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Epidemiology of Postpartum Depression: A prospective study

by

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Abstract

Objective: To develop a model of the association between a history of depression and postpartum depression after adjustment for demographic, obstetric, behavioural risk, mental health and psychosocial risk factors using prospective data.

Design: Secondary analysis of data from a randomized controlled trial of prenatal care.

Participants: 1403 pregnant women attending low risk maternity clinics in Calgary, Alberta.

Main Outcome Measure: Postpartum depression data were collected using the Edinburgh Postnatal Depression Scale (EPDS).

Main Results: The risk factors retained in the final model for women with postpartum depression (prevalence 4.5%) included a history of depression (OR 2.25, 95%CI 1.15-4.43), not breastfeeding at three months postpartum (2.00, 1.16-3.46), at-risk T-ACE classification (modified) (2.66, 1.29-5.48) and low postnatal parenting self-efficacy (4.37, 2.16-8.87).

Conclusions: Women who developed postpartum depression were characterized by a history of depression, not breastfeeding after three months, at-risk T-ACE (modified) and low postnatal parenting self-efficacy.

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Dedication

For my grandfather, Roland Davey who believed in the importance of education.

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Chapter One: Introduction

1.1 Introduction

Postpartum depression affects 10-15% of all new mothers and consequently is the most common complication of pregnancy in developed countries (1). Adverse health impacts on the mother, child and family due to the occurrence of the disorder during such a vulnerable life stage are well documented. Specifically, postpartum depression has implications for the mother's mental health and well-being including an increased risk of future depressive episodes (2), low self esteem, stress and negative maternal attitudes (3, 4). Postpartum depression is also an important child health issue as it adversely affects the establishment of a secure mother-infant relationship which can increase the risk for developmental problems such as delayed cognitive development and child behaviour problems (5). As well, postpartum depression can interfere with parenting (6) and marital relationship satisfaction for both partners (7, 8).

Consequently, women suffering from postpartum depression need to be identified and provided with timely treatment and support to minimize the impact of the illness on child and family outcomes. Further, the ability to identify women who are at highest risk for postpartum depression in the prenatal or early postpartum periods could allow for the implementation of screening and preventative interventions to reduce the number of cases of postpartum depression prior to its development. The ongoing contact most women have with their health care providers during pregnancy and the early postpartum period provides an excellent opportunity for antenatal screening and intervention when necessary.

Unfortunately, the etiology of postpartum depression is not well known. While researchers have looked at the role that reproductive hormones play in the development of postpartum depression, no consistent differences in hormone levels either in pregnancy or the postpartum distinguish women who experience postpartum depression from those who do not (9) suggesting that postpartum depression is not the result of a simple endocrine excess or deficiency.

Currently, postpartum depression is hypothesized to be the result of an interaction between genetic vulnerability, hormonal changes and psychosocial factors (10) and many studies have focused on identifying risk factors that increase a women's probability of developing the disorder (11).

Risk factors that have shown consistent and strong relationships with postpartum depression include a history of depression, depression during pregnancy, anxiety during pregnancy, insufficient social support and stressful life events during pregnancy or the early puerperium (2), with depression during pregnancy proving most predictive (1, 2, 12). However, a history of depression is also a risk factor for depression during pregnancy (13) and therefore many newly pregnant women will have a past history of depression.

While many studies have examined risk factors that increase the likelihood of developing postpartum depression, the majority of these studies have examined these associations in isolation and the application of that knowledge to the development of screening mechanisms to identify those at risk remains limited.

Screening for postpartum depression in current clinical practice has focused on identifying women with current postpartum depression, primarily using self-report

instruments at various time points during the 12 months after delivery (14). The most commonly used instrument has been the Edinburgh Postnatal Depression Scale (EPDS) (15). The EPDS is a self-report instrument designed to identify symptoms of depression in new mothers during the postpartum period. Women respond to 10 questions about their mood in the past seven days and each response is scored from 0 to 3. A score of 13 or greater identifies women with symptoms consistent with major depression (14). The EPDS is an effective and well validated screening tool to quantify the likelihood that a women is suffering from postpartum depression (15).

There is the potential for improving identification and early intervention by including a screening component that focuses on prenatal and early postpartum prediction of postpartum depression. Screening would allow for the identification of women at risk, at sub-clinical stages or with diagnosable depression who would benefit from monitoring and or individualized intervention in both the antenatal and postpartum periods.

1.2 Statement of the research problem

Although the relationship between a history of depression and postpartum depression has been explored the effect of this relationship in consideration of other risk factors has not been well studied. Understanding the synergistic effect of risk factors would provide the opportunity to identify women at the greatest risk of developing postpartum depression and therefore allow for interventions to be focused on those most in need. In addition, with an improved understanding of women at risk, the current practice of screening in the prenatal period could be improved through the development of a perinatal predictive model for postpartum depression. Specifically, by identifying women at risk during pregnancy instead of waiting until postpartum depression occurs

could potentially reduce the number of women who develop postpartum depression and the consequent adverse health outcomes of the mother, family and child.

1.3 Purpose

The purpose of this study was to identify the pre and perinatal risk factors that in combination with a history of depression predict women most at risk of postpartum depression.

1.4 Objectives

1. To quantify the risk a history of depression poses for major postpartum depression as defined by a score of 13 or greater on the Edinburgh Postnatal Depression Scale (EPDS) (15) in a prospective community sample of medically low risk pregnant women.
2. To quantify the risk of major postpartum depression associated with pre and perinatal risk factors.
3. To develop a model of the association between a history of depression and postpartum depression after adjustment for demographic, obstetric, behavioural risk, mental health and psychosocial risk factors that distinguishes women with major postpartum depression (EPDS $\geq$13) from those without postpartum depression (EPDS <13).
4. To develop a model of the association between pre and perinatal risk factors and postpartum depression that distinguishes women with minor postpartum depression (EPDS 10-12) from those without postpartum depression (EPDS $\leq$ 9).
5. To develop a model of the association between pre and perinatal risk factors and postpartum depression that distinguishes women with major postpartum

depression (EPDS ≥13) from those with minor postpartum depression (EPDS 10-12).

1.5 Study design

A secondary analysis of the Community Perinatal Care Study was undertaken to address the research objectives. The Community Perinatal Care study was a prospective randomized controlled clinical trial involving 2015 medically low risk pregnant women in the Calgary Health Region, (Alberta, Canada). The women completed telephone questionnaires at study intake (prior to first clinic appointment), at mid-pregnancy and at three months postpartum, providing information on demographics, lifestyle, physical and emotional health, social supports, social isolation, parental expectations, and thoughts and feelings on their pregnancy experience. Data collection for the Community Perinatal Care study took place from April 2001 to July 2004. 1403 (70% completion rate) women completed the EPDS in the third interview.

1.6 Significance of study

The Community Perinatal Care study, with its prospective design, large sample size and rigorous research methods provided an opportunity for an analysis yielding high quality, novel insights into the covariates and predictors of postpartum depression. Prospective longitudinal research designs offer considerable advantages in that they allow for the identification of risk factors measured before outcomes and also may help describe the relative contributions of different risk factors to outcomes. The sets of risk factors identified from this study could be used to develop a perinatal screening instrument that could be administered at prenatal appointments and well child visits to identify women with characteristics that place them at risk for postpartum depression.

Chapter Two: Literature Review

2.1 Overview

This chapter reviews the literature on postpartum depression. In the first section puerperal mood disorders will be defined followed by a more detailed summary of the diagnosis, symptoms and treatment of postpartum depression. The next section will describe the impact of postpartum depression on the mother, her partner and her child. The etiology of postpartum depression and a detailed summary of current knowledge of risk factors for postpartum depression are included. Finally, practice patterns related to screening for postpartum depression are described.

2.2 Puerperal mood disorders

Postpartum depression, postpartum blues and postpartum psychosis comprise the spectrum of mood disorders that occur following childbirth. These three disorders are known as postpartum affective disorders (2). Postpartum affective disorders are differentiated from each other by their prevalence, timing of onset and symptom severity.

2.2.1 Postpartum blues

The most common and mildest of the postpartum affective disorders is postpartum or “baby” blues which is estimated to affect between 50-85 % of all new mothers (16). Onset of postpartum blues occurs within a few days of childbirth, with symptoms peaking between four or five days and typically resolving by day ten (16). Typical symptoms include mood swings, irritability, tearfulness, generalized anxiety, increased sensitivity and sleep and appetite disturbance (2). Although the symptoms may be upsetting for the mother and her family, they do not reflect psychopathology and do not typically interfere with her ability to care for the baby (17). Most cases of postpartum

blues are not formally treated and either resolve spontaneously or with reassurance and increased support from professionals, family and friends within two weeks (18). More severe postpartum blues can progress to postpartum depression (19).

2.2.2 Postpartum depression

In terms of prevalence and symptom severity, postpartum depression falls in between postpartum blues and postpartum psychosis. The prevalence of postpartum depression is estimated to be 10-15%. While the DSM-IV specifies onset of postpartum depression to be within four weeks of childbirth, clinicians and researchers typically classify any episode of depression within the first year of birth as postpartum depression (1). The symptoms of postpartum depression are characterized by the symptoms of a major affective disorder although they are often focused on the infant or the women's role as a mother (6, 20). Treatment for postpartum depression is similar to the treatment of major depression and typically includes psychotherapy, pharmacotherapy and/or electroconvulsive therapy (17). Untreated postpartum depression may persist for several months to years and can have implications for maternal well being, her ability to parent and relationship with her partner as well as affecting the child's cognitive and behavioural development (5). A more comprehensive review of postpartum depression and its impact on the family are presented in later sections 2.2 - 2.4.

2.2.3 Postpartum psychosis

Postpartum (or puerperal) psychosis (occurring in 0.2% of all new mothers) is the most severe and least common of the postpartum affective disorders. The onset of postpartum psychosis is typically within two weeks of childbirth (21). Symptoms include depressed or elevated mood (that can fluctuate rapidly) disorganized behaviour, mood

lability and delusions or hallucinations (22) which are often focused on the infant (17). Mothers with postpartum psychosis are at risk of harming themselves or their baby and should be managed as emergency patients with appropriate psychiatric services as they will require admission to hospital (19). Typical treatment includes a combination of antipsychotic medication, antidepressants or mood stabilizers (17). Electroconvulsive therapy has also been found to be a rapid and effective treatment (19). Treatment also includes supervised support of the mother with her baby.

2.3 Summary of Postpartum depression

Postpartum depression was initially thought to be a unique type of depression caused by fluctuations in reproductive hormones at childbirth (23). Currently, it is accepted among clinicians and researchers that postpartum depression differs from major depression only by timing of onset and that depressive symptoms may be specific to the delivery or the baby (2).

2.3.1 Diagnosis of postpartum depression

The Diagnostics and Statistical Manual 4th edition (DSM-IV) classifies depression as postpartum depression if the onset of symptoms is within four weeks of delivery (24), if symptoms are present for at least two weeks and if they interfere with everyday functioning (24). The DSM-IV criteria used to diagnose depression including postpartum depression are presented in Appendix A. Postpartum depression is particularly difficult to diagnose because many of the typical symptoms of depression also coincide with the normal changes that occur during the postnatal period such as changes in weight, sleep and energy (25). Therefore, while it is usually quite easy to diagnose more severe cases

of depression, often less severe cases are dismissed as normal for women who have just given birth (2).

2.3.2 Symptoms of postpartum depression

Symptoms of postpartum depression include feelings of inadequacy and inability to cope with the infant, excessive worry about the baby's health or feeding habits and feelings related to being a "bad" or unloving mother. Other symptoms which are common to all forms of depression include tearfulness, despondency, emotional lability, feelings of guilt, loss of appetite, suicidal ideation and sleep disturbances (26).

2.3.3 Treatment of postpartum depression

Treatment of postpartum depression is similar to treatment of major depression although caution is taken to minimize the impact on the infant. Treatment includes one or a combination of psychotherapy, pharmacotherapy and/or electroconvulsive therapy (17). Choice of treatment should be individualized and appropriate to symptom severity as shown in Table 2.1.

Table 2.1 Treatment modalities for postpartum depression

Symptoms	Treatment
Mild to moderate	1. Psychotherapy a) Cognitive Behaviour Therapy (CBT) b) Interpersonal Psychotherapy c) Group Psychotherapy d) Family and Marital Therapy e) Supportive Psychotherapy
Moderate to severe or At a high risk of relapse	2. Pharmacotherapy (used with psychotherapy)
Suicide risk or Cannot tolerate / does not respond to medication	3. Electroconvulsive Therapy (ECT)

This information has been adapted from the British Columbia Reproductive Mental Health Program Website (27).

2.3.3.1 Psychotherapy

Psychotherapy is used to treat mild to moderate depression or in combination with other treatments for patients with more severe depression. There are several models of psychotherapy including cognitive behaviour therapy (CBT), interpersonal psychotherapy (ITP), group psychotherapy, family/marital therapy and supportive psychotherapy.

Cognitive behavioural therapy (CBT) combines education, thought pattern analysis and behaviour change components (27). CBT focuses on the interrelationships between thoughts, feelings, behaviour, physical reactions and the environment (28). Interpersonal psychotherapy (ITP) focuses on one or more problem areas: role transitions, interpersonal disputes, interpersonal deficits and grief (29). For pregnant and postpartum women, ITP focuses on role transition and learning new skills for becoming a mother. Group psychotherapy involves educating group members about the disorder in a supportive environment that permits relationship building (27). Group sessions for women with postpartum depression may involve education about the disorder, stress

management, communication skills, and life planning (30, 31). Marital or family psychotherapy targets the relationship if it is identified as the source of stress (27). Supportive psychotherapy involves support, reassurance, and psycho-education to patients and their families and is often used in conjunction with other therapies (27). Supportive psychotherapy may be the only treatment option available when a women is not functioning at a high enough level to engage in CBT or ITP or refuses pharmacotherapy (27).

2.3.3.2 Pharmacotherapy

Pharmacotherapy (predominantly antidepressant drugs) has to be considered in the context of breastfeeding as detectable levels of antidepressants and their metabolites have been identified in the serum of breastfeed infants (32). However, the need to relieve depressive symptoms when causing significant distress and disability may outweigh these risks. Before prescribing antidepressants, health care providers should establish a clear indication for the drug with no effective alternative treatment, prescribe the lowest effective dose for the shortest time necessary and select drugs with evidence of an absence of harm (19). Finally, each patient should be treated on an individual basis with full consideration of benefits and risks specific to the patient and baby (19).

2.3.3.3 Electroconvulsive therapy

Electroconvulsive therapy, a treatment used for major depression, is also thought to be effective and safe for postpartum women (33). In contrast to some antidepressant drugs, the anesthetic agents used with electroconvulsive therapy pose little risk to a nursing infant (34). Electroconvulsive treatment is only used for treating severe cases of

postpartum depression such as life threatening situations including suicide or having thoughts of infanticide or when other treatments are not effective (18).

2.4 Postpartum Depression Consequences

Postpartum depression has adverse consequences for the mother, her relationship with her partner, her interactions with her infant and her child's development (35).

2.4.1 Onset and Timing

The postpartum period may increase a woman's incidence of depression (9). This is supported by a prospective study by Cox et al. (20) comparing the incidence of depression in 232 women six months postpartum to a group of non-pregnant control women matched for age, martial status and number of children. Depression status was assessed using the Edinburgh Postnatal Depression Scale (15) and was confirmed by a standardized interview. A three times increased risk of the rate of onset of major or minor depression during the first five weeks postpartum was found for the new mothers (16 women) as compared to the non-pregnant control women (5 women) ($p=0.014$) (20).

While most cases of postpartum depression resolve within months of onset, for some women childbirth becomes the stressor that triggers the start of recurrent or chronic depressive disorders (2). In a prospective study, Nott (36) examined the extent and timing of psychiatric disorders occurring up to 15 months after childbirth and noted that the prevalence of depression cases defined by a score of two or greater on the overall severity rating (OSR) of the Standardized Psychiatric Interview (37) increased over time. Specifically, the proportion of women scoring in the depressed range was 18.5% at three months, 28% at nine months and 31% at 15 months (36). Of the 13.3% of subjects

experiencing depressions for the first time in their life, 45% remained depressed at nine months and 40% at 15 months (36).

In addition to the well-described individual suffering resulting from symptoms of depression, mothers with postpartum depression also find parenting more difficult and/or stressful than those without depression (6). A prospective study comparing 25 women with postpartum depression to 25 women without noted that depressed mothers reported significantly more difficulties with infant care ($p<0.01$) and more feelings of bother $p<0.05$) (38). However, depressed mothers did not rate their infants as more temperamentally difficult than non-depressed mothers (38). This study is one of a few that have attempted to assess the relationship between child temperament, postpartum depression and child developmental outcomes. Further prospective longitudinal studies are needed to assess causality among these factors, specifically whether infant differences in temperament are the result of a biological disposition or occur as a consequence of exposure to a depressed mother.

2.4.2 Impact on partner

Postpartum depression is associated with lower marital satisfaction (7). A cross-sectional study of 774 couples found that depression of one partner has detrimental effects on a relationship for both the depressed and non-depressed partners. Furthermore, the more depressed either partner was, the more dissatisfied he or she was with the relationship ($p<0.05$) (8). As well, and as noted by others, the more depressed one partner was, the more dissatisfied the non-depressed partner was with the relationship ($p<0.05$) (39, 40). While these studies provide support for an association between depression and martial satisfaction, they are not able to address whether depression causes marital

dissatisfaction or whether it is marital dissatisfaction that causes depression and research using prospective designs is needed to address the issue of causality.

Having a wife with postpartum depression also increases a husband/partner's risk of depression. In a recent study, the husbands of women with postpartum depression were depressed 50% more often than men who were married to women who were not depressed (41).

2.4.3 Impact on child

Postpartum depression is an important child health issue as it adversely affects the mother-infant relationship which may lead to developmental problems such as delayed cognitive development, specifically language and intelligence quotient (IQ), and child behaviour problems such as distractibility and antisocial behaviour (5).

There is substantial evidence correlating postpartum depression with increased risk for developmental problems in children (5, 42, 43), which some investigators have suggested is a consequence of a reduced capacity to relate to the child (44). A prospective study of 570 women, of which 10% were depressed, examined the effects of postpartum depression on the mother-infant relationship at three months of age (45). Infants of depressed mothers were significantly more likely to suffer from eating problems (29.3% vs. 9.0%, $p<0.001$), constipation (27.6% vs. 13.2%, $p<0.01$) and sleeping problems (32.8% vs. 17.6%, $p<0.01$) compared to infants of non-depressed mothers (45). As well, depressed mothers described increased frequency of crying (25.9% vs. 10.9%, $p<0.01$) and rated their infants as more demanding (58.6% vs. 39.1, $p<0.01$) than infants of non-depressed mothers (45).

Differences in mother-child interaction have also been observed in children up to 19 months of age. In a case-control study of 98 mother-child pairs of which 50% had a mother suffering from post partum depression, Stein et al. reported that on standardized measures the children of postpartum depressed mothers showed more anger ($p<0.01$), less affective sharing ($p<0.001$), a lower rate of interactive behaviour ($p<0.01$) and more negative responses ($p<0.05$) during play than children of non-depressed mothers (46). Case children also showed less sociability to a stranger ($p<0.01$) (46). The postpartum depressed mothers showed significantly less facilitation during structured play ($p<0.01$), and were rated as having less rapport ($p<0.05$) (46). Overall, postpartum depressed mother-child pairs showed significantly less interaction than control mother-child pairs ($p<0.01$) (46).

At least six studies have retrospectively assessed the long term impact of postpartum depression through interviewing the mother some years later about the child's current state or behaviour (47-52). Unfortunately, these studies had inconsistent findings that may in part be due to their retrospective design that leaves them vulnerable to recall bias. Led by Murray and colleagues in the 1990s, prospective studies looking at postpartum depression and child development began to be published (43, 53-61). The most recent review article summarizing the impact of postpartum depression on the child from high quality studies including the studies using the Murray cohort, was completed by Grace, Evindar and Stewart in 2003 (5). Grace et al (5) identified 13 studies, seven of which looked at cognitive development and six that focused on behavioural development. A summary of these articles as well as other high quality articles conducted or published since follows.

2.4.3.1 Cognitive development

The major findings of studies assessing the relationship between child cognitive development and postpartum depression are described in Appendix B. The first four studies completed by Murray and colleagues (43, 53, 56, 57) all pertain to the same cohort of women recruited from maternity hospitals in Cambridge, England between 1986–1988. Following the Murray studies, four other longitudinal studies looking at the relationship between maternal depression status and child cognitive development are included (54, 59-61).

In summary, there is evidence of a relationship between postpartum depression and poorer child cognitive outcomes, particularly up to the age of 18 months (43, 53, 61). The impact of postpartum depression on later child cognitive development is not as clear. While some studies have not revealed a negative effect of postpartum depression on child cognitive development (57, 60) others suggest an effect on child cognitive development up to five years postpartum (54, 59).

The effect of postpartum depression may have particular impact on boys (43, 53) or when there is marital friction among the parents (43). Whether lower socioeconomic status makes a child more vulnerable to the effects of postpartum depression on their cognitive development remains unclear as one study found that children of lower socioeconomic status families scored lower on the Bayley's scales of mental development and the Reynell Scales of language development than children of higher socioeconomic families (43) while another study found that children of lower socioeconomic status families had greater success at the object concept task than children of higher socioeconomic status families (53). Given that these studies were both using the

same cohort of women it is likely that the Bayley and Reynell scales are measuring different aspects of cognitive development than the object concept task and therefore the role that socioeconomic status plays in each is different.

A major limitation of these studies is that four of the key studies are based on the Murray cohort which greatly reduces the variability among the sample. This is a particular limitation in this case since the sample was drawn from Cambridge, England which has a higher education level and socioeconomic status than a general population.

2.4.3.2 Behavioural development

Many studies have focused on the role that postpartum depression plays in a child's behaviour development (42). The major findings of studies that assess this relationship are displayed (58, 59, 62-64) in Appendix C.

In summary, one study found an association between postpartum depression and child behaviour problems, specifically behaviour disturbances at home and at school including more low-level physical play, less creative play and more negative responses during social interactions (62). However, only three studies found an association between later maternal depression and child behavioural problems including an increased risk of child behavioural problems on the internalizing scale, the externalizing scale and total behaviour problems of the Child Behaviour Checklist (CBCL) (59, 63, 64).

It has been hypothesized that postpartum depression may be associated with child behaviour problems among certain vulnerable populations including low socioeconomic status and male gender (58) and those of greater contextual risk made up of stress, parenting hassles, social support, marital satisfaction and family conflict (64). It has also been suggested that while postpartum depression may not directly influence child

behaviour problems, it may exert an indirect effect by significantly increasing a mothers' risk for developing later maternal depression which increases the risk of child behaviour problems (63).

A major limitation of these studies is that child behaviour was assessed based on maternal report and is therefore subject to information bias. For example, mothers who were depressed during the child behaviour assessment were more likely to rate their child as having more or greater behaviour problems than non-depressed mothers. Future studies should attempt to validate maternal report of child behaviour through videotaped sessions and/or through assessments with trained professionals.

2.4.3.3 Psychiatric disorders

Children of depressed parents are at an increased risk of developing mood disorders (42, 65). Beardslee et al. (66) assessed 139 adolescents (average age 14 years) and their parents using structured diagnostic instruments and scored them according to the Diagnostic and Statistical Manual (DSM-III) criteria (67) at study intake and four years later. Using a stepwise logistic approach to modeling, three predictor variables were found to be significant at $p<0.05$. Of these predictor variables, two were related to parental psychiatric disorder (duration of parents major depressive disorder and the number of parental non-affective disorders) while the third predictor variable was the number of child diagnoses (66). Based on this model, if none of the three predictor variables were present, only 7% of the children were diagnosed with a psychiatric illness, while if all three of the variables were present, 50% of the children were diagnosed ($p<0.001$) (66).

These findings are consistent with a study by Orvaschel, Walsh-Allis and Ye (68)

who examined the prevalence of psychiatric disorders in 61 children of parents with recurrent major depression and 45 children of normal control parents. Depression status of parents and children were determined based on clinical interviews. The rate of psychiatric disorder among the children with depressed parents was significantly higher than among children of non-depressed parents (68). Specifically, 41% of the children with depressed parents met criteria for at least one psychiatric disorder compared to 15% of children with non-depressed parents (68).

Similarly, in a longitudinal study by Weissman, Fendrich, Warner and Wickramaratne (69), 174 adolescents were followed for incidence of suicide attempts and DSM-III psychiatric disorders, including major depression, any anxiety disorder, conduct disorder, or substance abuse. During the two-year follow-up period, all first onsets of major depression and anxiety disorders and all suicide attempts were among adolescents with depressed parents. Weissman et al. (69) reported an overall suicide rate of 7.8% among children of depressed parents versus 1.4% among adolescents. By age 20, over 50% of the offspring of depressed patients reported major depression.

2.5 Etiology of postpartum depression

During the postpartum period, all women experience fluctuating reproductive hormones and therefore many studies have focused on the role reproductive hormones play in causing postpartum depression.

The function of hormones in triggering postpartum depression remains controversial (70). To date, no consistent differences in hormone levels either in pregnancy or the postpartum distinguish women who experience postpartum depression from those who do not, suggesting that the condition does not reflect a simple endocrine

excess or deficiency state (9). However, Studd and Panay (70) note that the incidence of depression is greatest at times of hormonal fluctuations including the premenstrual phase, the postpartum phase and the climacteric perimenopausal phase (the period of transition from fertility to sterility) suggesting that the role of hormones in mood disorders among women deserves further research. Glover (71) suggests that individuals may vary in their biochemical response to the fluctuations in these hormones rather than to the absolute level of the hormones. This differential sensitivity to a rapid decline in estrogen and progesterone for some women has been supported in a study by Bloch et al. (72) which simulated the withdrawal of hormones in 16 women of normal mood. Among women with a previous history of postpartum depression, five of the eight subjects displayed depressive symptoms while none of the women without a previous history of depression developed symptoms of depression ($p=0.03$) (72).

Researchers have also looked for an association between postpartum depression and thyroid dysfunction (73, 74) or the presence of anti-thyroid antibodies during pregnancy (75-77). While there is some support that thyroid dysfunction may contribute to postpartum depression in a small group of women, no clear relationship exists between thyroid dysfunction and postpartum depression in most women (9).

While various models have been proposed for the etiology of postpartum depression, it is likely a result of an interaction between genetic vulnerability, hormonal changes, and psychosocial factors (10). With the biological mechanisms yet to be elucidated, much of the postpartum depression research has focused on identifying the psychosocial risk factors that leave women most susceptible to developing the disorder (11).

2.6 Risk factors for postpartum depression

2.6.1 Literature search strategy

A systematic literature search was conducted to find those studies most directly related to the research objectives of this study. That is, studies that examined risk factors or predictors of postpartum depression. The research databases Embase (1980 to present) and Medline (1966 to present) were searched for studies up to March 14, 2005. Studies were limited to English language studies as the researcher was not fluent in any other languages. The MeSH search terms used for the Embase search included “exp puerperal depression”, “exp risk factor” and “exp prediction” or “predictor.mp”. After limiting to English language studies, 245 studies were retrieved. More search terms had to be used for the Medline search as the version being used did not map to subject headings. The search terms included in the Medline search were “postpartum depression.mp”, “post partum depression.mp”, “postpartum mood disorder.mp”, “post partum mood disorder.mp”, “postnatal depression.mp”, “post natal depression.mp”, “postnatal mood disorder.mp”, “puerperal depression.mp”, “puerperal mood disorder.mp”, “risk factor.mp” and “predictor.mp”. After limiting this search to English language studies, 60 studies were found.

In total, the search identified 275 potential studies after removing duplicate studies between the two databases. Each study’s title and abstract were reviewed to identify studies that directly examined risk factors for postpartum depression.

The studies also had to meet the following criteria to ensure methodological rigor. The diagnostic and temporal criteria of postpartum depression used had to be stated and only cases of non-psychotic depression measured between two weeks and one year

postpartum were included. As well, the method of assessment (self report or clinical interview) had to be clearly stated with proven reliability. Finally, risk factors had to be explicitly defined and measured, and the statistical relationship between the variable and postpartum depression clearly stated. Of the 275 studies identified from the database search, 92 studies that met these criteria were found. Following closer examination two comprehensive meta-analyses (1, 12) and a systematic review article (2) that summarized the results of earlier studies directly examining risk factors for postpartum depression were identified.

2.6.2 Systematic reviews and meta-analyses

The systematic review was completed by Robertson et al., in 2004. It included 19 database searches of the medical, psychological and social sciences literature (2). The literature search completed by Robertson et al. (2) identified the two major meta-analyses by Beck (12) and O'Hara and Swain (1) which included results from over 70 studies on over 12 000 subjects. The search was also able to identify studies that had been completed or published subsequent to these meta-analyses up to and including studies published in 2002 which resulted in inclusion of an additional 10, 000 subjects.

Both of the meta-analyses completed by O'Hara and Swain (1) and Beck (12) as well as the review article by Robertson et al. (2) calculated effect sizes for each risk factor for postpartum depression. O'Hara and Swain (1) and Robertson et al. (2) calculated Cohen's *d* while Beck (12) converted Cohen's *d* to r as their measure of effect size. The significant risk factors identified from each of these studies is presented in Table 2.2. For ease of comparison, the r effect sizes presented by Beck (12) have been converted back to Cohen's d effect sizes using Friedman's formula #6 (78): d = [2 (r)] /

$[(1 - r^2)^{0.5}]$. The conventional interpretations of Cohen's d values were used with 0.2 indicating a weak relationship, 0.4 indicating a moderate relationship and 0.8 or more indicating a strong relationship (79).

Table 2.2 Summary of risk factors for postpartum depression from review articles

	O'Hara and Swain 1996	Beck 2001	Robertson et al. 2004
Risk Factor	**Cohen's d (95% CI) (# of studies)**	**Cohen's d* (# of studies)**	**Cohen's d (total # subjects)**
Depression during Pregnancy	0.75 (0.67 – 0.83) (n=12)	1.01 (n=21)	0.75 (>3000)
Anxiety during Pregnancy	0.68 (0.55 – 0.81) (n=5)	1.01 (n=4)	0.68 (>1100)
Social Support	-0.63 (-0.75 - -0.51) (n=4)	0.90 (n=27)	-0.64 (>3100)
Stressful Life Events	0.60 (0.54 – 0.67) (n=14)	0.87 (n = 16)	0.61 (>2500)
Previous history of Depression	0.57 (0.49 – 0.65) (n=13)	0.85 (n=11)	0.58 (>3700)
Marital Relationship	n/a	0.85 (n=14)	0.39 (>1700)
Neuroticism	0.39 (0.21 – 0.57) (n=4)	n/a	0.39 (>600)
Obstetric and Pregnancy Complications	0.26 (0.19 – 0.34) (n=12)	n/a	0.26 (>9500)
Socioeconomic Status	n/a	0.45 (n=8)	-0.14 (>1700)
Self Esteem	n/a	1.06 (n=6)	n/a
Childcare Stress	n/a	1.04 (n=7)	n/a
Infant Temperament	n/a	0.72 (n=10)	n/a
Maternity Blues	n/a	0.65 (n=5)	n/a
Marital Status	n/a	0.52 (n=3)	n/a
Negative Cognitive attributional style	0.24 (0.18 - 0.31) (n=8)	n/a	n/a
Unplanned or Unwanted Pregnancy	n/a	0.32 (n=6)	n/a

* Cohen's d values calculated from un-weighted r values (since no different when rated by sample size or quality of study) presented in Beck (12).

2.6.3 Consistent risk factors for postpartum depression

Consistent risk factors for postpartum depression identified by both meta-analyses by O'Hara & Swain (1) and Beck (12) and the review article by Robertson et al. (2) as presented in Table 2.2 are:

- depression during pregnancy
- anxiety during pregnancy
- experiencing stressful life events during pregnancy or the early puerperium,
- insufficient social support
- history of depression

Depression during pregnancy is consistently the strongest predictor of postpartum depression (1, 2, 12). Anxiety during pregnancy is a very strong predictor of postpartum depression, with higher levels of anxiety during pregnancy predicting the severity of postpartum depression symptoms (1, 12, 80-82).

There is a strong relationship between the recent occurrence of stressful life events and depression (66). Stressful life events may include death of a loved one, relationship trauma or divorce, losing a job and moving (2). Pregnancy and childbirth are significant life events for women and therefore the stress associated with either may induce depression (11).

Adequate social support is a protective factor against developing postpartum depression (2, 83). Social support refers to the physical and emotional comfort provided via close relationships (84). Social support can be provided by a spouse or partner, relatives, friends or coworkers. There are three types of social support; 1) informational support which involves providing knowledge, advice or guidance, 2) instrumental support

which includes practical help such as maternal aid or help with tasks and 3) emotional support which is expressions of caring or esteem (2). Social isolation (or lack of social support) during pregnancy was found to be a strong risk factor for postpartum depression (85).

A history of depression is a risk factor for both depression during pregnancy and postpartum depression (13). Therefore screening for a history of depression may-be an easy way to identify women at risk of depression in both periods.

While not all of these risk factors are modifiable, they are important factors to consider when attempting to identify women at the greatest risk of postpartum depression. According to Robertson et al. (2), the two strongest risk factors of postpartum depression, depression and anxiety during pregnancy, highlight the need to begin screening programs prenatally. Likewise, pregnant women with a previous history of depression can be identified, monitored and provided with support as required in the prenatal period. Social support and response to stressful life events are potentially modifiable states and consequently provide important areas of focus for future support programs.

2.6.4 Risk factors for postpartum depression from recent studies

The results of eight studies published subsequent to the review article by Robertson et al. (2) were examined to determine the current state of knowledge for risk factors of postpartum depression. The unadjusted odds ratios or relative risks resulting from bivariate analyses of significant and insignificant risk factors (where presented) and postpartum depression from recent studies that examined multiple risk factors (11, 86-91) are presented in table 2.3. Studies using regression modelling to present adjusted odds

ratios or relative risks significant and insignificant predictors of postpartum depression were not summarized due to difficulty in comparing studies that adjusted for different predictors in their models.

Risk factors found to be significant in these recent studies, in addition to the consistently reported risk factors from the meta-analyses (1, 12) and systematic review (2) are summarized below.

The demographic variables younger age (86), in particular 16 years or younger (11, 87), low socioeconomic status (88) and primiparous (86, 88) increased the risk of postpartum depression.

Variables related to the mother's health including experiencing body pain in the previous four weeks (86) and low physical functioning (86) were found to increase the risk of postpartum depression in one study. While having a baby with colic or reflux (87) also increased the risk of postpartum depression.

Increased risk was also observed for several obstetric and several utilization variables including instrumental delivery (88), not the desired sex of the baby (87) and attending three or more non-routine child visits to doctors (89).

While marital dissatisfaction had already been identified as a risk factor for postpartum depression(1, 2, 12, 66), three more recent studies may provide clarity around what aspects of marital dissatisfaction are most associated with postpartum depression. Specifically, communication problems (11, 87), low instrumental support (89), deficient emotional support (11, 87) and deficient psychological crisis support (11, 87) have also been found to increase the risk of postpartum depression. An increased risk of postpartum depression was also found for women with poor relationships with their in-laws (90).

Three studies examined risk factors relating to the women's personality. The risk of postpartum depression was increased by having a vulnerable personality (11, 87), neurotocism (91) and introversion (91).

One study found low social support, specifically not having any relatives in the city where they lived, no close friends to talk to and finding it hard to find someone to talk to increased the risk of postpartum depression (86).

As well, this same study examined factors related to immigration (86). Immigration within the last three years, language barriers, and migrating for marriage were all associated with an increased risk of postpartum depression (86).

Table 2.3 Risk factors for postpartum depression from recently published studies (2003-2005)

Authors (year)	Design and Sample Size	Postpartum Depression assessment instrument and timing	Potential Risk Factors			Limitations
Chee, Lee, Chong, Tan, Ng & Fones (2005)	Prospective Cohort 278 women	Structured Clinical Interview for DSM-IV, non-patient version (SCID-IV) 6 weeks postpartum	**Risk Factor**	**OR (95% CI)**	**p-value**	This study had a very high drop-out rate (~50%) and the women who dropped out had higher EPDS scores than women who remained in the study (8.13 ± 4.45 vs. 7.21 ± 4.58, p=0.018) and therefore this may have affected the odds ratio estimates.
			Male infant	1.06 (0.42-2.69)	0.90	
			Age ≤ 20 and ≥ 35 y	1.47 (0.54-4.02)	0.46	
			Chinese ethnicity	1.58 (0.60-4.13)	0.36	
			High educational level	2.04 (0.57-7.25)	0.27	
			Unemployed	1.33 (0.48-3.65)	0.58	
			High household income	1.84 (0.64-5.26)	0.26	
			2 or more living children	1.50 (0.55-4.08)	0.43	
			Living with husband and in-laws	0.36 (0.05-2.78)	0.32	
			Living with husband and own parents	2.31 (0.70-7.59)	0.17	
			Unplanned pregnancy	1.77 (0.67-4.66)	0.25	
			Spouse unhappy with the gender of baby	1.54 (0.18-12.81)	0.69	
			Marital dissatisfaction*	6.22 (2.30-16.82)	0.001	
			Low instrumental support*	5.12 (1.88-13.97)	0.001	
			Low emotional support	2.44 (0.96-6.24)	0.062	
			No relative/friend having baby at the same time	1.01 (0.39-2.60)	0.98	
			Conflicts with relatives foreseen	3.53 (0.91-13.68)	0.068	

Authors (year)	Design and Sample Size	Postpartum Depression assessment instrument and timing	Potential Risk Factors			Limitations
			Non-routine child visits to doctors - 3 and above*	3.28 (1.16-9.30)	0.026	
			Currently breastfeeding	1.53 (0.49-4.76)	0.4	
			History of abortion	2.02 (0.63-6.51)	0.24	
			History of miscarriage	1.31 (0.41-4.14)	0.65	
			Depression during previous pregnancy	2.38 (0.87-6.48)	0.091	
			Past history of depression*	3.81 (1.45-10.06)	0.007	
			Family history of mental disorder	2.82 (0.31-25.46)	0.36	
Boyce & Hickey (2005)	Prospective Cohort 425 women	Structured clinical interview for DSM-III-R 6, 12, 18 and 24 weeks postpartum	**Risk Factor**	**OR (95% CI)**	**p-value**	While the study was prospective, the risk factor a previous history of depression was measured retrospectively and therefore may be under or overestimated.
			Age ≤ 16 years*	14.65 (2.38-90.38)	Not presented	
			Education ≤ 9 years	1.22 (0.49-3.06)		
			Education ≥14 years	1.01 (0.34-3.0)		
			Unemployed	2.74 (0.92-7.81)		
			Partner unemployed	1.23 (0.27-5.56)		
			No partner	2.33 (0.83-6.54)		
			Single/separated	2.07 (0.98-4.36)		
			Past personal psychotic history*	5.40 (2.15-13.52)		
			Family psychotic history	1.65 (0.87-3.13)		
			One or more life events*	3.14 (1.35-7.30)		
			Global dissatisfaction with intimate relationship	3.25 (1.00-10.55)		

Authors (year)	Design and Sample Size	Postpartum Depression assessment instrument and timing	Potential Risk Factors			Limitations
			Problems communicating in intimate relationship*	5.34 (1.53-18.71)		
			Deficient emotional support in intimate relationship*	11.62 (1.57-85.55)		
			Worsening relationship	4.16 (0.99-17.3)		
			Unsatisfactory social support*	2.23 (1.15-4.32)		
			Everyday instrumental social support	1.31 (0.63-2.73)		
			Dissatisfaction with instrumental crisis	1.73 (0.87-3.44)		
			Dissatisfaction with psychological crisis support*	2.51 (1.29-4.86)		
			Low organized / responsive personality*	3.53 (1.67-7.45)		
			Vulnerable personality style*	5.63 (2.79-11.36)		
			Not the desired sex of baby*	3.07 (1.56-6.04)		
			Colic or reflux*	2.05 (1.05-3.99)		
Verkerk Denollet, Van Heck, Van Son, & Pop	Prospective Cohort 277 women	Clinical interview according to RDC	**Risk Factor**	**OR (95% CI)**	**p-value**	Study focused on relationship between personality and postpartum
			Neurotocism (predicting depression at 1 or more assessment points during 1st yr)*	4.53 (2.39-8.60)	< 0.001	

Authors (year)	Design and Sample Size	Postpartum Depression assessment instrument and timing	Potential Risk Factors			Limitations
(2005)		3, 6, 12 months postpartum	Introversion (predicting depression at 1 or more assessment points during 1st yr)*	1.95 (1.05-3.64)	0.034	depression and therefore may be confounded by other known risk factors such as concurrent life events, social support, and quality of the marital relationship which were not measured.
			Personal history of depression (predicting depression at 3 mo)*	3.67 (1.31-10.28)	0.013	
			Family history of depression	Not presented	n.s.	
			Severe depressive symptomatology during the second trimester of pregnancy	Not presented	n.s.	
Ozdemir, Ergin, Selimoglu, & Bilgel (2004)	Prospective Cohort 912 women	Zung's Self-Rating Depression Scale 1 month postpartum	**Risk Factor**	**OR (95% CI)**	**p-value**	Postpartum depression status was based on the Zung's which is a self-report questionnaire and therefore a clinical interview to confirm cases would have
			Age in years: < 20 20 – 24 25 – 29 30 – 34 ≥ 35	 0.30 (0.04-2.08) 1.74 (0.46-6.50) 2.08 (0.57-7.63) 1.48 (0.38-5.68) 1.0 (referent)	 0.224 0.412 0.268 0.572	
			Education: Illiterate Primary education Secondary education Post Secondary	 2.09 (0.50-8.65) 1.47 (0.47-4.55) 1.17 (0.36-3.74) 1.0 (referent)	 0.310 0.507 0.795	

Authors (year)	Design and Sample Size	Postpartum Depression assessment instrument and timing	Potential Risk Factors			Limitations
			Socioeconomic status: Bad* Middle Good	 2.69 (1.20-6.02) 1.28 (0.72-2.30) 1.0 (referent)	 0.017 0.403	increased the validity of their results. As well, the reference categories used to calculate the associations between the potential risk factors and postpartum depression may have influenced the estimates. For example, for age >= 35 was used as the reference category even
			Previous pregnancies None* One Two Three or more	 5.02 (1.22-20.61) 1.64 (0.58-4.63) 0.85 (0.30-2.42) 1.0 (referent)	 0.025 0.353 0.765	
			Previous pregnancy: Live birth Stillbirth Abortion No previous pregnancies	 0.85 (0.53-1.39) 0.34 (0.47-2.57) 1.77 (0.94-3.32) 1.0 (referent)	 0.522 0.298 0.075	
			Current Delivery: Difficult vaginal delivery C-section delivery Instrumental delivery* Easy vaginal delivery	 1.41 (0.76-2.64) 1.34 (0.72-2.47) 3.13 (1.51-6.50) 1.0 (referent)	 0.279 0.353 0.002	

Authors (year)	Design and Sample Size	Postpartum Depression assessment instrument and timing	Potential Risk Factors			Limitations
			Planned pregnancy	1.049 (0.511-2.151)	0.897	though there isn't any evidence to support that this age group has a lesser risk than women in some of the other categories.
Lee, Yip, Leung & Chung (2004)	Prospective Cohort 959 women	EPDS 3 months postpartum	**Risk Factor**	**OR (95% CI)**	**p-value**	Postpartum depression status based on self report using the EPDS and not a clinical interview. Also while the study was designed as a prospective study, some of the potential risk factors were not measured until the 3-month postpartum assessment and
			Past depression*	2.80 (1.51-5.17)	0.01	
			Marital dissatisfaction*	2.83 (1.89-4.26)	0.01	
			Poor in-law relationship*	2.90 (1.62-5.17)	0.01	
			Depression during third trimester: Mild to moderate* Severe* Nil or insignificant	 3.71 (2.28 – 6.02) 9.07 (4.99 – 16.50) 1.00 (referent)	 <0.001	
			Age	Not presented	n.s.	
			Marital status			
			Number of children			
			Recent immigration			
			Education			
			Unemployment			
			Being a "house-wife"			

Authors (year)	Design and Sample Size	Postpartum Depression assessment instrument and timing	Potential Risk Factors			Limitations
			Household income			assessment and therefore this may have influenced the results.
			Financial difficulty			
			Social class			
			Past deliberate self harm			
			History of prolonged hypnotic use			
			Family psychiatric history			
			Previous miscarriage			
			Previous induced abortion			
			Past infertility			
			History of major medical illness			
			Emergency C-section delivery			
			Failed breastfeeding			
			Neonatal admission			
			Poor social support			
			Partner non-participation in baby care			
			Peiyue support (designated female family member or friend who helps out >4 hours per day in first month)			
			Mother-in-law relationship			
			Small accommodation			
		EPDS	**Risk Factor**	**OR (95% CI)**	**p-value**	

Authors (year)	Design and Sample Size	Postpartum Depression assessment instrument and timing	Potential Risk Factors			Limitations
			Risk Factor	**OR (95% CI)**	**p-value**	
Small, Lumley, & Yelland (2003)			Marital status (not married)*	0.88 (0.20-3.78)		
			Partner not born in same country	1.79 (0.60-5.57)		
			Age: <25 (ref 25-34)*	3.14 (1.58-7.15)		
			Age: >34 (ref 25-34)	0.69 (0.15-2.76)		
			Income (< $20,000)	1.91 (0.88-4.17)		
			Pension (yes)	1.88 (0.93-3.98)		
			School (< year 12)	1.99 (0.98-4.39)		
			Further education (None/<diploma)	1.55 (0.59-4.32)		
			Migration history, time in Australia: <3 years*	3.41 (1.41-7.01)		
			Migration history, time in Australia: ≤ 5 years	1.96 (0.98-3.95)		
			English-speaking ability (no/little English)*	2.77 (1.35-6.75)		
			Migrating for marriage*	2.97 (1.52-6.74)		
			Experience of life in Australia (harder than expected)	2.03 (0.87-4.75)		
			Birth with forceps or vacuum extraction	2.15 (0.75-5.79)		
			Caesarean birth	1.21 (0.52-2.82)		
			Operative delivery	1.50 (0.74-3.11)		
			Labour: 12 hours or more	0.98 (0.46-2.08)		

Authors (year)	Design and Sample Size	Postpartum Depression assessment instrument and timing	Potential Risk Factors			Limitations
			Used pharmacological pain relief	2.55 (0.96-7.34)		
			Pain worse than expected	2.10 (0.98-4.60)		
			Unable to hold baby soon after birth	1.23 (0.46-3.17)		
			Did not talk afterwards with caregivers about the birth	0.53 (0.07-2.45)		
			Less than happy with antenatal care	0.96 (0.42-2.26)		
			Less than very happy with antenatal care	1.23 (0.59-2.56)		
			Did not have active say in decision making about care in labour, all or most of the time	1.69 (0.78-3.74)		
			Less than very happy with pain relief	1.69 (0.77-3.82)		
			Unwanted people present during labour and birth	2.45 (0.84- 7.44)		
			Less than very happy with postnatal care	0.95 (0.59-2.56)		
			No relatives in Melbourne*	2.76 (1.26-6.24)		
			Parents not in Australia	1.17 (0.53-2.59)		
			No close friends to talk to*	2.91 (1.37-6.24)		
			Hard to find someone to talk to*	3.81 (1.74-9.10)		

Authors (year)	Design and Sample Size	Postpartum Depression assessment instrument and timing	Potential Risk Factors			Limitations
			Wanted more help in early postnatal period	1.49 (0.72-3.07)		
			Reported problems (3+) in postnatal period	3.71 (1.63-8.48)		
			Body pain in previous 4 weeks*	4.74 (1.83-12.60)		
			SF-36 physical functioning sub-scale (score in lowest quartile)*	3.99 (2.12-9.24)		
			Bottle/mixed feeding from birth	0.95 (0.28-3.06)		
			Feeding problems	1.81 (0.83-3.91)		
			Crying baby	2.01 (1.00-4.04)		
			Sleeping problems	1.36 (0.68-2.75)		
			Health problems	1.68 (0.70-3.89)		
Boyce (2003)	Prospective longitudinal 42 PPD women 382 control women	EPDS 6, 12, 18, 24 weeks SCID to confirm cases	**Risk Factor**	**OR (95% CI)**	**p-value**	Again, small sample size especially for case women resulted in wide confidence intervals limiting the
			Aged 16 or younger*	14.65 (2.38-90.38)	Not presented	
			Past history of psychiatric illness*	5.40 (2.1-13.5)		
			1 or more life events*	3.14 (1.45-7.30)		
			Partner not easy to talk to*	5.34 (1.53-18.71)		
			Lack of emotional support from partner*	11.62 (1.57-85.55)		

Authors (year)	Design and Sample Size	Postpartum Depression assessment instrument and timing	Potential Risk Factors			Limitations
			Unsatisfied with social support following a crisis*	2.51 (1.29-4.86)		conclusions that can be drawn from the results.
			Vulnerable personality score*	5.63 (2.80-11.36)		

OR= odds ratio, CI = confidence interval, n.s.= non significant, * significant risk factor at $p<0.05$ or the 95% confidence interval does not include 1.

In addition to the consistently reported risk factors from the meta-analyses (1, 2, 12), these recent studies provide support for the existence of additional risk factors and therefore future studies should continue to examine these and other unstudied risk factors.

2.6.5 Limitations of the current research

While the research to date has provided insight to specific components that make a woman particularly susceptible to developing postpartum depression, the relative contribution of these risk factors, and the synergistic effect of multiple risk factors, have not been examined comprehensively. Given that the etiology of postpartum depression is thought to be multifactorial, implying that it is caused by a combination of biological, genetic and psychosocial factors (92), improved knowledge of the impact of risk factors *in combination* is vital to understanding which women are at risk.

The methods used in previous studies also limit the state of the current research. For example, studies using small sample sizes were limited by their power to detect associations, while failure to measure and therefore adjust for known risk factors in some studies may have resulted in their findings being confounded by other variables. While many of the recent studies use prospective designs, eliminating the opportunity for recall bias, there are still vulnerable to losing participants to follow up and therefore selection bias if their final sample is not representative of the population who should have been theoretically eligible to participate.

Evidence on the effects of multiple risk factors from this large prospective study with rigorous research methods may improve current screening practices and ultimately health outcomes of the mother, family and child.

2.7 Current practice of screening for postpartum depression

Currently, screening efforts for postpartum depression used in clinical practice have focused on identifying women *once they have developed the disorder* using self report instruments during the first postpartum year, most commonly the Edinburgh Postnatal Depression Scale (EPDS) (14).

According to the Postpartum Adjustment Support Services of Canada (PASS-CAN, 2005), few physicians in Canada are screening for postpartum depression at the 6 week postpartum visit. The lack of postpartum depression screening may be related to a lack of national clinical guidelines for physicians in Canada. For example, the Society of Obstetricians and Gynecologists of Canada (SOGC) do not provide any clinical practice guidelines for screening for postpartum depression.

Reproductive mental health Best Practice Guidelines were developed by the British Columbia Reproductive Care Program and a working group of experts within the field of Reproductive and Community Medicine across British Columbia (93). These guidelines are fairly comprehensive and cover early identification, assessment, treatment and follow-up of women with mental illness during pregnancy, postpartum and lactation. However, these guidelines have only been distributed in British Colombia.

Best practice guidelines specifically for nursing practice were recently published in Ontario (94). These guidelines cover the postpartum period focusing on identification using the EPDS and treatment involving supportive interactions targeting individual mental health needs.

Clinical practice guidelines are also provided by the Scotish Intercollegiate Guidelines Network titled *Guideline 60: Postnatal Depression and Puerperal Psychosis*

(95). The guideline includes screening, diagnosis, prevention and management involving both primary and secondary care. This guideline supports administering the EPDS at six weeks and three months postpartum as part of a screening program using a cut-point of 10 or greater.

Routine screening in the antenatal period for prediction of postpartum depression is not supported as to date no adequate screening instrument had been identified or tested (95).

While the guidelines previously mentioned are available, national adoption of these guidelines by health care providers in Canada has not taken place.

2.7.1 Current practice of screening in Alberta

Recently, a cross sectional survey assessed the current knowledge and practice of postpartum depression among physicians in Alberta (May 2002 – January 2003) (96). 717 physicians (33.7% response rate) returned a questionnaire that assessed their estimated postpartum depression prevalence among patients, risk factor recognition, current screening practices, use of medication and other therapies and referral practices (96).

The results from the physician survey revealed that 56.7% of respondents reported screening all postpartum patients, while 25.8% screen those patients at an elevated risk. Female physicians were more likely than male physicians to screen all postpartum patients ($p<0.0001$). Among the 17% who never screen, the most common reasons given were “not aware of screening methods” (43%), “postpartum depression is not a significant problem in my practice” (34.4%), and “there are no clear guidelines for screening for postpartum depression” (24%). The methods of screening used by the

physicians included clinical interview (70.8%) and intuition/experience (61.7%). Less than 5% used standard instruments with 3.1% using self-report questionnaires and 1.3% using structured interviews. Overall, only 30 (4%) physicians reported using either self-report questionnaires or structured interviews with standardized instruments for screening for postpartum depression. Eighty-two percent reported screening at 4-8 weeks postpartum while 70.5% reported screening at 0-4 weeks postpartum. Only 34% reported screening after 8 weeks postpartum. The topic of prenatal screening was not addressed in this survey.

Of note, 91.5% of responding physicians believed that management of postpartum depression could be improved. Suggestions offered by the physicians include; physicians should be better trained to recognize the signs of postpartum depression, the treatment and screening methods should be improved and standardized post-natal tests provided by the government to screen for postpartum depression should be implemented.

Public health nurses in Alberta routinely screen for postpartum depression by administering the Edinburgh Postnatal Depression Scale (15). The first administration of the EPDS occurs in the immediate postpartum period (~48 hours postpartum) at the time of the first postnatal home visit which likely identifies women suffering from the postpartum blues. While this practice may aid in identifying women at risk of developing postpartum depression, as the postpartum blues have been shown to be a risk factor for postpartum depression (35), the timing of this screening is not the most appropriate for identifying postpartum depression. Only those women who screen in the “at-risk” category are followed up at 16 and 32 weeks, therefore some women who do not initially have depressive symptoms but later go on to develop the disorder will not be identified.

2.7.2 Summary

In summary, there is the opportunity to improve detection and treatment of women with postpartum depression through the further development of national clinical practice guidelines related to screening to improve current detection of women at risk of postpartum depression by screening for risk factors in both the antenatal and early postnatal periods.

This study was designed to improve on our knowledge of women at risk of postpartum depression by identifying and examining the independent effects and interactions among potential risk factors especially those present in the antenatal period. A better understanding of the combination of risk factors that place women at the greatest risk could lead to the development of a new predictive index/screening tool for postpartum depression.

Chapter Three: Methods

3.1 Research design

The research objectives were addressed through a secondary analysis of an existing data set developed through the Community Perinatal Care Study (CPC) and described below.

3.2 The Community Perinatal Care study

The Community Perinatal Care (CPC) study was a prospective randomized controlled trial of prenatal conducted in the Calgary Health Region in April 2001 – July 2004. The CPC study involved approximately 2000 medically low risk pregnant women recruited from two clinics in Northwest Calgary (the Low Risk Maternity Clinic and the Grace Maternal Child Clinic) and one in Northeast Calgary (the Maternity Care Clinic). Women agreeing to participate were randomized to one of three groups involving increasing levels of prenatal support as follows: 1) standard of care at the prenatal clinics (control); 2) standard of care plus consultation with a nurse; or 3) standard of care plus consultation with a nurse and a home visitor. The CPC study was funded by the Physician Partnership Steering Committee, The Calgary Children's Initiative and the Calgary Health Region.

3.2.1 Inclusion and exclusion criteria for the CPC study

All women who booked their first prenatal appointment at one of the three low risk maternity clinics were invited to participate. Participation in the study was voluntary and those declining to participate received the standard of care. Women were excluded from the study if they:

1) were under 18 years of age (due to ethical issues related to informed consent)

2) had their first appointment with the prenatal clinic prior to completing the baseline study questionnaire
3) did not plan to attend the clinic at the time of the first recruitment call
4) lived outside the Calgary Health Region
5) were not pregnant (e.g. abortion, miscarriage) at time of contact for recruitment
6) could not communicate to study interviewers or translators in any of English, French, Cantonese, Mandarin, Punjubi/Urdu/Hindi or Arabic languages.

3.2.2 Data collection for the CPC study

All subjects completed self-report questionnaires at study intake during the first trimester (prior to first clinic appointment), at mid-pregnancy and at three months postpartum. Women provided information on demographics, lifestyle, physical and emotional health, social supports, social isolation, parental expectations, and thoughts and feelings on their pregnancy experience. To collect information on the various constructs, standardized tools were included as part of the questionnaires when one was available and questions were created specifically for the CPC study when standardized items were not available. Standardized tools included in one of the three questionnaires that provided variables for the present study include the Edinburgh Postnatal Depression Scale (15), the Kellner Symptom Questionnaire (97), the Social Support Index (98), the Network Orientation Scale (99) and the Parental Expectations Survey (100). The psychometric properties of each instrument are described below.

3.2.3 Standardized instruments

3.2.3.1 Edinburgh Postnatal Depression Scale

Postpartum depression was measured by the Edinburgh Postnatal Depression Scale (EPDS) (15). The EPDS is a ten item self-report questionnaire. Responses are scored from zero to three, for a maximum score of 30. A score of greater than or equal to 13 has been recommended for identifying women with symptoms of major depression (14). The EPDS was designed specifically for postpartum women and therefore does not include questions about changes in sleep and energy, which are normal symptoms of the postpartum period. The EPDS has been shown to have good reliability and validity. In a community sample of 60 postpartum women with major or minor depression, the internal consistency of the EPDS was 0.87 (15). The validity of the EPDS was determined in a cohort of 84 new mothers, including women with depressive illness and controls, using a cut point of 12 or greater. The sensitivity of the EPDS for identifying women with major or minor depression as diagnosed according to the Research Diagnostic Criteria (RDC) was found to be 86% while the specificity was 78% (15). The positive predictive value for identifying women who met RDC criteria was 73% (15).

3.2.3.2 Kellner Symptom Questionnaire

The depression and anxiety subscales of the Kellner Symptom Questionnaire (SQ) were used to measure the women's depression and anxiety during pregnancy. The SQ is a self-rated scale that measures distress and well-being (97). The patient is instructed to read quickly through a list of 92 psychiatric and somatic conditions and choose the response (yes or no, true or false) that best describes how she has been feeling during the past week and on the day of the interview. Respondents are given a rating of one for each

symptom that is checked “yes” or “true” and for each statement of well-being that is checked “no” or “false.” A higher score indicates more distress than a lower score (97). The SQ has good reliability and validity. Specifically, the test-retest reliability of the SQ was determined in a study of 18 anxious outpatients at four weeks. The test-retest correlations for the subscales were; anxiety 0.71; depression 0.95; somatic 0.77; hostility 0.82 (97). The SQ has been validated against the Hamilton Depression and Anxiety Rating Scales. The correlation of the SQ depression scale with the Hamilton Rating Scale for Depression was 0.66 in a depressed population and 0.65 in a matched normal control group (97). The correlation of the SQ anxiety scale with the Hamilton Anxiety Rating Scale was 0.69 (97).

3.2.3.3 Social Support Index

The Social Support Index (SSI) is a 17 question self-report questionnaire designed to assess how the family views the community as a source of support (98). Each question is rated on a five point scale of agreement ranging from zero “strongly disagree” to four “strongly agree”. A total score is obtained by summing up all scores. A minimum of 0 and a maximum of 68 are possible (98). The internal consistency of the SSI, measured by Cronbach’s alpha is 0.82 (98). The test-retest correlation is 0.83 (98).

3.2.3.4 The Network Orientation Scale

Social isolation or lack of help seeking was measured by the Network Orientation Scale (NOS). The NOS is a 20-item self report scale used to assess negative network orientation which is the perspective that it is inadvisable, useless, or risky to seek help from others (99). The NOS does not measure whether a person has adequate social support, but instead is used to determine if the individual is willing to utilize, maintain

and nurture their supports. Each question is rated on a scale of agreement from one "strongly agree" to four "strongly disagree". A total score ranging from 20 to 160 is obtained, with higher scores indicating more negative network orientation (99). The Cronbach's alphas, measuring interval consistency of the NOS range from 0.60 to 0.88 (99). Test-retest correlations were 0.85 and 0.87 over one and two week intervals respectively (99).

3.2.3.5 The Parental Expectations Survey

Parenting self-efficacy was measured by the Parental Expectations Survey (PES). The PES is used to assess new parents perceptions about their abilities to take care of their new infants (100). The PES was also modified to create a prenatal version after permission was granted from the author specifically for the CPC study. Both instruments have 25 self report items. Each question is rated on a Likert-type scale scored from zero (cannot do) to ten (certain can do). The average score from the questionnaire is obtained by summing all scores and dividing by the total number of scores (100). The psychometric testing of the PES was completed on a sample of 82 first-time mothers. The Cronbach's alpha was 0.91 at one month postpartum and 0.86 at three months postpartum (100). Concurrent validity was determined by comparing the women's scores on the PES to the women's scores from Self-Evaluation subscale of the "What Being the Parent of a Baby is Like" Questionnaire (WPL-R). Correlations of 0.75 at one month postpartum and 0.64 at three months postpartum were found between the two scales (100).

The timing of the administration of each standardized tool as well as a description of the construct it was used to measure is summarized in Table 3.1. Data collection for the CPC study commenced in April 2001 and was completed in July 2004.

Table 3.1 Standardized tools from the CPC study used in the present study

Tool	When administered	Description
Symptom Questionnaire (SQ) (97)	First trimester	Assesses the mother's depression and anxiety during pregnancy
Social Support Index (SSI) (98)	First trimester	Assesses the degree to which the mother finds support in her community
Network Orientation Scale (NOS) (99)	First trimester	Measures the mother's unwillingness to maintain, nurture or use those social supports that she has
Parental Expectations Survey (PES) (100)	Mid-pregnancy and 3 months postpartum	Assesses the mother's perception of her future ability or current ability as a parent
Edinburgh Postnatal Depression Scale (EPDS) (15)	3 months postpartum	Screens for indications of postpartum depression

3.2.4 Recruitment for the CPC study

A total of 2015 women participated in the CPC study. Of the original participants, 1403 (70%) women completed the EPDS during the third interview and the data from these subjects comprise the sample used for the current study.

3.3 Ethical considerations

All women provided informed consent for the original CPC study. It received ethics approval from the Conjoint Health Research Ethics Board (CHREB), Faculty of Medicine, University of Calgary. The present study also received ethics approval from the Conjoint Health Research Ethics Board, Faculty of Medicine, University of Calgary in March 2006 (Appendix D). To ensure confidentiality, all identifying information was removed from the electronic dataset prior to being used in this study. The CHREB waived consent for the present study to use the CPC dataset as the objectives were consistent with the original study objectives.

3.4 Study variables

The dependent variable was *postpartum depression* as measured by the Edinburgh Postnatal Depression Scale (EPDS) (15), while the primary independent variable was a *history of depression.*

Other variables included in the analysis were based on the literature and addressed potential demographic, obstetric, behavioural risk, mental health and psychosocial risk factors.

The demographic variables included *study group, maternal age, marital status, parity, maternal education level, total household income, country mother was born,* and *maternal ethnicity*.

Obstetric variables included whether the index pregnancy was *planned, induction of labour, mode of delivery, baby's length of hospital stay, baby's sex, number of babies, gestational age, birth weight* and *breastfeeding status at three months.*

The behavioural risk variables included *alcohol consumption during the index pregnancy, binge drinking during the index pregnancy, modified T-ACE classification* (a quick screen for prenatal alcohol use classified as "at risk" if answered yes to any of; 1) being annoyed by someone commenting on their drinking, 2) attempting to cut down on their drinking, 3) having a drink first thing in the morning, *smoking during the index pregnancy* and *illicit drug use during the index pregnancy*. Variables relating to being abused or witnessing abuse to someone close to them including *ever being abused, ever witnessed abuse, abuse during the index pregnancy, witness to abuse during the index pregnancy* and *postpartum abuse*. These variables are referring to all forms of abuse included physical, emotional, sexual, financial or neglect.

The mental health variables included *family history of depression, depression during the index pregnancy* as measured by the depression subscale of the Kellner Symptom Questionnaire (SQ) (97), and *anxiety during the index pregnancy* as measured by the anxiety subscale of the SQ (97).

The psychosocial variables included *social support during the index pregnancy* as measured by the Social Support Index (SSI) (98), *social isolation during the index pregnancy* as measured by the Network Orientation Scale (NOS) (99), and *prenatal and postnatal parenting self-efficacy* as measured by the Parenting Expectations Scale (PES) (100).

3.5 Data analysis

Women were divided into three groups based on their EPDS score obtained during the postnatal period as described in Table 3.2.

Table 3.2 Postpartum depression classification

EPDS Score	Classification
≤ 9	No postpartum depression
10 - 12	Minor postpartum depression
≥ 13	Major postpartum depression

EPDS = Edinburgh Postnatal Depression Scale (15).

3.5.1 Changes to variables

For the statistical analysis, the continuous variables were categorized to make their values more interpretable and to allow for the calculation of relative risks. As well, many of the categorical variables were collapsed into fewer categories to increase cell size or to allow for a meaningful comparisons between strata. Finally, a few variables

were created based on participants' responses to questions in the CPC questionnaires. The final versions of variables used in the analysis, as well as specification of the risk and referent categories are described in Table 3.3.

Table 3.3 Variable categories

Variable	Risk Categories	Referent Category
Demographic Variables:		
Study group	Nurse Nurse + Home Visitor	Standard of Care
Maternal age	< 25 years	≥ 25 years
Stable partner	No partner	Stable partner
Parity	No live births	≥1 other live birth
Maternal Education	Less than high school Graduated high school	Some post secondary
Total household income	< $40,000 / year	≥ $40,000 / year
Maternal country born	Other	Canada
Ethnicity	Other	Caucasian
Obstetric Variables:		
Planned pregnancy	Unplanned	Planned
Induction of labour	Induced	Not induced
Mode of delivery	Cesarean section	Vaginal
Length of hospital stay	> 2 days	≤ 2 days
Gestational age	Premature (< 37 wks)	Not premature (≥ 37 wks)
Birth weight	LBW (< 2500 grams)	Not LBW (≥ 2500 grams)
Sex of baby	Male	Female
Breastfeeding status at 3 months	Not breastfeeding	Still breastfeeding
Number of babies	Multiple birth	Singleton
Behavioural Risk:		
Alcohol consumption during pregnancy[1]	Yes	No
Binge drank during pregnancy[1]	Yes	No
T-ACE classification (modified)	At risk	Low risk
Smoking during pregnancy[1]	Yes	No
Illicit drug use during pregnancy[1]	Yes	No
Ever abused[2]	Abused	Not abused
Ever witnessed abuse[2]	Witness to abuse	Have not witnessed abuse
Abuse[2] during pregnancy[1]	Abused	Not abused
Witnessed abuse[2] during pregnancy[1]	Witness to abuse	Have not witnessed abuse
Postnatal abuse[2]	Abused	Not abused
Mental Health:		
History of depression	History of depression	No history of depression
Family history of depression	Family history	No family history
Depression during pregnancy[1] from SQ	Depressed (SQ>8.30)	Not depressed (SQ ≤ 8.30)

Variable	Risk Categories	Referent Category
Anxiety during pregnancy[1] from SQ	Anxious (SQ>11.58)	Not anxious (SQ ≤ 11.58)
Psychosocial:		
Social support during pregnancy[1] from SSI	Low (Lower 33%: SSI<48)	High (Upper 67%: SSI ≥ 48)
Social isolation during pregnancy[1] from NOS	Yes (Upper 33%: NOS>44)	No (Lower 67%: NOS ≤ 44)
Prenatal[1] parenting self-efficacy from prenatal PES	Low (Lower 33 %: PES<8.00)	High (Upper 67%: PES ≥ 8.00)
Postnatal parenting self-efficacy from postnatal PES	Low (Lower 33%: PES<8.48)	High (Upper 67%: PES ≥ 8.48)

LBW = low birth weight, PPD = postpartum depression, EPDS = Edinburgh Postnatal Depression Scale (15), SQ = Kellner Symptom Questionnaire (97), SSI = Social Support Index (98), NOS = Network Orientation Scale (99), PES= Parental Expectations Survey (100), [1]refers to index pregnancy, [2]refers to all forms of abuse including physical, emotional, sexual, financial and neglect.

3.5.2 Statistical analysis

All statistical analyses were performed with Intercooled Stata Version 8.2 for MacIntosh (101) except for the initial bivariate analysis between all study variables and the three category version of postpartum depression which was performed in SPSS version 12 for Windows since the chi-square test for a linear trend was not available in Stata. All tests were two-tailed, with p-values of less than 0.05 considered statistically significant. All confidence intervals presented are exact 95% confidence intervals calculated by Stata according to the methods of Clopper-Pearson (101). Associations were considered significant if the confidence interval did not include 1.00.

3.5.2.1 Univariate analysis

Univariate analyses were completed for all continuous and categorical variables to describe the characteristics of the study sample. The number, minimum, maximum, mean

and standard deviation are presented for continuous variables while the frequency and percent are presented for categorical variables.

3.5.2.2 Bivariate analysis

Initially, a bivariate analysis using Pearson's chi-square test (or Fisher's Exact test when expected cell counts were five or less) were carried out to determine if the distribution of postpartum depression differed for each stratum of all pre and perinatal risk factors. The Chi-square trend test was used to examine the relationship between postpartum depression (using the three category version as described previously in Table 3.2) and all other predictors. The frequency and percentage of women in each postpartum depression category for each stratum of the risk factors as well as p-values for Pearson's chi-square test or Fisher's Exact test (where appropriate) and the linear-by-linear association chi-square test were calculated.

The bivariate analysis provided the opportunity to determine which EPDS score was a good cut-point for classifying women as having postpartum depression. Specifically, we wanted to determine if women who fell into the minor postpartum depression category (EPDS 10-12), were more like those women without symptoms of postpartum depression, those with major postpartum depression, or if they constituted a distinct middle risk group of women.

The bivariate analysis was also repeated for all pre and perinatal risk factors comparing the following pairs of postpartum depression categories:

a) women with major postpartum depression (EPDS $\geq$13) to women without postpartum depression (EPDS <13)

b) women with minor postpartum depression (EPDS 10-12) to women without postpartum depression (EPDS ≤ 9) and

c) women with major postpartum depression (EPDS ≥ 13) to women with minor postpartum depression (EPDS 10 – 12).

These bivariate analyses used Pearson's chi-square test (or Fisher's Exact test when expected cell counts were five or less) to determine if the distribution of postpartum depression differed for each strata of all pre and perinatal risk factors. The frequency and percentage of women in each postpartum depression category for each strata of the risk factors as well as p-values for Pearson's chi-square test or Fisher's Exact test (where appropriate) were calculated.

3.5.2.3 Crude analysis

A crude analysis calculating the relative risk of postpartum depression associated with each variable was also completed. A relative risk is the ratio of disease among the exposed divided by the risk among the unexposed (102). Relative risks are the measure of association used in prospective studies since data is collected to assess the incidence of disease. A point estimate and exact 95% confidence interval for the relative risk of postpartum depression associated with each variable was calculated comparing the following pairs of postpartum depression categories:

a) women with major postpartum depression (EPDS ≥13) to women without postpartum depression (EPDS <13)

b) women with minor postpartum depression (EPDS 10-12) to women without postpartum depression (EPDS ≤ 9) and

c) women with major postpartum depression (EPDS ≥ 13) to women with minor postpartum depression (EPDS 10 – 12).

This analysis allowed for measurement of the crude association between a history of depression and postpartum depression which was the first analytic objective. As well, it provided a measure of the association between each variable and the outcome variable major postpartum depression, the second analytic objective. This analysis also facilitated assessment of confounding, as a variable must be associated with both the predictor and the outcome variable in order to be considered as a confounder.

3.5.2.4 Classical stratified analysis

A classical stratified analysis (trivariate analysis) was conducted to assess if any of the other variables were confounding or modifying the relationship between a history of depression and major postpartum depression. This analysis involved taking the primary bivariate relationship of interest (history of depression and major postpartum depression) and stratifying by all other variables.

A confounder is a third variable that distorts the association between the exposure and outcome variables of interest because of a strong relationship with both the exposure and outcome variables (102). For example, age could confound the relationship between inactivity and heart disease. By definition, a confounder must be associated with the exposure variable, associated with the outcome variable and cannot lie on the causal pathway of exposure causing outcome. In this case, age is associated with inactivity (with increasing age, inactivity increases), age is associated with the outcome (with increasing age, more heart disease) and age does not lie on the causal pathway of inactivity‡heart disease. Therefore a strategy to control for age either in the design or analysis stage of the

study is important to ensure that the risk of heart disease is attributable to inactivity and not mixed with the effect of age.

An effect modifier is a factor that modifies the effect of a presumed causal factor under study (102). For example, gender is an effect modifier of the relationship between death of a loved one and depression since women are more likely to suffer from depression than men (19). In this case, gender modifies the relationship between death of a loved one and depression and therefore, gender specific risks need to be presented.

In this study, a variable was considered an effect modifier of the relationship between history of depression and major postpartum depression if the stratum specific relative risks were different. A p-value of less than 0.05 from the Mantel-Haenszel test for homogeneity indicated evidence of effect modification.

If stratum specific estimates were similar, (no evidence of effect modification), the variable was assessed as a confounder. Specifically, the crude relative risk and exact 95% confidence interval for history of depression and major postpartum depression was compared to the Mantel-Haenszel combined relative risk and 95% confidence interval for the potential confounding variable to determine if they were different. This decision was made based on visual inspection and therefore an absolute difference of 0.7 was set as a meaningful difference *a-priori*. If an absolute difference of 0.7 or greater was found between the crude and Mantel-Haenszel combined relative risks, this provided evidence of confounding.

Variables found to show evidence of effect modification or confounding of the relationship between history of depression and major postpartum depression were then

selected for the multivariate model according to their relationship with the independent and dependent variables.

3.5.2.5 Multivariate analysis – statistical modelling

Finally, a multivariate strategy (logistic regression models) was used to identify the risk factors most predictive of major postpartum depression. A multiple logistic regression model was chosen since the outcome of interest, major postpartum depression, was defined as a discrete outcome (no PPD: EPDS <13, major PPD ≥13). Logistic regression is used to model an individual's risk (probability of disease y) as a function of a risk factor x: $P(y|x) = 1 / 1 + e^{-\alpha-\beta\chi}$ where e is the natural exponential function (102). In this case, the model is describing the probability of major postpartum depression as a function of a history of depression and other risk factors. The logistic model provides estimates of the odds ratio associated with each risk factor adjusted for the other variables in the model (102). Specifically, since the data were collected prospectively, the odds ratio is the ratio of the odds of disease (major postpartum depression) among those exposed (with a history of depression) divided by the odds of disease (major postpartum depression) among the unexposed (without a history of depression) after adjustment for other variables in the model.

There was no evidence of confounding or effect modification by any of the variables from the classical stratified analysis and this, consequently, suggests that a history of depression is a risk factor for major postpartum depression independent of all other studied risk factors. Therefore, variables were selected for the multivariate model based on significant association with major postpartum depression from the bivariate analysis.

As well, multicollinearity among related variables was considered initially by looking at the distribution of cross tabulations between variables. When two variables were highly related, the variable that best represented the construct of interest was chosen. Multicollinearity was also considered during the modelling process by observing how including a variable in the model changed the coefficients and standard errors of the first variable in the model. If a second variable was added into the model and the odds ratio of the first variable became non-significant, a decision was made as to which variable to include based on statistical strength and clinical relevance of each predictor variable.

The primary independent variable of interest, a *history of depression* was entered first into the model followed by significant demographic, obstetric, behavioural risk, mental health and psychosocial variables using the “enter” method. As well, effect modification by significant variables was assessed by testing interaction terms. Given the large number of potential predictors, one could test many interaction terms for many combinations of variables. However, only those interactions which had been reported in the literature or which had a theoretical relationship in a biological or sociologic sense were examined. The final model included all statistically significant independent variables and interaction terms. Adjusted odds ratios and exact 95% confidence intervals were calculated from the regression coefficients and standard errors of the variables retained in the model.

Logistic regression models were also created to identify the risk factors that most distinguished:

a) women with minor postpartum depression (EPDS 10-12) from women without postpartum depression (EPDS ≤ 9) and

b) women with major postpartum depression (EPDS ≥ 13) from women with minor postpartum depression (EPDS 10-12).

Again, multicollinearity of variables was considered according to the methods described above. Variables were entered into the model in the same order; a history of depression (if significant), demographic variables, obstetric variables, behavioural risk variables, mental health variables and finally psychosocial variables again one at a time. As above, only those interaction terms between significant variables reported in the literature or which had a theoretical relationship in a biological or sociologic sense were tested for significance. Significant independent variables and interaction terms were retained in the model and again adjusted odds ratios and exact 95% confidence intervals were calculated.

3.6 Sample size calculation

The prevalence of a previous history of depression, a known risk factor for postpartum depression was compared for those with postpartum depression and those without from a recent study by Boyce and Hickey (87). A history of depression was present in 4% of the non-depressed population and 24% of the postpartum depressed population (20% difference) (87). Sample size calculations were undertaken to determine 1) if our sample size was sufficient to obtain an odds ratio of 2 or greater based on the estimates for Boyce and Hickey and 2) given our sample size, what difference are we able to detect while maintaining 80% power, significance of $p<0.05$ and an odds ratio of

2 or greater. An odds ratio of 2.0 or greater was considered to be clinically meaningful (103).

At 80% power and a significance level of $p<0.05$, we would have required 186 study participants to observe a 20% difference in the prevalence of a history of depression as significant and would have obtained an odds ratio of 7.58.

Given our sample size of approximately 1500 women, using a 4 to 1 case control ratio and maintaining 80% power, we are able to detect a 6% difference in the history of depression as significant ($p<0.05$) and an odds ratio of 2.05.

Chapter Four: Results

4.1 Univariate analysis: participant characteristics

The characteristics of the participants have been grouped in the following categories; demographic, obstetric, behavioural risk, mental health and psychosocial variables and described as continuous or categorical variables.

4.1.1 Participant characteristics – continuous variables

Table 4.1 provides the mean, standard deviation and range for the continuous variables.

4.1.1.1 Demographic

The mothers in the study ranged in *age* from 18.5 to 47.1 years with a mean age of 29.4 years.

4.1.1.2 Obstetric

The babies mean *length of stay* in the hospital was 3.0 days, with participants staying between 1 and 125 days. Child *gestational age*, the number of weeks from conception to birth, ranged from 25 to 43 weeks with the mean being 39.2 weeks. The mean *birth weight* of babies born in the study was 3373.6 grams with a range of 710 grams to 5072 grams.

All continuous variables were normally distributed based on visual inspection of box plots except for the variable measuring the baby's length of hospital stay. The variable for length of hospital stay was positively skewed with many outliers. Transformations did not greatly improve the normality of babies length of hospital stay, so instead it was dichotomized at two days or less and greater than two days since the average length of hospital stay in Alberta for new babies is two days (104). The

categorized versions of all continuous variables as previously described in Table 3.2 were used in all subsequent analyses to permit the calculation of relative risks.

4.1.2 Participant characteristics – categorical variables

Table 4.1 also provides the frequency and percent for each category of the categorical variables.

4.1.2.1 Demographic

The number of women was relatively equal across all three *study groups*, although there was a slightly greater percentage of women in the standard of care group (36.8%) as compared to both the nurse (31.8%) and nurse + home visitor groups (31.4%). Overall, the study sample represented a low risk population. The typical participant was 25 years of *age* or older (81.7%), had a stable *partner* (92.9%), had completed at least some post secondary *education* (74.5%), had a total household *income* of $40,000 per year or greater, was *born in Canada* (75.8%), was of Caucasian *ethnicity* (76.2%) and about half of the women were *having their first child* (54.3%).

4.1.2.2 Obstetric

The majority of the women in the study reported having *planned the index pregnancy* (70.2%). Most women *entered labour* spontaneously (62.4%) and *delivered* vaginally (78.7%). Almost all women had singleton *births*, as only seven women in the study population had twins. Most babies' *hospital stay length was* two days or less (66.3%) and 49.8% of the babies were *female*. At three months postpartum, 75.6% of the women were still *breastfeeding* their babies.

4.1.2.3 Behavioural risk

Approximately, one quarter (26.9%) of women admitted to *drinking alcohol* at some point in their pregnancy, with 6.2% admitting to *binge drinking* (drinking five or more alcoholic beverages on at least one occasion) during their pregnancy. According to the *T-ACE (modified),* 13.9% of the women had drinking habits classifying them as "at risk". One fifth (20.0%) of the study sample admitted to *smoking during pregnancy* while the rate of self-reported *drug use* was 2.6%.

One third (33.0%) of the women reported a *past history of abuse* and had *witnessed abuse during their lifetime* (38.9%). Rates of *abuse during pregnancy* (4.5%), *witnessing abuse during pregnancy* (8.9%) and *abuse postpartum* (4.3%) were much lower.

4.1.2.4 Mental health

Eleven percent of women had *postpartum depression* based on their Edinburgh Postnatal Depression Scale score (EPDS) (15), with 4.5% of the women having symptoms of major postpartum depression while 6.5% were found to display symptoms of minor postpartum depression. Almost 40% reported a *family history of depression* (39.9%) while only a small percentage of the women reported being *depressed* (6.1%) and *anxious* (6.7%) *during pregnancy* as measured by the Kellner Symptom Questionnaire (SQ) depression and anxiety subscales (97).

4.1.2.5 Psychosocial

Since the cut-points for psychosocial variables were set arbitrarily based on the distribution of their scores, the percentages for each category of a variable do not provide any descriptive information about the sample.

Table 4.1 Participant characteristics

Domain	Variable	n	Mean	SD	Min	Max
Demographic	**Maternal age** (years)	1401	29.4	4.8	18.5	47.1
Obstetric	**Length of hospital** stay (days)	1396	3.0	5.7	1	125
	Infants' gestational age (weeks)	1397	39.2	1.8	25	43
	Infants' birth weight (grams)	1401	3373.6	519.7	710	5072

Domain	Variable	Frequency	Percent
Demographic	**Study group**		
	Standard of care	516	36.8
	Nurse	446	31.8
	Nurse + Home visitor	441	31.4
	Maternal age		
	Younger than 25	257	18.3
	25 or older	1144	81.7
	Marital status[1]		
	No stable partner	100	7.1
	Stable partner	1302	92.9
	Parity		
	No live births	762	54.3
	≥ 1 other live birth	641	45.7
	Maternal education		
	Some high school or less	107	7.8
	Completed high school	244	17.7
	Some post secondary	1027	74.5
	Total household income		
	Less than $40,000/year	283	22.1
	At least $40,000/year	1000	77.9
	Country born		
	Canada	1062	75.8
	Other	340	24.2
	Ethnicity		
	Caucasian	1062	76.2
	Other	332	23.8
Obstetric	**Planned pregnancy**		
	Not planned	417	29.8
	Planned	982	70.2

Domain	Variable	Frequency	Percent
	Induction of labour		
	Not induced	827	62.4
	Induced	498	37.6
	Mode of delivery		
	Vaginal	1103	78.7
	Cesarean section	299	21.3
	Hospital stay length		
	2 days or less	925	66.3
	Longer than 2 days	478	33.7
	Sex of baby		
	Male	705	50.3
	Female	698	49.7
	Number of babies		
	Singleton	1396	99.5
	Multiple Birth	7	0.5
	Breastfeeding status at 3 months		
	Still breastfeeding	1060	75.6
	No longer breastfeeding	342	24.4
Behavioural risk	**Drank alcohol during pregnancy**[2]		
	No	1019	73.2
	Yes	374	26.8
	Binge drank during pregnancy[2]		
	No	1308	93.8
	Yes	87	6.2
	T-ACE classification (modified)		
	Low risk	905	86.1
	At risk	146	13.9
	Smoking during pregnancy[2]		
	No	1122	80.0
	Yes	281	20.0
	Illicit drug use during pregnancy[2]		
	No	1363	97.4
	Yes	37	2.6
	History of abuse[3]		
	Abused	939	67.0
	Never abused	463	33.0

Domain	Variable	Frequency	Percent
	Ever witnessed abuse[3]		
	Has not witnessed abuse	857	61.1
	Witnessed abuse	545	38.9
	Abuse[3] during pregnancy[2]		
	Not abused	1339	95.5
	Abused	63	4.5
	Witness to abuse[3] during pregnancy[2]		
	Has not witnessed abuse	1276	91.1
	Witnessed abuse	124	8.9
	Postnatal abuse[3]		
	Not abused	1343	95.7
	Abused	60	4.3
Mental health	**Postpartum depression from EPDS**		
	No PPD	1248	89.0
	Minor PPD	91	6.5
	Major PPD	64	4.5
	History of depression		
	No history of depression	1085	77.4
	History of depression	316	22.6
	Family history of depression		
	No family history	836	60.1
	Family history	554	39.9
	Depression during pregnancy[2] from SQ		
	No depression	1318	93.9
	Depression	85	6.1
	Anxiety during pregnancy[2] from SQ		
	No anxiety	1309	93.3
	Anxiety	94	6.7
Psychosocial	**Social support during pregnancy[2] from SSI**		
	High (upper 66%)	980	70.0
	Low (lower 33%)	421	30.0
	Social isolation during pregnancy[2] from NOS		
	No (lower 66%)	1051	75.6
	Yes (upper 33%)	339	25.4

Domain	Variable	Frequency	Percent
	Prenatal parenting self-efficacy from PES		
	High (upper 66%)	944	67.3
	Low (lower 33%)	458	32.7
	Postnatal parenting self-efficacy from PES		
	High (upper 66%)	912	65.1
	Low (lower 33%)	490	34.9

SD = standard deviation, Min = minimum, Max = maximum, PPD = postpartum depression, EPDS = Edinburgh Postnatal Depression Scale (15), SQ = Kellner Symptom Questionnaire (97), SSI = Social Support Index (98), NOS = Network Orientation Scale (99), PES= Parental Expectations Survey (100), [1]having a stable partner was defined as currently being married or common law, [2]refers to index pregnancy, [3]refers to all forms of abuse including physical, emotional, sexual, financial and neglect.

4.2 Effect of study group on postpartum depression

Study group was not a significant predictor of postpartum depression as displayed in Table 4.2. The additional support provided by a nurse (group 2) or by a nurse and home visitor (group 3) did not have a significant impact on postpartum depression status and therefore was not considered in subsequent analyses.

Table 4.2 Study group by postpartum depression status

Risk Factor	No PPD (EPDS ≤ 9) n = 1248 n (row %)	Minor PPD (EPDS 10-12) n = 91 n (row %)	Major PPD (EPDS ≥13) n = 64 n (row %)	p-value	Trend p-value
Demographic:					
Study group					
Standard of care	452 (87.6)	38 (7.4)	26 (5.0)	0.667	0.164
Nurse	396 (88.8)	29 (6.5)	21 (4.7)		
Nurse + Home visitor	400 (90.7)	24 (5.4)	17 (3.9)		

PPD = postpartum depression, EPDS = Edinburgh Postnatal Depression Scale (15), p-value from Pearson's Chi square test, *p-value calculated from Fisher's exact test, Trend p-value from (exact 2-sided).

4.3 Participant characteristics by postpartum depression status

The frequency and percents for postpartum depression by each level of the demographic and obstetric variables (Table 4.3) and behavioural risk, mental health and psychosocial variables (Table 4.4) are presented. P-values for Pearson's chi-square test or Fisher's Exact test (where appropriate) and the linear-by-linear association chi-square test (exact two-sided) are also displayed.

4.3.1 Demographic

Higher EPDS scores were associated with not having a stable partner, incomes less than $40,000 per year, being born outside Canada, non-Caucasian ethnicity and lower education levels ($p<0.05$ trend).

4.3.2 Obstetric

Higher EPDS scores were associated with having an unplanned pregnancy, having a female baby and not breastfeeding at three months postpartum ($p<0.05$ trend).

Women whose labours were induced were more likely to be at risk (8.4%) but less likely to have postpartum depression (3.8%) than women whose labours were not induced (at risk 5.2%, PPD 5.1%) ($p<0.05$).

Table 4.3 Demographic and obstetric characteristics by postpartum depression status

Risk Factor	No PPD (EPDS ≤ 9) n = 1248 n (row %)	Minor PPD (EPDS 10-12) n = 91 n (row %)	Major PPD (EPDS ≥13) n = 64 n (row %)	p-value	Trend p-value
Demographic:					
Maternal age					
Younger than 25	225 (87.6)	18 (7.0)	14 (5.5)	0.696	0.395
25 or older	1021 (89.3)	73 (6.4)	50 (4.4)		
Marital status[1]					
No stable partner	82 (82.0)	11 (11.0)	7 (7.0)	0.069	0.039
Stable partner	1165 (89.5)	80 (6.1)	57 (4.4)		
Parity					
No live births	687 (90.2)	45 (5.9)	30 (3.9)	0.277	0.114
≥ 1 other live birth	561 (87.5)	46 (7.2)	34 (5.3)		
Maternal education					
Less than high school	86 (80.4)	9 (8.4)	12 (11.2)	0.011	0.003
Completed high school	215 (88.1)	19 (7.8)	10 (4.1)		
Some post secondary	922 (89.8)	63 (6.1)	42 (4.1)		
Total household income					
Less than $40,000 /yr	240 (84.8)	20 (7.1)	23 (8.1)	0.002*	<0.001
At least $40,000/yr	909 (90.9)	58 (5.8)	33 (3.3)		
Country born					
Canada	963 (90.7)	60 (5.7)	39 (3.7)	0.001	<0.001
Other	284 (83.5)	31 (9.1)	25 (7.4)		
Ethnicity					
Caucasian	960 (90.4)	64 (6.0)	38 (3.6)	0.002	<0.001
Other	279 (84.0)	27 (8.1)	26 (7.8)		
Obstetric:					
Planned pregnancy					
Not planned	353 (84.7)	37 (8.9)	27 (6.5)	0.003	0.001
Planned	892 (90.8)	53 (5.4)	37 (3.8)		
Induction of labour					
Not induced	742 (89.7)	43 (5.2)	42 (5.1)	0.043	0.792
Induced	437 (87.8)	42 (8.4)	19 (3.8)		
Mode of delivery					
Vaginal	985 (89.3)	67 (6.1)	51 (4.6)	0.474	0.649
Cesarean section	262 (87.6)	24 (8.0)	13 (4.3)		

Risk Factor	No PPD (EPDS ≤ 9) n = 1248 n (row %)	Minor PPD (EPDS 10-12) n = 91 n (row %)	Major PPD (EPDS ≥13) n = 64 n (row %)	p-value	Trend p-value
Hospital stay length					
2 days or less	837 (90.5)	50 (5.4)	38 (4.1)	0.053	0.056
Longer than 2 days	407 (86.4)	40 (8.5)	24 (5.1)		
Sex of baby					
Male	614 (87.1)	54 (7.7)	37 (5.2)	0.081	0.042
Female	634 (90.8)	37 (5.3)	27 (3.9)		
Number of babies					
Singleton	1243 (89.0)	91 (6.5)	62 (4.4)	0.057*	0.051
Multiple Birth	5 (71.4)	0 (0.0)	2 (28.6)		
Breastfeeding status at 3 months					
Still breastfeeding	955 (90.1)	68 (6.4)	37 (3.5)	0.006	0.004
No longer breastfeeding	293 (85.7)	23 (6.7)	26 (7.6)		

PPD = postpartum depression, EPDS = Edinburgh Postnatal Depression Scale (15), p-value from Pearson's Chi square test, *p-value calculated from Fisher's exact test, Trend p-value from (exact 2-sided), [1]having a stable partner was defined as currently being married or common law.

4.3.3 Behavioural risk

Higher EPDS scores were associated with "at-risk" T-ACE classification (modified), smoking during pregnancy, ever being abused or witnessing abuse, abuse during pregnancy and postnatal abuse ($p<0.05$ trend).

4.3.4 Mental health

Higher EPDS scores were associated with having a history of depression, family history of depression, depression during pregnancy and anxiety during pregnancy ($p<0.05$ trend). Women with a history of depression were more likely to have minor (10.8%) or major postpartum depression (9.2%) than those without a history of depression (minor PPD 5.3%, major PPD 3.2%) (Figure 4.1).

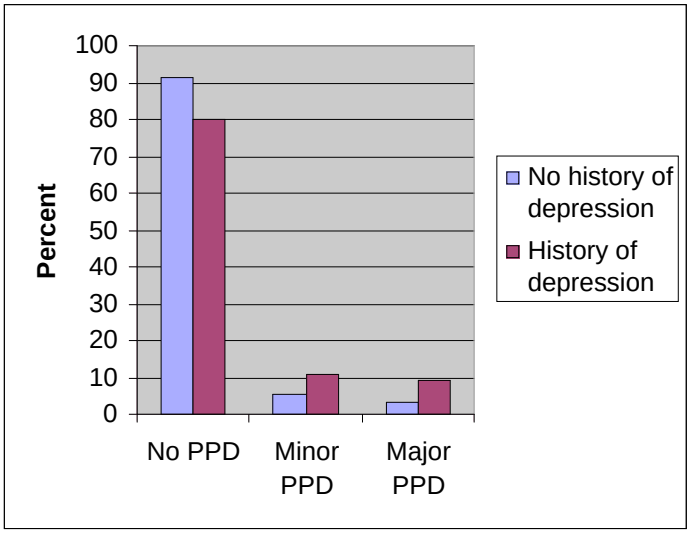

Figure 4.1 History of depression by postpartum depression status.

4.3.5 Psychosocial

Higher EPDS scores were associated with poor social support during pregnancy, social isolation during pregnancy and low postnatal parenting self-efficacy ($p<0.001$ trend).

Table 4.4 Behavioural risk, mental health and psychosocial characteristics by postpartum depression status

Risk Factor	No PPD (EPDS ≤ 9) n = 1248 n (row %)	Minor PPD (EPDS 10-12) n = 91 n (row %)	Major PPD (EPDS ≥13) n = 64 n (row %)	p-value	Trend p-value
Behavioural risk:					
Drank alcohol during pregnancy[1]					
No	913 (89.6)	63 (6.2)	43 (4.2)	0.427*	0.213
Yes	327 (87.4)	26 (7.0)	21 (5.6)		
Binge drank during pregnancy[1]					
No	1163 (88.9)	86 (6.6)	59 (4.5)	0.683*	1.000
Yes	78 (89.7)	4 (4.6)	5 (5.7)		
T-ACE classification (modified)					
Low risk	822 (90.8)	57 (6.3)	26 (2.9)	0.001	0.001
At risk	122 (83.6)	11 (7.5)	13 (8.9)		
Smoking during pregnancy[1]					
No	1006 (89.7)	73 (6.5)	45 (3.8)	0.033	0.023
Yes	242 (86.1)	18 (6.4)	21 (7.5)		
Illicit drug use during pregnancy[1]					
No	1215 (89.1)	88 (6.5)	60 (4.4)	0.112*	0.072
Yes	30 (81.1)	3 (8.1)	4 (10.8)		
History of abuse[2]					
Abused	852 (90.7)	52 (5.5)	35 (3.7)	0.013	0.004
Never abused	396 (85.5)	38 (8.2)	29 (6.3)		
Ever witnessed abuse[2]					
Has not witnessed abuse	777 (90.7)	49 (5.7)	31 (3.6)	0.035	0.011
Witnessed abuse	471 (86.4)	41 (7.5)	33 (6.1)		
Abuse[2] during pregnancy[1]					
Not abused	1202 (89.8)	82 (6.1)	55 (4.1)	<0.001	<0.001
Abused	45 (71.4)	9 (14.3)	9 (14.3)		
Witness to abuse[2] during pregnancy[1]					
Not witnessed abuse	1142 (89.5)	80 (6.3)	54 (4.2)	0.144	0.056
Witnessed abuse	104 (83.9)	11 (8.9)	9 (7.3)		

Risk Factor	No PPD (EPDS ≤ 9) n = 1248 n (row %)	Minor PPD (EPDS 10-12) n = 91 n (row %)	Major PPD (EPDS ≥13) n = 64 n (row %)	p-value	Trend p-value
Postnatal abuse[2]					
Not abused	1211 (90.2)	82 (6.1)	50 (3.7)	<0.001	<0.001
Abused	37 (61.7)	9 (15.0)	14 (23.3)		
Mental health:					
History of depression					
No history of depression	993 (91.5)	57 (5.3)	35 (3.2)	<0.001	<0.001
History of depression	253 (80.1)	34 (10.8)	29 (9.2)		
Family history of depression					
No family history	759 (90.8)	46 (5.5)	31 (3.7)	0.039	0.014
Family history	479 (86.5)	43 (7.8)	32 (5.8)		
Depression during pregnancy[1] from SQ					
No depression	1189 (90.2)	79 (6.0)	50 (3.8)	<0.001	<0.001
Depression	59 (69.4)	12 (14.1)	14 (16.5)		
Anxiety during pregnancy[1] from SQ					
No anxiety	1177 (89.9)	78 (6.0)	54 (4.1)	<0.001	<0.001
Anxiety	71 (75.5)	13 (13.8)	10 (10.6)		
Psychosocial:					
Social support during pregnancy[1] from SSI					
High (upper 66%)	888 (90.6)	59 (6.0)	33 (3.4)	0.002	0.001
Low (lower 33%)	358 (85.0)	32 (7.6)	31 (7.4)		
Social isolation during pregnancy[1] from NOS					
No (lower 66%)	961 (91.4)	57 (5.4)	33 (3.1)	<0.001	<0.001
Yes (upper 33%)	275 (81.1)	33 (9.7)	31 (9.1)		
Prenatal parenting self-efficacy from PES					
High (upper 66%)	850 (90.0)	51 (5.4)	43 (4.6)	0.060	0.276
Low (lower 33%)	398 (86.9)	40 (8.7)	20 (4.4)		

Risk Factor	No PPD (EPDS ≤ 9) n = 1248 n (row %)	Minor PPD (EPDS 10-12) n = 91 n (row %)	Major PPD (EPDS ≥13) n = 64 n (row %)	p-value	Trend p-value
Postnatal parenting self-efficacy from PES					
High (upper 66%)	834 (91.4)	47 (5.2)	31 (3.4)	<0.001	<0.001
Low (lower 33%)	414 (84.5)	44 (9.0)	32 (6.5)		

PPD = postpartum depression, EPDS = Edinburgh Postnatal Depression Scale (15), p-value from Pearson's Chi square test, *p-value calculated from Fisher's exact test, Trend p-value from (exact 2-sided), SQ = Kellner Symptom Questionnaire (97), SSI = Social Support Index (98), NOS = Network Orientation Scale (99), PES= Parental Expectations Survey (100), [1]refers to index pregnancy, [2]refers to all forms of abuse including physical, emotional, sexual, financial and neglect.

From this bivariate analysis, women with minor postpartum depression (EPDS scores of 10-12) do appear to be a distinct group from both those without postpartum depression (EPDS ≤ 9) and those with major postpartum depression (EPDS ≥ 13). Generally, the risk categories were associated with increasing postpartum depression scores.

Each subsequent section of the results chapter addressed one of the objectives of this project.

4.4 History of depression and major postpartum depression (EPDS ≥13)

Objective 1

To quantify the risk a history of depression poses for major postpartum depression as defined by a score of 13 or greater on the Edinburgh Postnatal Depression Scale (EPDS) (15) in a community sample of medically low risk pregnant women.

4.4.1 Bivariate analysis

Table 4.5 provides the frequency and percents of women with and without major postpartum depression for those with and without a history of depression. A p-value for Pearson's chi-square test, the relative risk of postpartum depression associated with a history of depression and exact 95% confidence interval are also presented.

A history of depression was significantly associated with major postpartum depression ($p<0.001$). Women with a history of depression were more likely to have major postpartum depression (9.18%) than those without a history of depression (3.23%). Among women with a history of depression, the risk of major postpartum depression was 2.84 (95% CI: 1.77-4.58) times the risk of major postpartum depression for women without a history of depression.

Table 4.5 History of depression and major postpartum depression

Risk Factor	**No PPD (EPDS<13) n=1339** n (row %)	**Major PPD (EPDS ≥13) n=64** n (row %)	**RR (95% CI)**	**p-value**
History of Depression				
Yes	287 (90.8)	29 (9.2)	2.8 (1.8 – 4.6)	<0.001
No	1050 (96.8)	35 (3.2)		

PPD = postpartum depression, EPDS = Edinburgh Postnatal Depression Scale,
RR = relative risk, CI = confidence interval, p-value from Pearson's Chi-square test.

4.5 Pre and perinatal risk factors and major postpartum depression (EPDS ≥ 13)

Objective 2

To quantify the risk of major postpartum depression associated with pre and perinatal risk factors.

4.5.1 Bivariate analysis

The results of the Pearson chi-square or Fisher's exact tests (where appropriate) for the demographic and obstetric variables (Table 4.6) and behavioural risk, mental health and psychosocial variables (Table 4.7) are summarized. Relative risks and exact 95% confidence intervals associated with each variable are also presented.

4.5.1.1 Demographic

Women with less education, incomes less than $40,000 per year, born outside of Canada and of non-Caucasian ethnicity were more likely to have major postpartum depression ($p<=0.005$). Women who had not completed high school were 2.74 (95% CI: 1.49 – 5.05) times more likely to have major postpartum depression than women who had completed some post secondary. Likewise, the risk of major postpartum depression was increased by 2.46 (95% CI: 1.47-4.12) for women with an income less than $40,000 per year, 2.00 (95% CI: 1.23 – 3.26) for women born outside of Canada and 2.19 (95% CI: 1.35 -3.55) for non-Caucasian women compared to women with incomes greater than $40,000, Canadian born and Caucasian women respectively.

4.5.1.2 Obstetric

Major postpartum depression was associated with having an unplanned pregnancy ($p<0.05$), a multiple birth ($p=0.002$) and not breastfeeding at three months postpartum ($p=0.001$).

Women with unplanned pregnancies were 1.72 (95% CI: 1.06 – 2.78) times more likely to have major postpartum depression than women with planned pregnancies. Women with multiple births were 6.43 (95% CI: 1.94 – 21.28) times more likely to have major postpartum depression than women who had singleton births, although this result is based on a very small sample of women who had multiple births (n=7) and therefore should be interpreted with caution. The risk of major postpartum depression among women who were not breastfeeding at three months postpartum was 2.18 (95% CI: 1.34 – 3.54) times the risk for women who were breastfeeding.

Table 4.6 Demographic and obstetric risk factors and major postpartum depression

Risk Factor	No PPD (EPDS <13) n = 1339 n (row %)	Major PPD (EPDS ≥13) n = 64 n (row %)	RR (95% CI)	p-value
Demographic:				
Maternal age				
Younger than 25	243 (94.5)	14 (5.5)	1.25 (0.70 – 2.22)	0.455
25 or older	1094 (95.6)	50 (4.4)	1.00 (ref)	
Marital status[1]				
No stable partner	93 (93.0)	7 (7.0)	1.60 (0.75 – 3.41)	0.226
Stable partner	1245 (95.6)	57 (4.4)	1.00 (ref)	
Parity				
No live births	732 (96.1)	30 (3.9)	1.35 (0.83 – 2.18)	0.221
≥ 1 previous live birth	607 (94.7)	34 (5.3)	1.00 (ref)	
Maternal education				
Less than high school	95 (88.8)	12 (11.2)	2.74 (1.49 - 5.05)	0.004
Completed high school	234 (95.9)	10 (4.1)	1.00 (0.51 – 1.97)	
Some post secondary	985 (95.9)	42 (4.1)	1.00 (ref)	
Total household income				
Less than $40 000/year	260 (91.9)	23 (8.1)	2.46 (1.47 – 4.12)	<0.001
At least $40 000/year	967 (96.7)	33 (3.3)	1.00 (ref)	
Country mother was born				
Other	315 (92.7)	25 (7.3)	2.00 (1.23 – 3.26)	0.005
Canada	1023 (96.3)	39 (3.7)	1.00 (ref)	
Maternal ethnicity				
Other	306 (92.2)	26 (7.8)	2.19 (1.35 – 3.55)	0.001
Caucasian	1024 (96.4)	38 (3.6)	1.00 (ref)	
Obstetric:				
Planned pregnancy				
Not planned	390 (93.5)	27 (6.5)	1.72 (1.06 – 2.78)	0.027
Planned	945 (96.2)	37 (3.8)	1.00 (ref)	
Induction of labour				
Induced	479 (96.2)	19 (3.8)	0.75	0.288
Not induced	785 (94.9)	42 (5.1)	1.00 (ref)	
Mode of delivery				
Cesarean Section	286 (95.7)	13 (4.3)	0.94 (0.52 – 1.71)	0.839
Vaginal	1052 (95.4)	51 (4.6)	1.00 (ref)	

Risk Factor	No PPD (EPDS <13) n = 1339 n (row %)	Major PPD (EPDS ≥13) n = 64 n (row %)	RR (95% CI)	p-value
Gestational age				
Premature (<37 weeks)	54 (93.1)	4 (6.9)	1.54 (0.58 – 4.09)	0.335*
Not premature (≥37 weeks)	1279 (95.5)	60 (4.5)	1.00 (ref)	
Birth weight				
LBW (<2500 grams)	64 (92.8)	5 (7.2)	1.64 (0.68 – 3.95)	0.240*
Not LBW (≥2500 grams)	1273 (95.6)	59 (4.4)	1.00 (ref)	
Sex of baby				
Male	668 (94.8)	37 (5.2)	0.74 (0.45 – 1.20)	0.215
Female	671 (96.1)	27 (3.8)	1.00 (ref)	
Number of babies				
Multiple birth	5 (71.4)	2 (28.6)	6.43 (1.94–21.28)	0.037*
Singleton	1334 (95.6)	62 (4.4)	1.00 (ref)	
Hospital stay length				
Longer than 2 days	447 (94.9)	24 (5.1)	1.24 (0.75 – 2.04)	0.397
2 days or less	887 (95.9)	38 (4.1)	1.00 (ref)	
Breastfeeding status at 3 months				
No longer breastfeeding	316 (92.4)	26 (7.6)	2.18 (1.34 – 3.54)	0.001
Still breastfeeding	1023 (96.5)	37 (3.5)	1.00 (ref)	

PPD = postpartum depression, EPDS = Edinburgh Postnatal Depression Scale (15), RR = relative risk, CI = confidence interval, p-value from Pearson's Chi square test, *p-value calculated from Fisher's exact test, [1]having a stable partner was defined as currently being married or common law, LBW = low birth weight.

4.5.1.3 Behavioural risk

Women who were classified as "at risk" by the T-ACE screen (modified), abused during pregnancy or abused postpartum were more likely to have major postpartum depression ($p<0.001$). Women who smoked during pregnancy, had ever been abused or witnessed abuse were also more likely to have postpartum depression ($p<0.05$).

Specifically, the risk of major postpartum depression was increased by 3.10 (95% CI: 1.63 – 5.89) for women classified as “at risk” by the T-ACE (modified), 3.48 (95% CI: 1.80 – 6.71) for women who were abused during pregnancy and 6.27 (95% CI: 3.68 – 10.68) for women who were abused in the postpartum period as compared to women classified as “low risk”, women who were not abused during pregnancy and women who were not abused in the postpartum period respectively. Women who smoked were 1.95 (95% CI: 1.18 – 3.23) times more likely to have major postpartum depression than non-smokers. An increased risk of major postpartum depression of 1.68 (95% CI: 1.04 – 2.71) was found for women who had been abused compared to women who had never been abused. Similarly, the risk of major postpartum depression for women who witnessed abuse was 1.67 (95% CI: 1.04 – 2.70) times the risk for women who had never witnessed abuse.

4.5.1.4 Mental health

Depression and anxiety during pregnancy were both significantly associated with major postpartum depression ($p<0.01$).

Women with high scores on the depression subscale were 4.34 (95% CI: 2.50 – 7.53) times more likely to have major postpartum depression than women with low scores. Similarly, women with high scores on the anxiety subscale were 2.58 (95% CI: 1.36 – 4.90) times more likely to have major postpartum depression that women with low scores.

4.5.1.5 Psychosocial

Women who reported low social support, being socially isolated or low postnatal parenting self-efficacy were more likely to have major postpartum depression ($p<0.01$).

The increased risk of major postpartum depression was 2.19 (95% CI: 1.36 – 3.52) for women with low social support, 2.91 (95% CI: 1.81 – 4.68) for socially isolated women and 1.92 (95% CI: 1.19 – 3.11) for women with low postnatal parenting self-efficacy as compared to women with high social support, non socially isolated women and women with higher postnatal parenting self-efficacy respectively.

Table 4.7 Behavioural risk, mental health and psychosocial risk factors and major postpartum depression

	No PPD (EPDS <13) n = 1339	Major PPD (EPDS ≥13) n = 64		
Risk Factor	**n (row %)**	**n (row %)**	**RR (95% CI)**	**p-value**
Behavioural Risk:				
Alcohol consumption during pregnancy[1]				
Yes	353 (94.4)	21 (5.6)	1.33 (0.80 – 2.21)	0.270
No	976 (95.8)	43 (4.2)	1.00 (ref)	
Binge drank during pregnancy[1]				
Yes	82 (94.2)	5 (5.8)	1.27 (0.52 – 3.09)	0.592*
No	1249 (95.5)	59 (4.5)	1.00 (ref)	
T-ACE classification (modified)				
At risk	133 (91.1)	13 (8.9)	3.10 (1.63 – 5.89)	<0.001
Low risk	879 (97.1)	26 (2.9)	1.00 (ref)	
Smoking during pregnancy[1]				
Yes	260 (92.5)	21 (7.5)	1.95 (1.18 – 3.23)	0.009
No	1079 (96.2)	45 (3.8)	1.00 (ref)	
Illicit drug use during pregnancy[1]				
Yes	33 (89.2)	4 (10.8)	2.46 (0.94 – 6.40)	0.085*
No	1303 (95.6)	60 (4.4)	1.00 (ref)	
History of abuse[2]				
Abused	434 (93.7)	29 (6.3)	1.68 (1.04 – 2.71)	0.032
Never abused	904 (96.3)	35 (3.7)	1.00 (ref)	
Ever witnessed abuse[2]				
Witnessed abuse	512 (93.9)	33 (6.1)	1.67 (1.04 – 2.70)	0.033
Has not witnessed abuse	826 (96.4)	31 (3.6)	1.00 (ref)	
Abuse[2] during pregnancy[1]				
Abused	54 (85.7)	9 (14.3)	3.48 (1.80 – 6.71)	<0.001
Not abused	1284 (95.9)	55 (4.1)	1.00 (ref)	
Witnessed abuse[2] during pregnancy[1]				
Witnessed abuse	115 (92.7)	9 (7.3)	1.72 (0.87 – 3.39)	0.121
Has not witnessed abuse	1222 (95.8)	54 (4.2)	1.00 (ref)	

Risk Factor	No PPD (EPDS <13) n = 1339 n (row %)	Major PPD (EPDS ≥13) n = 64 n (row %)	RR (95% CI)	p-value
Postnatal abuse[2]				
Abused	46 (76.7)	14 (23.3)	6.27 (3.68–10.68)	<0.001
Not abused	1293 (96.3)	50 (3.7)	1.00 (ref)	
Mental health:				
Family history of depression				
Family history	522 (94.2)	32 (5.8)	1.56 (0.96 – 2.52)	0.070
No family history	805 (96.3)	31 (3.7)	1.00 (ref)	
Depression during pregnancy[1] from SQ				
Depression	71 (83.5)	14 (16.5)	4.34 (2.50 – 7.53)	<0.001
No depression	1268 (96.2)	50 (3.8)	1.00 (ref)	
Anxiety during pregnancy[1] from SQ				
Anxious	84 (89.4)	10 (10.6)	2.58 (1.36 – 4.90)	0.003
Not anxious	1255 (95.9)	54 (4.1)	1.00 (ref)	
Psychosocial:				
Social support during pregnancy[1] from SSI				
Low (lower 33%)	390 (92.6)	31 (7.4)	2.19 (1.36 – 3.52)	0.001
High (upper 66%)	947 (96.6)	33 (3.4)	1.00 (ref)	
Social Isolation during pregnancy[1] from NOS				
Yes (upper 33%)	308 (90.9)	31 (9.1)	2.91 (1.81 – 4.68)	<0.001
No (lower 66%)	1018 (96.9)	33 (3.1)	1.00 (ref)	
Prenatal[1] parenting self-efficacy from PES				
Low (lower 33%)	438 (95.6)	20 (4.4)	0.96 (0.57 – 1.61)	0.873
High (upper 66%)	901 (95.4)	43 (4.6)	1.00 (ref)	
Postnatal parenting self-efficacy from PES				
Low (lower 33%)	458 (93.5)	32 (6.5)	1.92 (1.19 – 3.11)	0.007
High (upper 66%)	881 (96.6)	31 (3.4)	1.00 (ref)	

PPD = postpartum depression, EPDS = Edinburgh Postnatal Depression Scale (15), RR = relative risk, CI = confidence interval, p-value from Pearson's Chi square test, *p-value calculated from Fisher's exact test, SQ = Symptom Questionnaire (97), SSI = Social Support Index (98), NOS = Network Orientation Scale (99), PES = Parental Expectations Scale (100), [1]refers to index pregnancy, [2]refers to all forms of abuse including physical, emotional, sexual, financial and neglect.

4.6 Pre and perinatal risk factors that distinguish women with major postpartum depression (EPDS ≥13) from women without postpartum depression (EPDS <13)

Objective 3

To develop a model of the association between a history of depression and postpartum depression after adjustment for demographic, obstetric, behavioural risk, mental health and psychosocial risk factors that distinguishes women with major postpartum depression (EPDS ≥13) from those without postpartum depression (EPDS <13).

4.6.1 Classical stratified analysis: assessment of potential effect modifiers and confounders of relationship between a history of depression and major postpartum depression

None of the variables were found to modify the relationship between a history of depression and major postpartum depression based on a significant result from the Mantel-Haenszel test of homogeneity. As well, based on an absolute difference of 0.7 between the crude and Mantel-Haenszel relative risks being significant, none of the variables were confounders. The results of the trivariate analysis are included in Appendix E.

Since the trivariate analysis did not provide any statistical evidence to support including any of the variables as confounders or effect modifiers of the primary relationship in the regression modelling process, those variables that were determined to be statistically significant from the bivariate analysis were considered for the logistic regression model.

4.6.2 Multivariate analysis: development of logistic regression model of pre and perinatal risk factors that distinguish women with major postpartum depression from women without postpartum depression

The adjusted odds ratios for the independent predictors for the final logistic regression model that compares those women with major postpartum depression to those without postpartum depression are presented in Table 4.8.

The 17 independent predictors considered for inclusion in the model based on $p<0.05$ in the bivariate analysis were history of depression, income, ethnicity, planned pregnancy, induction of labour, multiple birth, breastfeeding status at three months postpartum, T-ACE classification (modified), smoking during pregnancy, lifetime abuse, abuse during pregnancy, postnatal abuse, depression during pregnancy, anxiety during pregnancy, social support, social isolation and postnatal parenting expectations. The independent predictors history of depression, T-ACE classification (modified), breastfeeding status at three months postpartum and postnatal parenting expectations remained significant and therefore were retained in the model. All interaction terms tested were non-significant ($p>0.05$).

Table 4.8 Multivariate model of pre and perinatal risk factors that distinguish women with major postpartum depression from women without postpartum depression

Variable	OR*	(95 % CI)	p-value
History of depression	2.25	(1.15 – 4.43)	0.019
Not breastfeeding at 3 months postpartum	2.40	(1.22 – 4.73)	0.012
At-risk T-ACE classification (modified)	2.66	(1.29 – 5.48)	0.008
Low postnatal parenting self-efficacy	4.37	(2.16 – 8.87)	<0.001

OR*= adjusted odds ratio, CI= confidence interval, p-value from Pearson's Chi square test, McFadden's (pseudo) $R^2 = 0.1293$.

An alternate model for comparing women with major postpartum depression to those without was also created because inclusion of the modified T-ACE variable made the variables ethnicity, income and social isolation non-significant even though these variables were found to be strong predictors from the bivariate analysis and through development of the model. It was hypothesized that these variables may be important predictors of major postpartum depression among those women that do not drink alcohol.

The modelling process was repeated considering the same independent variables in the same order except that T-ACE (modified) variable was not included. The independent predictors that remained significant were a history of depression, ethnicity, breastfeeding status at three months postpartum, postpartum abuse and social isolation and their adjusted odds ratios are presented in Table 4.9. All interaction terms tested were non-significant.

Table 4.9 Alternate multivariate model of pre and perinatal risk factors that distinguish women with major postpartum depression from women without postpartum depression

Variable	OR*	(95 % CI)	p-value
History of Depression	2.36	(1.36 – 4.11)	0.002
Non-Caucasian	2.22	(1.25 – 3.96)	0.007
Not Breastfeeding at 3 months postpartum	2.00	(1.16 – 3.46)	0.013
Postpartum abuse	5.04	(2.45 – 10.37)	<0.001
Socially isolated	1.84	(1.04 – 3.25)	0.035

OR*= adjusted odds ratio, CI= confidence interval, p-value from Pearson's Chi square test, McFadden's (pseudo) $R^2 = 0.1206$.

4.7 Pre and perinatal risk factors that distinguish women with minor postpartum depression (EPDS 10-12) from women without postpartum depression (EPDS ≤9)

Objective 4

To develop a model of the association between pre and perinatal factors and postpartum depression that distinguishes women with minor postpartum depression (EPDS 10-12) from those without postpartum depression (EPDS ≤9).

4.7.1 Bivariate analysis: pre and perinatal risk factors and minor postpartum depression

The results of the bivariate analysis for the demographic and obstetric variables are summarized in Table 4.10 and the behavioural risk, mental health and psychosocial variables in Table 4.11.

4.7.1.1 Demographic

Marital status and the country the mother was born were both significantly associated with minor postpartum depression ($p<0.05$). Specifically, the risk of minor postpartum depression was increased by 1.84 (95% CI:1.01 – 3.33) for women who did not have a stable partner and 1.68 (95% CI: 1.11 – 2.54) for women who were born in a country other than Canada as compared to women in stable relationships and Canadian born women respectively.

4.7.1.2 Obstetric

Women with unplanned pregnancies, induced labours and hospital stay lengths of greater than two days were more likely to have minor postpartum depression ($p<0.005$). Women with unplanned pregnancies were 1.69 (95% CI: 1.13 – 2.53) times more likely to have minor postpartum depression than women with planned pregnancies. Women with induced labours were 1.60 (95% CI; 1.06 – 2.41) times more likely to have minor

postpartum depression than women whose labours were not induced. Likewise, the risk of minor postpartum depression was increased by 1.59 (95% CI: 1.06 – 2.37) for women who stayed in the hospital longer than two days when their baby was first born as compared to shorter hospital stays.

Table 4.10 Demographic and obstetric risk factors and minor postpartum depression

Risk Factor	No PPD (EPDS ≤9) n = 1339 n (row %)	Minor PPD (EPDS 10-12) n = 64 n (row %)	RR (95% CI)	p-value
Demographic:				
Maternal age				
Younger than 25	225 (92.6)	18 (7.4)	1.11 (0.68 – 1.82)	0.681
25 or older	1021 (93.3)	73 (6.7)	1.00 (ref)	
Marital status[1]				
No stable partner	82 (88.2)	11 (11.8)	1.84 (1.01 – 3.33)	0.046
Stable partner	1165 (93.6)	80 (6.4)	1.00 (ref)	
Parity				
No live births	687 (93.9)	45 (6.2)	1.23 (0.83 – 1.83)	0.300
≥ 1 other live birth	561 (92.4)	46 (7.6)	1.00 (ref)	
Maternal education				
Less than high school	86 (90.5)	9 (9.5)	1.48 (0.76 -2.88)	0.386
Completed high school	215 (91.9)	19 (8.1)	1.27 (0.78 – 2.08)	
Some post secondary	922 (93.6)	63 (6.4)	1.00 (ref)	
Total household income				
Less than $40 000/year	240 (92.3)	20 (7.69)	1.28 (0.79 – 2.09)	0.320
At least $40 000/year	909 (94.0)	58 (6.0)	1.00 (ref)	
Country born				
Other	284 (90.2)	31 (9.8)	1.68 (1.11 – 2.54)	0.014
Canada	963 (94.1)	60 (5.9)	1.00 (ref)	
Ethnicity				
Other	279 (91.2)	27 (8.8)	1.41 (0.92 – 2.17)	0.118
Caucasian	960 (93.8)	64 (6.2)	1.00 (ref)	
Obstetric:				
Planned pregnancy				
Not planned	353 (90.5)	37 (9.5)	1.69 (1.13 – 2.53)	0.010
Planned	892 (94.4)	53 (5.6)	1.00 (ref)	
Induction of labour				
Induced	437 (91.2)	42 (8.8)	1.60 (1.06 – 2.41)	0.023
Not induced	742 (94.5)	43 (5.5)	1.00 (ref)	
Mode of delivery				
Cesarean Section	262 (91.6)	24 (8.4)	1.32 (0.84 – 2.06)	0.228
Vaginal	985 (93.6)	67 (6.4)	1.00 (ref)	

Risk Factor	No PPD (EPDS ≤9) n = 1339 n (row %)	Minor PPD (EPDS 10-12) n = 64 n (row %)	RR (95% CI)	p-value
Gestational age				
Premature (<37 weeks)	50 (92.6)	4 (7.4)	1.11 (0.42 – 2.93)	0.779*
Not premature (≥ 37 weeks)	1194 (93.4)	85 (6.65)	1.00 (ref)	
Birth weight				
LBW (<2500 grams)	58 (90.6)	6 (9.4)	1.42 (0.65 – 3.13)	0.387
Not LBW (≥ 2500 grams)	1189 (93.4)	84 (6.6)	1.00 (ref)	
Sex of baby				
Female	634 (94.5)	37 (5.5)	0.68 (0.46 – 1.02)	0.062
Male	614 (91.9)	54 (8.1)	1.00 (ref)	
Number of babies				
Multiple birth	5 (100.0)	0 (0.0)	0 (-- --)	1.000*
Singleton	1243 (93.2)	91 (6.8)	1.00 (ref)	
Hospital stay length				
Longer than 2 days	407 (91.0)	40 (9.0)	1.59 (1.06 – 2.37)	0.023
2 days or less	837 (94.4)	50 (5.6)	1.00 (ref)	
Breastfeeding status at 3 months				
No longer breastfeeding	293 (92.7)	23 (7.3)	1.09 (0.69 – 1.73)	0.697
Still breastfeeding	955 (93.4)	68 (6.6)	1.00 (ref)	

PPD = postpartum depression, EPDS = Edinburgh Postnatal Depression Scale (15), RR = relative risk, CI = confidence interval, p-value from Pearson's Chi square test, *p-value calculated from Fisher's exact test, [1]having a stable partner was defined as currently being married or common law, LBW = low birth weight

4.7.1.3 Behavioural risk

Abuse was significantly associated with minor postpartum depression as women who had ever been abused, were abused during pregnancy or in the postpartum period were more likely to have minor postpartum depression ($p<0.05$). This increased risk of minor postpartum depression was 1.52 (95% CI: 1.02 – 2.28) for ever being abused, 2.61 (95% CI: 1.39 – 4.91) for women who were abused during pregnancy and 3.09 (95% CI:

1.66 – 5.75) for women who were abused in the postpartum period as compared to women who had never been abused, women who were not abused during pregnancy and women who were not abused in the postpartum period respectively.

4.7.1.4 Mental health

Women with a history of depression, depression or anxiety during pregnancy were more likely to be at risk of minor postpartum depression ($p<=0.001$).

Specifically, women with a history of depression were 2.18 (95% CI: 1.46 – 3.27) times more likely to have minor postpartum depression than women without a history of depression. Women with high scores on the depression subscale during pregnancy were 2.71 (95% CI: 1.55 – 4.74) times more likely to have minor postpartum depression than women with low scores. Similarly, women with high scores on the anxiety subscale during pregnancy were 2.49 (1.45 – 4.29) times more likely to have minor postpartum depression than women with low scores.

4.7.1.5 Psychosocial

Women who reported being socially isolated or low prenatal or postnatal parenting self-efficacy were more likely to have minor postpartum depression ($p<0.05$). The increased risk was 1.91 (95% CI: 1.27 – 2.88) for socially isolated women, 1.61 (95% CI: 1.08 – 2.40) for women with low prenatal parenting self-efficacy and 1.80 (95% CI: 1.21 – 2.67) for women with low postnatal parenting self-efficacy as compared to non-socially isolated women, and women with higher prenatal and postnatal parenting self-efficacy respectively.

Table 4.11 Behavioural risk, mental health and psychosocial factors and minor postpartum depression

Risk Factor	No PPD (EPDS ≤9) n = 1339 n (row %)	Mild PPD (EPDS 10-12) n = 64 n (row %)	RR (95% CI)	p-value
Behavioural risk:				
Drank alcohol during pregnancy[1]				
Yes	327 (92.6)	26 (7.4)	1.14 (0.73 – 1.77)	0.558
No	913 (93.5)	63 (6.5)	1.00 (ref)	
Binge drank during pregnancy[1]				
Yes	78 (95.1)	4 (4.9)	0.71 (0.27 – 1.88)	0.650*
No	1163 (93.1)	86 (6.9)	1.00 (ref)	
T-ACE classification (modified)				
At-risk	122 (91.7)	11 (8.3)	1.28 (0.69 – 2.37)	0.443
Low-risk	822 (93.5)	57 (6.5)	1.00 (ref)	
Smoking during pregnancy[1]				
Yes	242 (93.1)	18 (6.9)	1.02 (0.62 – 1.68)	0.928
No	1006 (93.2)	73 (6.8)	1.00 (ref)	
Illicit drug use during pregnancy[1]				
Yes	30 (90.9)	3 (9.1)	1.35 (0.45 – 4.03)	0.488*
No	1215 (93.3)	88 (6.7)	1.00 (ref)	
History of abuse[2]				
Abused	396 (91.2)	38 (8.8)	1.52 (1.02 – 2.28)	0.040
Never abused	852 (94.3)	52 (5.7)	1.00 (ref)	
Ever witnessed abuse[2]				
Witnessed abuse	471 (92.0)	41 (8.0)	1.35 (0.90 – 2.01)	0.141
Has not witnessed abuse	777 (94.1)	49 (5.9)	1.00 (ref)	
Abuse[2] during pregnancy[1]				
Abused	45 (83.3)	9 (16.7)	2.61 (1.39 – 4.91)	0.003
Not abused	1202 (93.6)	82 (6.4)	1.00 (ref)	
Witness to abuse[2] during pregnancy[1]				
Witnessed abuse	104 (90.4)	11 (9.6)	1.46 (0.80 – 2.66)	0.219
Not witnessed abuse	1142 (93.5)	80 (6.5)	1.00 (ref)	

Postnatal abuse[2]				
Abused	37 (80.4)	9 (19.6)	3.09 (1.66 – 5.75)	<0.001
Not abused	1211 (93.7)	82 (6.3)	1.00 (ref)	
Mental health:				
History of depression				
History of depression	253 (88.2)	34 (11.8)	2.18 (1.46 – 3.27)	<0.001
No history	993 (94.6)	57 (5.4)	1.00 (ref)	
Family history of depression				
Family history	479 (91.8)	43 (8.2)	1.44 (0.97 – 2.15)	0.073
No family history	759 (94.3)	46 (5.7)	1.00 (ref)	
Depression during pregnancy[1] from SQ				
Depression	59 (83.1)	12 (16.9)	2.71 (1.55 – 4.74)	<0.001
No depression	1189 (93.8)	79 (6.2)	1.00 (ref)	
Anxiety during pregnancy[1] from SQ				
Anxious	71 (84.5)	13 (15.5)	2.49 (1.45 – 4.29)	0.001
Not anxious	1177 (93.8)	78 (6.2)	1.00 (ref)	
Psychosocial:				
Social support during pregnancy[1] from SSI				
Low (lower 33%)	358 (91.8)	32 (8.2)	1.32 (0.87 – 1.99)	0.192
High (upper 66%)	888 (93.8)	59 (6.2)	1.00 (ref)	
Social Isolation during pregnancy[1] from NOS				
Yes (upper 33%)	275 (89.3)	33 (10.7)	1.91 (1.27 – 2.88)	0.002
No (lower 66%)	961 (94.4)	57 (5.6)	1.00 (ref)	
Prenatal[1] parenting self-efficacy from PES				
Low (lower 33%)	398 (90.9)	40 (9.1)	1.61 (1.08 – 2.40)	0.018
High (upper 66%)	850 (94.3)	51 (5.7)	1.00 (ref)	
Postnatal parenting self-efficacy from PES				
Low (lower 33%)	414 (90.4)	44 (9.6)	1.80 (1.21 – 2.67)	0.003
High (upper 66%)	834 (94.7)	47 (5.3)	1.00 (ref)	

PPD = postpartum depression, EPDS = Edinburgh Postnatal Depression Scale (15), RR = relative risk, CI = confidence interval, p-value from Pearson's Chi square test, *p-value calculated from Fisher's exact test, SQ = Symptom Questionnaire (97), SSI = Social Support Index (98), NOS = Network Orientation Scale (99), PES = Parental Expectations Scale (100), [1]refers to index pregnancy, [2]refers to all forms of abuse including physical, emotional, sexual, financial and neglect.

4.7.2 Multivariate analysis: development of regression model of pre and perinatal risk factors that distinguish women with minor postpartum depression from women without postpartum depression

The 14 variables history of depression, marital status, country the mother was born, planned pregnancy, induction of labour, hospital stay length, lifetime abuse, abuse during pregnancy, abuse postpartum, depression during pregnancy, anxiety during pregnancy, social isolation, and prenatal and postnatal parenting expectations were significant at the bivariate level and were therefore considered for the modelling process.

The adjusted odds ratios and exact 95% confidence intervals for the independent predictors retained in the final model for minor postpartum depression are presented in Table 4.12.

The final model included history of depression, country the mother was born, abuse during pregnancy, anxiety during pregnancy and postnatal parenting expectations. Again, all interaction terms tested were non-significant.

Table 4.12 Multivariate model of pre and perinatal risk factors that distinguish women with minor postpartum depression from women without postpartum depression

Variable	OR*	(95 % CI)	p-value
History of depression	2.16	(1.34 – 3.46)	0.002
Mother born outside Canada	1.92	(1.19 – 3.08)	0.007
Abuse during pregnancy	2.35	(1.07 – 5.16)	0.034
Anxious during pregnancy	2.00	(1.02 – 3.91)	0.043
Low postnatal parenting self-efficacy	1.63	(1.05 – 2.52)	0.030

OR*= adjusted odds ratio, CI= confidence interval, p-value from Pearson's Chi square test, McFadden's (pseudo) R^2=0.0523.

4.8 Pre and perinatal risk factors that distinguish women with major postpartum depression (EPDS >=13) from women with minor postpartum depression (EPDS 10-12)

Objective 5

To develop a model of the association between pre and perinatal risk factors and postpartum depression that distinguishes women with major postpartum depression (EPDS scores of ≥ 13) from those with minor postpartum depression (EPDS scores 10-12).

4.8.1 Bivariate analysis: pre and perinatal risk factors and major postpartum depression compared to minor postpartum depression

The results of the bivariate analysis for the obstetric and demographic predictors are summarized in Table 4.13 and for the behavioural risk, mental health and psychosocial predictors in Table 4.14.

4.8.1.1 Obstetric

Postpartum depression was more common among women whose labours were not induced and who were no longer breastfeeding at three months postpartum ($p<0.05$). The risk of major postpartum depression was decreased by 0.63 (95% CI: 0.41 – 0.97) for women whose labours were induced compared to women with non-induced labours. Women who were no longer breastfeeding at three months postpartum were 1.51 (95% CI: 1.04 – 2.18) times more likely to have major postpartum depression than women who were still breastfeeding.

Table 4.13 Demographic and obstetric risk factors and major postpartum depression compared to minor postpartum depression

	Minor PPD (EPDS 10-12) n = 1339	Major PPD (EPDS>=13) n = 64		
Risk Factor	**n (row %)**	**n (row %)**	**RR (95% CI)**	**p-value**
Demographic:				
Maternal age				
Younger than 25	18 (56.3)	14 (43.7)	1.08 (0.69 – 1.68)	0.751
25 or older	73 (59.4)	50 (40.6)	1.0 (ref)	
Marital status[1]				
No stable partner	11 (61.1)	7 (38.9)	0.93 (0.51 – 1.72)	0.826
Stable partner	80 (58.4)	57 (41.6)	1.0 (ref)	
Parity				
No live births	45 (60.0)	30 (40.0)	106 (0.73 – 1.55)	0.752
≥ 1 other live birth	46 (57.5)	34 (42.5)	1.0 (ref)	
Maternal education				
Less than high school	9 (42.9)	12 (57.1)	1.43 (0.92 – 2.21)	0.246
Completed high school	19 (65.5)	10 (34.5)	0.86 (0.50 – 1.50)	
Some post secondary	63 (60.0)	42 (40.0)	1.0 (ref)	
Total household income	20 (46.5)	23 (53.5)	1.47 (1.00 – 2.18)	0.059
Less than $40 000/year	58 (63.7)	33 (36.3)	1.0 (ref)	
At least $40 000/year				
Country born				
Other	31 (55.4)	25 (44.6)	1.13 (0.77 – 1.66)	0.524
Canada	60 (60.6)	39 (39.4)	1.0 (ref)	
Ethnicity				
Other	27 (50.9)	26 (49.1)	1.32 (0.91 – 1.91)	0.157
Caucasian	64 (62.8)	38 (37.2)	1.0 (ref)	
Obstetric:				
Planned pregnancy				
Not planned	37 (57.8)	27 (42.2)	1.03 (0.70 – 1.50)	0.894
Planned	53 (58.9)	37 (41.1)	1.0 (ref)	
Induction of labour				
Induced	42 (68.9)	19 (31.1)	0.63 (0.41 – 0.97)	0.027
Not induced	43 (50.6)	42 (49.4)	1.0 (ref)	
Mode of delivery				
Cesarean section	24 (64.9)	13 (35.1)	0.81 (0.50 – 1.32)	0.383
Vaginal	67 (56.8)	51 (43.2)	1.0 (ref)	

Risk Factor	Minor PPD (EPDS 10-12) n = 1339 n (row %)	Major PPD (EPDS>=13) n = 64 n (row %)	RR (95% CI)	p-value
Gestational age				
Premature (<37 weeks)	4 (50.0)	4 (50.0)	1.21 (0.59 – 2.48)	0.720*
Not premature (≥ 37 weeks)	85 (58.6)	60 (41.4)	1.0 (ref)	
Birth weight				
LBW (< 2500 grams)	6 (54.5)	5 (45.5)	1.10 (0.56 – 2.17)	1.000*
Not LBW (≥ 2500 grams)	84 (58.7)	59 (41.3)	1.0 (ref)	
Sex of baby				
Female	37 (57.8)	27 (42.2)	1.04 (0.71 – 1.52)	0.849
Male	54 (59.3)	37 (40.7)	1.0 (ref)	
Number of babies				
Multiple birth	0 (0.0)	2 (100.0)	2.47 (2.04 – 2.99)	0.169*
Singleton	91 (59.5)	62 (40.5)	1.0 (ref)	
Hospital stay length				
Longer than 2 days	40 (62.5)	24 (37.5)	0.87 (0.58 – 1.29)	0.482
2 days or less	50 (56.8)	38 (43.2)	1.0 (ref)	
Breastfeeding status at 3 months				
No longer breastfeeding	23 (46.9)	26 (53.1)	1.51 (1.04 – 2.18)	0.036
Still breastfeeding	68 (64.8)	37 (35.2)	1.0 (ref)	

PPD = postpartum depression, EPDS = Edinburgh Postnatal Depression Scale (15), RR = relative risk, CI = confidence interval, p-value from Pearson's Chi square test, *p-value calculated from Fisher's exact test, [1]having a stable partner was defined as currently being married or common law, LBW = low birth weight.

4.8.1.2 Behavioural risk

The risk of major postpartum depression was increased for women who were classified as "at risk" by the T-ACE screen (modified) or abused postpartum ($p<0.05$). Specifically, the risk of major postpartum depression was increased by 1.73 (95% CI: 1.06 – 2.81) for women classified as "at risk" by the T-ACE (modified) and 1.61 (95% CI: 1.08 – 2.38) for women who were abused during pregnancy and as compared to

women classified as “low risk” and women who were not abused in the postpartum period respectively.

Table 4.14 Behavioural risk, mental health and psychosocial risk factors and major postpartum depression compared to minor postpartum depression

	Minor PPD (EPDS 10-12) n = 1339	Major PPD (EPDS>=13) n = 64		
Risk Factor	**n (row %)**	**n (row %)**	**RR (95% CI)**	**p-value**
Behavioural Risk:				
Alcohol consumption during pregnancy[1]				
Yes	26 (55.3)	21 (44.7)	1.10 (0.74 – 1.63)	0.634
No	63 (59.4)	43 (40.6)	1.0 (ref)	
Binge drank during pregnancy[1]				
Yes	4 (44.4)	5 (55.6)	1.37 (0.74 – 2.53)	0.491*
No	86 (59.3)	59 (40.7)	1.0 (ref)	
T-ACE classification (modified)				
At risk	11 (45.8)	13 (54.2)	1.73 (1.06 – 2.81)	0.041
Low risk	57 (68.7)	26 (31.3)	1.0 (ref)	
Smoking during pregnancy[1]				
Yes	18 (46.2)	21 (53.8)	1.45 (1.00 – 2.11)	0.066
No	73 (62.9)	43 (37.1)	1.0 (ref)	
Drug use during Pregnancy[1]				
Yes	3 (42.9)	4 (57.1)	1.41 (0.72 – 2.76)	0.448*
No	88 (59.5)	60 (40.5)	1.0 (ref)	
History of abuse[2]				
Abused	38 (56.7)	29 (43.3)	1/08 (0.74 – 1.57)	0.703
Never abused	52 (59.8)	35 (40.2)	1.0 (ref)	
Ever witnessed abuse[2]				
Witnessed abuse	41 (55.4)	33 (44.6)	1.15 (0.79 – 1.67)	0.462
Has not witnessed abuse	49 (61.3)	31 (38.7)	1.0 (ref)	
Abuse[2] during pregnancy[1]				
Abused	9 (50.0)	9 (50.0)	1.25 (0.75 – 2.06)	0.425
Not abused	82 (59.8)	55 (40.2)	1.0 (ref)	
Witness to abuse[2] during pregnancy[1]				
Witnessed abuse	11 (55.0)	9 (45.0)	1.12 (0.66 – 1.89)	0.690
Has not witnessed abuse	80 (59.7)	54 (40.3)	1.0 (ref)	

Risk Factor	Minor PPD (EPDS 10-12) n = 1339 n (row %)	Major PPD (EPDS>=13) n = 64 n (row %)	RR (95% CI)	p-value
Postnatal abuse[2]				
Abused	9 (39.1)	14 (60.9)	1.61 (1.08 – 2.38)	0.039
Not abused	82 (62.1)	50 (37.9)	1.0 (ref)	
Mental health:				
History of depression				
History of depression	34 (54.0)	29 (46.0)	1.21 (0.83 – 1.76)	0.321
No history	57 (62.0)	35 (38.0)	1.0 (ref)	
Family history of depression				
Family history	43 (57.3)	32 (42.7)	1.06 (0.73 – 1.55)	0.763
No family history	46 (59.7)	31 (40.3)	1.0 (ref)	
Depression during pregnancy[1] from SQ				
Depression	12 (46.2)	14 (53.8)	1.39 (0.92 – 2.11)	0.154
No depression	79 (61.2)	50 (38.8)	1.0 (ref)	
Anxiety during pregnancy[1] from SQ				
Anxious	13 (56.5)	10 (43.5)	1.06 (0.64 – 1.77)	0.817
Not anxious	78 (59.1)	54 (40.9)	1.0 (ref)	
Psychosocial:				
Social support during pregnancy[1] from SSI	32 (50.8)	31 (49.2)	1.37 (0.95 – 1.99)	0.098
Low (lower 33%)	59 (64.1)	33 (35.9)	1.0 (ref)	
High (upper 66%)				
Social Isolation during pregnancy[1] from NOS	33 (51.6)	31 (48.4)	1.32 (0.91 – 1.91)	0.144
Yes (upper 33%)	57 (63.3)	33 (36.7)	1.0 (ref)	
No (lower 66%)				
Prenatal parenting self-efficacy from PES				
Low (lower 33%)	40 (66.7)	20 (33.3)	0.73 (0.48 – 1.11)	0.127
High (upper 66%)	51 (54.3)	43 (45.7)	1.0 (ref)	
Postnatal parenting self-efficacy from PES				
Low (lower 33%)	44 (57.9)	32 (42.1)	1.06 (0.72 – 1.55)	0.766
High (upper 66%)	47 (60.3)	31 (39.7)	1.0 (ref)	

PPD = postpartum depression, EPDS = Edinburgh Postnatal Depression Scale (15), RR = relative risk, CI = confidence interval, p-value from Pearson's Chi square test, *p-value calculated from Fisher's exact test, SQ = Symptom Questionnaire (97), SSI = Social

Support Index (98), NOS = Network Orientation Scale (99), PES = Parental Expectations Scale (100), [1]refers to index pregnancy, [2]refers to all forms of abuse including physical, emotional, sexual, financial and neglect.

4.8.2 Multivariate Analysis: development of regression model of pre and perinatal risk factors that distinguish women with major postpartum depression from women with minor postpartum depression

Variables considered for the model comparing women with major postpartum depression to women with minor postpartum depression included induction of labour, breastfeeding status at three months postpartum, T-ACE classification (modified) and postnatal abuse.

Adjusted odds ratios and exact 95% confidence intervals for the independent predictors retained in the final model are presented in Table 4.15.

The final model includes breastfeeding status at three months postpartum and postnatal abuse. Again, all interaction terms tested were non-significant and therefore were not included in the final model.

Table 4.15 Multivariate model of pre and perinatal risk factors that distinguish women with major postpartum depression from women with minor postpartum depression

Variable	OR*	(95 % CI)	p-value
Not Breastfeeding at 3 months postpartum	2.02	(1.01 – 4.07)	0.048
Postnatal Abuse	2.51	(1.00 – 6.32)	0.050

OR*= adjusted odds ratio, CI= confidence interval, p-value from Pearson's Chi square test, McFadden's (pseudo) $R^2 = 0.0398$.

4.9 Summary of Multivariate Results

The risk factors that remained significant in all models are summarized in Table 4.16.

Table 4.16 Summary table of multivariate models

Model	Variable	OR*	(95% CI)
Major PPD (EPDS ≥13) vs. no PPD (EPDS <13)	History of depression	2.25	(1.15-4.43)
	Not breastfeeding at 3 months postpartum	2.40	(1.22-4.73)
	At-risk T-ACE (modified)	2.66	(1.29-5.48)
	Low postnatal parenting self-efficacy	4.37	(2.16-8.87)
Alternate Model **Major PPD (EPDS ≥13) vs. no PPD (EPDS <13)**	History of Depression	2.36	(1.36-4.11)
	Non-Caucasian	2.22	(1.25-3.96)
	Not breastfeeding at 3 months postpartum	2.00	(1.16-3.46)
	Postpartum abuse	5.04	(2.45-10.37)
	Socially isolated	1.84	(1.04-3.25)
Minor PPD (EPDS 10-12) vs. no PPD (EPDS <10)	History of Depression	2.16	(1.34-3.46)
	Mother born outside Canada	1.92	(1.19-3.08)
	Abuse during pregnancy	2.35	(1.07-5.16)
	Anxious during pregnancy	2.00	(1.02-3.19)
	Low postnatal parenting self-efficacy	1.63	(1.05-2.52)
Major PPD (EPDS ≥ 13) vs. Minor PPD (EPDS 10-12)	Not breastfeeding at 3 months postpartum	2.02	(1.01-4.07)
	Postnatal abuse	2.51	(1.00-6.32)

Chapter Five: Discussion

5.1 Major Findings

The risk factors associated with major postpartum depression from the multivariate analyses included a history of depression, non-Caucasian ethnicity, not breastfeeding at three months postpartum, at-risk T-ACE classification (modified), postpartum abuse, social isolation and low postnatal parenting self-efficacy.

Risk factors associated with minor postpartum depression from the multivariate analysis included a history of depression, the mother being born outside Canada, abuse during pregnancy, anxiety during pregnancy, and low postnatal parenting self-efficacy.

The risk factors that differentiated women with major postpartum depression from women with minor postpartum depression from the multivariate analysis included postpartum abuse and not breastfeeding at three months postpartum.

5.2 Study population characteristics

The prevalence of major postpartum depression three months after delivery was 4.5%. Specifically, 4.5% is the point prevalence which refers to the number of persons with a disease or attribute at a specified point in time (102). This is much lower than the generally reported prevalence of 10-15% (1).

The lower rate of postpartum depression could be due to using a cut-point of 13 or greater on the EPDS which identified cases of major depression only (14). Frequently in postpartum depression studies, it is unclear as to whether researchers are referring to major depression alone or to both major and minor depression which has contributed to the widely varying prevalence estimates across studies (105). Using a cut-point of 10 on the EPDS, we would have obtained a prevalence of 11% which is comparable to the

expected prevalence of 10-15% from other studies (1). This cut point would include women with minor depression where the sensitivity of the EPDS is lower (14). To reduce the risk of over estimates of depression in this cohort, women were classified as depressed if they scored 13 or greater on the EPDS where the sensitivity of the instrument is higher (14) to be confident that our model was identifying women at the highest risk of postpartum depression.

While the prevalence of postpartum depression was lower than originally anticipated in the study sample, the overall sample size of the study was large (n=1500 women) and therefore even with a lower prevalence, it was still possible to assess the study objectives.

The data collected from these women allowed for examination of the impact of the T-ACE screen on risk of postpartum depression. Originally, 45% of the study sample was classified as "at risk" based on the author's scoring directions (106). However, given the habit of alcohol abstinence among many women of non-Caucasian ethnicity and the recruitment of patients from community settings which did not specifically target women at risk of addiction, this seemed like an inappropriately high proportion of the population whose alcohol consumption would classify them as "at risk". After further examination, it was discovered that many women had answered "two drinks" to the first question which asked "How many drinks does it take you to feel high" which immediately put them in the at-risk category. It was hypothesized that women were misinterpreting the word "high" and consequently, it was decided to drop the first question and calculate their alcohol risk based on the other three questions which classified 13.9% of the women as at-risk. This finding emphasizes the need to carefully examine findings from a screening

tool in relationship to what is known about the study sample to ensure that the findings are meaningful and relevant in the current context.

5.3 Comparing women with major postpartum depression to women without postpartum depression

Variables that remained significant in the multivariate model when comparing women with and without major postpartum depression included a history of depression, at risk T-ACE classification (modified), not breastfeeding at three months postpartum and low self-reported postnatal parenting competence. It is well supported by the literature that a history of depression increases the risk for postpartum depression (1, 2, 12, 81, 107). The large sample size of this study permitted a multivariate analysis of the risk associated with a history of depression adjusting for risk factors from many domains (demographic, obstetric, behavioural risk, mental health and psychosocial) and therefore expands on current knowledge by identifying a set of independent predictors that in combination with a history of depression characterize women at the greatest risk of postpartum depression.

Studies reporting an association between alcohol consumption and depression have been reported (108-110), with some investigators noting that this association was particularly true for women (111-113). No studies looking specifically at alcohol consumption as a risk factor for depression in the postpartum period were found although a recently published prospective study of 595 women selected based on alcohol or marijuana use examined antenatal risk factors associated with postnatal co-morbid alcohol use and depressive symptoms at 8 weeks postpartum (114). Binge drinking (four or more drinks per occasion) during each trimester [1st trimester (OR 4.9, 95% CI

2.8–8.7), 2nd (3.5, 1.3–9.3), 3rd (10.1, 3.7–27.8) increased the risk of postpartum co-morbid depressive symptoms and alcohol use while average daily alcohol volume was not a significant predictor (114). Turnbull and Gomburg also found an association between depression and binge drinking, but not between depression and daily drinking among women (111), although this study was not specific to postpartum women. In this analysis the modified T-ACE (measuring annoyance with someone criticising their drinking, feeling need to cut-down, and having an "eye-opener" or drink first thing in the morning) was a strong predictor of postpartum depression because it is identifying women who typically consume high quantities of alcohol and the questions were related to general habits and not specifically about alcohol use during pregnancy. Our study extends the current findings by providing support that women's typical drinking patterns (not during the pregnancy period) as identified by the modified T-ACE are strongly associated with postpartum depression.

Two recent cross-sectional studies, have reported a negative association between breastfeeding and postpartum depression (115, 116). Specifically, in a study of 526 Canadian women, women with EPDS scores of 12 or greater were less likely to be breastfeeding at six weeks postpartum (OR 2.78, 95% CI 1.17-6.62) (115) while among 1058 Icelandic women, exclusive breastfeeding mothers (not supplementing with formula) had lower mean scores on the EPDS compared to mothers who were not exclusively breastfeeding (5.9 (SD=4.6) and 7.1 (SD=4.9) $p<0.001$) (116). Both studies' authors were unable to comment on the direction of this relationship given their cross sectional designs. The majority of previous studies support an inverse relationship between breastfeeding and postpartum depression (117-120), strongest earlier in the

postpartum period (121), although a few do not (122-124). The studies that do not report an inverse relationship, collected their data later in the postpartum period (124) or collapsed their data across the entire postpartum measurement period (122, 123).

This study adds support that breastfeeding is associated with postpartum depression although we are unable to determine the direction of this relationship. The direction of this association should be examined in future studies since breastfeeding status may be a non-invasive way to identify women who may be at elevated risk for postpartum depression. It is likely that women who choose not to engage in breastfeeding or who want to breastfeed but are unable to, constitute two groups of women vulnerable to developing postpartum depression and the support required by each may be quite different.

Low postnatal parenting self-efficacy was associated with postpartum depression. No studies have been identified that examined the relationship between parenting self-efficacy and postpartum depression however, given the importance of parenting on child development outcomes, there may be opportunities to develop specific interventions that would optimize developmental outcomes in the presence of postpartum depression.

Interestingly, during the modeling process, by adding in the modified T-ACE variable, the demographic variables income and ethnicity became non-significant although they were strong predictors at the bivariate level. While this data suggests that the modified T-ACE identifies women at risk of postpartum depression, it also suggests that understanding the study population and the objective of the model development is critical to effective modeling. The opportunity, and need, to develop more than one model may be based on the intended application of the model. For example, the ability to

identify women at risk based on income and ethnicity may be more valuable to health care providers than the T-ACE screen. Further, it is noted that the T-ACE screen as used in this analysis was modified and has not been validated. In consideration of the above mentioned points and given that our study sample included a proportion of women whose cultural values included alcohol abstinence, an alternative model was developed that did not include the modified T-ACE variable. The variables that remained significant in this alternative model were a history of depression, non-Caucasian ethnicity, not breastfeeding at three months postpartum, postpartum abuse and feeling socially isolated.

A history of depression and not-breastfeeding at three months postpartum were significant in both models, suggesting that these are strong predictors independent of all other variables.

Non-Caucasian ethnicity was a significant predictor of post partum depression in the alternate model. During the modelling process, both of the demographic variables ethnicity and maternal country of birth were significant predictors. However, as these were highly correlated, ethnicity was chosen over country of birth due to a greater strength of association with postpartum depression to avoid multicollinearity. In reviewing the literature, no studies have examined the relationship between ethnicity and postpartum depression, although a recent population-based prospective study of 594 Canadian mothers (35) did examine maternal country of birth as a risk factor for depressive symptoms at eight weeks postpartum. These investigators noted that women born outside of Canada were more likely to develop depressive symptoms at eight weeks postpartum (OR 2.65 95% CI 1.45-4.85), which is in agreement with our findings (35). Given that both variables were statistically significant at both the bivariate and

multivariate levels, health care providers may chose to enquire about either variable to assist in identification of women at risk.

Social isolation during pregnancy was significantly associated with postpartum depression. The relationship between social isolation and postpartum depression has not been widely studied and only one study was found which examined this relationship. A large community-based prospective study of 5091 Danish women found that perceived social isolation remained a significant predictor of postpartum depression in their multivariate model and was associated with an odds ratio of 3.6 (95% CI 1.9-7.0) after adjustment for covariates (85). The broader construct of social support (compared to isolation) has been extensively studied using prospective designs and lack of social support has been identified as a key risk factor for postpartum depression (2, 11, 35, 84, 85). Recent prospective studies suggest not having any relatives in the city , an absence of close friends or someone to talk to (86), lack of perceived support from members of the women's primary group and lack of support regarding pregnancy itself (125) may be most associated with postpartum depression. Our study, had the opportunity to consider both social isolation and social support and found that social isolation remained significant in the multivariate model while social support did not, perhaps indicating that social isolation is a specific aspect of social support that best predicts which women will develop postpartum depression.

Postpartum abuse was another factor found to be significant in the alternative model. Although studies have reported an association between depression and abuse in the general population of women (126, 127) and a history of emotional abuse as an adult and postpartum depression (128), only one study specifically examining postnatal abuse

as a covariate of postpartum depression was found (129). Records and Rice did not find an association between postpartum abuse and postpartum depression after adjustment for initial depression, although their findings are based on a very small sample of 28 women as 61 women (66%) were lost to follow up (129) and therefore should be interpreted with caution.

In this study, postnatal abuse was the strongest predictor in the alternate model (RR 5.04 95% CI 2.45-10.37) after adjustment for other covariates and therefore further studies should continue to explore this relationship to confirm if postnatal abuse is a key risk factor for postpartum depression. Previous abuse is a strong risk factor for postpartum abuse (130) so while postpartum abuse may have been the strongest predictor of the abuse variables, clinically, asking women about previous abuse or abuse during pregnancy may be helpful for identifying women at risk given that these variables were significant at the bivariate level.

These sets of identified risk factors suggest two groups of vulnerable women and both models have implications for clinical practice. This analysis underscores that often more than one model is needed to identify different vulnerable populations.

5.4 Comparing women with minor postpartum depression to women without postpartum depression

Women with minor postpartum depression in this study represent a population of women with EDPS scores that are thought to reflect sub-clinical depression and they are therefore an important group to identify, monitor and provide with appropriate support and treatment to decrease symptom severity and potentially prevent the onset of major postpartum depression.

The variables that remained significant in the model comparing women with minor postpartum depression to women without postpartum depression included a history of depression, the mother being born outside Canada, abuse during pregnancy, anxiety during pregnancy and low self reported postnatal parenting competence. A history of depression and low self reported postnatal parenting competence are variables that were identified as risk factors for major post partum depression and have been discussed. Similarly, being born outside Canada remained significant and therefore suggests that women who immigrate to Canada from other countries are at an increased risk of depressive symptoms as is supported by the literature (35).

Abuse during pregnancy identified women at risk of minor postpartum depression, and as previously mentioned, a link between abuse and depression has been shown (126, 127) as has a link between emotional abuse as an adult and postpartum depression (128). However, no studies were found that examined the relationship between abuse during pregnancy and postpartum depression. Our findings suggest that while abuse during pregnancy is associated with increased depressive symptoms postpartum, abuse occurring in the postpartum period is more strongly associated with clinical major postpartum depression as explained in the previous model.

Recent prospective studies have found an association between anxiety and an increased risk of postpartum depression (81, 131). Johnstone et al. found in a sample of 424 Australian women, that women with a past history of anxiety were more likely to have postpartum depression (OR 4.2, 95% CI 1.77-9.85) (81) while Heron et al. found among a community sample of 8323 women in England, antenatal anxiety predicted

postnatal depression at eight weeks and eight months, even after controlling for antenatal depression (OR 3.22, 95% CI 2.28-4.55) (131).

This study contributes new findings which suggest some differences between women with minor postpartum depression (EPDS 10-12) and women with major postpartum depression (EPDS >=13). Anxiety was not significant when comparing those with major postpartum depression to those without, while it was an important predictor in the model comparing women with minor postpartum depression to women without postpartum depression. This suggests that while anxiety during pregnancy may increase psychological distress and therefore may indicate less severe postpartum depression, it may not be independently associated with major postpartum depression.

To our knowledge, no previous studies have attempted to develop a model of the risk factors that distinguish women with minor postpartum depression from women without postpartum depression. Therefore, these novel findings may have implications for clinical practice with respect to identification of women in the prenatal period who are at risk of either minor or more severe postpartum depression.

5.5 Comparing women with major postpartum depression to women with minor postpartum depression

The variables that remained significant at the bivariate level when comparing women with major postpartum depression to women with minor postpartum depression represent the factors that differentiate women with sub-clinical depression from women with major postpartum depression. Very few factors remained significant at the bivariate level and therefore indicate that women with minor postpartum depression and women with major postpartum depression are very similar, with many of the same underlying

risk factors. Specifically, the only variables that remained significant in the multivariate model were breastfeeding status at three months postpartum and postnatal abuse, both of which were measured at the same time as postpartum depression status and therefore it may be more appropriate to consider these variables as correlates not as risk factors. This finding suggests that women with minor postpartum depression and women with major postpartum depression may be similar in their predisposition to depressive symptoms in the postpartum period, but that stressful events, such as not being able to breastfeeding or experiencing abuse postpartum may provide enough psychological distress to lead to the development of more severe depression.

To our knowledge, no previous studies have attempted to develop a model of risk factors that distinguish women with major postpartum depression from women with minor postpartum depression. While these findings suggest that women with minor postpartum depression are similar to women with major postpartum depression, future studies should examine the role of factors that contribute to a stressful or unstable postpartum environment in the development of more serious depression.

5.6 Limitations

This study was based on analysis of data from the Community Perinatal Care study, which limited the scope of data collection specifically pertinent to postpartum depression. Consequently, data on variables which have been noted by others to influence postpartum depression, such as having an instrumental delivery, not having an infant of the desired gender, vulnerable personality styles, specific types of social support, language barriers and timing of immigration were not collected.

The outcome variable, postpartum depression was assessed based on maternal self report on the Edinburgh Postnatal Depression Scale (15), which has been determined to be a valid method of data collection in this population (132), however, it would have been ideal to confirm cases with elevated EPDS scores using a standard diagnostic interview such as the Schedule for Affective Disorders and Schizophrenia (SADS) (133). Mothers who were identified as depressed based only on their questionnaire responses may not meet diagnostic criteria for clinical depression, which would have lead to overreporting. Likewise, mothers with borderline EPDS scores may have met diagnostic criteria in a clinical interview and exclusion of these cases would result in underreporting. However, given the objectives of the primary study, and the large sample size, it was not feasible to complete clinical interviews to confirm postpartum depression status. The EPDS is the most widely used and most appropriate self-report instrument for identifying symptoms of postpartum depression according to the American Psychological Association (APA) providing some confidence and comparability of the findings (132). The EPDS was designed specifically for a postpartum population and therefore does not include questions about changes in sleep and energy, disturbance of which are normal in the postpartum period.

The Postpartum Depression Screening Scale (PDSS) is another instrument that could have be used (134), however the length of this tool (35 items) combined with the recency of development render it less comparable to other literature and less amenable to phone interview. (134). Other alternative screening instruments that have been used for community screening of depression include the Beck Depression Inventory (BDI) (135), the Hamilton Depression Rating Scale (136) and the Zung Depression Rating Scale

(137). While these instruments have been used to screen for depression in postpartum women, their use has not been specifically validated for a postpartum population.

Another limitation of this study was the use of the Kellner Symptom Questionnaire (SQ) (97) for identifying depression and anxiety symptoms during pregnancy. The SQ is a self report instrument which ideally would have been accompanied by a clinical interview for improved the accuracy of classifying participants with depression and anxiety disorder. The SQ was chosen for the CPC study because it efficiently assesses four domains (depression, anxiety, somatic and anger-hostility) and can be administered at no cost.

The instruments used to collect information for the psychosocial variables; the Social Support Index (SSI) for social support, the Network Orientation Scale (NOS) for social isolation and the Parenting Expectation Scale (PES) for prenatal and postnatal parenting self-efficacy do not have guidelines for cut-points and therefore were dichotomized into the upper 66 percent of scores and the lower 33 percent of scores. While this allows for comparisons to be made within our study sample, it makes comparisons to other studies more challenging.

The longitudinal design of this study resulted in some loss to follow-up which may have influenced the prevalence of postpartum depression as those women most at risk of postpartum depression may have differentially dropped out of the study. Data from women who participated in the study but eventually dropped out or who were unreachable and therefore did not complete the third interview at three months postpartum was examined to determine if the proportion with a history of depression or who were depressed during pregnancy was different compared to women who completed

the study. Women who were unreachable or who dropped out of the study were more likely to report a history of depression compared to women who completed the CPC Study (33% vs. 23%; $p<0.001$). However, we found no difference in the proportion who were classified as depressed during pregnancy when comparing women who completed the study to women who did not (6.5% vs. 7.5%; $p=0.517$). While women who were lost to follow up were more likely to have a history of depression, they were not more likely to be depressed during pregnancy and therefore while there is the potential that women lost to follow up may have contributed to our low prevalence estimate for postpartum depression of 4.5%, it is also possible that our prevalence estimate represents the population prevalence.

5.7 Strengths

The prospective design of this study was a major strength. Prospective longitudinal research designs permit examination of causal relationships between risk factors and an outcome since the temporal association (exposure preceding outcome) is met. Prospective studies provide the strongest evidence of causal relationships between exposures and outcomes although the other causal criteria (strength of the association, consistency, specificity, biological gradient and biological plausibility) still have to be considered. In this study, prospective data collection allowed for temporal association to be met for variables collected during pregnancy, although not for the variables collected in the postpartum. A prospective design is also less subject to recall bias than a retrospective design, since participants are being asked questions about their present state, not about events in the past.

Another strength of this study was the large sample size (n=1500 women) which allows for the examination of numerous potential risk factors, and allows for multivariate analysis. Multivariate analysis is important to assess the individual effects and interactions among risk factors to understand the relative contribution of each. Understanding the relative contribution of risk factors is important for the design of targeted screening or intervention programs.

5.8 Recommendations

The EPDS is an effective and well validated screening tool for identifying women currently suffering from postpartum depression and therefore its use in this setting should be continued (15). Further, the EPDS has been translated into many languages including Arabic, Mandarin, Czech, Dutch, French, German, Greek, Hebrew, Hindi, Icelandic, Japanese, Maltese, Norwegian, Portuguese, Punjabi, Slovenian, Spanish, Swedish, Urdu, and Vietnamese and remains valid and reliable across cultures making universal adoption of this tool in clinical practice very feasible, even among an ethnically diverse patient population (138). In addition, the use of the EPDS could be expanded to the antenatal period to identify women with symptoms of depression during pregnancy as the EPDS has also been validated in the antenatal period (139).

There is also the potential for identification of and early intervention for women at risk of postpartum depression by screening women for risk during pregnancy or the early postpartum period. This would allow for the identification of those women at risk or at sub-clinical stages of depression who would benefit from monitoring and or an individualized intervention in both the antenatal and early postpartum periods. Prior to adoption of a screening protocol, sufficient resources for support and treatment programs

would have to be assured, as health care providers would experience an increased workload associated with identifying women with psychosocial morbidity.

Researchers have attempted to develop antenatal screening tools to identify women at risk of postpartum depression covering well established risk factors for depression including a past history of depression, recent life stressors, quality of partner relationship, past or current history of abuse or neglect, social support, self esteem and personality traits (85, 140-142). However to date, none have been able to demonstrate adequate sensitivity (the test's ability to detect the condition when it is present), specificity (the test's ability to correctly identify the absence of a condition) or positive predictive values (the proportion of individuals with a positive result correctly predicted) (143).

The failure of these screening instruments to accurately detect women who go on to develop postpartum depression may be due to the limited understanding of the effects of risk factors in combination. While these screening tools have including the risk factors with the strongest associations with postpartum depression in isolation, they have not been able to base their prediction on the *combination of risk factors* with the strongest association with postpartum depression. It is hoped that by designing a screening instrument comprised of the set of risk factors that best predict women at the greatest risk, the sensitivity and specificity will be improved from past instruments. Further, it has been suggested that improvements in the prediction of postpartum depression instruments will likely be the result of including postpartum factors as well as antenatal factors (144). The results of this study support this finding, as women at risk of the most severe

depression were distinguished from women with minor postpartum depression only by the postpartum factors postnatal abuse and not breastfeeding at three months postpartum.

The models proposed from this analysis offer novel findings of the sets of pre and perinatal risk factors that describe women most at risk of postpartum depression and therefore provide a starting point for the development of a perinatal screening protocol. Further research on the potential for screening using these risk factors should be conducted to determine if such a program could identify women at risk and effectively monitor and intervene to reduce the incidence and severity of postpartum depression.

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APPENDIX A: DSM-IV criteria for major depression

A. Five (or more) of the following symptoms have been present during the same 2-week period and represent a change from previous functioning; at least one of the symptoms is either (1) depressed mood or (2) loss of interest or pleasure.

(1) depressed mood most of the day, nearly every day, as indicated by either subjective report (e.g., feels sad or empty) or observation made by others (e.g., appears tearful). Note: In children and adolescents, can be irritable mood.

(2) markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day (as indicated by either subjective account or observation made by others)

(3) significant weight loss when not dieting or weight gain (e.g., a change of more than 5% of body weight in a month), or decrease or increase in appetite nearly every day. Note: In children, consider failure to make expected weight gains.

(4) insomnia or hypersomnia nearly every day

(5) psychomotor agitation or retardation nearly every day (observable by others, not merely subjective feelings of restlessness or being slowed down)

(6) fatigue or loss of energy nearly every day

(7) feelings of worthlessness or excessive or inappropriate guilt (which may be delusional) nearly every day (not merely self-reproach or guilt about being sick)

(8) diminished ability to think or concentrate, or indecisiveness, nearly every day (either by subjective account or as observed by others)

(9) recurrent thoughts of death (not just fear of dying), recurrent suicidal ideation without a specific plan, or a suicide attempt or a specific plan for committing suicide

B. The symptoms do not meet criteria for a Mixed Episode.

C. The symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.

D. The symptoms are not due to the direct physiological effects of a substance (e.g., a drug of abuse, a medication) or a general medical condition (e.g., hypothyroidism).

E. The symptoms are not better accounted for by Bereavement, i.e., after the loss of a loved one, the symptoms persist for longer than 2 months or are characterized by marked functional impairment, morbid preoccupation with worthlessness, suicidal ideation, psychotic symptoms, or psychomotor retardation.

APPENDIX B: Impact of postpartum depression on child cognitive development

Authors	Study Design Sample Size	Maternal Depression Measures and timing of Assessment	Child Cognitive Outcome Measure and Age of Children	Results	Limitations
Murray, 1992	Nested Case Control Analysis from Prospective Cohort 56 PPD mother infant pairs 42 control pairs	1. Edinburgh Postnatal Depression Scale (EPDS; Cox et al., 1987) (6 and 12 mo) 2. Schedule for Affective Disorders, Lifetime Version (SADS-L; Endicott & Spitzer, 1978) (18 mo)	1. Bayley's Scales of Infant Mental Development (Bayley, 1969) (18 mo) 2. Reynell Scales of Language Development (Huntley, 1985) (18 mo) 3. Strange Situation Procedure (Ainsworth & Wittig, 1969) (18 mo) 4. Piaget's Object Concept Task (Wishart and Bower, 1984) (9 and 18 mo)	• Infants of mothers with PPD were more likely to fail the object concept task at 9 mo and 18 mo than controls ($p<0.04$). • Infants of mothers with PPD were more likely to be insecurely attached to their mothers at 18 months as well ($p<0.0003$). • PPD had no effect on Bayley's scores or Reynell scores at 18 months. • Overall there was a tendency for girls to outperform boys ($p<0.06$) and for infants of parents with marital friction ($p<0.1$) to perform less well on cognitive tasks. • Girls were also less likely to be insecure than boys ($p<0.02$). • Maternal PPD was only associated with poorer Bayley's scales among those children of lower socioeconomic status ($p<0.003$). • Children of lower socioeconomic status families performed more poorly on the Bayley's than children of higher socioeconomic status ($p<0.02$). • Similar results were found for the Reynell, as higher parental socioeconomic status was related to better outcome ($p<0.009$) and girls scored better than boys ($P<0.0004$).	The use of a sample from Cambridge is not representative of the general population as the socioeconomic status and level of education are higher. This particularly becomes a problem during the repeated assessments using the 1 cohort for the 4 Murray studies, as this limits the variability in the sample, which is not representative of the general population.

Authors	Study Design Sample Size	Maternal Depression Measures and timing of Assessment	Child Cognitive Outcome Measure and Age of Children	Results	Limitations
Murray, Kempton, Woolgar, Hooper, 1993	Nested Case Control Analysis from Prospective Cohort 56 PPD mother infant pairs 42 control pairs	1. EPDS (Cox et al., 1987) (6 and 12 mo) 2. SADS-L (Endicott & Spitzer, 1978) (18 mo)	1. Piaget's Object Concept Task (Wishart and Bower, 1984) (9 and 18 mo) 2. Bayley's Scales of Infant Mental Development (Bayley, 1969) (18 mo)	• Postpartum depressed mothers expressed more negative emotion than either the women with a history of depression or the control women ($p<0.005$). • No association between maternal depression, infant gender, maternal socioeconomic status or education level and success on the object concept task at 9 months was noted. • At 18 months, maternal depression ($p<0.05$), socioeconomic status ($p<0.05$) and child gender ($p<0.03$) were all significant predictors of child success on the object concept task. Specifically, children of non depressed mothers had greater success than children of postpartum depressed mothers, girls had greater success than boys, and children of lower socioeconomic status families had greater success than children from higher socioeconomic status families. • Higher scores on the Bayley's at 18 months, were predicted by depression, gender (girls performed better than boys) and the interaction between depression and gender ($p<0.04$). • Multivariate analyses revealed that the quality of early maternal communication with the infant in large part mediated any association between depression, infant cognitive development and gender.	

Authors	Study Design Sample Size	Maternal Depression Measures and timing of Assessment	Child Cognitive Outcome Measure and Age of Children	Results	Limitations
Murray, Fiori-Cowley, Hooper, Cooper, 1996a	Nested Case Control Analysis from Prospective Cohort 56 PPD mother infant pairs 42 control pairs	1. EPDS (Cox et al., 1987) (6 and 12 mo) 2. SADS-L (Endicott & Spitzer, 1978) (18 mo)	1. Bayley's Scales of Infant Mental Development (Bayley, 1969) (18 mo) 2. Strange Situation Procedure (Ainsworth & Wittig, 1969) (18 mo)	• Depressed mothers were less sensitive to their infants ($p<0.01$), less affirming of their infants ($p<0.05$) and more negating toward infant experience ($p<0.01$) than non-depressed mothers. • These disturbances were found to be associated with poorer child cognitive outcomes at the 18 month assessments, particularly among boys. Boys of postpartum depressed mothers performed significantly worse on the BSID mental scale than control boys ($p<0.05$). • Infant attachment was associated with postpartum depression of the mother ($p<0.005$).	
Murray, Hipwell, Hooper, Stein, Cooper, 1996b	Nested Case Control Analysis from Prospective Cohort 56 PPD mother infant pairs 42 control pairs	1. EPDS (Cox et al., 1987) (6 and 12 mo) 2. SADS-L (Endicott & Spitzer, 1978) (18 mo, 5 yrs)	1. McCarthy Scales of Children's Abilities (McCarthy, 1972) (5 yrs)	• No relationship was found between postnatal depression and maternal depression at any time during the child's life and the child's cognitive performance at 5 years of age. • Child cognitive performance at 5 years of age was also not related to the length of child exposure or the recentcy of exposure to maternal depression. • As well, even among vulnerable groups such as children from lower socioeconomic status families or boys again there was no evidence that postpartum depression had an adverse effect on child cognitive development. • However, a significant difference in General Cognitive Index (CGI) from the McCarthy scales for upper-middle socioeconomic status as compared to lower socioeconomic status was found ($p<0.005$).	
Hay,	Prospective 4-	1. Semi-structured	1. McCarthy Scales of	• Maternal depression during the first year of	The small number of

Authors	Study Design Sample Size	Maternal Depression Measures and timing of Assessment	Child Cognitive Outcome Measure and Age of Children	Results	Limitations
Kumar, 1995	year follow-up 22 PPD mother infant pairs 71 control mother infant pairs	Interview examined using DSM-IV criteria (3 months pregnant, 3 mo postpartum, 1 yr, 4 yr)	Children's Abilities (McCarthy, 1972) (4 yrs)	life predicted poorer child cognitive development. • Children with postpartum depressed mothers had significantly lower mean general cognitive index (GCI) scores from the McCarthy Scales (McCarthy, 1972) than children with non-depressed mothers ($p<0.003$). • Proposed mediators child gender, maternal smoking, obstetrical complications, lower socioeconomic status of the family and the degree of marital conflict did not account for the influence of maternal depression on child cognitive ability. • Low birth weight was found to affect child cognitive ability score even for children of non depressed mothers, however the impact of postpartum depression was still significant when the low birth weight babies were removed from the sample ($p<0.009$). • Maternal education was found to be a protective effect of the relationship between postpartum depression and child cognitive development, as the difference between the children of depressed and non-depressed mothers was only significant when the mother had less education ($p<0.02$).	cases in this sample limits the power of their study to detect a difference. This is especially true when stratifying on a third variable and may explain why many of the proposed effect modifiers (child gender, low SES, maternal smoking etc) were not found to be significant.
Brennan, Hammen, Anderson, Bor, Najman, Williams, 2000	Prospective 5-year follow up 3767 mother child pairs	1. 7 depression items of the Delusions-Symptoms-States Inventory (Bedford & Foulds, 1978) (during pregnancy, 3-4 days postpartum, 6 mo, 5 yrs)	1. Peabody Picture Vocabulary Test Revised (Dunn & Dunn, 1981) (5 yrs)	• Severity of maternal depression significantly predicted child cognitive functioning ($p<0.01$) with the higher the maternal depression severity score the lower the Peabody vocabulary score in their child. • Similarly, chronicity of depression predicted Peabody vocabulary score ($p<0.01$). • While the results of both of these analyses	Use of the delusions-Symptom-States Inventory for determining maternal depression status. May have missed cases of depression due to lack of

Authors	Study Design Sample Size	Maternal Depression Measures and timing of Assessment	Child Cognitive Outcome Measure and Age of Children	Results	Limitations
				show statistical significance, the percentage of variance in Peabody test scores explained by maternal depression was close to 0 and should be interpreted with caution. • Timing of maternal depression was not associated with Peabody vocabulary score.	screening between 6 months and 5 years. Chronicity measure may reflect recurrent depression and not chronic depression.
Kurstjens, Wolke, 2001	Retrospective Case Control 92 PPD mother infant pairs 721 control mother infant pairs	1. SADS-L (Endicott & Spitzer, 1978) (6 yr 3 mo) 2. Standardized Diagnostic Interview using DSM-IV criteria (6 yr 3 mo)	1. Griffiths Scales of Babies Abilities (Brandt, 1983) (20 mo) 2. Columbia Mental Maturity Scales (CMM; Burgemeister, Blum & Lorge, 1972) (4 yr 8 mo) 3. Kaufman Assessment Battery for Children (K-ABC; Kaufman & Kaufman, 1983) (6 yr 3 mo)	• PPD was not found to have any adverse effects on cognitive development of children at 20 months, 4 years 8 months or 6 years 3 months. As well, there were no significant interactions by sex, socioeconomic status or birth risk, severity of depression, timing of onset, duration, or chronicity of depression. • However, significant interactions were found for socioeconomic status and gender with chronicity of maternal depression. For example, low socioeconomic boys or boys born at neonatal risk of chronically depressed mothers had lower Achievement scores (AS) of the K-ABC at 6 years 3 months than children of mothers with less severe depression or controls ($p<0.05$).	Retrospective determination of depression during the past 7 years is highly subject to recall bias.
Righetti-Veltema, Bousquet, Manzano, 2003	Prospective Matched Case Control 119 socio-economically disadvantaged families 35 PPD mother infant pairs 35 age and	1. EPDS (Cox et al., 1987) (3 mo, 18 mo)	1. Denver Developmental Screen (Frankenberg & Dodds, 1967) (18 mo) 2. Bayley's Scales of Infant Behavior Development (Bayley, 1969) (18 mo) 3. Strange Situation Procedure (Ainsworth & Wittig, 1969) (18 mo) 4. Piaget's Object	• The infants of postpartum depressed mothers were more likely to fail the Object concept task (42.9% vs. 77.1%, $p=0.001$) and were more likely to be insecurely attached to their mothers (31.4% vs. 11.4%, $p<0.05$) than the control infants. • No differences on outcomes from the Denver Developmental Screen and BSID were found.	Depression status determined based solely on the EPDS, a self report measure instead of being confirmed by a clinical interview.

Authors	Study Design Sample Size	Maternal Depression Measures and timing of Assessment	Child Cognitive Outcome Measure and Age of Children	Results	Limitations
	parity matched control pairs		Concept Task (Wishart and Bower, 1984) (18 mo)		

APPENDIX C: Impact of postpartum depression on child behavioural development

Authors	Study Design Sample Size	Maternal Depression Measures and timing of Assessment	Child Behaviour Outcome Measure and Age of Children	Results	Limitations
Murray, Sinclair, Cooper, Ducournau, Turner, Stein, 1999	Nested Case Control Analysis from Prospective Cohort 55 depressed mother infant pairs 39 control pairs	1. EPDS (Cox et al., 1987) (6 and 12 mo) 2. SADS-L (Endicott and Spitzer, 1978) (18 mo, 5 yrs)	1. Videotaped mother-child interaction 2. Rutter A2 questionnaire (Rutter et al., 1970) 3. Child behaviour at school during free play (Sylva, Roy, & Painter, 1980)	• Half (50.9%) of the children with postpartum depressed mothers scored above the cut-off used to define clinically significant levels of disturbance at home (scores > 12) based on maternal report compared to only 15% of control children ($p<0.001$). • The aspects of child behaviour at school that were related to postpartum depression were the occurrence of low-level physical play (cases: 31%, control: 8%, $p<0.1$), the occurrence of creative play (cases: 14%, controls: 42%, $p<0.05$) and the quality of responsiveness in social interactions with case children being more likely to respond negatively (cases: 30%, controls: 0%, $p=0.004$). • The associations found remained even when accounting for current maternal depression and parental conflict. • These associations occurred independently of child gender and family socioeconomic status and were not explained by earlier impairments in cognitive functioning.	Child behaviour based on maternal report and depressed mothers may be more likely to perceive their children as having greater behaviour problems.
Sinclair, Murray, 1998	Nested Case Control Analysis from Prospective Cohort	1. Standardized Psychiatric Interview (SPI; Goldberg et al., 1970) (2-3 mo) 2. SADS-L (Endicott and Spitzer, 1978) (18 mo, 5 yrs)	Teacher Report based on: 1. Adjustment to School Questionnaire (ASQ; Thompson, 1975) 2. Prosocial Behaviour Questionnaire (PBQ; Weir & Duveen, 1981),	• Postpartum depression was not a significant predictor of readiness for school, personal maturity, prosocial behaviour, adaptability, emotional intensity or persistence. • The factors found to have the greatest influences on children's adjustments to school were socioeconomic status and children's	Teacher report on child behaviour was not compared to maternal report, therefore may have reflected behaviour in school and is not

Authors	Study Design Sample Size	Maternal Depression Measures and timing of Assessment	Child Behaviour Outcome Measure and Age of Children	Results	Limitations
	55 depressed mother infant pairs 39 control pairs		3. Temperament Assessment Battery for Children (TABC; Martin, 1988) 4. Preschool Behaviour Checklist (PBCL; McGuire & Richman, 1988)	gender (R^2=0.14, p<0.002), specifically boys of lower socioeconomic status adjusted more poorly. • Recent maternal depression was related to the child's personal maturity (p<0.025) although having a mother with postpartum depression was not. • Behaviour disturbance was related to postpartum depression, as children exposed to postpartum depression were more likely to score above 12 on the PBCL (clinical cut off) than control group children (p<0.0005). • As well, sex and social class modified the effect of postpartum depression on child behaviour disturbance. For example, boys with postpartum depressed mothers had higher scores on the activity and behaviour disturbance scales of the Preschool Behaviour Checklist while girls were similar control children. Similarly, boys from lower socioeconomic status with postpartum depressed mothers were the most easily distracted children.	generalizable to settings outside of school.
Philipps, O'Hara, 1991	Prospective 4.5 year follow-up 10 PPD mother infant pairs 60 control mother infant pairs	1. SADS-L (Endicott and Spitzer, 1978) (2nd trimester of pregnancy, wks 1-9 postpartum, 4.5 yrs)	Maternal report on: 1. Child Behaviour Checklist (CBCL; Achenbach, 1992) (4.5 yrs)	• Postpartum depression was not associated with child behaviour problems at 4.5 years of age. • However, depression during the follow up period was associated both with postpartum depression (p<0.06) and an increased risk of child behavioural problems on both the internalizing scale (p<0.01 and externalizing scale (p<0.05) of the CBCL.	Very small number of cases (n=10) limits power to detect a different between groups.

Authors	Study Design Sample Size	Maternal Depression Measures and timing of Assessment	Child Behaviour Outcome Measure and Age of Children	Results	Limitations
Brennan, Hammen, Anderson, Bor, Najman, Williams, 2000	Prospective 5-year follow up 3767 mother child pairs completed follow up measures	1. 7 depression items of the Delusions-Symptoms-States Inventory (Bedford & Foulds, 1978) (during pregnancy, 3-4 days postpartum, 6 mo, 5 yrs)	Maternal and Paternal report on: 1. CBCL (Achenbach, 1992) (5 yrs)	• Severity of maternal depression was significantly related to child behaviour problems ($p<0.001$) as was chronicity of maternal depression ($p<0.001$). When chronicity and severity of maternal depression were examined together, there was a significant interaction for child behaviour problems ($p<0.05$). • Timing of depression, based on data from women with only 1 depressive episode, was predictive of child behaviour both for moderate depression ($p<0.05$) and severe depression ($p<0.01$). For example, children with mothers who had their depressive episode closer to the child's 5 year assessment were more likely to have behavior problems than children who's mothers had suffered depression only during pregnancy or immediately postpartum.	As previously mentioned, use of the delusions-Symptom-States Inventory for determining maternal depression status has not been studied in this population. May have missed cases of depression due to lack of screening between 6 months and 5 years. Chronicity measure may reflect recurrent depression and not chronic depression.
Cicchetti, Rogosch, Toth, 1998	Prospective 21 month follow-up 104 depressed mother child pairs 52 control mother child pairs	1. Diagnostic Interview Schedule III-R (DIS-III-R; Robins et al., 1985) (21 mo)	1. Child attachment assessed by maternal report on Attachment Q-Set version 3 (Waters et al., 1995) 2. Child behaviour assessed by maternal and paternal report on CBCL (Achenbach, 1992)	• Children with depressed mothers were found to be significantly more likely to be insecurely attached to their mother than children of non-depressed mothers ($p<0.004$). • Maternal depression was significantly related to total child behaviour problems ($p<0.05$). • Multiple regression analysis revealed that contextual risk actually mediates the relationship between maternal depression and increased child behavior problems.	Depression status was assessed at 21 months postpartum and therefore doesn't necessarily represent postpartum depression; therefore it is not possible to draw any conclusions with regard to postpartum depression and child behavior or attachment insecurity.

APPENDIX D: Ethics approval

FACULTY OF MEDICINE | UNIVERSITY OF CALGARY

2006-03-13

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Dr. S.C. Tough
Department of Paediatrics
Room 3013
Alberta Children's Hospital
Calgary, Alberta

Dear Dr. Tough:

RE: Epidemiology of Postpartum Depression: A Prospective Study

Grant ID: 18859

MSc Student: Davey, Heather

The above-noted proposal including the Research Proposal (Final Version, dated November 1, 2005) has been submitted for Committee review and found to be ethically acceptable.

Dr. Ross, one of the investigators for this study, is a member of the CHREB but did not participate in the review, was not present during discussion and did not vote on this protocol

Please note that this approval is subject to the following conditions:
(1) consent for access to personal identified health information in retrospective chart review is not required on grounds considered under Section 50 of the Health Information Act; a copy of the informed consent form must have been given to each research subject, if required for this study;
(2) a Progress Report must be submitted by 2007-03-13, containing the following information:

i) the number of subjects recruited;
ii) a description of any protocol modification;
iii) any unusual and/or severe complications, adverse events or unanticipated problems involving risks to subjects or others, withdrawal of subjects from the research, or complaints about the research;
iv) a summary of any recent literature, finding, or other relevant information, especially information about risks associated with the research;
v) a copy of the current informed consent form;
vi) the expected date of termination of this project.

(3) a Final Report must be submitted at the termination of the project.

Please note that you have been named as a principal collaborator on this study because students are not permitted to serve as principal investigators. Please accept the Board's best wishes for success in your research.

Yours sincerely,

Glenys Godlovitch, BA(Hons), LLB, PhD

Associate Chair, Conjoint Health Research Ethics Board

GG/sg

c.c. Dr. T. Noseworthy (information) Research Services Ms. H. Davey (MSc Student)
Office of Information & Privacy Commissioner

APPENDIX E: Trivariate analysis

History of depression and major postpartum depression stratified by demographic variables

		OR	95 % CI	n
CRUDE OR		**2.84**	**(1.77 – 4.58)**	**1401**
Stratification variable				
Study group				
Control		3.05	(1.45 – 6.40)	514
Nurse		2.54	(1.09 – 5.94)	446
Nurse + home visitor		2.95	(1.17 – 7.46)	441
	MH OR	2.86	(1.77 – 4.61)	1401
	p-value	0.947		
Age category				
Younger than 25		2.80	(1.00 – 7.80)	257
25 or older		2.83	(1.64 – 4.86)	1142
	MH OR	2.82	(1.74 – 4.56)	1399
	p-value	0.986		
Stable partner				
No stable partner		3.45	(0.70 – 16.95)	100
Stable partner		2.72	(1.64 – 4.53)	1300
	MH OR	2.80	(1.72 – 4.52)	1400
	p-value	0.780		
Parity				
No live births		2.17	(1.07 – 4.42)	762
Live births		3.66	(1.92 – 6.99)	639
	MH OR	2.86	(1.78 – 4. 32)	1401
	p-value	0.285		
Maternal education level				
Some high school or less		2.47	(0.84 – 7.24)	105
Graduated high school		4.60	(1.34 – 15.76)	244
Some post secondary		2.34	(1.28 – 4.28)	1027
	MH OR	2.77	(1.71 – 4.49)	1376
	p-value	0.376		

	OR	95 % CI	n
CRUDE OR	**2.84**	**(1.77 – 4.58)**	**1401**
Total household income			
Less than $40,000/year	2.20	(1.01 – 4.78)	282
At least $40,000/year	3.21	(1.65 – 6.26)	1000
MH OR	2.72	(1.64 – 4.50)	1282
p-value	0.468		
Country mother was born			
Other	3.02	(1.41 – 6.48)	338
Canada	3.20	(1.73 – 5.90)	1062
MH OR	3.14	(1.94 – 5.07)	1400
p-value	0.911		
Maternal ethnicity			
Other	2.65	(1.26 – 5.56)	330
Caucasian	3.25	(1.75 – 6.04)	1062
MH OR	3.00	(1.87 – 4.84)	1392
p-value	0.679		

OR = odds ratio, CI = confidence interval, MH OR = Mantle Haenszel combined odds ratio, p-value calculated from Mantle-Haenszel test for homogeneity.

History of depression and major postpartum depression stratified by obstetric variables

		OR	95 % CI	n
CRUDE OR		**2.84**	**(1.77 – 4.58)**	**1401**
Stratification Variable				
Planned pregnancy				
Not planned		4.24	(2.00 – 8.90)	416
Planned		1.91	(0.98 – 3.74)	982
	MH OR	2.76	(1.69 – 4.51)	1398
	p-value	0.121		
Induction of labour				
Induced		1.72	(0.69 – 4.27)	497
Not induced		4.03	(2.25 – 7.22)	826
	MH OR	3.07	(1.90 – 4.97)	1323
	p-value	0.121		
Mode of delivery				
C-Section		1.06	(0.30 – 3.74)	299
Vaginally		3.54	(2.08 – 6.02)	1101
	MH OR	2.85	(1.77 – 4.59)	1400
	p-value	0.083		
Length of hospital stay				
Greater than 2 days		2.02	(0.91 – 4.48)	471
2 days or less		3.89	(2.10 – 7.22)	923
	MH OR	3.02	(1.87 – 4.90)	1394
	p-value	0.202		
Gestational age				
Premature		0.88	(0.10 – 7.81)	58
Not premature		3.06	(1.88 – 5.00)	1337
	MH OR	2.84	(1.77 – 4.58)	1395
	p-value	0.272		
Birth weight				
Low		4.59	(0.84 – 25.20)	69
Not low		2.73	(1.66 – 4.49)	1330
	MH OR	2.84	(1.77 – 4.58)	1399
	p-value	0.566		

		OR	95 % CI	n
CRUDE OR		**2.84**	**(1.77 – 4.58)**	**1401**
Sex of baby				
Male		2.24	(1.19 – 4.22)	703
Female		3.87	(1.86 – 8.05)	698
	MH OR	2.82	(1.75 – 4.53)	1401
	p-value	0.269		
Breastfeeding status at 3 months				
No longer breastfeeding		2.76	(1.33 – 5.73)	342
Still breastfeeding		2.82	(1.50 – 5.31)	1058
	MH OR	2.79	(1.73 – 4.51)	1400
	p-value	0.964		
Number of babies				
Multiple		--	--	7
Singleton		3.01	(1.86 – 4.88)	1394
	MH OR	2.90	(1.79 – 4.68)	1401
	p-value	0.879		

OR = odds ratio, CI = confidence interval, MH OR = Mantle Haenszel combined odds ratio, p-value calculated from Mantle Haenszel test for homogeneity.

History of depression and major postpartum depression stratified by behavioural risk variables

		OR	95 % CI	n
CRUDE OR		**2.84**	**(1.77 – 4.58)**	**1401**
Stratification variable				
Drank alcohol during pregnancy				
Yes		1.69	(0.73 – 3.90)	374
No		3.60	(2.02 – 6.42)	1017
	MH OR	2.74	(1.71 – 4.37)	1391
	p-value	0.144		
Binge drank during pregnancy				
Yes		0.50	(0.06 – 4.27)	87
No		3.24	(1.97 – 5.30)	1306
	MH OR	2.79	(1.74 - 4.45)	1393
	p-value	0.093		
T-ACE classification (modified)				
At risk		1.82	(0.64 – 5.15)	146
Low risk		2.67	(1.25 – 5.72)	905
	MH OR	2.31	(1.25 – 4.27)	1051
	p-value	0.560		
Smoking during pregnancy				
Yes		3.92	(1.57 – 9.80)	280
No		2.13	(1.15 – 3.96)	1121
	MH OR	2.68	(1.60 – 4.46)	1401
	p-value	0.276		
Drug use during pregnancy				
Yes		3.17	(0.36 – 27.72)	37
No		2.74	(1.67 – 4.49)	1361
	MH OR	2.77	(1.71 – 4.48)	1398
	p-value	0.898		
Ever abused				
Abused		2.71	(1.29 – 5.69)	463
Not abused		2.60	(1.28 – 5.28)	937
	MH OR	2.66	(1.58 – 4.47)	1400
	p-value	0.938		

	OR	95 % CI	n
CRUDE OR	**2.84**	**(1.77 – 4.58)**	**1401**
Ever witnessed abuse			
Witnessed abuse	2.60	(1.34 – 5.04)	545
Has not witnessed abuse	2.72	(1.33 – 5.54)	855
MH OR	2.64	(1.63 – 4.31)	1400
p-value	0.931		
Abuse during pregnancy			
Abused	2.20	(0.60 – 8.03)	63
Not abused	2.65	(1.58 – 4.46)	1337
MH OR	2.57	(1.59 – 4.17)	1400
p-value	0.792		
Witness to abuse during pregnancy			
Witnessed abuse	2.44	(0.69 – 8.61)	124
Has not witnessed abuse	2.93	(1.74 – 4.93)	1274
MH OR	2.85	(1.76 – 4.61)	1398
p-value	0.791		
Postpartum abuse			
Abused	1.33	(0.53 – 3.38)	60
Not abused	2.67	(1.55 – 4.61)	1341
MH OR	2.23	(1.40 – 3.56)	1401
p-value	0.2066		

OR = odds ratio, CI = confidence interval, MH OR = Mantle Haenszel combined odds ratio, p-value calculated from Mantle Haenszel test for homogeneity.

History of depression and major postpartum depression stratified by mental health variables

		OR	95 % CI	n
CRUDE OR		**2.84**	**(1.77 – 4.58)**	**1401**
Stratification Variable				
Family History of Depression				
Yes		1.98	(1.01 – 3.90)	554
No		3.89	(1.89 – 8.01)	835
	MH OR	2.54	(1.55 – 4.18)	1389
	p-value	0.172		
Depression during Pregnancy				
Depressed		2.00	(0.60 – 6.62)	85
Not depressed		2.27	(1.30 – 3.99)	1316
	MH OR	2.21	(1.33 – 3.69)	1401
	p-value	0.848		
Anxiety Disorder during Pregnancy				
Anxiety		3.37	(0.76 – 15.05)	94
No anxiety		2.50	(1.47 – 4.25)	1307
	MH OR	2.62	(1.58 – 4.35)	1401
	p-value	0.709		

OR = odds ratio, CI = confidence interval, MH OR = Mantle Haenszel combined odds ratio, p-value calculated from Mantle Haenszel test for homogeneity.

History of depression and postpartum depression stratified by psychosocial variables

		OR	95 % CI	n
CRUDE OR		**2.84**	**(1.77 – 4.58)**	**1401**
Stratification Variable				
Social support				
Low		2.90	(1.46 – 5.75)	421
High		2.22	(1.10 – 4.49)	979
	MH OR	2.57	(1.57 – 4.19)	1400
	p-value	0.592		
Social isolation				
Yes		2.79	(1.42 – 5.50)	338
No		2.09	(1.03 – 4.24)	1051
	MH OR	2.84	(1.77 – 4.58)	1389
	p-value	0.560		
Prenatal parenting competence				
Low		4.58	(1.92 – 10.92)	458
High		2.38	(1.32 – 4.30)	942
	MH OR	2.95	(1.82 – 4.79)	1400
	p-value	0.222		
Postpartum parenting competence				
Low		2.94	(1.52 – 5.71)	489
High		2.70	(1.35 – 5.42)	911
	MH OR	2.83	(1.75 – 4.57)	1400
	p-value	0.863		

OR = odds ratio, CI = confidence interval, MH OR = Mantle Haenszel combined odds ratio, p-value calculated from Mantle Haenszel test for homogeneity.