2009

THE IMPACT OF INFANT ADMISSION TO SPECIALIZED CARE ON THE TRAJECTORIES OF MATERNAL DEPRESSIVE SYMPTOMS

Kristine Sharpe
Western University

THE IMPACT OF INFANT ADMISSION TO SPECIALIZED CARE ON THE TRAJECTORIES OF MATERNAL DEPRESSIVE SYMPTOMS

(Spine title: Infant admission to specialized care & maternal depression)

(Thesis format: Monograph)

by

Kristine Sharpe

Graduate Program in
Epidemiology and Biostatistics

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science

School of Graduate and Postdoctoral Studies
The University of Western Ontario
London, Ontario, Canada

ABSTRACT

Depressive symptoms persisting from pregnancy to postpartum are a significant health concern for both mother and child. This thesis aims to elucidate the impact of neonatal admission to specialized care on trajectories of maternal depressive symptoms in a cohort of women from London, Ontario. We hypothesized that women giving birth to infants subsequently admitted to specialized care at birth were at higher risk for experiencing an increase in depressive symptoms from pregnancy to 2 years postpartum.

Data were collected from the Prenatal Health Project at the University of Western Ontario. Univariable and multivariable regression models were used to determine the relationship between infant admission to specialized care and trajectories of depressive symptoms.

Depression in pregnancy, lower current stress, higher current social support and higher current child health were associated with depressive symptoms that decrease from pregnancy to postpartum. Infant admission to specialized care was not significantly associated with trajectories of maternal depression.

Key words: *depression, prenatal depression, pregnancy, specialized care, infant health*

ACKNOWLEDGEMENTS

I would first like to express my sincerest gratitude to my supervisor Dr. Karen Campbell for her support, direction and understanding. Thank you for always being available to me and for your kindness, it will never be forgotten.

I am also grateful to my advisory committee, Dr. William Avison and Dr. Verinder Sharma, thank you for your expertise and for all your helpful suggestions.

My epidemiology colleagues, especially Brie Yama, Erin Graves and Su Yuan, were invaluable to the completion of this thesis. Thank you for your help with SAS, for listening to all my problems and most of all for your camaraderie. You have made the last year and a half a pleasure.

This thesis would not have been possible without the love and support from my family, especially my parents, Brian and Donna Sharpe, and my soon-to-be husband, Marcus Van Aarsen. Thank you for believing in me, for keeping me motivated and for your never-ending encouragement.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVATIONS

BMI	Body Mass Index
CES-D	Center for Epidemiologic Studies Depression Scale
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders
EPDS	Edinburgh Postnatal Depression Scale
FS II (R)	Functional Status II-R
MAO	Monoamine Oxidase
MDD	Major Depressive Disorder
NICU	Neonatal Intensive Care Unit
PCCU	Paediatric Critical Care Unit
PHP	Prenatal Health Project
SES	Socioeconomic Status
SSRI	Selective Serotonin Reuptake Inhibitor

CHAPTER 1: BACKGROUND AND SIGNIFICANCE OF MATERNAL DEPRESSION

The time during and after pregnancy is often viewed as a period of emotional well-being for a mother. However, depression in pregnant and new mothers is emerging as a major public health concern. The highest rates of depression are seen in women in their childbearing years[1]. The effect of this disease, and its treatment, on the child's physical and mental development has been well documented. Depression and the medications used to treat depression in pregnant women have been known to cause spontaneous abortions, physical malformations, growth defects, neonatal behavioural syndrome and lower psychomotor development[2].

The Public Heath Agency of Canada has estimated the population prevalence of depression at 10% for pregnant Canadian women[3]. This estimate is consistent with other studies[4,5]. Postpartum depression is estimated to affect between 3% and 20% of women after childbirth[6]. The rates of antepartum and postpartum depression are magnified in various vulnerable communities, such as poor urban communities[2]. A knowledge gap in maternal depression research exists, since studies tend to focus mostly on clinical depression and fail to include the impact of elevated depressive symptomatology in their analysis.

Most studies that have examined the trajectories of maternal depression from pregnancy to postpartum have concluded that the severity of depressive symptoms peak in pregnancy and then decrease after childbirth[7,8]. This is interesting since much emphasis is placed on postpartum depression when in reality, it may be more appropriate to screen women for depression in late pregnancy. Therefore, it is important to determine

the course of maternal depressive symptoms to determine the best point for screening and intervention.

Risk factors for depression in pregnancy and postpartum are well researched. The literature suggests that the strongest risk factor for depression in pregnancy or postpartum is a history of depression[4,9,10,11,12]. Also, women who are depressed in the antenatal period are more likely to be depressed postpartum[9]. Other important risk factors for depression include lack of social support, parity, increased weight, anxiety, stress, smoking, younger age, mothers' chronic disease, refusal to breastfeed, and thyroid dysfunction[9,10,12,13,14,15,16,17,18,19].

Child health is also an important risk factor for depression. Studies have shown that women who give birth to a fragile child and those who have children with health problems in infancy are at an increased risk for depression[4,18,20,21,22]. These studies use a variety of indicators of child health such as low birth weight, preterm birth, admission to the Neonatal Intensive Care Unit (NICU) or low apgar scores. A methodologic concern with these studies is that screening for depression occurred only after the birth of the child and no prenatal screening was performed[20,22]. Therefore, temporality is an issue as they cannot determine if depression preceded the birth of the fragile child or vice versa.

The effects of depression on child development have been well documented. Depression during pregnancy and postpartum has been shown to be associated with hyperactivity, autism and the relationship between the mother and child[2]. Children born to depressed parents are also at a very high risk of becoming depressed themselves[23]. Infants born preterm, low birth weight, or admitted to a NICU are already at risk for certain health conditions. This vulnerable population of children may be more susceptible

to the effects of maternal depressive symptoms at all points during pregnancy and after birth. For this reason, the trajectories of maternal depression need to be studied for women giving birth to a fragile child in order to document course, severity and best potential points for screening and intervention.

This thesis aims to elucidate the trajectories of maternal depressive symptoms and to determine the difference in trajectories for women whose infants were admitted to a specialized care unit at birth in relation to women who gave birth to a healthy infant. This will be done using data from a cohort of women from London, Ontario.

CHAPTER 2: LITERATURE REVIEW

2.1 Clinical Depression Versus Depressive Symptomatology

From *The Diagnostic and Statistical Manual of Mental Disorders,* fourth edition (DSM-IV)[24], a major depressive disorder (MDD) can be diagnosed when patients have four of nine symptoms (sleep disturbance, guilt, low energy, impaired concentration or decision making, appetite disturbance, psychomotor activation or retardation, low self-esteem, feelings of hopelessness and worthlessness and suicidal ideation) as well as experiencing 2 weeks of dysphoric mood or lack of interest or pleasure in usual activities[24].

Antepartum depression, defined as clinical depression occurring during pregnancy, is equivalent to a MDD. It is a strong predictor of postpartum depression[2]. Postpartum depression can be broken into two categories: postpartum blues; and postpartum major depression. Unlike postpartum major depression, postpartum blues do not interfere with maternal functioning and can be part of normal adjustment to the birth of a child. However, it must be noted that approximately 25% of women with postpartum blues will develop postpartum major depression[2]. Postpartum major depression can be diagnosed using the DSM-IV criteria for a major depressive episode with the additional requirement that symptoms must be during the first 4 weeks after the birth of a child.

To measure depressive symptomatology, self-report measures are available, such as the Edinburgh Postnatal Depression Scale (EPDS) or the Center for Epidemiologic Studies Depression Scale (CES-D) that do not diagnose clinical depression but determine which women are at an elevated risk for clinical depression[25,26]. These scales are an

important tool for identifying mothers with increased depressive symptomatology who are at risk for clinical depression.

2.2 Course of Depression Over Time

Studies have also researched the trajectories of maternal depression from pregnancy to postpartum. Many studies have concluded that depressive symptoms are higher in pregnancy and decline in the postpartum period[7,10,27,28]. A prospective cohort study of 1,662 women by Rich Edwards and colleagues[4] found that the prevalence of depression was higher at 28 weeks pregnancy then at 6 months postpartum. They also determined that for their cohort, the strongest risk factor for depression in the postpartum period was depression in pregnancy. Seimyr and colleagues[29] had women complete the EPDS in late pregnancy and at 2 months and 1 year postpartum and found that EDPS score was highest in pregnancy and declined at the postpartum assessments.

As mentioned in chapter 1, some studies suggest that depression in the postpartum period is a continuation of depressive symptoms from the prenatal period[30]. This finding is consistent with other researchers, who found that a large percentage of women with high depression scores in pregnancy continued to have a high depression scores postpartum[15,31]. A similar study conducted by Lee and colleagues[8] of 357 women from an antenatal clinic in Hong Kong also found that depression in pregnancy predicted depression in the postpartum period.

2.3 Impact of Depression on Child Health

Maternal depression can have a significant effect on a variety of child health and development characteristics. Depression during pregnancy and postpartum has been shown to impact chid behaviour, autism, depression in the child and the bond between the mother and child[23,32]. Deave and colleagues[33] in a prospective cohort study of 9,244 participants found that children of persistently depressed mothers were at risk for developmental delay. Stein and colleagues[34] found that depression in the postnatal period negatively effects maternal care giving. In a study conducted by Schwebel and colleagues[35] of 1,364 women it was determined that chronic maternal depression was a very strong predictor of child injury risk.

2.4 Risk Factors for Depression in Pregnancy and Postpartum

Risk factors for depression in pregnancy and postpartum are well researched and considered similar for both time periods. The risk factors for the relationship between infant admission to specialized care and maternal depressive symptoms are discussed below.

2.4.1 Age

The average childbearing age has risen from 27.0 to 29.3 in the last 20 years[36]. Statistics Canada[36] has shown that the fertility rate is declining for women in their 20's and increasing for women in their 30's. In a recent hospital based data-analysis by Delpisheh and colleagues[37], hospital records were examined in order to determine birth outcomes in older women. A significant association was found between advanced

maternal age and low birth weight birth, preterm birth and very preterm birth. Advanced maternal age has also been associated with chromosomal abnormalities in the fetus[38]. Younger maternal age has also been associated with poor child outcomes in birth. A study conducted by Fraser and colleagues[39] concluded that teenage mothers had a significantly higher risk of giving birth to an infant who is low birth weight, premature or small for gestational age.

Age has also been associated with the intention to breastfeed and the duration of breastfeeding which in turn has been linked to depression. A prospective cohort study of 1,745 women in Australia by Henderson and colleagues[40] found a significant association between maternal age and breastfeeding duration, showing that younger mothers breastfeed for a much shorter duration than older mothers. A similar cohort study of 2,420 women in Australia also found that younger maternal age is significantly associated with early cessation of breastfeeding. Numerous other studies have also found the same results; older mothers are more likely to breastfeed for a longer duration than younger mothers[41,42,43].

The research regarding the effect of age on maternal depressive symptoms is consistent over the literature. The majority of studies conclude that younger maternal age is associated with increased depressive symptoms in pregnancy and postpartum[4,44,45,46,47]. A cross-sectional study of 1,359 women in the United States concluded that younger age was significantly associated with increased depressive symptoms, as measured by the EPDS[48]. A prospective cohort study of 1,662 women by Rich-Edwards and colleagues[4] concluded that young maternal age was associated with a greater risk of antenatal and

postpartum depressive symptoms. However, this association was largely attributable to financial hardship, unwanted pregnancy and single marital status.

Maternal age has also been linked to the trajectories of maternal depressive symptoms. A study by Campbell and colleagues[49] examined the trajectories of maternal depression from child birth to child age 7 in a cohort of 1,261 women. It was determined that the trajectories of maternal depression differed by age; women with low-stable depressive symptoms were older compared to all other trajectory groups including the high-chronic trajectory.

2.4.2 Body Mass Index

Obesity in pregnancy is associated with a variety of negative outcomes for the infant and mother. A study conducted by Raatikainen and colleagues[50] of 25,601 pregnancies was done in Finland in order to elucidate the relationship between body mass index (BMI) and infant birth outcome. This study determined that there was a significant association between obese and overweight pregnancies and medical complications of pregnancy such as preeclampsia and chorioamnionitis. Also, obese and overweight pregnancies were significantly associated with infant low apgar scores at 5 minutes and infant admission to NICU. This is consistent with another cohort study conducted at McGill University[51] which concluded that increasing maternal BMI was associated with an increased risk of adverse pregnancy outcomes for the mother such as preeclampsia, gestational hypertension and gestational diabetes, as well as adverse outcome for the child such as antenatal admission and preterm birth.

Maternal BMI has also been associated with infant weight at birth. A study conducted by Fredrick and colleagues[52] found that maternal pre-pregnancy BMI was significantly, and positively, associated with infant birth weight. In this study, gestational weight gain was also positively associated with infant birth weight.

Research regarding the effect of BMI on maternal depressive symptomatology suggests that women who are unhappy with their body image are more likely to report increased depressive symptomatology in pregnancy and postpartum[53,54]. A study conducted by LaCoursiere et al[16] of 3,439 women found that women of normal BMI had the lowest rate of postpartum depressive symptoms by a self-report measure. Carter and colleagues[55] came to a similar conclusion. Overweight and obese women were at an increased risk for increased depressive symptoms at 4 and 14 months postpartum.

There is an issue of temporality that needs to be elucidated in future studies. Although there is evidence suggesting that BMI is a significant predictor of depressive symptomatology in pregnancy and postpartum, there is also evidence suggesting that maternal depression is a significant predictor of BMI. Therefore, without additional time points, it is difficult to determine if increased weight or increased depressive symptoms came first.

2.4.3 Thyroid Conditions

There are two main types of thyroid conditions; hyperthyroidism and hypothyroidism. Hyperthyroidism occurs when the serum thyroid hormones are increased and the thyroid gland is overactive. Hyperthyroidism can cause weight loss, anxiety, nervousness and a variety of other clinical symptoms. Hypothyroidism occurs when the

serum thyroid hormones are decreased and the thyroid gland is under active. Hypothyroidism can cause weight gain, constipation, decreased appetite and a variety of other clinical symptoms[56].

Thyroid problems in pregnancy can have a negative effect on the newborn infant. In a review by Lao[57] it was determined that hyperthyroidism in pregnancy can have an affect on a number of newborn outcomes such as preterm labour, fetal growth restriction and perinatal mortality, as well as a number of maternal characteristics such as preeclampsia and maternal mortality. In the same review article, it was shown that hypothyroidism is associated with poor maternal outcomes such as increased risk of miscarriage, preeclampsia and anaemia as well as a variety of poor infant outcomes such as fetal growth restriction, perinatal mortality and neonatal morbidity.

From a review of the literature, thyroid function emerged as a risk factor for increased depressive symptomatology. A review conducted by Moses-Kolko[2] stated thyroid function as a risk factor for increasing antepartum depressive symptoms. This is consistent with other research such as that of Pedersen and colleagues[58] who concluded that mean thyroxine concentrations were negatively and significantly correlated with mean depression scores postpartum.

2.4.4 Maternal Smoking

Maternal smoking before and during pregnancy is a significant health concern for both the mother and child. A case-control study conducted by Burguet and colleagues[59] of 864 women and their infants concluded that smokers were statistically more likely to give birth to very preterm infants compared to non-smokers. In a cross-sectional study of

4,193 women in Portugal, it was determined that women who smoked were at an increased risk of having a small for gestational age child[60]. These results were consistent in other studies[61,62]. Prenatal smoking has also been shown to elevate the risk of placenta previa and premature rupture of membranes[63].

Consistent results were found from the literature review concerning the effect of smoking on maternal depressive symptomatology in both pregnancy and postpartum. In a study by Marcus and colleagues[64] of 3,472 pregnant women, it was determined that smoking in pregnancy was significantly associated with increased depressive symptoms in pregnancy. This is consistent with other research in the postpartum period[65,66,67,68].

2.4.5 Parity

Parity has been shown to modify the relationship between maternal age and small for gestational age and preterm birth[69]. Other research also suggests that obstetric outcome is influenced by parity in older women, but not younger women[70].

In both pregnancy and postpartum, having an increased parity is a risk factor for depression. A prospective cohort study by Rubertsson and colleagues[15] of 2,430 women showed that having 3 or more children was significantly associated with depressive symptoms in both pregnancy and postpartum periods. In a cross-sectional study by Mayberry and colleagues[48] of 1,359 women, it was determined that there was a significant positive association with depressive symptom severity as measured by the EPDS. In a similar cross-sectional study of 139 women in pregnancy, it was determined that there was a positive correlation between gravida and depressive symptoms as measured by the CES-D[71]. This finding is consistent with other studies[13,67].

2.4.6 Maternal Chronic Disease

The Public Health Agency of Canada[72] lists six types of chronic disease; cancers (such as breast cancer and cervical cancer), cardiovascular disease, chronic respiratory disease (such as asthma), diabetes, mental illness and musculoskeletal diseases (such as arthritis). These diseases can have a negative effect on the mother in everyday life including the care of her child. They can also have a negative effect on the health of the child.

In a cross-sectional study of 1,040 women in the United States, it was determined that there was a positive association between preterm delivery and diabetes, as well as a positive association between preterm delivery and cardiovascular disease[73]. A study of 182 women in the United Kingdom found that infants born to mothers with Type 2 diabetes had an 11 times greater risk of congenital malformation[74].

In a report from the 1999 National Population Health Survey, the risk factors for depression in a Canadian population were examined. In this survey, it was determined that chronic health problems are a risk factor for depression in Canadian women[1]. Other research regarding the relationship between maternal chronic disease and maternal depression has shown that in both pregnancy and postpartum, women with chronic health conditions or a poor self-rating of health are at an increased risk for depression[19,75]. In a study conducted by Larsson and colleagues[31] of 1,489 women, it was determined that multiparas with elevated depressive symptoms in the antepartum period were more likely to have a chronic disease than women without elevated depressive symptoms. A study conducted by Marcus and colleagues[64] found a similar result. Poorer overall health was

found to be significantly associated with depressive symptoms as measured by the CES-D.

2.4.7 Stress

For a pregnant woman, some stress is to be expected. However, some women experience extreme stress in pregnancy and postpartum. In the literature regarding the association between stress and depression, results are consistent that increased stress is associated with increased depressive symptoms[18,47,76]. Stress in pregnancy can adversely affect the subsequent development and behaviour of the child. It has been shown to affect an infant's sleep pattern[77], and also negatively affect a child's intelligence score[78].

There are many different types of stress that may affect a soon-to-be or new mother. In a meta-analysis of 84 studies done by Beck[79], found that stress was a significant predictor of maternal depression postpartum. The types of stress found in this study were childcare stress and life stress. This is consistent with a longitudinal descriptive study by Miles and colleagues[17] which found that stress about the parental role was a significant predictor of depression. In a study conducted by Eberhard-Gran and colleagues[12] of 2,730 women, it was determined that high scores on the life event scale were associated with depression in both the pregnancy and postpartum period as measured by the EPDS.

2.4.8 Breastfeeding

The positive effect of breastfeeding on child health and well-being has been well documented. In Canada, breastfeeding is recommended as the optimal method of infant

feeding. Health Canada suggests that women breastfeed their children for at least 6 months and up to 2 years. Breastfeeding protects against infection for the child[80] and lowers the risk of Sudden Infant Death Syndrome[81]. Also, children who were exclusively breastfed were less likely to experience respiratory or ear infections than those experiencing other feeding combinations[82]. Breastfeeding has been known to positively affect cognitive development[83].

Breast milk may have greater importance for infants who are admitted to a specialized care unit. Although some infants admitted to a specialized care unit may be unable to breastfeed due to preterm birth or other medical issues, many infants in specialized care units are fed breast milk by tube that goes directly into their stomach. Increased ingestion of breast milk has been associated with higher Bayley Mental Developmental Index scores and fewer rehospitalizations up to 30 months after discharge in an NICU cohort[84].

Breastfeeding also has a positive impact on the health and wellness of the mother. Breastfeeding has been associated with lower postpartum weight retention[85] and greater mother-child attachment[86]. One of the most important positive aspects of breastfeeding is its effect on maternal depressive symptoms. The literature shows that women who did not breastfeed are at an increased risk of developing depression[12,45]. In a cohort study conducted by Davey and colleagues[87] of 1,403 Canadian women, it was determined that not breastfeeding at 8 weeks postpartum increased the risk of postpartum depression as measured by the EPDS. In a similar study conducted by Breese-McCoy and colleagues[65] of 209 women in the United States, it was determined that formula feeding instead of

breastfeeding was a significant risk factor for having increased depressive symptoms as measured by the EPDS.

Again, temporality is an issue in these studies. In a study conducted with 1,745 postnatal women by Henderson and colleagues[40] in Australia, it was shown that maternal depression had a significant negative impact on the duration of breastfeeding. Therefore, it is possible that the depression in the postpartum period found in these studies are a continuation of symptoms from pregnancy and due to the depressive symptoms, a mother makes the choice not to breastfeed.

2.4.9 Socioeconomic Status

Socioeconomic status (SES) is a difficult variable to capture. It can be determined using income, education, employment and a variety of other variables. It can also be calculated using a composite score of 2 or more of these variables. Income and education are two primary indicators of SES. Both income and education have been shown in the literature to have an impact on depressive symptoms.

SES has been associated with infant birth outcome. In a cohort study conducted by Luo and colleagues[88] of 713,950 women in Quebec, it was determined that low levels of neighbourhood income was associated with an elevated risk of preterm birth and small for gestational age birth (SGA). This is consistent with other Canadian research done in Halifax, which concluded that women in the lowest income group had significantly higher rates of preterm birth and small for gestational age birth[89].

The relationship between income and depressive symptoms is consistent in the literature. Women with a lower income are more at risk for increased depressive

symptoms[13,14,29,48,67,75,90,91]. Not only is income associated with depression at a single time point in the postpartum period, it may also be a significant predictor of the persistence of maternal depression over time. In a cohort study of 2,235 mothers by Pascoe and colleagues[92] found that indigence (poverty) was a risk factor for persistent positive CES-D score.

Like income, the literature consistently shows that lower education is associated with increased depressive symptoms in pregnancy and postpartum[14,15,18,45,46,48,64,68,75]. A recent prospective cohort study of 810 pregnant women by Field and colleagues[44] found that depressed women had a significantly lower education level.

2.4.10 Current Marital Status

Single marital status has been shown to be significantly associated with depression in pregnancy and postpartum[15]. In a meta-analysis of 84 studies, Beck[79] concluded that single marital status was a significant predictor of postpartum depression. This result is consistent in the literature[8,17,45].

The relationship between marital satisfaction and depression in pregnancy and postpartum has also been discussed in the literature. Marital dissatisfaction is significantly associated with depression in pregnancy and postpartum[47,71,93]. The aforementioned cohort study, by Pascoe and colleagues[92] also cited never being married or divorced as a risk factor for persistent positive CES-D score.

A secondary analysis of the 1994-95 Canadian National Population Health Survey determined in a bivariate analysis that single mothers were more likely to have had an episode of depression when compared to married mothers. However the multivariate

analysis showed that almost half of this association could be explained by stress and social support[94].

2.4.11 Current Antidepressant Use

For the pharmacological treatment of depression, there are 3 major categories of antidepressants: Tricyclics, monoamine oxidase (MAO) inhibitors and selective serotonin reuptake inhibitors (SSRIs). MAO inhibitors and SSRIs work by increasing in the brain the activity of serotonin and norepinephrine, two excitatory neurotransmitters. Tricyclics work in a similar fashion by preventing the reuptake of these excitatory neurotransmitters to allow them to continue working in the brain. All of these medications work to decrease the feeling of depression, however side effects exist, some more severe than others[95].

In a study of 103 mothers with postpartum mood disorders, it was determined that mothers who were compliant with treatment were more likely to have a decrease in depressive symptoms as measured by the EPDS[96]. In a review article by Gjerdingen[97] a similar result was found. Women with postpartum depression have an improvement in symptoms when antidepressant therapy is prescribed.

Antidepressants are often taken by depressed mothers in the postpartum period while continuing to breastfeed. Antidepressants must be taken with caution when still breastfeeding in order to protect the health of the child[98].

In a meta-analysis by Lattimore et al[99], researchers outlined the effects of SSRI use in breastfeeding mothers on the child. Poor sleep, irritability and poor feeding were the most commonly reported infant issues.

2.4.12 Current Maternal Social Support

Social support can come from a variety of places such as a spouse or partner, family, friends, communities or a combination of these. The literature regarding the association between social support and depression is very consistent. Studies show that low levels of social support predict depression in the postpartum period[2,29,79,100]. A cohort study conducted by Horwitz and colleagues[75] of 1,788 women in Connecticut found that low social support was statistically related to elevated depressive symptoms. In a similar study conducted in Australia of 425 women, it was determined that unsatisfactory social support was associated with a significantly increased risk of postnatal depression as measured by the EPDS[47].

An important risk factor for depression in the postnatal period is a mother's support from her partner. In a large prospective cohort study by Milgrom and colleagues[101] antenatal social support was found to be a key risk factor for postnatal depression. This is consistent with other research regarding partner support such as that of Seimyr and colleagues[29] which concluded that women with low social support from their partner had increased symptoms of depressed mood.

2.4.13 Current Child Health Status

Child health can be measured in a variety of ways such as standardized scales, number of child visits to primary care or even mother's self-report perception of child health. The literature regarding the effect of child health on maternal depression is mixed. This could be in part due to the many ways that child health can be characterized.

Maternal depression has been correlated with infant health problems[20]. In a cohort study by Mandl and colleagues[22] of 1,015 women at 3 and 8 weeks postpartum, women whose children had one or more emergency room visit were more likely to have increased depressive symptoms. This is consistent with other research[102]. The chronicity of maternal depression has been linked to increased child behaviour problems[103].

There is also a large body of research that suggests that depressed women may perceive their child as more fragile and may rate their child as more vulnerable[104]. Therefore, it is possible that maternal depression is the cause of increased child health problems or increased health care visits making temporality an issue.

2.4.14 Infant Admission to Specialized Care at Birth

The admission of a child to a specialized care unit such as a NICU can be a very stressful experience for a mother. A child can be admitted to one of theses units for reasons such as preterm birth, being small for gestational age and a variety of other serious medical problems. When an infant is admitted to a specialized care unit, the mother has the additional stress of being separated from her child, worry about the health of their child and perhaps even worry about caring for the child once released home[105].

There are studies which suggest that mothers of very low birth weight or preterm infants reported significantly higher levels of distress compared to term infant mothers in the postpartum period[106,107]. A study conducted by Drewett and colleagues[108] of 12,391 mother and infants in the United Kingdom found that high maternal depression scores as measured by the EPDS were significantly associated with preterm births. However there

are also studies which suggest that the psychosocial health of parents with children admitted to the NICU or preterm infants did not differ from parents of healthy children[46].

The issue of temporality also arises when discussing the impact of infant admission to specialized care at birth on maternal depression. It is unclear if depression preceded the child health problem or vice versa.

The mixed results found in the literature suggest that further research is needed in order to elucidate the relationship between infant admission to specialized care at birth and maternal mental health.

2.5 Literature Summary and Conceptual Model Development

From the literature review discussed above, a conceptual model was created to guide this study (Figure 2.1). This model displays the exposure-disease relationship of interest in this study which is the association between infant admission to specialized care and the change in maternal depressive symptoms from pregnancy to the postpartum period. The conceptual model was arranged according to the timeframe of the longitudinal cohort.

The baseline variables (age, BMI, thyroid function, smoking, parity and chronic disease) are appropriately found only once, at the far left of the conceptual model. Stress is believed to have a very important and dynamic impact on depression according to the literature. Therefore we believe stress must be present in the conceptual model at both time points in order to accurately illustrate its effect. It is very possible that "current" stress level is a mediator for the relationship between infant admission to specialized care and the trajectory of maternal depressive symptoms.

Marital status, SES, social support and antidepressant use are variables found at the far right of the conceptual model. We believe that the current status of these variables would have more of an impact on the change in depressive symptoms from pregnancy to postpartum and are unlikely to change greatly from their status in pregnancy. Infant admission to specialized care, breastfeeding and child health status are variables that can only be obtained after the birth of the child and can be found at the far right of the conceptual model.

The change in depressive symptom score from pregnancy to postpartum (Delta CES-D) was chosen as the outcome variable; as we are not simply interested in the effect of infant admission to specialized care on the depressive symptom score at one time point. Of greater interest in this study is how infant admission to specialized care can impact the change in depressive symptom scores over time.

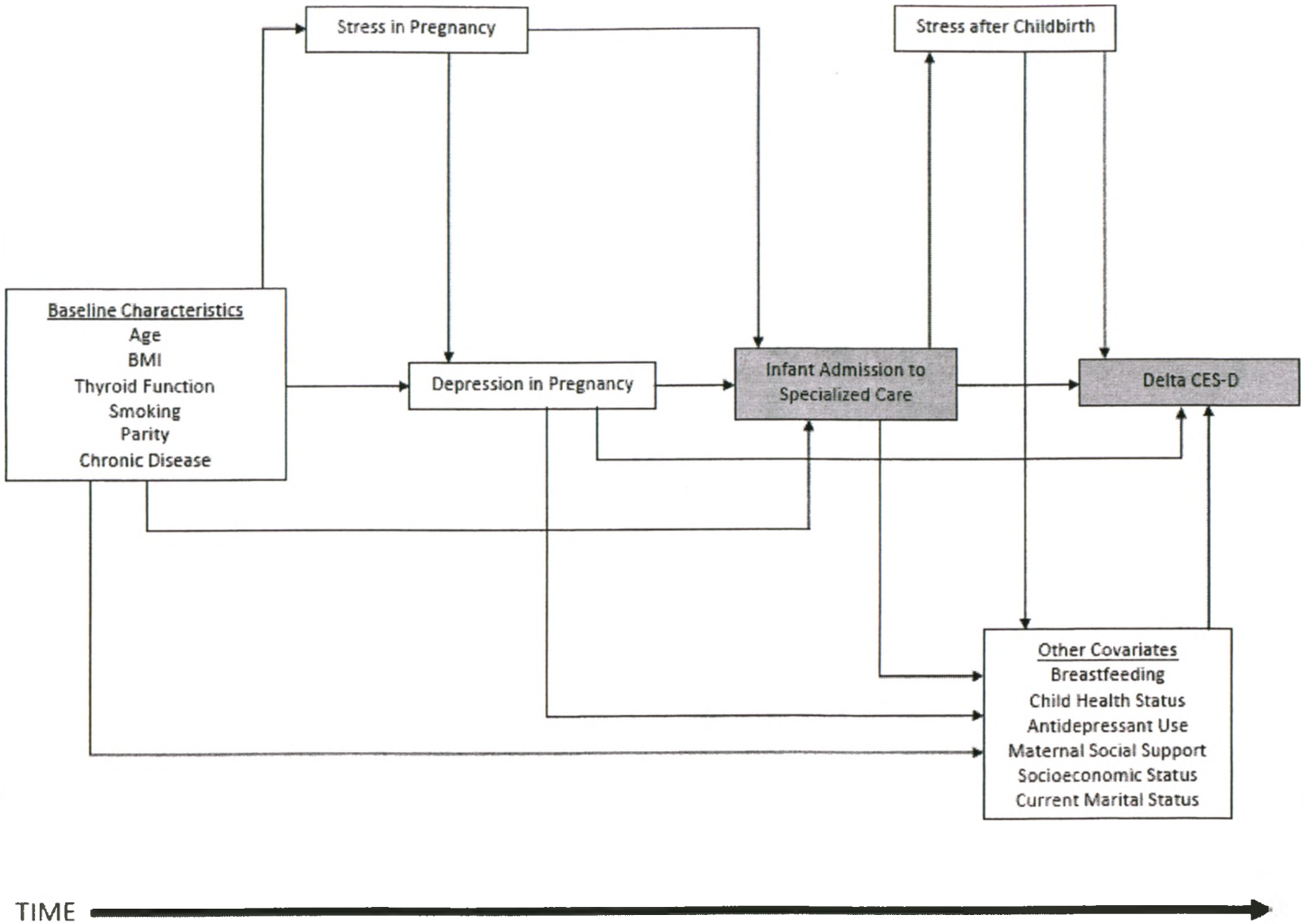

Figure 2.1: Conceptual model based on literature review

CHAPTER 3: OBJECTIVES AND HYPOTHESES

Based on the literature review, a conceptual model was formulated (Figure 2.1) to illustrate the hypothesized association between infant admission to specialized care and the trajectory of maternal depression. Specific objectives and hypotheses are stated below.

3.1 Rationale

The exact mechanism that causes depression is unknown but it is believed that several factors combine to make an individual more susceptible to depression. The factors believed to contribute to the onset of depression are biological, genetic and environmental. Biological factors include changes in brain chemistry such as fluctuating hormones and genetic factors include gene alterations such as a polymorphism in the serotonin transporter gene. As discussed previously in chapter 2, stress has been identified as an important environmental risk factor for depression. Specific genes have been found to moderate the relationship between stressful life events and depression, making certain individuals who carry the polymorphism more susceptible to depression[108]. Stress has also been shown to cause hormonal changes which mimic the hormonal changes found in depressed individuals[109]. There is also consistent evidence which shows an association between exposure to stressful life events and a subsequent episode of major depression[110].

We believe that the admission to specialized care of an infant is an appropriate proxy for child health at birth and is a more accurate measure than gestation at birth or birth weight as it will allow us to include babies of normal weight and gestation who have

medical problems that affect their health at birth. More importantly, we believe that infant admission to specialized care at birth is an important stressor that will affect a mother's mental health not simply due to child health but also the separation of the child from the mother. We believe that due to these reasons, infant admission to specialized care will contribute to the change maternal depressive symptoms from pregnancy to the 2+ year follow-up.

3.2 Objectives

Within the context of the conceptual model, the objectives of this study were:

1) To determine the trajectory of maternal depressive symptoms from pregnancy to the 2+ year follow-up interview for women who participated in both the Prenatal and Postnatal Health Projects at the University of Western Ontario
2) To examine how giving birth to a child admitted to specialized care at birth influences the trajectory of maternal depressive symptoms
3) To discuss these results in relation to screening policies to evaluate the best possible point for screening and delivery of mental health services

3.3 Hypothesis

The hypothesis for this study was:

1) Women giving birth to an infant who is admitted to specialized care at birth would be at higher risk for a trajectory of maternal depressive symptoms that increase from pregnancy to greater than 2 years postpartum after controlling for known confounders

3.4 Statement of Clarity

The outcome variable of interest in this thesis is the change in maternal depressive symptom score from pregnancy to the postpartum interview. In the body of this thesis, the change score will be referred to as the "trajectory" of maternal depressive symptoms.

CHAPTER 4: METHODS

A secondary data analysis was performed using data previously obtained from the Prenatal Health Project (PHP), a longitudinal cohort study funded by Canadian Institutes of Health Research. Grants for the PHP were obtained by principal investigator Dr. Martha Karen Campbell at the University of Western Ontario[112,113].

4.1 Prenatal Health Project

The first wave of data collection assembled a population based cohort. Women were recruited from ultrasound clinics in London, Ontario at 14-20 weeks gestation with a singleton pregnancy. Excluded were women who were not residents of London, Ontario. This was done because many women who live outside of London are referred to London clinics for care due to high-risk pregnancies. Including these women would distort prevalence estimates and other analyses. Subjects were asked after their ultrasound by an x-ray technician if they would be willing to speak to a research assistant. When consent was given, the research assistant explained the study, answered any questions the participant may have and asked if they would consent to a one-hour telephone interview. Participants who agreed were contacted a week later by phone to complete the interview. Interviewers recorded responses on scantron sheets, which were then scanned into the database program Microsoft Access and in turn were relocated into the statistical program SAS. The PHP had the objective of obtaining information to aid in the understanding of the mechanisms of preterm birth. This project collected a broad array of data including demographic characteristics, medical information, social measures and nutritional data, as well as information regarding obstetrical complications and birth outcome from a review

of the mother and infants' charts. From this first wave of data collection, we utilized data collected on the child such as admission to specialized care at birth.

During the first wave of data collection, participants were informed that they might be contacted in the future to participate in a follow-up study[112]. In a subsequent wave of follow-up post-natally, PHP participants were re-contacted approximately 24 months after the birth of their child. Participants were contacted by telephone and asked to participate in a follow-up one-hour telephone interview at a time convenient for them. Again, interviewers recorded responses onto a paper copy of the survey which was entered into a secured online database and then transferred to SAS. The objective of the postnatal follow-up wave of data collection was to extend the PHP in order to investigate the prenatal and postnatal determinants of maternal and child outcomes as well as health services utilization for both mother and child. The second objective of this study was to discover life course trajectories of numerous outcomes in the prospective cohort. Data collected from this study included child health measures and measures of mothers' mental health, as well as information regarding maternal lifestyle characteristics. From this study, data utilized will include the maternal CES-D score in pregnancy and postpartum to create the outcome variable of delta CES-D (the trajectory of maternal depressive symptoms), as well as information regarding potential confounders such as level of social support, stress level and child health.

The outcome variable to be used is the change in CES-D score from pregnancy to the 2+ year follow-up, which will measure mothers' depressive symptomatology. The change in CES-D score between these two time points will be referred to as the "trajectory" of maternal depression.

Data from both waves of data collection will be used to examine the trajectory of maternal depressive symptoms from pregnancy to the 2 year follow-up interview in relation to the child's admission to specialized care.

4.2 Variables of Interest in This Study

For both waves of data collection, data were collected via a telephone interview by a trained research assistant. Variables for this study were selected from a much larger set of PHP variables because they were elements of the conceptual model. Data collected for each variable are discussed below. Original survey questions and recodes can be seen in Table 4.1.

4.2.1 Maternal Depressive Symptoms

The CES-D scale was used to determine the level of maternal depressive symptomatology in this study. The CES-D is a 20-item scale that measures depressive symptomatology with emphasis on depressed mood[26]. The questionnaire asks how many times in the last week the participant has felt a certain way (e.g. loss of appetite, feelings of guilt and worthlessness). The range of scores is from 0 to 60, with each question being scored from 0 to 3. The CES-D demonstrates excellent discriminant and convergent validity and Cronbach's alpha ranges from 0.84 to 0.94 in the literature[26,114,115,116,117].

Maternal depression scores from both waves of data collection will be used two separate ways in analysis. Maternal depression in pregnancy will be a categorical predictor variable in analysis using a cut off score of 16 to determine women who are at a higher risk of depression as suggested in the literature[26].

The change in CES-D score will be the outcome variable. To create this variable, the CES-D score in pregnancy is subtracted from the score at the follow-up interview in order to create the CES-D change score, the trajectory of maternal depressive symptoms. The outcome variable, change in CES-D score, will remain a continuous variable in analysis in order to utilize linear regression models.

4.2.1.1 Change Scores

It is important to note the choice of change scores for analysis of the trajectory of maternal depressive symptoms from pregnancy to postpartum. For our thesis objectives we are less interested in a before and after analysis, which would require the use of analysis of covariance or fixed effects models. We are most interested in the actual change (increase or decrease) in depressive symptoms over time and the factors that cause this change.

4.2.2 Maternal Health and Lifestyle Variables

Maternal age at time of childbirth was used for every participant. This was determined in the Prenatal Health Project by simply asking for the birth date of the participant. The birth date of the participant was then subtracted from the birth date of the child in order to create the maternal age at delivery variable. For analysis, age was divided into 3 groups; 16-21, 22-34 and 35 or older. The age variable was categorized in this manner for ease of interpretation.

Weight and height were based on participants' reports of their height in inches or centimetres without shoes on and their weight prior to pregnancy in kilograms or pounds.

The estimated pre-pregnancy BMI was then calculated with the standard equation: BMI= weight (kg) / height^2 (m^2). For analysis and ease of interpretation, BMI was recoded into the four standard categories; underweight (BMI < 18.5), normal (BMI 18.5-24.9), overweight (BMI 25.0- 29.9) and obese (BMI >30).

Maternal thyroid function was obtained from two separate questions; if the participant indicated that they were currently suffering from a thyroid condition or if they were currently taking a thyroid medication. This includes medication for both hyperthyroid and hypothyroid conditions. Participants were given a list of chronic health conditions and asked if they currently, or in the past, suffered from any of these conditions. An "other" category was provided for participants to include any other chronic conditions they deemed important. Thyroid disease was determined from the "other" category. Participants were also asked if they took any over-the-counter or prescription medications regularly. If the participant indicated that they were currently taking a thyroid medication they were classified as having a thyroid disease.

Smoking status was determined from subject response to a question which asked participants how many cigarettes smoked currently and before getting pregnant. Both smoking questions yielded counts which were subsequently categorized as binary, yes or no, variables. If the participant indicated that zero cigarettes were smoked, they were categorized as a non-smoker.

Parity was determined by asking the participants the number of completed pregnancies they have had. For analysis, parity was recoded as a binary variable; zero for no other children or one for one or more other children.

The data for chronic disease was obtained by asking participants if they have or have ever had a variety of health conditions such as diabetes, heart disease, cardiovascular disease, or any other medical conditions. If the participant selected the other category, they were asked to specify the medical condition. For this variable, chronic diseases of interest were diabetes, heart disease, high blood pressure, asthma or any other cardiac conditions. We will model chronic disease as a binary yes or no variable.

Education was determined from the first wave of data collection and income was determined from the second wave of data collection. Education was determined by asking the participant for the highest level of formal education they had completed. The response options for this question included elementary school, some high school, completed high school, some college or university, college diploma, university degree, trade school and other. If the other category was selected then further explanation was asked for from the participant. Education was recoded as a binary variable for analysis with response options of high school or less and more education than high school. This was done in order to separate women who have sought post-secondary education from those who have not while also considering sample size.

Income was determined using a closed-ended question with a list of response options. These response options ranged from less than $10,000 to over $80,000. Participants were also given the options of "no income", "don't know" and "refuse to answer". Income was recoded for analysis using the categories of $0-$30,000 and $30,001 or more. This cut point was chosen as it close to the poverty line in Ontario of $25,867 to $31,801 for a household with a family size of two or three[115].

Marital status was determined differently in the two waves of data collection. The first wave of data collection asked participants for their marital status. Response options available to the participant were "married", "common-law", "single", "separated/ divorced" and "widowed". An early version of the follow-up questionnaire asked participants if there had been any change in their marital status since the first wave of data collection. If the respondent indicated that there had been no change, then the marital status variable was coded to the marital status indicated previously. If the respondent indicated that there had been a change in their marital status they were then prompted to give their current marital status. In analysis, marital status was recoded into three categories; "Married", "Common-Law" and "Single/ Separated/ Divorced/ Widowed".

4.2.3 Infant Admission to Specialized Care

Infant admission to specialized care is the exposure of interest in this thesis. During the Prenatal Health Project, infant birth outcome was recorded, which included infant admission to any specialized care units. The specialized care units of interest are the NICU, Pediatric Critical Care Unit (PCCU) and 7 East Nursery.

The NICU is located at St. Joseph's Health Care in London, Ontario. It is a Level III unit and specializes in the care of premature and critically ill infants. The PCCU is located on the Victoria Campus of the London Health Sciences Centre. The PCCU is also responsible for caring for critically ill infants but specialized in children with complex surgical and medical issues. 7 East Nursery is a step down unit for children in the pediatric critical care unit, where children are admitted only if not intubated.

For analysis, infant admission to specialized care was recoded as a binary, yes or no, variable.

4.2.4 Breastfeeding

For this project, we were most interested in the duration of breastfeeding. Information regarding breastfeeding was extracted from the second wave of data collection. Participants were asked how the child was fed at birth, such as breastfeeding or formula. If the child was breastfed, participants were then asked how long the child was breastfed in months. Breastfeeding was recoded as a categorical variable for analysis using the categories "did not breastfeed", "breastfed 0 to 3 months", "breastfed 3 to 6 months" and "breastfed greater than 6 months".

4.2.5 Stress in Pregnancy and Current Stress Level

Stress had multiple measures in both waves of data collection. Stressful life events occurring to the participant during the previous 12-month period were measured using a 40-item checklist of negative events, which were derived from several established life event indices[119,120,121,122]. For 19 of the items, respondents were asked to include events occurring to a husband/partner or children in addition to themselves, and of these, nine items included the possibility of events occurring to relatives or close friends. Chronic strain was measured using 29 items taken from Wheaton's original 51-item scale[123]. These 29 items included chronic strain experienced across several areas, such as family strain, relationship strain, general or ambient strain, and occupational strain. In addition, caregiver strain was assessed using a 7-item scale by Pearlin et al[124] and

economic strain was determined using a 10-item scale developed by Avison[125]. This 10-item scale examined the extent to which respondents had difficulties meeting financial commitments such as housing, childcare and medical expenses. For analyses, stress score was determined by standardizing the seven subscales and then the subscales were summed to create the stress score. The stress score was then standardized and left continuous for analysis. Stress score was calculated in the same fashion for both waves of data collection.

4.2.6 Current Maternal Social Support

Social support data were extracted from the second wave of data collection. Social support was determined by three scales developed by Turner and Marino[126]. They include a 7-item scale regarding support from a husband or partner, an 8-item scale regarding support from family and an 8-item scale regarding support from friends. A series of statements was read to the participant and they indicated whether they "strongly agree", "agree", "neither agree nor disagree", "disagree" or "strongly disagree". For analysis, social support was calculated by the addition of the three subscales which had been standardized. The sum of the scales was then standardized and left continuous.

4.2.7 Maternal Antidepressant Use

Maternal antidepressant use was determined in the second wave of data collection. Participants were asked if they were currently taking any antidepressant medications. For analysis, antidepressant use was coded as a binary, yes or no variable.

4.2.8 Current Child Health Status

Current child health status was determined in the second wave of data collection using the Functional Status II (R) (FS II (R)). The FS II (R) was adapted from the Functional Status I Measure by Stein[127]. For this project, the short 14-item scale was used. This scale has an internal consistency, measured by Cronbach's alpha, of greater than 0.80 and has excellent psychometric properties[127].

The FS II (R) asks a respondent to describe a child's behaviour over the past 2 weeks. Response options include "Never or Rarely", "Some of the Time" and "Almost Always" for statements such as "Over the last 2 weeks did your child... eat well, sleep well, act moody, etc". If the response indicated that the child had behaviours that varied from normal, a follow-up question was asked to determine if the abnormal behaviour was "Fully", "Partly", or "Not At All" due to illness. If the participant indicated that the behaviour was "Not At All" or "Partly" due to illness then the first question was recoded to the normal response. The questions in part one were then scored from 0 to 2, summed and then standardized. The variable remained continuous in analysis.

4.3 Data Cleaning

Each variable used in analysis was checked for missing and implausible values. When a missing value was encountered, original survey was pulled and checked. When possible, the correction was made in SAS. Variables were recoded for analysis as indicated in the variable-by-variable discussion.

4.4 Statistical Analyses

4.4.1 Univariable Analysis

Final forms of the predictor variables after recoding can be seen in Figure 4.1. Characteristics of participants in this study are described in Table 5.1. Variables were first examined in a univariate manner (Table 5.2) in order to determine the mean delta CES-D for different levels of the predictor variables. Next, a univariable analysis was performed (Table 5.3). This was done to determine the relationship between the outcome variable, delta CES-D, and the predictor variables individually. For the univariable model, significance was set at p=0.2, according to guidelines for predictive model building[128].

4.4.2 Multivariable Analysis

Since the outcome variable of delta CES-D is a continuous variable in analysis, multiple linear regression models were used. Predictor variables that were found to be significant at the univariable level were then entered into a multivariable model in blocks, according to the conceptual model in Figure 2.1. Statistically insignificant variables were removed from the model at each step. The results from the multivariable models can be seen in Table 5.4. For the first three multivariable models (model 1 to model 3), statistical significance was set at p=0.2 and for the final model (model 4) statistical significance was set at p=0.05. These significance levels were determined using guidelines for predictive model building[128].

The first multivariable model contained baseline variables that were significant in the univariable analysis (age, thyroid issues, smoking, parity and chronic disease). In

model 2, statistically significant variables from model 1, as well as stress in pregnancy and depression in pregnancy were entered into the regression model. In model 3, statistically significant variables from model 2 as well as infant admission to specialized care were entered into the model. The final model (model 4) contained all statistically significant variables from model 3, as well as current stress, breastfeeding, current child health status, current antidepressant use, current social support, socioeconomic status, and current marital status.

4.5 Sensitivity Analyses

4.5.1 Effect Measure Modification

The association between infant admission to specialized care and the change in maternal depressive symptoms from pregnancy to postpartum is of primary interest in this study. However, it is possible that the effect of infant admission to specialized care is different for women above the CES-D cut-off in pregnancy compared to women below the CES-D cut-off in pregnancy. In order to clarify this issue, effect measure modification will be examined. This will be done using the interaction term approach, which involves crossing the predictor and modifier variables and including them in the regression model. First, only infant admission to specialized care and maternal depression in pregnancy as well as the interaction term will be entered into a regression model in order to look for significant interactions in a crude manner. If a statistically significant interaction is found, the interaction term will be entered into the final multiple regression model.

4.5.2 Sensitivity to Sample Issues

4.5.2.1 Age

A small percentage of participants who completed both the prenatal interview and the postnatal follow-up interview were aged 16-21 (3.65 %). Of the women who did not complete the postnatal follow-up interview, almost 10 % were aged 16-21. It is possible that the inclusion of younger women may skew our results as they may be more disadvantaged, have less support and have more stress, perhaps due to an unexpected pregnancy. Therefore, a post hoc analysis will be done removing women aged 16-21 in order to examine their effect on the multiple regression.

4.5.2.2 Predictors Based on Depression Status in Pregnancy

In our dataset, 15 % of women scored above the cut-off of 16 on the CES-D scale in pregnancy, meaning they are at an increased risk for depression. In order to determine if variables found to be significant predictors of the trajectories of maternal depressive symptoms are the same for women who were above and below the CES-D cut-off in pregnancy we will repeat multivariable regression analyses separately for these two groups of women.

4.5.2.3 Antidepressant Use

Data regarding antidepressant use was determined at the second wave of data collection in the PHP. It is very possible that women who are taking antidepressants at the second wave of data collection were also taking this medication at the first wave of data collection during pregnancy. Antidepressant use in pregnancy has been significantly

associated with preterm birth, infant birth weight, apgar score and infant admission to specialized care[21,129]. Antidepressant use in pregnancy has also been associated with withdrawal syndrome in newborns[130,131]. Neonatal withdrawal syndrome may cause infants to be admitted to specialized care in order to monitor this condition. In order to be sure that the association between antidepressant use and infant admission to specialized care does not mask the true association between infant admission to specialized care and the change in maternal depressive symptoms from pregnancy to postpartum a sensitivity analysis will be performed. This analysis will repeat the final multivariable regression model excluding women taking antidepressant medications.

4.5.3 Alternative Regression Model Approaches

4.5.3.1 All Factors Included in Analysis

In analysis, the first three multivariable models (model 1 to model 3) had statistical significance set at p=0.2 according to guidelines for predictive model building[128]. In order to determine if these guidelines allowed all significant variables to appear in the final model a sensitivity analysis will be done which includes all variables, except those which were insignificant at the univariable level in the final model.

4.5.3.2 Alternative to Change Score

When presented with longitudinal data, a variety of analysis techniques are available. For this thesis, the decision was made to examine the change in maternal depressive symptoms from pregnancy to the postpartum period. It is possible that by using change scores the ability to see certain effects may have been lost. Alternatively,

analysis could have been performed using maternal CES-D score at the follow-up interview as the outcome of interest. This would have determined factors that were significantly related to depression in the postpartum period adjusted for confounding factors such as depression in pregnancy. In order to examine the difference in factors significantly associated with the change in maternal depressive symptoms from pregnancy to postpartum compared to those associated with depression in the postpartum period a sensitivity analysis will be performed. In this sensitivity analysis, the univariable and multivariable analyses will be repeated using maternal depressive symptoms at the postpartum interview as the outcome variable.

Table 4.1: Original Form and Recodes of Predictor Variables

Variable	First or Second Collection Wave	Original Question	Final Recode
Age	First	Maternal year of birth asked; Maternal age at delivery calculated	Categorical variable created: Age 16-21 Age 22-34 Age 35+
Body Mass Index	First	Weight- "How much did you weight prior to this pregnancy?" (lbs or kg) Height- "How tall are you without shoes?" (cm or ft/inches)	Recoded using the standard calculation: $BMI = \frac{weight\ (kgs)}{height\ (m)^2}$ Categorical variable created: underweight (BMI < 18.5) normal (BMI 18.5- 24.9) overweight (BMI 25.0- 29.9) obese (BMI >30)
Thyroid Issues	First	"Do you have any other medical conditions?" "Please tell me any over-the-counter or prescription medications you take regularly now."	Participant considered having thyroid disease is explicitly stated or if currently taking a thyroid medication Recoded to a binary Yes or No variable
Smoking Before Pregnancy	First	"How many cigarettes did you smoke each day before learning you were pregnant?"	Recoded to a binary Yes or No variable
Smoking During Pregnancy	First	"How many cigarettes do you typically smoke each day now?"	Recoded to a binary Yes or No variable
Parity	First	Number of previous completed pregnancies.	Recoded into a binary variable: 0 other children 1+ other children

Table 4.1continued: Original Form and Recodes of Predictor Variables

Variable	First or Second Collection Wave	Original Question	Final Recode
Chronic Disease	First	Participants asked if they currently have or have had in the past: Cardiovascular disease High blood pressure before and during pregnancy Diabetes before and during pregnancy Asthma Other medical conditions	Participant were classified as having a chronic disease if they had heart disease, asthma, high blood pressure before pregnancy or any cardiac condition Overt diabetes was also included as a chronic disease. This variable was recoded by a colleague to exclude women with only gestational diabetes Final variable recoded to a binary Yes or No variable
Stress during pregnancy	First	Seven stress subscales: Stressful Life Events Family Strain Relationship Strain General Strain Occupational Strain Caregiver Strain Economic Strain	For the final variable, the 7 subscales were standardized. The subscales were then summed and the sum was standardized and left continuous for analysis.
Depression in Pregnancy	First	CES-D Scale	Recoded to binary variable based on score: 16 or greater Less than 16
Infant Admission to Specialized Care	First	After the birth of the child, admission status was noted by a nurse, physician or research assistant	Final variable recoded to a binary Yes or No variable
Current Stress	Second	Seven stress subscales: Stressful Life Events Family Strain Relationship Strain General Strain Occupational Strain Caregiver Strain Economic Strain	For the final variable, the 7 subscales were standardized. The subscales were then summed and the sum was standardized and left continuous for analysis.
Breast-feeding	Second	"How did you feed your infant at birth?" If breastfed, participant then asked: "At what age did you stop breastfeeding? (months)"	Final Variable recoded into a categorical variable: Did not breastfeed Breastfed 0-3 months Breastfed 3-6 months Breastfed greater than 6 months

Table 4.1continued: Original Form and Recodes of Predictor Variables

Variable	**First or Second Collection Wave**	**Original Question**	**Final Recode**
Education	Second	"What is the highest level of formal education you have completed?" Elementary school Some high school Completed high school Some college or university College diploma University degree Trade school Other	Final variable recoded into two categories: High school or less More education then high school
Income	Second	"What is your best estimate of the total income of all members of your household from all sources before taxes and deductions for the past year?" Response options given from less than $10,000 to $80,000 in increments of $10,000	Final variable recoded into two categories: Zero to $30,000 Greater than $30,000
Current Marital Status	Second	"Since the last time we spoke, has you marital status changed?" If Yes, participant asked to Specify "What is your current marital status?"	Final variable recoded into three categories: Married Common Law Single/Separated/Divorced
Current Anti-depressant Use	Second	"Do you take any anti-depressant medications?"	Final variable remained a binary Yes/No variable
Current Social Support	Second	Three subscale which report support from Husband/Partner, Family/Relative and Freinds	Three subscales summed, standardized and final variable left continuous for analysis
Current Child Health Status	Second	Functional Status II(R) Scale	Scale summed, standardized and the final variable left continuous for analysis

CHAPTER 5: RESULTS

5.1 Study Sample

Figure 5.1 displays the flow of participants from recruitment to the PHP through the waves of follow-up. Of the 2,357 participants in the prenatal interview, 1,603 women completed at least one postnatal follow-up interview. In order to be eligible for analysis, women had to have completed the CES-D scale in both pregnancy and at the postpartum follow-up interview. Of the 1,603 participants, 3 women did not complete the prenatal CES-D and 6 other participants were excluded due to database errors. Therefore, 1,594 women remained for analysis giving a response rate of 68 %.

5.2 Sample Characteristics

The characteristics of the participants are summarized in Table 5.1. Most women were in the 22 to 34 year age range (77%), were married (83%), had more than one child (62%), had more than a high school education (87%) and had an income greater than $30,000 (93%). The majority of women were of normal body weight (60%), did not smoke before pregnancy (80%) or during pregnancy (92%), and did not suffer from thyroid disease (94%) or other chronic diseases (80%).

For depression scores in pregnancy, most women were below the cut-off of 16 points on the CES-D scale, though 15% of participants did score above 16. Most women were not taking antidepressants at the 2 year follow-up (93%).

A small proportion of women (8%) delivered children who were admitted to a specialized care unit, which includes the NICU at St. Joseph's Health Care, the PCCU or 7 East Nursery at Victoria Campus of London Health Sciences Centre. Most women

breastfed for greater than 6 months (51%) and only a small portion of women did not breastfeed at all (14%).

5.3 Trajectories of Maternal Depressive Symptoms

Figure 5.2 shows the trajectories of maternal depressive symptoms for women who were at risk of depression in pregnancy (above the CES-D cut off of 16) versus those who were not. For women who were at risk for depression in pregnancy, their CES-D score decreased from pregnancy to postpartum. This is in contrast to women who were not at risk for depression in pregnancy whose depressive symptoms seemed to slightly increase from pregnancy to postpartum.

5.4 Univariable Models and Multivariable Regression Models

Table 5.2 displays the univariate associations between the predictor variables and the change in CES-D score from pregnancy to the 2 year follow-up (Delta CES-D). Table 5.3 summarizes the univariable regression models between each predictor variable and the delta CES-D. Table 5.4 represent the multivariable regression models, with each column presenting a new regression model with variables entered in blocks according to the conceptual model (Figure 2.1).

5.4.1 Age

Women aged 16 to 21 had a lower mean delta CES-D score compared to women 22-34 or 35+. In the univariable model, there was a statistically significant decrease in delta CES-D score for women 16-21 versus women 22-34. This parameter estimate

remained significant in the first multivariable model but fell out of significance in model 2 (when stress in pregnancy and depression in pregnancy were added) and remained statistically insignificant for the rest of the models.

In the univariable model, there was a statistically insignificant decrease in delta CES-D score for women 35+ versus women 22-34. This parameter estimate decreased and became significant after the addition of stress in pregnancy and depression in pregnancy into the model, this association remained significant in model 3. However, the addition of stress after childbirth, breastfeeding, child health status, antidepressant use, social support, SES and marital status in the fourth model made the association statistically insignificant.

5.4.2 Body Mass Index

In the univariable regression model, the association between BMI and delta CES-D was not statistically significant. BMI was therefore not included in the multivariable regression models.

5.4.3 Thyroid Disease

Women with thyroid disease had a slightly lower mean delta CES-D score compared to women without thyroid disease. In the univariable model, there was a statistically significant decrease in delta CES-D score for women with thyroid disease compared to women without thyroid disease. This association remained significant until NICU admission status was added to the model. Therefore, thyroid disease was not included in the final model.

5.4.4 Smoking

Women who smoked either before or during pregnancy had a slightly lower mean delta CES-D score compared to women who did not. In the univariable model there was a statistically significant decrease in delta CES-D score for women who smoked at either of these time points compared to women who did not smoke. In the first multivariable model, smoking before pregnancy fell out of the model but smoking during pregnancy remained significant. Smoking in pregnancy remained significant until stress in pregnancy and depression in pregnancy was added to the model. Therefore, smoking in pregnancy was not included in the final model.

5.4.5 Parity

Women with one or more children had a slightly lower mean delta CES-D then women with no other children. In the univariable model, there was a statistically significant decrease in delta CES-D score comparing women with more than one child to women with no other children. However, in the multivariable model, the association between parity and delta CES-D score was statistically insignificant. Therefore, parity was not included in the final model.

5.4.6 Chronic Disease

Women with a chronic disease had a slightly lower mean delta CES-D score compared to women with no chronic disease. In the univariable model, there was a statistically significant decrease in delta CES-D score comparing women with chronic disease to women with no chronic disease. In the first multivariable model, chronic

disease remains significant. However, when stress in pregnancy and depression in pregnancy were added to the model, the association between chronic disease and delta CES-D became statistically insignificant. Therefore, chronic disease was not included in the final model.

5.4.7 Maternal Stress in Pregnancy

For the association between maternal stress in pregnancy and delta CES-D score, there was a slightly negative Pearson correlation coefficient. In the univariable model, there was a statistically significant decrease in delta CES-D score for each unit increase in stress score. However, when this variable is added to the multivariable model, the association becomes insignificant. Therefore, maternal stress in pregnancy was not included in the final model.

5.4.8 Maternal Depression in Pregnancy

Women who scored above the cut-off of 16 on the CES-D scale in pregnancy had a lower mean delta CES-D than women who scored below this cut-off. In the univariable model, there was a statistically significant decrease in delta CES-D score comparing women above the CES-D cut-off of 16 to those below this cut-off. In the first multivariable model, the association increased very slightly but after the addition of infant admission to specialized care it decreased slightly again. In the final model, when current stress, breastfeeding, child health, antidepressant use, current social support, SES and marital status were added to the model the association decreased again and remained highly significant.

5.4.9 Infant Admission to Specialized Care at Birth

Women with a child admitted to specialized care had a slightly lower mean delta CES-D score than women with a child not admitted to a specialized care unit. In the univariable model, there was a statistically significant decrease in delta CES-D score comparing women with a child admitted to a specialized care unit to those who did not. When admission to a specialized care unit was entered into the multivariable model in model 3 it was not a statistically significant predictor of delta CES-D score. Admission to specialized care remained in the final model as it was the main question of interest; however it remained insignificant in the final model.

5.4.10 Current Maternal Stress

For the association between current maternal stress and delta CES-D score, there was a slightly positive Pearson correlation coefficient. In the univariable model, there was a statistically significant increase in delta CES-D score for each unit increase in stress score, meaning that as stress score increases, delta CES-D score increases slightly. When this variable was added to the final multivariable model, the association remained positive and significant.

5.4.11 Breastfeeding

Women who breastfed for 0-3 months, 3-6 months or greater than 6 months had a slightly higher mean delta CES-D score compared to women who did not breastfeed. In the univariable model, there was a statistically significant increase in delta CES-D score comparing women who breastfed for 0-3 months, 3-6 months or greater than 6 months to

those who did not breastfeed. However, when this variable was entered into the final model it was statistically insignificant for all levels of breastfeeding.

5.4.12 Socioeconomic Status

SES was categorized in two ways; education and income. Women with a high school education or less had only a very slightly lower mean delta CES-D score compared to women with more education than high school. In the univariable regression model, the association between education and delta CES-D was not statistically significant. Education was therefore not included in the multivariable regression models.

For the income variable, women with an income of 0-$30,000 had only a slightly higher mean delta CES-D score compared to women with an income of greater than $30,000. In the univariable regression model, like education, the association between income and delta CES-D was not statistically significant. Income was therefore not included in the multivariable regression models.

5.4.13 Marital Status

Women with a Common Law marital status had a slightly lower mean delta CES-D score than women who were married or single. In the univariable model, there was a statistically significant increase in delta CES-D score comparing single/never married/divorced women to married women. However, when marital status was entered into the multivariable model in model 4 it was not statistically significant for all marital levels.

5.4.14 Maternal Antidepressant Use

In the univariable regression model, the association between current maternal antidepressant use and delta CES-D was not statistically significant. Current maternal antidepressant use was therefore not included in the multivariable regression models.

5.4.15 Current Maternal Social Support

For the association between current maternal social support and delta CES-D score, there was a very small negative Pearson correlation coefficient. In the univariable model, there was a statistically significant decrease in delta CES-D score for each unit increase in social support score, meaning that as social support score increases, delta CES-D score decreases very slightly. When this variable is added to the final multivariable model, the association remains negative and significant.

5.4.16 Child Health Status

For the association between child health status and delta CES-D score, there was a very small negative Pearson correlation coefficient. In the univariable model, there was a statistically significant decrease in delta CES-D score for each unit increase in child health score, meaning that as child health score increases, delta CES-D score decreases very slightly. When this variable is added to the final multivariable model, the association remains negative and significant.

5.5 Parsimonious Model

Since infant admission to specialized care at birth was the main variable of interest in this thesis, it was entered in all multivariable models. In order to be sure that keeping this variable did not negatively affect analyses, a parsimonious model (model 5) was created which excluded infant admission to specialized care and all other variables deemed statistically insignificant in the final multivariable model (Table 5.5). This table contains both the unstandardized and standardized regression coefficients.

In the parsimonious model, all significant variables remained significant and all statistically insignificant variables remained statistically insignificant. Regression coefficients remained similar, except the regression coefficient for current social support, which decreases very slightly.

5.6 Sensitivity Analyses

5.6.1 Effect Measure Modification

Table 5.6 displays the summary of the interaction term analyses in the unadjusted and adjusted regression models for the interaction between depression in pregnancy and infant admission to specialized care. In the unadjusted regression model, the interaction term was found to be statistically insignificant. The interaction term remained statistically insignificant in the adjusted regression equation.

These results suggest that the effect of infant admission to specialized care on the trajectory of maternal depression is statistically insignificant for all women in this study, regardless of their depression status in pregnancy.

5.6.2 Sensitivity to Sample Issues

Table 5.7 shows the results of the final model for various sensitivity analyses discussed below. The final result of the sensitivity analyses further demonstrates that infant admission to specialized care is not significantly associated with the trajectory of maternal depressive symptoms.

5.6.2.1 Age

After exclusion of younger women (16-22) there was almost no difference in parameter estimates in the final model. Infant admission to specialized care remained statistically insignificant.

5.6.2.2 Predictors Based on Depression Status in Pregnancy

The final multivariable regression model for women at risk for depression in pregnancy compared to those who were not was determined (Table 5.7). For women with a CES-D score less than the cut-off in pregnancy, higher social support, lower stress and higher child health status and were significantly associated with a trajectory of maternal depressive symptoms that decrease from pregnancy to postpartum. Single marital status was associated with a trajectory of maternal depressive symptoms that significantly increased from pregnancy to postpartum. Parameter estimates remained very similar to the final model which encompassed all participants.

For women who were at risk for depression in pregnancy, higher social support and lower stress were significantly associated with a decreasing trajectory of maternal depressive symptoms. For this group of women, child health status was not significantly

associated with the trajectory of maternal depressive symptoms although the p-value bordered on statistical significance.

For both groups of women, infant admission to specialized care was not significantly associated with the trajectory of maternal depressive symptoms.

5.6.2.3 Antidepressant Use

Table 5.7 displays the results of the sensitivity analysis which excludes women taking antidepressants from the final regression model. All regression coefficients significant in the entire model remained similar and significant in the model excluding women taking antidepressants. Infant admission to specialized care remained statistically insignificant.

The only variable different between these two models was the age variable. When women taking antidepressants were excluded from analysis there was a statistically significant decrease in delta CES-D for women 16-21 compared to women 22-34 in the final multivariable model. Although this relationship is significant when women taking antidepressants were removed from the model, this association bordered on significance in the regression model including all participants and the regression coefficients were very similar.

5.6.3 Alternative Regression Model Approaches

5.6.3.1 All Variables Included in Analysis

Table 5.8 displays the results of the sensitivity analysis which compared the block regression analysis to including all variables (significant in the univariable model) in the

final regression model. In the block regression analysis, depression in pregnancy, current stress, current social support and current child health status were found to be significant predictors of the trajectories of maternal depression. When all variables were entered into the final model, these variables remained significant with similar regression coefficients except for current stress which remained statistically significant but the regression coefficient was larger. Also significant in the regression model with all variables was younger age, parity, stress in pregnancy, and single marital status. Infant admission to specialized care remained statistically insignificant.

5.6.3.2 Alternative to Change Score

Table 5.9 displays the univariable associations between the predictor variables and the CES-D score at the postpartum follow-up interview. Table 5.10 displays the multivariable regression models with variables entered in by blocks as done previously.

In the univariable regression model, all variables except for parity and breastfeeding were significantly associated with the CES-D score at the postpartum follow-up interview.

In the final regression model age, stress in pregnancy, depression in pregnancy, current stress, education, antidepressant use, current social support and current child health status were significantly associated with the postpartum CES-D score. Infant admission to specialized care was not significantly associated with postpartum CES-D score.

In the parsimonious model, all variables remained similar in regression coefficient and p-value except for age 16-21, which fell out of significance when variables deemed insignificant in the final model were removed to create the parsimonious model.

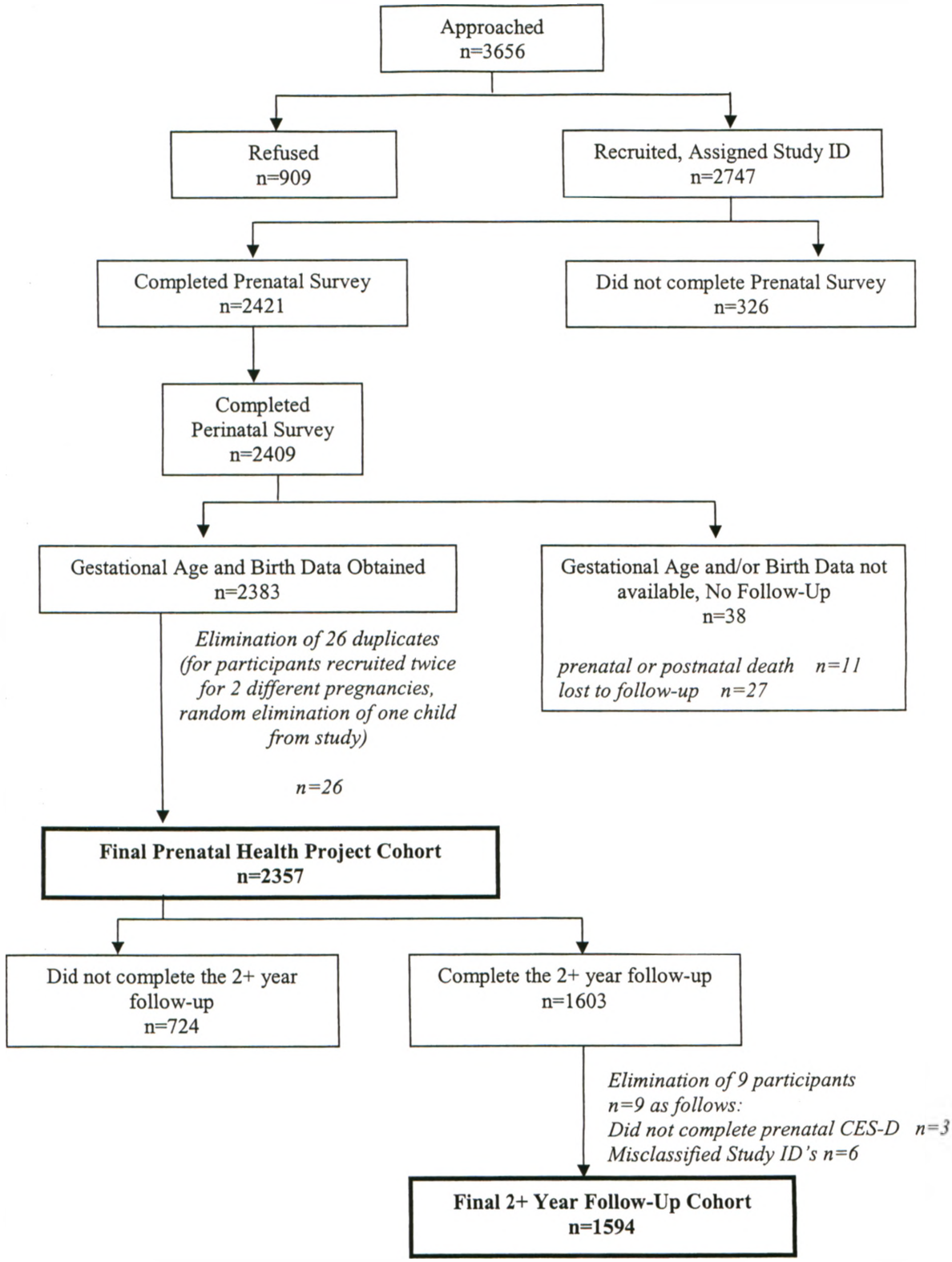

Figure 5.1: Flow of Participants in Prenatal and Postnatal Health Projects

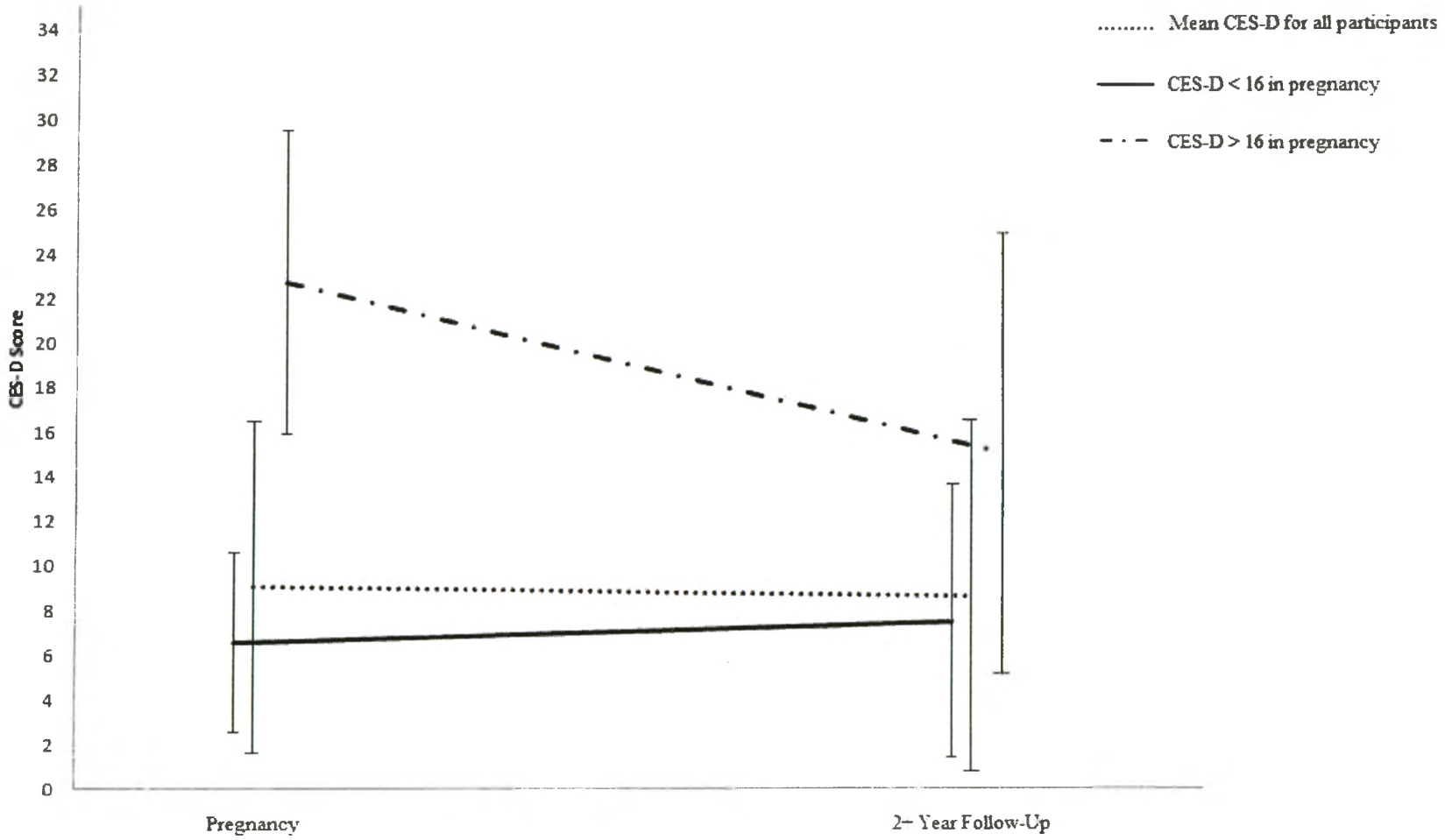

Figure 5.2: Maternal CES-D Score from Pregnancy to Postpartum

Table 5.1: Characteristics of Sample Participants

VARIABLE	FREQUENCY (%)
AGE	
16-21	58 (3.65 %)
22-34	1220 (76.73 %)
35+	312 (19.62 %)
BMI	
underweight (BMI < 18.5)	54 (3.50 %)
normal (BMI 18.5- 24.9)	928 (60.22 %)
overweight (BMI 25.0- 29.9)	353 (22.91 %)
obese (BMI >30)	206 (13.37 %)
THYROID ISSUES	
No	1512 (94.86 %)
Yes	82 (5.14 %)
SMOKING	
SMOKING BEFORE PREGNANCY	
No	1265 (80.37 %)
Yes	309 (19.63 %)
SMOKING IN PREGNANCY	
No	1456 (92.39 %)
Yes	120 (7.61 %)
PARITY	
Zero	597 (37.55 %)
One or greater	993 (62.45 %)
CHRONIC DISEASE	
No	1280 (80.30 %)
Yes	314 (19.70 %)
MATERNAL DEPRESSION IN PREGNANCY	
CES-D less than 16	1350 (84.69 %)
CES-D >= 16	244 (15.31 %)
INFANT ADMISSION TO SPECIALIZED CARE	
No Admission	1425 (92.11 %)
Admission to Specialized Care	122 (7.89 %)
BREASTFEEDING	
Did not breastfeed	235 (14.74 %)
Breastfed > zero < 3 months	188 (11.79 %)
Breastfed 3 to 6 months	356 (22.33 %)
Breastfed > 6 months	815 (51.13 %)
SOCIOECONOMIC STATUS	
EDUCATION	
High school or less	201 (12.71 %)
More education than high school	1381 (87.29 %)
INCOME	
Zero - $30,000	99 (6.80 %)
Greater than $30,000	1356 (93.20 %)
CURRENT MARITAL STATUS	
Married	1318 (82.89 %)
Common Law	132 (8.30 %)
Single/ Never Married/ Divorced	140 (8.81 %)
CURRENT ANTIDEPRESSANT USE	
No	1490 (93.48 %)
Yes	104 (6.52 %)
CONTINUOUS VARIABLES	**MEAN (SD)**
STRESS DURING PREGNANCY	0 (1) (Standardized)
CURRENT STRESS	0 (1) (Standardized)
CURRENT SOCIAL SUPPORT	0 (1) (Standardized)
CHILD HEALTH STATUS (FS2R)	0 (1) (Standardized)

NOTE: Current refers to the time of the postpartum follow-up interview

Table 5.2: Univariate Associations with Delta CES-D Score

OVERALL MEAN DELTA CES-D	-0.37 (8.19)		
VARIABLE	**Mean ΔCES-D (SD)**	**Mean Pregnancy CES-D (SD)**	**Mean Postpartum CES-D (SD)**
AGE*			
16-21	-3.4 (11.0)	16.4 (10.1)	13.0 (7.7)
22-34	-0.2 (8.2)	9.1 (7.2)	8.9 (8.0)
35+	-0.5 (7.3)	7.7 (6.5)	7.2 (6.6)
BMI			
underweight (BMI < 18.5)	-0.7 (8.3)	9.4 (7.5)	8.6 (6.8)
normal (BMI 18.5- 24.9)	-0.3 (7.9)	8.6 (7.3)	8.3 (7.4)
overweight (BMI 25.0- 29.9)	-0.2 (9.1)	9.2 (7.4)	9.0 (8.4)
obese (BMI >30)	-0.7 (7.7)	10.3 (7.4)	9.6 (8.6)
THYROID ISSUES*			
No	-0.3 (8.2)	9.1 (7.4)	8.8 (7.9)
Yes	-1.6 (7.7)	9.0 (6.8)	7.3 (6.9)
SMOKING BEFORE PREGNANCY*			
No	-0.2 (7.4)	8.4 (6.7)	8.2 (7.2)
Yes	-1.1 (10.9)	12.1 (9.1)	11.0 (9.8)
SMOKING DURING PREGNANCY*			
No	-0.2 (7.8)	8.7 (6.9)	8.5 (7.6)
Yes	-2.6 (12.0)	14.3 (10.4)	11.7 (10.4)
PARITY*			
Zero	-0.2 (8.2)	9.0 (7.4)	8.8 (8.2)
One or greater	-0.7 (8.1)	9.2 (7.4)	8.5 (7.2)
CHRONIC DISEASE*			
No	-0.2 (8.2)	8.8 (7.0)	8.5 (7.9)
Yes	-1.0 (8.1)	10.2 (8.5)	9.3 (7.7)
DEPRESSION IN PREGNANCY*			
CES-D less than 16	1.0 (6.8)	6.6 (4.0)	7.5 (6.8)
CES-D greater than 16	-7.7 (11.0)	22.7 (6.8)	15.0 (10.0)
ADMISSION TO SPECIALIZED CARE*			
No Infant Admission	-0.3 (8.2)	8.9 (7.2)	8.7 (7.8)
Infant Admitted to Specialized Care	-1.4 (7.9)	10.2 (8.8)	8.9 (8.2)
BREASTFEEDING*			
Did not breastfeed	-1.3 (8.6)	10.1 (8.3)	8.8 (8.4)
Breastfed > zero but < 3 months	-0.2 (8.4)	9.8 (8.0)	9.6 (8.4)
Breastfed 3 to 6 months	0.1 (9.1)	9.2 (7.2)	9.2 (8.6)
Breastfed greater than 6 months	-0.4 (7.6)	8.5 (7.0)	8.2 (7.1)
EDUCATION			
High school or less	-0.4 (11.1)	12.9 (9.7)	12.5 (10.2)
More education than high school	-0.3 (7.6)	8.5 (6.7)	8.1 (7.2)
INCOME			
Zero - $30,000	0.4 (10.9)	8.6 (6.9)	8.3 (7.5)
Greater than $30,000	-0.2 (7.9)	14.0 (10.2)	14.5 (10.8)
MARITAL STATUS*			
Married	-0.4 (7.3)	8.3 (6.6)	7.8 (7.0)
Common Law	-1.2 (10.9)	12.1 (9.0)	10.9 (9.3)
Single/ Never Married/ Divorced	1.0 (11.8)	13.4 (9.7)	14.3 (10.8)
ANTIDEPRESSANT USE			
No	-0.4 (7.9)	8.7 (7.0)	8.3 (7.4)
Yes	-0.1 (11.2)	13.7 (10.1)	13.6 (11.5)
CONTINUOUS VARIABLES	**PEARSON CORRELATION COEFFICIENT (p-value)**		
STRESS DURING PREGNANCY*	-0.2 (<.0001)	0.5 (<.0001)	0.3 (<.0001)
CURRENT STRESS*	0.1 (<.0001)	0.4 (<.0001)	0.5 (<.0001)
CURRENT SOCIAL SUPPORT*	-0.1 (<.0001)	-0.3 (<.0001)	-0.4 (<.0001)
CURRENT CHILD HEALTH*	-0.1 (0.0003)	-0.2 (<.0001)	-0.2 (<.0001)

*Denotes variables that were significant at p< 0.2 hence retained for later multivariable analysis

Table 5.3: Regression coefficients for univariable regression model predicting change in CES-D score

	BETA (P-VALUE)
VARIABLE	**UNIVARIABLE MODEL**
AGE	
16-21	-3.2 (<0.01)*
22-34[1]	[reference]
35+	-0.3 (0.59)
BMI	
Underweight	-0.4 (0.74)
Normal Weight	[reference]
Overweight	0.2 (0.7228)
Obese	-0.4 (0.57)
THYROID ISSUES	
No[1]	[reference]
Yes	-1.3 (0.15)*
SMOKING	
SMOKING BEFORE PREGNANCY	
No[1]	[reference]
Yes	-0.9 (0.08)*
SMOKING DURING PREGNANCY	
No[1]	[reference]
Yes	-2.4 (<0.01)*
PARITY	
Zero	-0.6 (0.19)*
One or greater[1]	[reference]
CHRONIC DISEASE	
No[1]	[reference]
Yes	-0.7 (0.16)*
STRESS DURING PREGNANCY (continuous)	-1.34 (<.0001)*
DEPRESSION IN PREGNANCY	
CES-D less than 16[1]	[reference]
CES-D greater than or equal to 16	-8.6 (<.0001)*
ADMISSION TO SPECIALIZED CARE	
No Infant Admission[1]	[reference]
Infant Admitted to Specialized Care	-1.0 (0.18)*
CURRENT STRESS (continuous)	1.2 (<.0001)*
BREASTFEEDING	
Did not breastfeed[1]	[reference]
Breastfed 0 to 3 months	1.1 (0.18)*
Breastfed 3 to 6 months	1.3 (0.05)*
Breastfed more than 6 months	0.9 (0.13)*
SOCIOECONOMIC STATUS	
EDUCATION	
High school or less	-0.1 (0.90)
More education than high school[1]	[reference]
INCOME	
Zero - $30,000	0.7 (0.41)
Greater than $30,000[1]	[reference]
CURRENT MARITAL STATUS	
Married[1]	[reference]
Common Law	-0.8 (0.28)
Single/ Never Married/ Divorced	1.4 (0.05)*
ANTIDEPRESSANT USE	
No[1]	[reference]
Yes	0.3 (0.75)
CURRENT SOCIAL SUPPORT (continuous)	-1.1 (<.0001)*
CHILD HEALTH STATUS (continuous)	-0.7 (<0.01)*

* Statistically significant at p <0.2

Table 5.4: Regression coefficients for multivariable regression models predicting change in CES-D score

	BETA (p-value)			
VARIABLE	**MODEL 1** **R^2= 0.01** **Ad.R^2= 0.01**	**MODEL 2** **R^2= 0.15** **Ad.R^2=0.15**	**MODEL 3** **R^2= 0.15** **Ad.R^2=0.14**	**MODEL 4** **R^2= 0.25** **Ad.R^2=0.24**
AGE				
16-21	-2.6 (0.02)*	0.0 (1.0)	-0.4 (0.72)	-2.0 (0.06)
22-34[1]	[reference]	[reference]	[reference]	[reference]
35+	-0.3 (0.52)	-0.7 (0.14)*	-0.6 (0.19)*	-0.6 (0.17)
THYROID ISSUES				
Yes	-1.5 (0.11)*	-1.2 (0.15)*	-1.1 (0.21)	———
SMOKING				
BEFORE PREGNANCY		———	———	———
Yes	0.3 (0.68)			
DURING PREGNANCY			———	———
Yes	-2.3 (0.02)*	-0.4 (0.64)		
PARITY				
Zero	-0.5 (0.22)	———	———	———
One or greater[1]	[reference]			
CHRONIC DISEASE				
Yes	-0.7 (0.18)*	-0.4 (0.36)	———	———
STRESS DURING PREGNANCY				
(continuous)		-0.1 (0.53)	———	———
DEPRESSION IN PREGNANCY				
CES-D less than 16[1]		[reference]	[reference]	[reference]
CES-D greater than 16		-8.5 (<.0001)*	-8.8 (<.0001)*	-11.2 (<.0001)*
INFANT ADMISSION TO SPECIALIZED CARE				
Yes			-0.4 (0.57)	-0.6 (0.39)
CURRENT STRESS				
(continuous)				1.7 (<.0001)*
BREASTFEEDING				
Did not breastfeed[1]				[reference]
0 to 3 months				0.3 (0.70)
3 to 6 months				0.7 (0.28)
More than 6 months				0.3 (0.55)
CURRENT MARITAL STATUS				
Married[1]				[reference]
Common Law				0.1 (0.90)
Single/ Never Married/ Divorced				0.8 (0.27)
CURRENT SOCIAL SUPPORT				
(continuous)				-1.2 (<.0001)*
CHILD HEALTH STATUS				
(continuous)				-0.7 (<0.01)*

NOTE: Variables found to be insignificant in univariable analysis are not included in this table.
NOTE: For the first 4 models $p < 0.2$ is considered significant. For model 4 and 5, $p < 0.05$ is considered significant.
[1]Reference group for dummy variables in regression models (for categorical variables)
* Statistically significant

Table 5.5 Regression coefficients for parsimonious model predicting change in CES-D score

	BETA	STANDARDIZED BETA
VARIABLE	**MODEL 5 PARSIMONIOUS MODEL** **R^2= 0.25** **Ad. R^2= 0.24**	**MODEL 5 PARSIMONIOUS MODEL** **R^2= 0.25** **Ad. R^2= 0.24**
DEPRESSION IN PREGNANCY CES-D less than 16[1] CES-D greater than 16	 [reference] -11.2 (<.0001)*	 [reference] -0.5 (<.0001)*
CURRENT STRESS (continuous)	1.7 (<.0001)*	0.2 (<.0001)*
CURRENT SOCIAL SUPPORT (continuous)	-1.3 (<.0001)*	-0.2 (<.0001)*
CHILD HEALTH STATUS (continuous)	-0.7 (0.0001)*	-0.1 (0.0001)*

*Statistically significant at $p < 0.05$

Table 5.6: Evaluating effect measure modification

	UNADJUSTED[1]		ADJUSTED[2]	
INTERACTION TERM	**BETA**	**P-VALUE**	**BETA**	**P-VALUE**
Depression in Pregnancy x Infant Admission to Specialized Care	0.4	0.8212	-0.5	0.7580

NOTE: statistical significance is considered p=0.05

[1]Unadjusted- Dependant variable: delta CES-D, Independent variables: maternal depression in pregnancy, infant admission to specialized care

[2]Adjusted- Dependant variable: delta CES-D, Independent variables: maternal depression in pregnancy, infant admission to specialized care, current stress level, current social support, current child health status

Table 5.7: Sensitivity Analysis of Sample Issues

	BETA (p-value)			
VARIABLE	**MODEL 4 Excluding 16-21 age group**	**MODEL 4**		**MODEL 4 Excluding women taking antidepressants**
		Women with pregnancy CES-D > 16	**Women with pregnancy CES-D <16**	
AGE				
16-21	----------	-1.7 (0.45)	-1.2 (0.36)	-2.2 (0.04)*
22-34[1]	[reference]	[reference]	[reference]	[reference]
35+	-0.6 (0.17)	0.3 (0.90)	-0.6 (0.14)	-0.5 (0.29)
DEPRESSION IN PREGNANCY				
CES-D less than 16[1]	[reference]			[reference]
CES-D greater than 16	-11.0 (<.0001)*			-11.2 (<.0001)*
INFANT ADMISSION TO SPECIALIZED CARE				
Yes	-0.85 (0.21)	-1.5 (0.49)	-0.5 (0.43)	-0.1 (0.93)
CURRENT STRESS (continuous)	-1.7 (<.0001)*	2.7 (<0.01)*	1.5 (<.0001)*	1.5 (<.0001)*
BREASTFEEDING				
Did not breastfeed[1]	[reference]	[reference]	[reference]	[reference]
Breastfed 0 to 3 months	0.4 (0.60)	-0.3 (0.89)	0.3 (0.71)	0.4 (0.60)
Breastfed 3 to 6 months	0.8 (0.21)	2.1 (0.31)	0.4 (0.56)	0.7 (0.26)
Breastfed more than 6 months	0.4 (0.50)	2.1 (0.25)	0.03 (0.95)	0.3 (0.53)
CURRENT MARITAL STATUS				
Married[1]	[reference]	[reference]	[reference]	[reference]
Common Law	0.4 (0.58)	-1.6 (0.42)	0.6 (0.43)	0.1 (0.87)
Single/ Never Married/ Divorced	0.8 (0.26)	-1.3 (0.50)	1.6 (0.04)*	0.6 (0.39)
CURRENT SOCIAL SUPPORT (continuous)	-1.2 (<.0001)*	-2.29 (<0.01)*	-0.9 (<0.01)*	-1.1 (<.0001)*
CHILD HEALTH (continuous)	-0.7 (<0.01)*	-1.3 (0.06)	-0.7 (<0.01)*	-0.7 (<.0001)*

[1]Reference group for dummy variables in regression models (for categorical variables)

*Statistically significant at $p < 0.05$

Table 5.8: Comparing block regression analysis to all variables in final model

	BETA (P-VALUE)
VARIABLE	**SENSITIVITY ANALYSIS (All variables in final model)**
AGE	
16-21	-2.8 (<0.01)*
22-34[1]	[reference]
35+	-0.7 (0.12)
BMI	
Underweight	———
Normal Weight	
Overweight	
Obese	
THYROID CONDITIONS	
Yes	-0.8 (0.34)
SMOKING	
BEFORE PREGNANCY	
Yes	0.4 (0.43)
DURING PREGNANCY	
Yes	-1.2 (0.17)
PARITY	
Zero	-1.0 (0.01)*
One or greater[1]	[reference]
CHRONIC DISEASE	
Yes	-0.2 (0.70)
STRESS DURING PREGNANCY	
(continuous)	-2.2 (<.0001)*
DEPRESSION IN PREGNANCY	
CES-D less than 16[1]	[reference]
CES-D greater than 16	-9.7 (<.0001)*
INFANT ADMISSION TO SPECIALIZED CARE	
Yes	-0.6 (0.33)
CURRENT STRESS (continuous)	2.7 (<.0001)*
BREASTFEEDING	
Did not breastfeed[1]	[reference]
Breastfed > zero but < 3 months	0.7 (0.34)
Breastfed 3 to 6 months	0.8 (0.20)
Breastfed greater than 6 months	0.4 (0.48)
SOCIOECONOMIC STATUS	
EDUCATION	
High school or less	———
More than high school[1]	
INCOME	
Zero - $30,000	———
Greater than $30,000[1]	
CURRENT MARITAL STATUS	
Married[1]	[reference]
Common Law	0.8 (0.21)
Single/ Never Married/ Divorced	1.6 (0.03)*
ANTIDEPRESSANT USE	
Yes	———
CURRENT SOCIAL SUPPORT	
(continuous)	-1.2 (<.0001)*
CHILD HEALTH (continuous)	-0.8 (<.0001)*

*Statistically significant at p< 0.05

Table 5.9: Regression coefficients for univariable regression model predicting CES-D score in the postpartum period

	BETA (P-VALUE)
VARIABLE	**UNIVARIABLE MODEL**
AGE	
16-21	4.2 (<.0001)*
22-34[1]	[reference]
35+	-1.7 (<0.01)*
BMI	
Underweight	0.2 (0.82)
Normal Weight	[reference]
Overweight	0.6 (0.19)*
Obese	1.2 (0.05)*
THYROID ISSUES	
No[1]	[reference]
Yes	-1.3 (0.15)*
SMOKING	
SMOKING BEFORE PREGNANCY	
No[1]	[reference]
Yes	2.85 (<.0001)*
SMOKING DURING PREGNANCY	
No[1]	[reference]
Yes	3.2 (<.0001)*
PARITY	
Zero	-0.3 (0.41)
One or greater[1]	[reference]
CHRONIC DISEASE	
No[1]	[reference]
Yes	0.7 (0.13)*
STRESS DURING PREGNANCY (continuous)	2.6 (<.0001)*
DEPRESSION IN PREGNANCY	
CES-D less than 16[1]	[reference]
CES-D greater than or equal to 16	7.5 (<.0001)*
ADMISSION TO SPECIALIZED CARE	
No Infant Admission[1]	[reference]
Infant Admitted to Specialized Care	0.2 (0.78)
CURRENT STRESS (continuous)	4.3 (<.0001)*
BREASTFEEDING	
Did not breastfeed[1]	[reference]
Breastfed 0 to 3 months	0.8 (0.33)
Breastfed 3 to 6 months	0.4 (0.58)
Breastfed more than 6 months	-0.7 (0.25)
SOCIOECONOMIC STATUS	
EDUCATION	
High school or less	4.4 (<.0001)*
More education than high school[1]	[reference]
INCOME	
Zero - $30,000	6.2 (<.0001)*
Greater than $30,000[1]	[reference]
CURRENT MARITAL STATUS	
Married[1]	[reference]
Common Law	3.0 (<.0001)*
Single/ Never Married/ Divorced	6.5 (<.0001)*
ANTIDEPRESSANT USE	
No[1]	[reference]
Yes	5.2 (<.0001)*
CURRENT SOCIAL SUPPORT (continuous)	-3.4 (<.0001)*
CHILD HEALTH STATUS (continuous)	-2.0 (<.0001)*

* Statistically significant at p< 0.2

Table 5.10: Regression coefficients for multivariable regression models predicting CES-D score in the postpartum period

	BETA (p-value)				
VARIABLE	**MODEL 1** **R^2= 0.04** **Ad. R^2= 0.03**	**MODEL 2** **R^2= 0.17** **Ad. R^2= 0.16**	**MODEL 3** **R^2= 0.16** **Ad. R^2= 0.16**	**MODEL 4** **R^2= 0.40** **Ad. R^2= 0.39**	**MODEL 5 Parsimonious Model** **R^2= 0.39** **Ad. R^2= 0.39**
AGE					
16-21	2.8 (0.01)*	1.2 (0.23)	1.2 (0.27)	-2.5 (0.02)*	-1.7 (0.07)
22-34[1]	[reference]	[reference]	[reference]	[reference]	[reference]
35+	-1.5 (<0.01)*	-1.2 (0.01)*	-1.1 (0.02)*	-1.2 (0.01)*	-1.2 (<.01)*
THYROID ISSUES					
Yes	-1.2 (0.17)*	-1.4 (0.08)*	-1.4 (0.09)*	-1.0 (0.21)	———
SMOKING					
BEFORE PREGNANCY					———
Yes	2.0 (<0.01)*	0.6 (0.18)*	0.7 (0.15)*	-0.2 (0.60)	
DURING PREGNANCY					
Yes	1.0 (0.24)	———	———	———	———
CHRONIC DISEASE					
Yes	0.5 (0.23)	———	———	———	———
STRESS DURING PREGNANCY					
(continuous)		1.7 (<.0001)*	1.7 (<.0001)*	-0.5 (0.03)*	-0.4 (0.05)*
DEPRESSION IN PREGNANCY					
CES-D less than 16[1]		[reference]	[reference]	[reference]	[reference]
CES-D greater than 16		5.2 (<.0001)*	5.2 (<.0001)*	3.8 (<.0001)*	3.4 (<.0001)*
INFANT ADMISSION TO SPECIALIZED CARE					———
Yes			-0.3 (0.63)	-0.5 (0.42)	
CURRENT STRESS					
(continuous)				3.0 (<.0001)*	3.0 (<.0001)*
SOCIOECONOMIC STATUS					
EDUCATION					
High school or less				1.9 (<0.01)*	2.0 (<.0001)*
More than high school[1]				[reference]	[reference]
INCOME					
Zero - $30,000				0.3 (0.68)	———
Greater than $30,000[1]				[reference]	
CURRENT MARITAL STATUS					
Married[1]				[reference]	———
Common Law				1.1 (0.09)	
Single/ Never Married/ Divorced				1.2 (0.08)	
ANTIDEPRESSANT USE					
No[1]				[reference]	[reference]
Yes				2.0 (<0.01)*	2.0 (<0.01)*
CURRENT SOCIAL SUPPORT (continuous)				-1.4 (<.0001)*	-1.5 (<.0001)*
CHILD HEALTH STATUS (continuous)				-1.0 (<.0001)*	-1.1 (<.0001)*

NOTE: Variables found to be insignificant in univariable analysis are not included in this table.
NOTE: For the first 4 models p=0.2 is considered significant. For model 4 and 5, p= 0.05 is considered significant.
[1]Reference group for dummy variables in regression models (for categorical variables)
* Statistically significant at p< 0.05

CHAPTER 6: DISCUSSION AND CONCLUSIONS

6.1 Interpretation of Results

Figure 5.2 shows that women who were at risk for depression in pregnancy have depressive symptoms that decrease from pregnancy to the postpartum interview. This is in contrast to women who were not at risk for depression in pregnancy who had depressive symptoms which slightly increased from pregnancy to the postpartum interview. This finding is consistent with other research studies as discussed in chapter 2, which suggest that depressive symptoms are highest in pregnancy and decline after childbirth. However, figure 5.2 also displays regression towards the mean. Women who had high CES-D scores in pregnancy had lower CES-D scores at the postpartum interview and women with lower CES-D scores in pregnancy had higher CES-D scores at the postpartum interview.

The analyses determined that being above the cut off of 16 on the CES-D scale in pregnancy, having a lower current stress score, having higher social support and having a child with a higher health status was associated with a CES-D score that decreases from pregnancy to the postpartum follow-up interview. A final conceptual model that displays only statistically significant associations can be seen in figure 6.1. The final multivariable regression model in table 5.4, explained 24% (adjusted R^2) of the variability of the delta CES-D in our sample.

Age went in and out of significance through the multivariable models and was not statistically significant in the final model. This could be due to the age-depression link being more and issue of socioeconomic circumstances rather than biological age itself.

Thyroid issues behaved as expected. We would assume that women with thyroid issues would be treated for this condition medically and it would no longer become a stressor on their everyday lives or affect them as much on a biological level. If there had been a significant association between thyroid issues and depression that increased from pregnancy to postpartum we would assume that the medication being taken for this condition was not effective.

Smoking, breastfeeding and marital status were all significantly associated with the trajectories of maternal depressive symptoms in the univariable model. However, when entered into the multivariable regression model the association became statistically insignificant suggesting that these variables are correlated with other variables in the model which explain away their associations.

BMI, parity, and chronic disease variable did not behave as expected, as they were not significant predictors of a trajectory of maternal depressive symptoms that increase from pregnancy to postpartum. It is possible that the association between the trajectory of maternal depressive symptoms and these variables is explained away by the inclusion of the stress variable.

Maternal depression in pregnancy behaved as expected and coincided with other research which determined that depressive symptom scores are higher in pregnancy and decline in the postpartum period.

Current antidepressant use also behaved as expected, a significant association between antidepressant use and the trajectory of maternal depressive symptoms would have suggested that the pharmacological treatment was not effective.

Current stress score, current social support and current child health behaved as expected in the literature. Lower stress, higher support and higher child health was associated with a trajectory of maternal depressive symptoms that decreased from pregnancy to postpartum.

The predictor of interest, infant admission to specialized care at birth, was not significantly associated with the trajectory of maternal depressive symptoms as would have been expected after reviewing the literature. It is possible that this was a stressful experience in the mothers' life and this association could have been explained away by adjusting for the possible mediation by the stress variable. However, the questions asked in the seven stress subscales used in the PHP did not encompass the event of an infant being admitted to specialized care at birth therefore we believe that the measures of stress and infant admission to specialized care are, to a large degree, non-overlapping.

It is also possible that infant admission to specialized care had an effect on maternal depressive scores that was transient and could not be elucidated by the time points chosen in this study. This issue has also been illustrated in the work by Clifford and colleagues[132] on the effect of infant colic on lasting maternal distress. In this study, it was determined that 85% of colic cases had remitted by 3 months. Maternal distress was measured using the EPDS at 1 week postpartum and 6 months postpartum and a change score was created. Results of this study found that there was no difference in change score for women with colicky infants versus women with infants who were never colicky. Results from our study suggest that infant admission to specialized care, like colic, may have a transient impact on maternal distress and the negative result found in our study may be related to timing of the follow-up interview. Another possibility is heterogeneity

of the group of infants admitted to specialized care at birth may camouflage a true association. Infants can be admitted to specialized care units at birth for short term medical issues such as feeding difficulties or a course of antibiotics as well as long term medical issues such as preterm birth or being small for gestational age at birth. The large spectrum of severity that could not be captured for this group may limit our ability to determine the impact of infant admission to specialized care on the trajectories of maternal depressive symptoms. Women whose infants were admitted for only a short duration may not have experienced stress of the same magnitude as women whose infants were admitted for a long duration. Therefore, an association may have been missed between severe infant health issues at birth and the trajectory of maternal depressive symptoms.

6.2 Variable Rationale

Mother's subjective experience is of great interest to us in this project; therefore, a self-report measure of depressive symptomatology is preferred over a clinical diagnosis. As stated previously, there are many self-report scales available which do not confer clinical diagnoses but indicate women at an increased risk of clinical depression. The EPDS and the CES-D are both widely used self-report scales, each with their own strengths. The EPDS has been approved for both pregnant and postnatal populations with high sensitivity and specificity[25,133]. Its major advantage is that it does not include somatic symptoms such as insomnia and appetite changes that may occur for women in pregnancy and postpartum.

Although the CES-D has not been validated in pregnant populations, like the EPDS it does not require participants to give much information regarding somatic symptoms and has been validated for other conditions with distinctive somatic symptoms[134].

Ideally, weight and height measurements taken by a physician or a trained research assistant with a standardized protocol would be preferred. However, in this project we are limited by telephone interviews and therefore self-report weight and height. In a study conducted by Huber[135] of 381 women's self-reported weight and height versus direct measurement, it was determined that women did underestimate self-report weight and height, however this was done by all women regardless of age, education, race or marital status.

We realize the issues surrounding self-reported smoking status. It is possible that women will underreport the number of cigarettes smoked due to social desirability. However, in this study we are limited by a telephone interview and therefore self-report smoking status.

Socioeconomic status is a difficult variable to capture. A measure of SES that captured income, education and employment for both the mother and father (if applicable) of the child in our study would have been ideal. However, information regarding the father was not available and the decision was made to use both maternal education and household income as measures of SES.

Thyroid disease was captured by asking participants if they had any chronic conditions and/or if they were currently taking any medications. The way in which the thyroid disease variable was collected was not robust enough in order to separate a

hypothyroid disorder from a hyperthyroid disorder. In the literature, hypothyroid disorders are more likely to cause depression. However, in this study, we are limited by the information collected at each wave of data collection and information that is voluntarily given by the participant.

For the infant admission to specialized care variable, a measure of dose-response would have been preferred such as number of days admitted to specialized care in order to determine level of child health at birth. However, this information was not available to us as it was not collected in the PHP.

6.3 Sensitivity Analyses

Results of analyses including all variables in the final model suggest that the choice to build models based on a cut point of $p<0.2$, although generous, may not have been inclusive enough in order to allow all variables significantly associated with the outcome to remain in the final model. However, the association between infant admission to specialized care and the change in maternal depressive symptoms remained statistically insignificant using both methods suggesting that the finding is robust.

Results from the analyses using postpartum CES-D as the outcome, rather than the change in CES-D score from pregnancy to postpartum suggest similar results with few exceptions.

Given that we are most interested in the trajectory or the change in maternal depressive symptoms from pregnancy to the postpartum follow-up interview and given the robustness of the finding in regards to the lack of long term impact of infant admission to specialized care, we fail to find in favour of our hypothesis.

6.4 Strengths and Limitations

6.4.1 Strengths

The large prospective cohort design of the PHP allows us to survey the same women at different time points. Surveying women at the two separate occasions will alleviate recall bias as they are reporting on their feelings and habits at the present time and are not asked to report on few past experiences. Another strength of the study is that we are investigating maternal depressive symptomatology. This includes women who do not meet the criteria for clinical or postpartum depression but have increased depressive symptoms that have an impact on their everyday lives. Including these women in our study will have an important impact on screening and delivery of services to pregnant women who do not meet the criteria for clinical depression but may be having difficulties in caring for their child.

Recruitment of participants in the PHP from 8 ultrasound clinics in London, Ontario was a community based recruitment strategy that provided a good representative sample and will allow our results to be very generalizable to mothers in London Ontario. The prenatal and postnatal health projects collected a large number of variables which allowed us to control for a variety of other risk factors of maternal depression.

6.4.2 Limitations

Subject attrition may be a problem in this study as women who show high levels of depression symptoms in pregnancy were statistically less likely to agree to complete the follow-up questionnaire questionnaire which could possibly affect the results of our study as well as its generalizability.

The data used from the Prenatal Health Project provides us with information regarding maternal health conditions, but this information is lacking in the data from the Postnatal Health Project. Therefore, this variable has no real longitudinal component and we are unable to determine the actual chronicity of these medical conditions to adjust for their presence or absence over time. Data from both waves of data collection were obtained via self-report measures. Self-report measures are susceptible to systematic error. Participants are more likely to give a more socially acceptable response especially for measures such as smoking status and weight.

6.4.3 Generalizability and Validity

Table 6.1 summarizes the difference in prenatal characteristics for women who completed versus those who did not complete the 2+ year follow-up. Women who did not complete the 2+ year follow-up interview were younger, were more likely to smoke before and during pregnancy, were more likely to have less than a high school education, were more likely to have more than one child, and were more likely to be above the cut-off of 16 for the CES-D scale in pregnancy.

Generalizability would be an issue for assessing prevalences but, ordinarily, not for assessing relationships between predictors and outcome. Rothman and Greenland's[136] state that, since confounders, causes and other associations between variables and the outcome are controlled for in analyses, a universal statement of cause and effect can be made. Identifying the causal relationship within the study population allows you to draw a universal statement, regardless of any statistical differences in descriptive frequencies between groups. Therefore, in theory, generalizability is not an issue; any differences

between women who completed and did not complete the 2+ year follow-up do not affect the generalizability of our results.

However, in this particular situation, we cannot preclude the possibility of a threat to study validity caused by differential loss to follow-up. It is possible that the individuals who experienced depressive symptoms that increased from pregnancy to postpartum were at a greater likelihood to not complete the 2 year follow-up study. This could bias the trajectory observed, as some of the trend of decreased CES-D in women with higher prenatal CES-D may be due women with increasing symptoms being underrepresented due to loss to follow-up. As previously discussed, regression to the mean can be seen in figure 5.2. Regression to the mean is a statistical phenomenon that is expected when variables are measured at multiple time points in a longitudinal cohort study. To what degree both phenomena, regression to the mean and differential loss to follow-up, are responsible for the trend seen in 5.2 is unknown. Thus, the relative contribution of these to the observed trajectory of maternal depressive symptoms is unknown.

6.5 Conclusions and Future Directions

Results suggest that women with higher social support, lower stress and higher child health are more likely to have a trajectory of maternal depression that decreases from pregnancy to postpartum. These results outline groups of women who may be at an increased risk for depressive symptoms that increase after pregnancy, and therefore are in particular need of depression screening in pregnancy.

The results also suggest that women who have high depression scores in pregnancy have depressive symptoms that decrease from pregnancy to the postpartum period which is consistent with the literature. This illustrates the importance of screening for depression in the antenatal period. In pregnancy, a woman seeking prenatal care will visit her family physician or obstetrician regularly. Prenatal visits, due to their frequency, are a perfect setting for the evaluation of maternal depression in pregnancy. Screening for depression in pregnancy and providing quick and efficient treatment could prevent the harmful effects of maternal depression on the health and development of the child. Pregnant women who seek antenatal care have many prenatal health visits to their family physician or obstetrician. These visits should provide ample opportunity for depression screening before the birth of the child. Further research is necessary in order to determine the effectiveness of screening policies for pregnant women in London, Ontario; especially for women with significant predictors of depression such as low social support and increased stress.

Table 6.1: Prenatal Characteristics (Completed Postpartum Follow-Up Versus Lost to Follow-Up)

PRENATAL VARIABLES	FREQUENCY (%)		p-value
	Participants who did not completed 2+ year follow-up	Participants who completed the 2+ year follow-up	
AGE			
16-21	76 (9.96 %)	58 (3.64 %)	
22-34	574 (75.23 %)	1221 (76.65 %)	<.0001*
35+	113 (14.81 %)	314 (19.71 %)	
BMI			
Underweight	45 (6.28 %)	55 (3.58 %)	
Normal weight	444 (61.92 %)	926 (60.29 %)	0.007*
Overweight	138 (19.25 %)	352 (22.52 %)	
Obese	90 (12.55 %)	203 (13.22 %)	
THYROID ISSUES			
No	734 (96.20 %)	1519 (94.88 %)	0.0954
Yes	29 (3.80 %)	82 (5.12 %)	
SMOKING			
BEFORE PREGNANCY			
No	526 (69.67 %)	1269 (80.42 %)	<.0001*
Yes	229 (30.33 %)	309 (19.58 %)	
DURING PREGNANCY			
No	631 (83.80 %)	1460 (92.41 %)	<.0001*
Yes	122 (16.20 %)	120 (7.59 %)	
PARITY			
Zero	242 (31.76 %)	598 (37.52 %)	0.0060*
One or greater	520 (68.24 %)	996 (62.48 %)	
CHRONIC DISEASE			
No	608 (79.69 %)	1287 (80.39 %)	0.8506
Yes	155 (20.31 %)	314 (19.61 %)	
MATERNAL DEPRESSION IN PREGNANCY			
CES-D less than 16	571 (74.84 %)	1357 (84.76 %)	<.0001*
CES-D >= 16	192 (25.16 %)	244 (15.24 %)	
INFANT ADMISSION TO SPECIALIZED CARE			
No	659 (91.53 %)	1428 (92.19 %)	0.6335
Yes	61 (8.47 %)	121 (7.81 %)	
SOCIOECONOMIC STATUS			
EDUCATION			
High school or less	203 (26.89 %)	201 (12.69 %)	<.0001*
More than high school	552 (73.11 %)	1383 (87.31 %)	

NOTE: difference between groups tested with chi-square analysis

*Statistically significant at $p < 0.05$

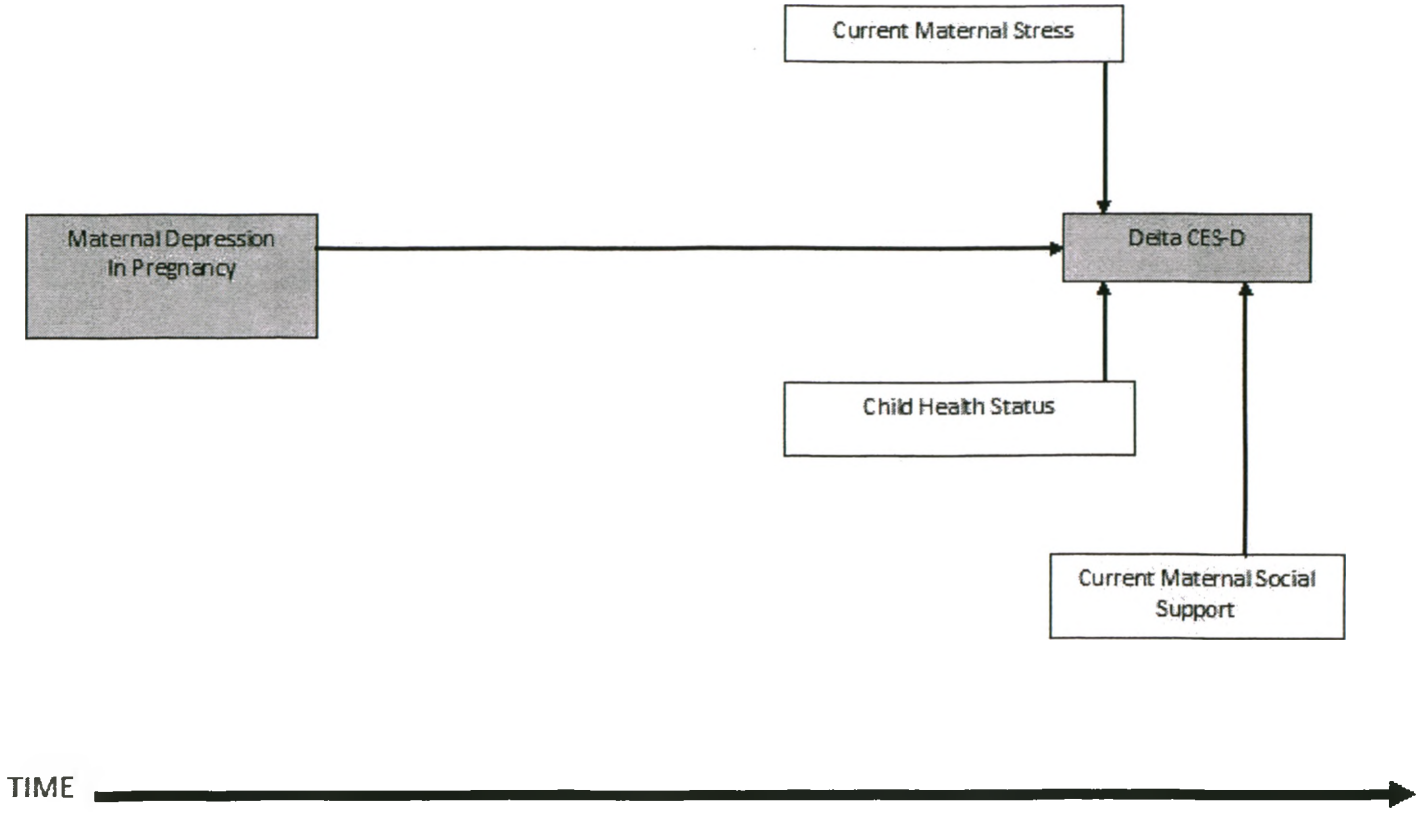

Figure 6.1: Final conceptual model based on analysis

REFERENCES (CHAPTERS 1-6)

1. Stewart DE, Gucciardi E, Grace SL. Depression. Women's Health 2004; 4 (Suppl 1):S19-S26.

2. Moses-Kolko EL, Roth EK. Antepartum and postpartum depression: Healthy mom, healthy baby. Journal of the American Medical Women's Association 2004;59:181-191.

3. Depression in Pregnancy [Internet Page]. Ottawa: Public Health Agency of Canada; c2005 [updated 2005 Aug 17, cited 2009 Jan 20]. Available from: http://www.phac-aspc.gc.ca/mh-sm/preg_dep-eng.php.

4. Rich-Edwards JW, Kleinman K, Abrams A, et al. Sociodemographic predictors of antenatal and postpartum depressive symptoms among women in a medical group practice. Journal of Epidemiology and Community Health 2006; 60: 221-227.

5. Ross LE, McLean LM. Anxiety disorders during pregnancy and the postpartum period: a systematic review. Journal of clinical psychiatry 2006;67:1285-1298.

6. Post Partum Depression [internet Page]. Ottawa: Canadian Mental Health Association; c2009 [cited 2009 Jan 20]. Available from: http://www.cmha.ca/BINS/content_page.asp?cid=3-86-87-88&lang=1

7. Evans J, Heron J, Francomb H, et al. Cohort study of depressed mood during pregnancy and after childbirth. British medical journal 2001;323:257-260.

8. Lee AM, Lam SK, Lau SM, Chong CS, Chui HW, Fong DY. Prevalence, course and risk factors for antenatal anxiety and depression. Obstetrics & Gynecology 2007; 110:1102-1112.

9. Heron J, O'Connor TG, Evans J, et al. The course of anxiety and depression through pregnancy and the postpartum in a community sample. Journal of affective disorders 2004; 80:65-73.

10. Andersson L, Sundstrom-Poromaa I, Wulff M. et al. Depression and anxiety during pregnancy and six months postpartum:a follow-up study. Acta Obstetrica et Gynecologica 2006;85:937-944.

11. Verkerk GJ, Pop VJ, Van Son MJ, Van Heck GL. Prediction of depression in the postpartum period: a longitudinal follow-up study in high-risk and low-risk women. Journal of affective disorders 2003; 77: 159-166.

12. Eberhard-Gran M, Eskild A, Tambs K et al. Depression in postpartum and non-postpartum women: prevalence and risk factors. Acta Psychiatrica Scandinavica 2002;106: 426-433.

13. Dietz PM, Williams SB, Callaghan WM, et al. Clinically identified maternal depression before, during and after pregnancies ending in live births. American Journal of Psychiatry 2007;164:1515-1520.

14. O'Keane V, Marsh, MS. Depression during pregnancy. British Medical Journal 2007;334:1003-1005.

15. Rubertsson C, Wickberg B, Gustavsson P and Radesatd I. Depressive symptoms in early pregnancy, two months and one year postpartum and psychosocial risk factors in a national Swedish sample. Archives of Women's Mental Health 2005;8:97-104.

16. LaCoursiere DY, Baksh L, Bloebaum L and Varner MW. Maternal body mass index and self-reported postpartum depressive symptoms. Maternal and Child Health Journal 2006; 10 (4):385-390.

17. Miles MS, Holditch-Davis D, Schwartz TA, et al. Depressive symptoms in mothers of prematurely born infants. Journal of Development & Behavioural Pediatrics 2007;28:36-44.

18. Davis L, Edwards H, Mohay H, Wollin J. The impact of very premature birth on the psychological health of mothers. Early Human Development 2003;73:61-70.

19. Orr ST, Blazer DG, James SA, et al. Depressive symptoms and indicators of maternal health status during pregnancy. Journal of Women's Health 2007;16:535-541.

20. Weiss SJ, and Chen JL. Factors influencing maternal mental health and family functioning during the low birth weight infant's first year of life. Journal of Pediatric Nursing 2002; 17: 114-125.

21. Suri R, Altshuler L, Hellemann G, et al. Effects of antenatal depression and antidepressant treatment on gestational age at birth and risk of preterm birth. The American Journal of Psychiatry 2007;164:1206-1213.

22. Mandl KD, Tronick EZ, Brennan TA, Alpert HR, Homer CJ. Infant health care use and maternal depression. Archives of Pediatric and Adolescent Medicine 1999; 153: 808-813.

23. Weissman MM, Wickramaratne P, Nomura V, Pilowsky D, Verdeli H. Offspring of Depressed Parents: 20 years later. The American Journal of Psychiatry 2006; 163: 1001-1008.

24. American Psychiatric Association. *The Diagnostic and Statistical Manual of Mental Disorders,* 4th ed. Washington, DC: American Psychiatric Association; 1994.

25. Cox JL, Holden JM, Sagovsky R. Edinburgh Postnatal Depression Scale (EPDS). British Journal of Psychiatry 1987; 150.

26. Radloff, LS. The CES-D Scale: a self-report depression scale for research in the general population. Applied Psychological Measurement 1977; 1:385-401.

27. Limlomwongse N and Liabsuetrakul T. Cohort study of depressed moods in thai women during late pregnancyand 6-8 weeks postpartum using the Edinburgh postnatal depression scale (EDPS). Archives of Women's Mental Health 2006;9:131-138.

28. Luoma I, Tamminen T, Kaukonen P, Laippala P, Puura K, Salmelin R, Almqvist F. Longitudinal study of maternal depressive symptoms and child well-being. Journal of the American Academy of Child and Adolescent Psychiatry 2001; 40:1367-1374.

29. Seimyr L, Edhborg M, Lundh W, Sjogren B. In the shadow of maternal depressed mood: experiences of parenthood during the first year after childbirth. Journal of Psychosomatic Obstetrics and Gynecology 2004; 25: 23-34.

30. Najman JM, Andersen MJ, Bor W, O'Callaghan MJ, Williams GM. Postnatal depression- myth and reality: maternal depression before and after the birth of a child. Social Psychiatry and Psychiatric Epidemiology 2000; 35: 19-27.

31. Larsson C, Sydsjo G, Joefsson A. Health, sociodemographic data, and pregnancy outcome in women with antepartum depressive symptoms. Obstetrics & Gynecology 2004; 104:459-466.

32. Hammen C, Brennan PA. Severity, chronicity and timing of maternal depression and risk for adolescent offspring diagnoses in a community sample. Archives of General Psychiatry 2003; 60: 253-258.

33. Deave T, Heron J, Evans J, Emond A. The impact of maternal depression in pregnancy on early child development. British Journal of Obstetrics and Gynaecology 2008; 115: 1043-1051.

34. Stein A, Malmberg LE, Sylva K, Barnes J, Leach P, FCCC team. The influence of maternal depression, caregiving and socioeconomic status in the post-natal year on children's language development. Child: Care, Health and Development 2008; 34: 603-612.

35. Schwebel DC, Brezausek CM. Chronic maternal depression and children's injury risk. Journal of Pediatric Psychology 2008; 33: 1108-1116.

36. Births [internet page]. Ottawa: Statistics Canada; c2008 [updated 2008 Sep 26; cited 2009 Jan 20]. Available from: http://www.statcan.gc.ca/daily-quotidien/080926/dq080926a-eng.htm- .

37. Delpisheh A, Brabin L, Attia E, Brabin BJ. Pregnancy late in life: A hospital-based study of birth outcomes. Journal of Women's Health 2008; 17: 965-970.

38. Little BB, Ramin SM, Cambridge BS, Schnider NR, Cohen DS, Snell LM, Harrod MJ, Johnston WL. Risk of chromosomal abnormalities, with emphasis on live born offspring of young mothers. American Journal of Human Genetics 1995; 57: 1178-1185.

39. Fraser AM, Brockert JE, Ward RH. Association of young maternal age with adverse reproductive outcomes. The New England Journal of Medicine 1995; 332: 1113-1117.

40. Henderson JJ, Evans SF, Straton JA, Priest SR, Hagan R. Impact of postnatal depression on breastfeeding duration. Birth 2003; 30: 175-180.

41. Chin AC, Myers L, Magnus JH. Race, education, and breastfeeding initiation in Louisiana, 2000-2004. Journal of Human Lactation 2008; 24: 175-185.

42. Ladomenou F, Kafatos A, Galanakis E. Risk factors related to intention to breastfeed, early weaning and suboptimal duration of breastfeeding. Acta Paediatrica 2007; 96: 1441-1444.

43. Taveras EM, Capra AM, Braveman PA, Jensvold NG, Escobar GJ, Lieu TA. Clinician support and psychosocial risk factors associated with breastfeeding discontinuation. Pediatrics 2003; 112: 108-115.

44. Field T, Hernandez-Reif M, Diego M. Risk factors and stress variables that differentiate depressed from nondepressed pregnant women. Infant Behaviour and Development 2006; 29: 169-174.

45. McLennan JD, Kotelchuck M, Cho H. Prevalence, persistence and correlates of depressive symptoms in a national sample of mothers of toddlers. Journal of the American Academy of Child and Adolescent Psychiatry 2001; 40: 1316-1323.

46. Klassen AF, Lee SK, Raina P, Lisonkova S. Psychological health of family caregivers of children admitted at birth to a NICU and healthy children: a population-based cross-sectional survey. BMC Pediatrics 2004; 4: 24-34.

47. Boyce P, Hickey A. Psychosocial risk factors to major depression after birth. Social Psychiatry and Psychiatric Epidemiology 2005; 40: 605-612.

48. Mayberry LJ, Horowitz JA, Delercq E. Depression symptom prevalence and demographic risk factors among US women during the first 2 years postpartum. Journal of Obstetric, Gynaecologic and Neonatal Nursing 2007; 36: 542-549.

49. Campbell SB, Matestic P, von Stauffenberg C, Mohan R, Kirchner T. Trajectories of Maternal Depressive Symptoms, maternal sensitivity and children's functioning at school entry. Developmental Psychology 2007; 43: 1202- 1215.

50. Raatikainen K, Heiskanen N, Heinonen S. Transition from overweight to obesity worsens pregnancy outcome in a BMI-dependant manner. Obesity 2006;14: 165-171.

51. Abenhaim HA, Kinch RA, Morin L, Benjamin A, Usher R. Effect of prepregnancy body mass index categories on obstetrical and neonatal outcomes. Archives of Gynecology and Obstetrics 2007; 275: 39-43.

52. Frederick IO, Williams MA, Sales AE, Martin DP, Killien M. Pre-Pregnancy body mass index, gestational weight gain, and other maternal characteristics in relation to infant birth weight. Journal of Maternal and Child Health 2008; 12: 557-567.

53. DiPietro JA, Millet S, Costigan KA, Gurewitsch E, Caulfield LE. Psychosocial influences on weight gain attitudes and behaviours during pregnancy. Journal of the American Dietetic Association 2003; 103: 1314-1319.

54. Duncombe D, Wertheim EH, Skouteris H, Paxton SJ, Kelly L. How well do women adapt to change in their body size and shape across the course of pregnancy? Journal of Health Psychology 2008; 13: 503-515.

55. Carter AS, Wood Baker C, Brownell KD. Body mass index, eating attitudes and symptoms of depression and anxiety in pregnancy and the postpartum period. Psychosomatic Medicine 2000; 62: 264-270.

56. Higgins C. (2007). *Understanding Laboratory Investigations for Nurses and Health Professionals. Second Edition.* Hoboken: Blackwell Publishing.

57. Lao, TT. Thyroid disorders in pregnancy. Current Opinion in Obstetrics and Gynecology 2005; 17: 123-127.

58. Pedersen CA, Johnson JL, Silva S, Bunevicius R, Meltzer-Brody S, Hamer RM, Leserman J. Antenatal thyroid correlates of postpartum depression. Psychoneuroendocrinology 2007; 32:235-345.

59. Burguet A, Kaminski M, Abraham-Lerat L, Schaal JP, Cambonie G, Fresson J, Grandjean H, Truffert P, Marpeau L, Voyer M, Roze JC, Treisser A, Larroque B. The complex relationship between smoking in pregnancy and very preterm delivery. Results of the Epipage study. International Journal of Obstetrics and Gynaecology 2004; 111: 258-265.

60. Rodrigues T, Barros H. Comparison of risk factors for small-for-gestational-age and preterm in a Portuguese cohort of newborns. Maternal and Child Health Journal 2007; 11: 417-424.

61. Bernstein IM, Mongeon JA, Badger GJ, Solomon L, Heil SH, Higgins ST. Maternal Smoking and its association with birth weight. Obstetrics & Gynecology 2005; 106: 986-991.

62. Chiolero A, Bovet P, Paccaud F. Association between maternal smoking and low birth weight in Switzerland: the EDEN study. Swiss Medical Weekly 2005; 135: 525-530.

63. Castles A, Adams K, Melvin CL, Kelsch C, Boulton ML. Effect of smoking during pregnancy. American Journal of Preventative Medicine 1999; 16: 208-215.

64. Marcus SM, Flynn HA, Blow FC, Barry KL. Depressive symptoms among pregnant women screened in obstetric settings. Journal of Women's Health 2003; 12: 373-380.

65. Breese McCoy SJ, Beal M, Miller Shipman SB, Payton ME, Watson GH. Risk factors for postpartum depression: a retrospective investigation at 4-weeks postnatal and a review of the literature. Journal of the American Osteopathic Association 2006; 106: 193-198.

66. Leiferman J. The effect of maternal depressive symptomatology on maternal behaviours associated with child health. Health Education & Behaviour 2002; 29: 596-607.

67. Whitaker RC, Orzol SM, Kahn RS. The co-occurance of smoking and a major depressive episode among mothers 15 months after delivery. Preventive Medicine 2007; 45: 476-480.

68. Kavanaugh M, McMillen RC, Pascoe JM, Southward LH, Winickoff JP, Weitzman M. The co-occurance of maternal depressive symptoms and smoking in a national survey of mothers. Ambulatory Pediatrcis 2005; 5:341-348.

69. Lisonkova S, Janssen P, Sheps S, Lee S, Dahlgren L. The effect of maternal age on adverse birth outcomes: does parity matter? American Journal of Obstetrics and Gynaecology 2008; 199: S69.

70. Chan BC, Lao TT. Effect of parity and advanced maternal age on obstetric outcome. International Journal of Gynecology and Obstetrics 2008; 102: 237-241.

71. Records K, Rice M. Psychosocial correlates of depression symptoms during the third trimester of pregnancy. Journal of Obstetric, Gynecologic, & Neonatal Nursing 2007; 36: 231-242.

72. Chronic Diseases [internet page]. Ottawa: Public Health Agency of Canada. c2008 [updated 2008 nov 14; cited 2009 Jan 20] Available from: http://www.phac-aspc.gc.ca/cd-mc/index-eng.php .

73. Schoenfisch AL, Dement JM, Rodriguez-Acosta RL. Demographic, clinical and occupational characteristics associated with early onset of delivery: Findings from the Duke Health and safety surveillance system, 2001-2004. American Journal of Industrial Medicine 2008; 51: 911-922.

74. Dunne F, Brydon P, Smith K, Gee H. Pregnancy in women with Type 2 diabetes: 12 year outcome data 1990-2002. Diabetic Medicine 2003; 20:734-738.

75. Horwitz S, Briggs-Gowan MJ, Storfer-Isser A, et al. Prevalence, correlates and persistence of maternal depression. Journal of Women's Health 2007;16: 678-691.

76. Leigh B, Milgrom J. Risk factors for antenatal depression, postnatal depression and parenting stress. BioMed Central Psychiatry 2008; 8:24-34.

77. O'Connor TG, Capariello P, Blackmore ER, Gregory AM, Glover V, Fleming P. Prenatal mood disturbance predicts sleep problems in infancy and toddlerhood. Early Human Development 2007; 83: 451-458.

78. Slykerman RF, Thompson JM, Pryor JE, Becroft DM, Robinson E, Clark PM, Wild CJ, Mitchell EA. Maternal stress, social support and preschool children's intelligence. Early Human Development 2005; 81: 815-821.

79. Beck CT. Predictors of postpartum depression. An Update. Nursing Research 2001; 50: 275-285.

80. Uhari, M., K. Mantysaari, M. Niemala. A meta-analytic review of the risk factors of acute otitis media. Clinical Infectious Disease, 1996; 22:1079-83.

81. Ford RP, Taylor BJ, Mitchell EA. Breastfeeding and the risk of sudden infant death syndrome. International Journal of Epidemiology 1993; 5:332-336.

82. Hetzner NM, Razza RA, Malone LM, Brooks-Gunn J. Associations among feeding behaviours during infancy and child illness at two years. Maternal and Child Health Journal 2008 [EPub Ahead of Print].

83. Kramer MS, Aboud F, Mironova E, Vanilovich I, Platt RW, Matush L, Igumnov S, Fombonne E, Bogdanovich N, Ducruet T, Collet J, Chalmers B, Hodnett E, Davidovsky S, Skugarevsky, Trofinovich O, Kozlova L, Shapiro S. Breastfeeding and child cognitive development. Archives of General Psychiatry 2008; 65: 578-584.

84. Vohr BR, Poindexter BB, Dusick AM, McKinley LT, Higgins RD, Langer JC, Poole WK. Persistent beneficial effects of breast milk ingested in the neonatal intensive care unit on outcomes of extremely low birth weight infants at 30 months of age. Pediatrics 2007; 120: 953-959.

85. Baker JL, Gamberg M, Heitman BL, Lissner L, Sorenson TI, Rasmussen KM. Breastfeeding reduces postpartum weight retention. The American Journal of Clinical Nutrition 2008; 88: 1543-1551.

86. Britton JR, Britton HL, Gronwaldt V. Breastfeeding, sensitivity and attachment. Pediatrics 2006; 118: 1436-1443.

87. Davey HL, Tough SC, Adair CE, Benzies KM. Risk factors for sub-clinical and major postpartum depression among a community cohort of Canadian women. Maternal and Child Health Journal 2008 [EPub ahead of print].

88. Luo ZC, Kierans WJ, Wilkins R, Liston RM, Mohamed J, Kramer MS. Disparities in birth outcomes by neighbourhood income. Temporal trends in rural and urban areas, British Columbia. Epidemiology 2004; 15: 679-686.

89. Jospeh KS, Liston RM, Dodds L, Dahlgren L, Allen AC. Socioeconomic status and perinatal outcomes in a setting with universal access to essential health care services. Canadian Medical Association Journal 2007; 177: 583-590.

90. Holzman C, Eyster J, Tiedje LB, Roman LA, Seagull E, Rahbar MH. A life course perspective on depressive symptoms in mid-pregnancy. Maternal and Child Health Journal 2006; 10: 127-138.

91. Lanzi RG, Pascoe JM, Keltner B, Landesman Ramey S. Correlates of maternal depressive symptoms in a national head start program sample. Archives of Pediatrics & Adolescent Medicine 1999; 153: 801-807.

92. Pascoe JM, Stolfi A, Ormond MB. Correlates of mothers' persistent depressive symptoms: a national study. Journal of Pediatric Health Care 2006; 20: 261-269.

93. Escriba-Aguir V, Gonzalez-Galarzo MC, Barona-Vilar C, Artazcoz L. Factors related to depression during pregnancy: are there gender differences? Journal of Epidemiology and Community Health 2008; 62:410-414.

94. Cairney J, Boyle M, Offord DR, Racine Y. Stress, social support and depression in single and married mothers. Social Psychiatry and Psychiatric Epidemiology 2003; 38:442-449.

95. Passer MW, Smith RE, Atkinson ML, Mitchell JB, Muir DW. (2003). *Psychology. Frontiers and Applications. First Canadian Edition.* Toronto: McGraw-Hill Ryerson.

96. Orhan FS, Soykan A, Ulukol B. Patient compliance to psychiatric interventions and course of postpartum mood disorders. International Journal of Psychiatry in Medicine 2007; 37: 445-457.

97. Gjerdingen D. The effectiveness of various postpartum depression treatments and the impact of antidepressant drugs on nursing infants. The Journal of the American Board of Family Medicine 2003; 16: 372-382.

98. Sears M, Sears W. (2000). The breastfeeding book: everything you need to know about nursing your child from birth through weaning. New York: Brown and Company.

99. Lattimore KA, Donn SM, Kaciroti N, Kemper AR, Neal CR, Vazquez DM. Selective serotonin reuptake inhibitor (SSRI) use during pregnancy and effects on the fetus and newborn: a meta-analysis. Journal of Perinatology 2005; 25: 595-604.

100. Robertson E, Grace S, Wallington T, Stewart DE. Antenatal risk factors for postpartum depression: a synthesis of recent literature. General Hospital Psychiatry 2004; 26: 289-295.

101. Milgrom J, Gemmill AW, Bilszta JL, Hayes B, Barnett B, Brooks J, Erickson J, Ellwood D, Buist A. Antenatal risk factors for postnatal depression: a large prospective study. Journal of Affective Disorders 2008;108: 147-157.

102. Ueda M, Yamashita H, Yoshida K. Impact of infant health problems on postnatal depression: pilot study to evaluate a health visiting system. Psychiatry and Clinical Neurosciences 2006; 60: 182-189.

103. Brennan PA, Hammen C, Andersen MJ, Bor W, Najman JM, Williams GM. Chronicity, severity and timing of maternal depressive symptoms: relationships with child outcomes at age 5. Developmental Psychology 2000; 36: 759-766.

104. Bendell D, Field T, Yando R, Lang C, Martinez A, Pickens J. "Depressed" mothers' perceptions of their preschool children's vulnerability. Child Psychiatry & Human Development 1994; 24: 183-190.

105. Jackson K, Ternestedt BM, Schollin J. From alienation to familiarity: experiences of mothers and fathers of preterm infants. Journal of Advanced Nursing 2003; 43: 120-129.

106. Singer LT, Salvador A, Guo S, Collin M, Lilien L, Baley J. Maternal psychological distress and parenting stress after the birth of a very low-birth-weight infant. Journal of the American Medical Association 1999; 281:799-805.

107. Meyer EC, Coll, CT, Seifer R, Ramos A, Kilis E, Oh W. Psychological distress in mothers of preterm infants. Developmental and Behavioural Pediatrics 1995; 16:412-417.

108. Drewett R, Blair P, Emmett P, Emond A. Failure to thrive in the term and preterm infants of mothers depressed in the postnatal period: a population-based birth cohort study. Journal of Child Psychology and Psychiatry 2004; 42: 359-366.

109. Caspi A, Sugden K, Moffitt TE, Taylor A, Craig IW, Harrington H, McClay J, Mill J, Martin J, Braithwaite A, Poulton R. Influence of Life Stress on Depression: Moderation by a Polymorphism in the 5-HTT Gene. Science 2003; 301: 386-389.

110. van Praag. Can stress cause depression? Progress in Neuro-Psychopharmacology & Biological Psychiatry 2004; 28: 891-907.

111. Kessler RC. The effects of stressful life events on depression. Annual Review of Psychology. 1997; 48: 191-214.

112. Campbell MK. CIHR Grant. *Pretnatal Health Project.* London, Ontario 2000.

113. Campbell MK. CIHR Grant. *Postnatal Health Project.* London, Ontario 2005.

114. Ali J, Avison WR. Employment transitions and psychological distress: the contrasting experiences of single and married mothers. Journal of Health and Social Behaviour 1997; 38: 345-362.

115. Avison, WR, Turner RJ. Stressful life events and depressive symptoms: disaggregating the effects of chronic strains and eventful stressors. Journal of Health and Social Behaviour 1988; 29: 253-264.

116. Roberts RE, Vernon SW. The center for epidemiological studies depression scale: its use in a community sample. American Journal of Psychiatry 1983; 140:141.

117. Turner R, Noh J, Noh S. Physical disability and depression: a longitudinal analysis. Journal of Health and Social Behaviour 1988; 29: 23-37.

118. Poverty Lines [internet page]. Ottawa: Canadian Council on Social Development; c2006 [cited 2009 Feb 21]. Available from: http://www.ccsd.ca/factsheets/fs_lico05_bt.htm

119. Turner, R. J., Wheaton, B., & Lloyd, D. A. The epidemiology of social stress. American Sociological Review 1995; 60: 104–125.

120. Sarason, I. G., Johnson, J. H., & Siegel, J. M. Assessing the impact of life changes: Development of the Life Experiences Survey. Journal of Consulting and Clinical Psychology 1978; 46 932–946.

121. Henderson S, Byrne DG, Duncan-Jones P. Neurosis and the Social Environment. New York; Academic Press, 1981.

122. Holmes TH, Rahe RH. The social readjustment rating scale. Journal of Psychosomatic Research 1967; 11:213-218.

123. Wheaton, B., 1994. Sampling the stress universe. In: Avison, W.R. and Gotlib, I.H., Editors, 1994. *Stress and mental health: Contemporary issues and prospects for the future*, Plenum Press, New York, pp. 77–114.

124. Pearlin, LI., Mullan JT, Semple SJ, Skaff MM. Caregiving and the stress process: An overview of concepts and their measures. The Gerontologist 1990; 30: 583-594.

125. Avison WR. Family structure and mental health. In The Social Contexts of Stress and Health, edited by Maney AC. Washington, DC: National Institute of Mental Health.

126. Turner RJ, Marino F. Social support and social structure: A descriptive epidemiology. Journal of Health and Social Behavior 1994; 35: 193–212.

127. Stein RE, Jessop DJ. Functional status II(R), A measure of child health status. Med Care 1990; 28: 1041-1055.

128. Lee KI, Koval J. Determination of the best significance level in forward stepwise logistic regression. Communications in Statistics- Simulation and Computation 1997; 26: 559-575.

129. Oberlander TF, Warburton W, Misri S, Aghajanian J, Hertzman C. Neonatal outcomes after prenatal exposure to selective serotonin reuptake inhibitor antidepressants and maternal depression using population-based linked health data. Archives of General Psychiatry 2006; 63: 898-906.

130. Nordeng H, Lindemann R, Perminov KV, Reikvam A. Neonatal withdrawal syndrome after in utero exposure to selective serotonin reuptake inhibitors. Acta Paediatrica 2001; 90: 288-291.

131. Moses-Kolko EL, Bogen D, Perel J, Bregar A, Uhl K, Levin B, Wisner KL. Neonatal signs after late in utero exposure to serotonin reuptake inhibitors: literature review and implications for clinical applications. The Jounal of the American Medical Association 2005; 293: 2372-2383.

132. Clifford TJ, Campbell MK, Speechley KN, Gorodzinsky F. Sequelae of infant colic: Evidence of transient infant distress and absence of lasting effects on maternal mental health. Archives of Pediatrics & Adolescent Medicine 2002;156:1183-1188.

133. Murray D, Cox JL. Screening for depression during pregnancy with the Edinburgh depression scale (EPDS). Journal of Reproductive and Infant Psychology 1990; 8: 99-107.

134. Devins G, Orme C. Center for Epidemiologic Studies Depression Scale. In: *Test Critiques Vol II.* Editors: Keyser DJ, Sweetland RC. Kansas City, MO: Test Corporation of America, 1985; pp. 144–160.

135. Huber LR. Validity of self-reported height and weight in women of reproductive age. Maternal and Child Health Journal 2007; 11: 137-144.

136. Rothman KJ, Greenland S. *Modern Epidemiology 2nd Edition.* Lippincott Williams & Wilkins 1998.

APPENDIX A: SAMPLE SIZE CALCULATION

The sample required in order to detect a half a standard deviation change in delta CES-D can be determined using an equation for continuous variables[1].

$$n = \frac{(c_{1-\beta} + c_{1-\frac{\alpha}{2}})^2 \sigma^2}{(\mu_1 - \mu_2)^2 f(1-f)}$$

Where:
β= Type II Error = 0.2
α= Type I Error = 0.05
($\mu_1 - \mu_2$)= Difference that is significant= Half a standard deviation= 4.1
σ = Standard Deviation = 8.2
f = Frequency of infant admission to specialized care = 0.08

$$n = \frac{(1.64 + 0.84)^2 (8.20)^2}{(4.10)^2 \, 0.08(1 - 0.08)}$$

$$n = \frac{(6.18) \quad (67.08)^2}{(16.81) \quad (0.07)}$$

$$n = 339.5 = 340$$

The flow diagram of participants in the Prenatal Health Project (Figure 5.1) shows that 1594 women participated at both waves of data collection. Therefore, the sample size available to us in the PHP was more than sufficient in order to detect a half a standard deviation change in delta CES-D.

APPENDIX B: ETHICS APPROVAL FORMS

The UNIVERSITY *of* WESTERN ONTARIO

Research Ethics Office - Dental Sciences Building, London, ON, Canada N6A 5C1
Telephone: (519) 661-3036 Fax: (519) 850-2466 E-mail: ethics@uwo.ca

REVIEW BOARD FOR HEALTH SCIENCES RESEARCH INVOLVING HUMAN SUBJECTS (FULL BOARD)
CERTIFICATION OF APPROVAL OF HUMAN RESEARCH

ALL HEALTH SCIENCES RESEARCH INVOLVING HUMAN SUBJECTS AT THE UNIVERSITY OF WESTERN ONTARIO
OPERATES IN ACCORDANCE WITH AND CONFORMS TO THE TRI-COUNCIL POLICY STATEMENT
(ETHICAL CONDUCT FOR RESEARCH INVOLVING HUMANS)

2000-2001 REVIEW BOARD MEMBERSHIP

1) Dr. P.G.R. Harding, (Chair) (Obstetrics Gynaecology)
2) Ms. S. Hoddinott, Director of Research Services (Epidemiology)
3) St. Joseph's Health Centre Representative ()
4) Dr. R. McManus, London Health Sciences Centre - Victoria Campus Representative (Endocrinology Metabolism)
5) London Health Sciences Centre - University Campus Representative
6) Dr. L. Heller, Office of the President Representative (French)
7) Ms. S. Agranove, Office of the President Representative (Community)
8) Ms. S. Finchet-Stoll, Office of the President Representative (Legal)
9) Dr. D. Freeman, Faculty of Medicine Dentistry Representative (Clinical)
10) Dr. G. Woodbury, Faculty of Medicine Dentistry Representative (Basic)(Epidemiology)
11) Dr. G. McCarthy, School of Dentistry Representative (Oral Biology)
12) Ms. D. Travis, Faculty of Health Sciences Representative, (Nursing)
13) Dr. D. Jonker, London Regional Cancer Centre Representative, (Oncology)
14) Ms. N. Pus, London Clinical Research Association Representative (Nursing)
15) Dr. M. Gibson, Research Institutes Representative (Psychology)

Alternates are appointed for each member.

THE REVIEW BOARD HAS EXAMINED THE RESEARCH PROJECT ENTITLED:

Prediction of Preterm Birth

REVIEW NO. 08253E

AS SUBMITTED BY: Dr. M.K. Campbell - Epidemiology & Biostatistics, University of Western Ontario

AND CONSIDERS IT TO BE ACCEPTABLE ON ETHICAL GROUNDS FOR RESEARCH INVOLVING HUMAN SUBJECTS UNDER CONDITIONS OF THE UNIVERSITY'S POLICY ON RESEARCH INVOLVING HUMAN SUBJECTS.

APPROVAL DATE: April 26, 2001 (UWO Protocol, Letter of Information & Consent)

AGENCY: CIHR

AGENCY TITLE:

c.c. Hospital Administration

P. Harding, Chair

Western

Office of Research Ethics

The University of Western Ontario
Room 00045 Dental Sciences Building, London, ON, Canada N6A 5C1
Telephone: (519) 661-3036 Fax: (519) 850-2466 Email: ethics@uwo.ca
Website: www.uwo.ca/research/ethics

Use of Human Subjects - Ethics Approval Notice

Principal Investigator: Dr. M.K. Campbell
Review Number: 10787E **Revision Number:** 1
Protocol Title: Maternal and Infant Health, Health Services Needs and Utilization
Department and Institution: Epidemiology & Biostatistics, University of Western Ontario
Sponsor:
Ethics Approval Date: September 1, 2005 **Expiry Date:** March 31, 2010
Documents Reviewed and Approved: Revised Sample Size, Revised End Date, Revised Study Instrument
Documents Received for Information:

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted expedited approval to the above named research study on the approval date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations

This approval shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the UWO Updated Approval Request Form.

During the course of the research, no deviations from, or changes to, the protocol or consent form may be initiated without prior written approval from the HSREB except when necessary to eliminate immediate hazards to the subject or when the change(s) involve only logistical or administrative aspects of the study (e.g. change of monitor, telephone number). Expedited review of minor change(s) in ongoing studies will be considered. Subjects must receive a copy of the signed information/consent documentation.

Investigators must promptly also report to the HSREB:

a) changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;

b) all adverse and unexpected experiences or events that are both serious and unexpected;

c) new information that may adversely affect the safety of the subjects or the conduct of the study.

If these changes/adverse events require a change to the information/consent documentation, and/or recruitment advertisement, the newly revised information/consent documentation, and/or advertisement, must be submitted to this office for approval.

Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

Chair of HSREB: Dr. Paul Harding
Deputy Chair: Susan Hoddinott

Ethics Officer to Contact for Further Information			
☐ Karen Kueneman	☐ Janice Sutherland	☐ Susan Underhill	☐ Jennifer McEwen

This is an official document. Please retain the original in your files

cc: ORE File
LHRI
Faxed: Y/ N

REFERENCES (APPENDICES)

1. Bracken MB. *Perinatal Epidemiology.* Oxford University Press. New York, 1984.