes. Entered yes. Template has epidural, note has combined spinal/epidural. Entered combined spinal/epidural.
72	Note has preeclampsia, but not in diagnosis list. Entered it has a diagnosis.
74	Note has combined spinal/epidural, but template has epidural. Entered combined spinal/epidural. Note has no LMP and has pregnancy due to IVF. IVF entered in diagnosis list.
76	Oligohydramnios entered in note but not in template, put it in the diagnosis list.
78	Template has vaginal delivery, but note has Vaginal Birth after Cesarean (VBAC). VBAC entered.
82	Template has no tears, note has bilateral labial tears. Labial tears entered.
90	Template has G:2, note has G5. Entered G5 because on self-report patient wrote G5.
91	Template has G:3, note has G2. Entered G3 because on self-report patient wrote G3. Anesthesia on template had spinal/epidural, note had epidural. Entered epidural.
93	Anesthesia on template had epidural, note had spinal/epidural. Entered spinal/epidural
95	Template says NSVD, note says vacuum. Entered vacuum.
99	Diagnosis of GDM in chart, but not on active problem list. Entered GDM has a diagnosis. Also, epidural in template but spinal/epidural in note. Entered spinal/epidural.
101	Diagnosis of GDM in chart, but not on active problem list. Entered GDM has a diagnosis.
105	Diagnosis of GDM in chart, but not on active problem list. Entered GDM has a diagnosis.
106	Diagnosis of pre-eclampsia in note but not in active problem list. Entered it into active problem list.
107	Induction says no on template, yes in note. Entered yes.
110	Template has epidural and note has combined spinal/epidural. Combined spinal/epidural entered.

111	Diagnosis of GDM in chart, but not on active problem list. Entered GDM has a diagnosis.
114	Diagnosis of pre-eclampsia in chart but in active problem list. Entered preeclampsia as diagnosis.
124	Note has c-section with vacuum assist and template only has c-section. C-section with vacuum entered. Also, template has epidural and note has combined spinal/epidural. Entered combined spinal/epidural.
126	Template has yes for induction, note does not have induction. Entered no for induction.
135	Delivery weight missing. Looked in anesthesia note at time of delivery. Note says patient current weight is 262, however last weight on flow sheet was 164. Entered 164 as weight at delivery. Diagnosis of depression in note but not in diagnosis list, entered depression in diagnosis list.
139	Template has no for induction, note says yes. Entered yes.
141	Template has LMP as 4/10/11, this date is incorrect since we have not had this date yet. LMP in the note says uncertain, possibly 4/7/10 and therefore it was left blank.
145	Template has spinal and note has spinal/epidural. Entered spinal/epidural.
146	Template has NSVD, note has VBAC. VBAC entered.
149	Depression and oligohydramnios in note not in diagnosis list, entered them into active problem list.
150	Template has spinal, note has spinal/epidural for anesthesia type. Entered spinal/epidural. Note has G4, P2002. Note has G3. G3 entered because that makes sense with P2002.
151	No diagnosis of GDM in active problem list, but diagnosis in note. Entered GDM as diagnosis in APL. Epidural in template, combined spinal/epidural in note. Entered spinal/epidural.
152	Template has 1st degree tear, note says no tears. No tears entered.

APPENDIX G

DATA ANALYSES ASSUMPTIONS

Assumptions for Independent t-tests

Assumption	Description
Normal distribution	The sampling distribution is normal.
Interval data	Data should be measured at the interval level, at least.
Homogeneity of variance	The outcome variable (depression) should be the same for each group (GDM vs no GDM).
Independence	Data from groups (GDM vs no GDM) are independent of each other.

Normal Distribution Tests

Test	Description	CES-D Result	EPDS Result
Skewness	Measure of symmetry. In a normal sample this score is zero.	1.32	1.11
Kurtosis	Degree to which scores group together at either end. In a normal sample this score is zero	1.67	.80
Kolmogorov-Simirnov	To determine if the distribution deviates from a similar normal distribution. These tests compare the scores to a sample with normally distributed scores (with the same mean and standard deviation). If the test is significant ($p < .05$) the distribution is different from a normal distribution and the assumption of normality is not met.	$p < .001$	$p < .001$
Shapiro-Wilk		$p < .001$	$p < .001$

Multiple Regression Assumptions

Assumption	Description	Assumption Met
Variable types	Quantitative means the variables should be measured at the interval level, at least. Unbounded is defined as the variability having no constraints (the range of scores spans the entire scale for that measure).	Met based on the description.
Non-zero variance	Predictor variables should have variation (do not have a variance of zero).	Met after review of descriptive statistics.
Multicollinearity	Predictor variables should not be highly correlated.	Met after review of correlation matrix, there were no variables highly correlated (r>.90) and all variance inflation factors less than ten.
Predictors uncorrelated with external variables	External variables are variables that have not been included in the analysis but are related to the outcome variable. Therefore external variables should not be correlated with predictor variables.	Met after review of the literature and correlation results did not suggest other variables to be correlated to depression.
Homoscedasticity	Residuals of each predictor variable should have the same variance.	Met after review of Levene's test.
Independent errors	Residuals between two participants should be uncorrelated	Met based on the Durbin Watson statistic. Durbin Watson value was 1.94 and a value less than one or greater than three indicates this assumption has not been met.
Normally distributed errors	Residuals are random, normally distributed, and have a mean of zero.	Met; the means of the residuals equals zero.
Independence	All values of the outcome variable come from separate participants, and therefore are independent of each other.	Met based on data collected from separate participants at one time point

Linearity	The relationship in the model is linear.	Met based on definition of assumption.

Note: Assumptions and descriptions are from Field, 2009.

APPENDIX H

PRENATAL DEPRESSION AND DEMOGRAPHIC RISK FACTORS

Author	Sample Size	Mean Age	Ethnicity/ Race	Income	Marital Status	Findings
Dayan et al. (2006)	681	28.5	Unknown	Unknown	89% married	Age and marital status not related to depression.
Diego, Field, & Hernandez-Reif (2005)	80	27	46% Hispanic 27% Black 16% White 11% Asian	Unknown	64% married	Age, marital status, and race not related to depression.
Glazier et al., (2004)	2,052	30.7	Unknown	35.6% >$70,000	89.7% married	Age and income related to depression.
Hart & McMahon, (2006)	53	31.24	Unknown	Unknown	94% married	Age not related to depression.
Holzman et al. (2006)	1,321	15% <20 56% 20-29 29% >30	69% White 25% African American 6% Other	54% Medicaid	52% married	Teens and disadvantaged more likely to be depressed.
Kim et al. (2006)	154	25	32% African American 31% Hispanic 15% White 10% African 7% Native American	Unknown	62% married	Marital status related to depression.
Lindgren, (2001)	252	29.5	77% White 13% Black 10% Other	44% < $30,000 56% >$30,001	72% married	Age, marital status, and income related to depression. Minority women had higher depression scores (not indicated if significant).

Marcus et al. (2003)	3,742	28.6	73% White 13% African American 6% Asian American 2% Hispanic 3% Other	Unknown	74% married	Marital status related to depression, age and race not related to depression.
Orr et al. (2006)	1163	20% <20 years	70% Black 30% White	68% Medicaid 6% Uninsured	44% married	Age, race, and marital status related to depression.
Rubertsson et al. (2005)	2,674	Unknown	Unknown	Unknown	Unknown	Age and marital status related to depression.
Steer et al. (1992)	712	323 teens (mean age 15.0) 389 adults (mean age 21.59)	62.2% Black 28.6% Hispanic 18.5% White	Unknown	11% married	Age related to depression.
Sleath et al. (2005)	73	23.6	25% White 25% African American 23% Hispanic	Unknown	Unknown	Race not related to depression.
Westdahl et al. (2007)	1,047	20.42	80% African American 13% Hispanic 7% White	Unknown	70% in relationship	Age and marital status related to depression.

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VITA

Mary Alice Byrn graduated with her Bachelor of Science in Nursing from Hope College, Holland Michigan in 2002. She began her nursing career at Children's Memorial Hospital on a pediatric neurosurgery unit. From 2003 to 2007, Mary worked as a Labor and Delivery nurse at Rush University. In 2005, Mary began the BSN to PhD program at Loyola University Chicago. She worked as a teaching assistant with undergraduate students for two years. She was hired as a research assistant in 2007 and has served as project director for two NIH-funded studies examining various treatments for women with type 2 diabetes who have co-morbid depression.

Mary is a member of the Alpha Sigma Nu Honor's Society, Sigma Theta Tau and currently serves as the chair of the Childbearing Research Section in the Midwest Nursing Research Society. She was awarded the dissertation award from Midwest Nursing Research Society for her research. In the past few years, she has co-authored two review papers published in the *Nursing Science Quarterly* and *Issues in Mental Health Nursing*. She also has numerous abstracts published in journals such as *Diabetes* and the *Annals of Behavioral Medicine*.

Mary has presented her research as the Midwest Nursing Research Society, Loyola University Chicago Graduate Research Symposium, and University of Chicago Diabetes Day.

Mary has mentored many undergraduate students and was involved in the Research Mentoring Program at Loyola University Chicago. Mary has given multiple guest lectures to undergraduate, Master's and PhD students. She plans to start a faculty position at Saint Mary's College in the fall.