The association between breastfeeding and self-reported postpartum depressive symptoms among Oregon mothers: An analysis of data from a population-based survey

A Thesis

by

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List of Abbreviations

PRAMS	Pregnancy Risk Assessment Monitoring System
CI	Confidence Interval
SRPPDS	Self-reported postpartum depressive symptoms
PPD	Postpartum Depression
CDC	Centers for Disease Control and Prevention
SLE	Stressful Life Events
OR	Odds Ratio
HR	Hazard Ratio
FPL	Federal Poverty Level
RSV	Respiratory syncytial virus
EPDS	Edinburgh Postnatal Depression Scale
BMI	Body Mass Index
DHS	Department of Human Services
NH	Non Hispanic
MLE	Maximum-Likelihood Estimation
GOF	Goodness of Fit

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Abstract:

Background:

Breastfeeding has been associated with numerous health benefits for both mother and infant. For mothers, associated benefits include decreased risk of diabetes, arthritis, and breast cancer. For infants, breastfeeding has been associated with reduction in the risk of otitis media, respiratory tract infections, gastrointestinal infections and obesity. Postpartum depression has been associated with poor mood, lack of energy and recurrent depression among mothers. For infants, postpartum depression has been associated with inhibited language development and behavioral problems. Several studies have found an association between postpartum depression and breastfeeding. Perinatal depression and postpartum depression have been found to be associated with decreased breastfeeding initiation and duration. This association has not been studied among Oregon mothers.

The first aim of this thesis is to identify the prevalence of any breastfeeding for at least eight weeks and the prevalence of self-reported postpartum depressive symptoms (SRPPDS) in Oregon mothers. Additionally, we aim to identify whether breastfeeding for at least eight weeks is associated with decreased risk of postpartum depressive symptoms among Oregon mothers. Finally, this thesis explores the question of a causal association between breastfeeding and self-reported postpartum depressive symptoms.

Methods:

Responses from the 2007 Oregon Pregnancy Risk Assessment Monitoring System (PRAMS) were used to evaluate the association between breastfeeding for at least eight weeks and self-reported postpartum depressive symptoms. Unless otherwise specified, all numbers in this thesis are unweighted, and all percentages are weighted. In 2007, 1894

mothers completed surveys out of the total of 3067 mothers sampled for PRAMS yielding a weighted response rate of 67%. Logistic regression with forward stepwise variable selection method was used to identify potential independent predictors of postpartum depressive symptoms. Women were excluded if information was missing regarding depressive symptoms or breastfeeding initiation and continuation. A total of 1759 mothers responded to all questions regarding breastfeeding and depressive symptoms and were included in analysis. All data analysis was conducted with sampling weights to account for sampling methods, non-response, and sampling bias. Model building and diagnostics were performed according to the methods of Hosmer & Lemeshow.

Results:

Among respondents in this analysis, 13.5% reported postpartum depressive symptoms and 72.2% reported breastfeeding for at least eight weeks. The weighted prevalence of depression among mothers who breastfed for at least eight weeks was 7.9% compared with a prevalence of 16.2% among mothers who breastfed less than eight weeks. Breastfeeding for at least eight weeks was reported by 77.2% of Oregon mothers. Oregon mothers who breastfed less than eight weeks were 1.6 times more likely to have self-reported postpartum depressive symptoms than mothers who breastfed at least eight weeks (95% CI: 1.004-2.57) adjusting for maternal age, family income, current smoking status, and body mass index. Stressful life events were found to be an effect modifier of this association. Among women who reported no stressful life events, mothers who breastfed less than eight weeks were 4.8 times more likely to report postpartum depressive symptoms than mothers who breastfed at least eight weeks (95%: 2.28-10.17).

Among mothers who reported at least one financial stressful life event, the odds of self-reported postpartum depressive symptoms in mothers who breastfed less than eight weeks were 1.18 times the odds of self-reported postpartum depressive symptoms in mothers who breastfed at least eight weeks (95%: 1.02-1.37).

Discussion:

In Oregon mothers, postpartum depressive symptoms were 60% more likely among those who breastfed for less than eight weeks compared with those who breastfed for at least eight weeks. When mothers report any financial stressful life events the odds of postpartum depressive symptoms is 18% higher in mothers who breastfed for less than eight weeks compared with mothers who breastfed for at least eight weeks. Stressful life events were a significant effect modifier of the association between breastfeeding at least eight week and postpartum depressive symptoms. In the absence of stressful life events the odds of depressive symptoms increases significantly in mothers who breastfeed for less than eight weeks compared with mothers who breastfed for at least eight weeks. An evaluation of the literature suggests multiple potential causal associations. There is some evidence that breastfeeding causes a decrease in risk of postpartum depressive symptoms and there is evidence that postpartum depressive symptoms cause a decrease in breastfeeding practices. It is most likely that causality is working in both directions.

Conclusion:

Oregon mothers who breastfed for less than eight weeks were more likely to report postpartum depressive symptoms. This relationship remained significant after adjusting for demographic and behavioral characteristics family income, body mass index, current smoking status, and maternal age. These findings are consistent with other

studies. Evaluation of these studies supports the possibility of a bidirectional causal relationship between breastfeeding and postpartum depressive symptoms.

Introduction

Breastfeeding

Breastfeeding has often been studied to explore significant associations with maternal and infant health outcomes. Breastfeeding has been associated with numerous positive health outcomes. For maternal health, breastfeeding promotes quick healing after delivery, decreased postpartum blood loss, and maternal weight loss after pregnancy.[1] Breastfeeding has been associated with reduced risk of type 2 diabetes, rheumatoid arthritis, cardiovascular disease, breast, and ovarian cancer.[1] For the infant, breastfeeding is associated with decreased risk of otitis media, upper and lower respiratory tract infections, asthma, RSV, necrotizing entercolitis, atopic dermatitis, gastroenteritis, obesity, celiac disease, diabetes, leukemia and sudden infant death syndrome.[1] The financial benefits of breastfeeding are seen immediately in formula cost and over extended periods with reduction of negative infant health care outcomes.[1] In these studies, breastfeeding was examined broadly from any to exclusive and in durations from one-month to longer than six-months.

In most cases, the benefits of breastfeeding have not been linked causally to the associated outcomes. Inconsistency in study definitions of breastfeeding as well as primarily observational studies contributed to difficulty in examining cause. Despite these difficulties there is still substantial evidence supporting breastfeeding practices for mothers and infants. The American Academy of Pediatrics recommends breastfeeding

exclusively at least six-months with continued breastfeeding until the infant is one year old. The Healthy People 2020 objectives include goals for breastfeeding initiation and duration. Among these are initiation of breastfeeding by at least 81.9% of mothers and continued breastfeeding of at least 6 months in 60.6%.[2,3] The Oregon 2011 breastfeeding report card estimated that 91.2% of mothers initiated breastfeeding while 62.5% breastfed at least 6 months.[2]

Several factors affect breastfeeding practices in new mothers.[4] Term infants were more likely to be breastfed than preterm infants. [4] Additionally, mothers younger than 25 years old, low socioeconomic status, maternal obesity, low education, maternal use of Medicaid insurance for delivery, and smoking are all associated with short breastfeeding duration.[5] Hispanic mothers had higher rates of breastfeeding initiation and breastfeeding duration at least 10 weeks compared to white and black mothers.[6] Women at least 25 years old were more likely to initiate breastfeeding and continue breastfeeding at least three months compared with mothers younger than 25.[7] Women without a partner or social support system were less likely to continue breastfeeding.[8]

Postpartum Depression

Postpartum depression (PPD) is defined as depression occurring in the first year after birth as diagnosed using a self-administered paper questionnaire or self-administered paper questionnaire coupled with a clinical diagnosis. When the second method is used prevalence estimates of PPD are typically 30% lower than the self-administered test alone. PPD differs from the postpartum blues ("baby blues") in the duration and severity of symptoms experienced. Postpartum blues usually resolves within two weeks after birth with supportive care.[9] It is possible for postpartum blues to

progress to postpartum depression without supportive care when symptoms continue beyond two weeks.[9] In many cases, women are reluctant to discuss depression with their physicians due to social stigma related to depression.[9] It is estimated that between 10 and 15% of mothers experience postpartum depression in the year after birth.[10] Symptoms include sadness, lack of energy, trouble concentrating, anxiety, and feelings of guilt or worthlessness, which can inhibit parenting.[11] Women with PPD were more likely to develop recurrent depression in later years.[12]

Postpartum depression has effects beyond maternal health. Children of mothers with PPD during their first year of life were more likely to have inhibited language development, emotional and behavioral problems.[13,14] Postpartum depression was also associated with increased infant visits for acute and emergency visits.[14] Since 2004, the Pregnancy Risk Assessment Monitoring System (PRAMS) has revealed a general prevalence of PPD between 11.2% and 13.2% in Oregon mothers.[15] One of the greatest risk factors for postpartum depression is depression during pregnancy.[9] Mothers with depression diagnosed during and in the first year postpartum were more often less educated, had more children, more likely white, single/ widowed/ divorced, using Medicaid and smokers.[14] Unmarried women living with their partner less than two years were at higher risk of postpartum depression.[16]

Kingston 2012 found mothers younger than 25 had greater proportions EPDS scores indicating greater depression than older women. Liu 2012 reported, among race/ ethnicity groups, a higher percentage of postpartum depression diagnosis occurred in Asian Pacific Islander and Hispanic categories. After adjusting for socio-economic factors and discussion about mood, Hispanic mothers were no more likely to receive a

postpartum depression diagnosis than White mothers. Asian and Pacific Islanders reporting greater than 6 stressful life events were more likely to be diagnosed with postpartum depression.

Specific Aims

This thesis aims to determine the association between breastfeeding for at least eight weeks and self-reported postpartum depressive symptoms among Oregon mothers. Additionally this thesis will explore the potential for a causal association between breastfeeding and depressive symptoms. Specifically:

1. To describe the prevalence of breastfeeding at least 8 weeks and self-reported postpartum depressive symptoms in the 2007 sample of Oregon mothers with live births.
2. To measure the association between breastfeeding and self-reported postpartum depressive symptoms while adjusting for potential confounders and to examine the potential presence of effect modification using logistic regression.
    a. Examine additional risk factors that may influence the primary relationship between breastfeeding and self-reported postpartum depressive symptoms including income, race/ ethnicity, education, and marital status, parity, maternal age, insurance, smoking status, maternal body mass index, and stressful life events.
3. To determine whether directionality and causality can be determined using these results combined with current literature on the association between breastfeeding and self-reported postpartum depressive symptoms.

The following is an overview of literature that will be used to explore the potential for a causal association between breastfeeding and postpartum depressive symptoms.

Breastfeeding and postpartum depression

Many previous studies have examined the association between postpartum depression and breastfeeding initiation and duration. The association has been examined with both breastfeeding and depression evaluated as exposures and outcomes. Table 1 below gives a brief overview of these studies including sample size, study type, exposure and outcome measures, associations found and confounders considered. These articles are grouped by outcome.

Each study is individually summarized below individually including a description of exposure and outcome measures and a brief overview of the methods. Following the study descriptions is a brief overview of the hypothesized biological connection. These studies and the biological descriptions will be used in the assessment of the causal association between breastfeeding and postpartum depressive symptoms in the discussion.

Table 1. Overview of literature examining breastfeeding and depressive symptoms

1st Author, Year	Sample Size	Method	Exposure*	Outcome**	Measure of Association	Confounders***
Postpartum Depressive Symptom Outcomes						
Warner 1996	2375	Cross-sectional	Any BF	EPDS Dep	OR: 1.52 (1.12-2.06)	Age, MOD, Par, Employ, Mar, PgInt, SES
Chaudron 2001	465	Longitudinal	Feelings towards BF	Depressive Episode	Relative Risk: 3.0 (1.04-9.22)	Age, Dep, Neg thoughts, Sleep diff.
Yonkers 2001	297	Cross-sectional	Any BF	EDPS Dep	OR: 1.67 (1.23-2.27)	Edu, Dep, Age, Race, Par, HH Employ,

Mezzacappa 2002	24	Longitudinal	BF	Neg Mood	ANOVA: t(21)= 2.30; p<0.05	Age, Par, Employ,
Groër 2005	183	Cross-sectional	Exclusive BF	Mood Scores, Stress scores	ANOVA t=2.89 p=0.004	Inc, Race, MOD, Par, Age, Mar
Hatton 2005	185	Longitudinal	Any BF	EPDS Dep	ANOVA p<0.05	Age, Inc, Edu, Race, Dep
Watkins 2011	2185	Longitudinal	Feelings towards BF	EPDS Dep	OR= 1.42 (1.04-1.93)	Age, Par, Edu, Race, WIC
Tashakori 2012	150	Case-control	BF	EPDS Dep	X2(t=-2.9,df=148); p=0.004	Age, Edu, SES, Sex, MOD, Dep, Par,
Ystrom 2012	42,225	Longitudinal	BF, Mixed BF, Form	Anx & Dep Symptoms	β=0.08(0.05-0.11) (Mixed) β=0.24(0.21-0.29) (Form)	Par, Smoke, Dep,
Zubaran 2012	89	Cross-sectional	BF self-efficacy	EPDS Dep, PDSS Dep	R^2=0.125; F(1,87)-12.43 p=0.001	SES, Age, Edu, Mar, Inc
Breastfeeding Outcomes						
Henderson 2003	1410	Longitudinal	EPDS Dep	BF Duration	HR=1.25 (1.03-1.52)	Age, Edu, SES, Smoke,
Dennis 2007	594	Longitudinal	EPDS Dep	BF duration	OR: 0.57 (0.34-0.95)	Inc, MOD, Race, Mar, Edu
Gaffney 2012	1447	Longitudinal	EPDS Dep	BFI	OR: 1.57 (1.16-2.13)	Race, Age, Edu, Inc, BMI, Smoke

*Anx- Anxiety; Dep-Depression; EPDS Dep- Depression determined by self-reported EPDS; PDSS Dep- Postpartum Depression Screening scale.
**BF-Breastfeeding predominantly; Mixed BF-Mixed breastfeeding and formula feeding/ solids; Form-Formula feeding predominantly and solids: Any BF- Any reported breastfeeding; BF self-efficacy- Breastfeeding self-efficacy scale short form; BFI-breastfeeding intensity
***Age-maternal age; Inc-Income; Edu-education; Race-Maternal Race/ Ethnicity; Dep-Antenatal depression; MOD-mode of delivery; Par-Parity; Sex- infant sex; SES-Socioeconomic status; Smoke-Maternal smoking postpartum; Mar- Marital status; WIC-Participation in Women Infant Child; BMI-Body Mass Index; PgInt=Pregnancy Intention; Neg thoughts- thoughts of death and dying; Sleep diff- difficulty falling asleep; Employ-employment status of mother or spouse; HH- who is living in the household

Postpartum depressive symptoms outcomes

Warner 1996 examined risk factors associated with postpartum depressive symptoms (EPDS >12) at six weeks. Mothers were interviewed between 6 and 8 weeks postpartum. Women who were not breastfeeding at six weeks were 1.52 times more likely to have postpartum depressive symptoms (EPDS >12) than women who continued to breastfeed at six weeks (95%: 1.12-2.06). Confounders considered included pregnancy intention, maternal employment and head of house employment, parity, marital status, maternal age, socioeconomic status, and mode of delivery,.

Chaudron 2001 examined women in the United State of America. Women were examined at one month postpartum and at 3 months postpartum if they did not have depressive symptoms at one month. Depressive symptoms were defined as major depressive symptoms (>15) on the Center for Epidemiologic Studies Depression Scale. They found breastfeeding mothers who worried about breastfeeding were significantly more likely to develop depressive symptoms postpartum (RR: 3.0 95%: 1.04-9.21); however, breastfeeding itself was not significantly predictive of major depressive episodes. Breastfeeding was defined as any breastfeeding compared with those who reported not breastfeeding.

Yonkers 2001 reported women with any breastfeeding at three weeks postpartum were less likely to have depressive symptoms (OR: 0.60; 95%: 0.44-0.81; p=0.008). This association was not seen at four and five weeks postpartum. Depressive symptoms were identified via EDPS score of at least 12.

Mezzacappa 2002 conducted an analysis of 24 mothers examined self-reports of Positive and Negative Affect Scale (PANAS) to assess current mood state. Mothers were assessed at two separate feedings (once bottle (formula) feeding, once breastfeeding). They completed the Positive And Negative Affect Score 10 minutes before and 10 minutes after feeding to determine the effect of feeding method on changes in mood. They found a significant decrease in positive mood before bottle-feeding to after bottle-feeding ($t(22)=4.38$; $p<0.01$). There was a significant decrease in negative mood from before to after breastfeeding ($t(21)=2.30$; $p<0.05$).

Groër 2005 examined the difference between exclusive breastfeeding, formula feeding, and controls in relation to stress, mood, and endocrine hormones. Among

mothers who breastfed mood scores (determined by Profile of Mood State) were significantly lower in regards to depression (t=2.89; p=0.004), anger (t=-2.59; p=0.01) and anxiety (t=2.7; p=0.008) compared with mothers who used formula. Mothers who used formula also had higher perceived stress scores (t=-2.4; p=0.016). Breastfeeding was defined as only feeding from the breast with no bottle use.

Hatton 2005 used data collected from a study evaluating Calcium for Preeclampsia Prevention (CPEP). That study collected information on breastfeeding and depressive symptoms (EPDS ≥14) at six and twelve-weeks postpartum. They found that depression symptoms were significantly lower in women who breastfeed for 6 weeks after controlling for age, income, education, race and history of depression (N=185). The association was not found at 12 weeks postpartum. Non-breastfeeding mothers had the highest probability of early major depressive disorder (EPDS ≥15). Breastfeeding was defined in this study as any current breastfeeding with no information regarding other supplementation.

Watkins 2011 examination of breastfeeding mothers from the Infant Feeding and Practices Study II considered the association between breastfeeding experiences and postpartum depressive symptoms (EPDS >12). They found that women who disliked breastfeeding during the first week were more likely have postpartum depression at two months (OR=1.42; 95%: 1.04-1.93). Confounders considered included maternal age, parity, education, ethnicity, and WIC participation. They also found the reverse association that mothers with postpartum depressive symptoms were less likely to still breastfeed at two months postpartum compared to mothers without postpartum depressive symptoms (p=0.04). Negative experiences regarding breastfeeding were significantly

associated with increase odds of postpartum depressive symptoms including severe pain with breastfeeding on day one (OR: 1.96; 95%: 1.17-3.29), and severe breast pain at two weeks (OR: 2.24; 95%: 1.18-4.26).

Tashakori 2012 recruited breastfeeding and non-breastfeeding mothers at two- and six-months postpartum. They defined their exposure as breastfeeding exclusively for the first six months and excluded any mothers who stopped exclusive breastfeeding. They found a significant difference in the prevalence of postpartum depression via the Edinburgh Postnatal Depression Scale between breastfeeding (n=2) and non-breastfeeding (n=14) mothers (p=0.004).

Ystrom 2012 used the longitudinal cohort study (MoBa) on Norwegian maternal health and examined the relationship between predominant breastfeeding (primarily breast milk), mixed breastfeeding (breast milk supplemented with formula or solids), and formula (bottle-feeding of only formula and solids) feeding and anxiety and depressive symptoms at 30 weeks gestation and six months postpartum. They found, after adjusting for pre-partum anxiety and depressive symptoms, mixed breastfeeding (β=0.04 CI: 0.02-0.07) and formula feeding (β=0.11 CI: 0.09-0.14) were predictive of increased postpartum anxiety and depressive symptoms. Additionally they found formula feeding exclusively to be a more severe risk factor of postpartum depressive symptoms than mixed breastfeeding (bottle and breastfeeding). Further, women who changed from breastfeeding to formula feeding had a greater increase in anxiety levels at six-months postpartum than women who continued to breastfeed at six months. Confounders considered included birth by cesarean, first child, plural birth, preterm birth, maternal smoking.

Zubaran 2012 examined breastfeeding self-efficacy effect on postpartum depressive symptoms (EPDS >12). Breastfeeding self-efficacy was based upon the Breastfeeding Self-Efficacy Scale short-form in which high scores can predict breastfeeding duration at 4, 6, 8, and 16 weeks postpartum. They interviewed mothers between two and twelve weeks postpartum. For analysis they considered only mothers who were still breastfeeding at week 12. The 89 mothers included for analysis were divided into exclusive breastfeeding (n=69) and mixed (breast milk and formula) feeding (n=20). They found that higher breastfeeding self-efficacy scores (found in exclusively breastfeeding mothers) were negatively associated with EPDS and PDSS scores ($p<0.001$).

Breastfeeding outcomes

Henderson 2003 found women with postpartum depression at any point postpartum were 1.25 times more likely to stop breastfeeding at that same time point than women who were not depressed (95%: 1.03-1.52). They defined breastfeeding as any breastfeeding, full breastfeeding (exclusive/almost exclusive), partial breastfeeding (high, medium, low), and no breastfeeding. Depression was determined using EPDS scores above 12. Measures were taken at 2, 6, and 12 months postpartum. In most cases women stopped breastfeeding up to ten weeks earlier than women without postpartum depression. The majority of women (82%) stopped breastfeeding after onset of postnatal depression compared with 7% of women who stopped breastfeeding before onset of postnatal depression.

Dennis 2007 conducted secondary data analysis of a longitudinal study of surveys sent at 1, 4 and 8 weeks postpartum. They found mothers with depressive symptoms at

one-week postpartum were less likely to continue breastfeeding at eight weeks postpartum (OR: 0.57; 95%: 0.34-0.95). They defined breastfeeding as any feeding of breast milk. Bottle-feeding was defined as no breast milk given. EPDS scores above 12 determined presence of depressive symptoms.

Gaffney 2012 used data from the Infant Feeding Practice survey to examine the effect of postpartum depression on amount of breast milk used in feeding as part of the total milk diet, which includes formula and breast milk. They found that women with postpartum depression were 1.57 times more likely to use less than 20% breast milk as the main source of nutrition for their infant after adjusting for maternal race/ethnicity, maternal age, maternal education, and household income (95%: 1.16-2.13). Postpartum depression was defined by an EPDS score of at least 10.

One article, Nishioka 2011, was excluded from analysis. This article examined differences in the proportion of breastfeeding vs. formula-feeding mothers with depressive symptoms as well as changes in infant feeding method. The article was unclear when reporting results about change in infant feeding methods.

Biological Plausibility

Several biological mechanisms have been proposed to explain the association between breastfeeding and depressive symptoms. Stuebe 2012 suggested breastfeeding promoted feelings of connection between mother and child, increasing levels of oxytocin in the maternal brain. Additionally, gonadal and lactogenic hormones and stress have overlapping effects on lactation success and depression during and after pregnancy. Decreased estrogen levels allowing milk development may play a role in postpartum depression development. Oxytocin promotes infant protection by mothers and milk

transfer, but low levels during pregnancy are associated with postpartum depression. Breastfeeding also increases prolactin levels postpartum. Decreased prolactin levels are associated with maternal anxiety. Improving breastfeeding duration in Oregon mothers may have a concurrent effect on postpartum depression outcomes.

Bair 2003 suggested that neurotransmitters associated with pain and depression may contribute to the link between difficultly with breastfeeding and postpartum depression due to decreased serotonin levels. Kendall-Tackett 2010 noted inflammation triggered by stress as well as sleep disturbance and fatigue related to cytokine levels may be a major biological risk factor for depression. Breastfeeding is thought to down regulate the stress response thereby reducing risk for depression. These biological bases will be examined in further detail in the discussion of cause.

Causality

Hill's criteria for causality will be used to examine the relationship between breastfeeding and postpartum depressive symptoms. In epidemiology, cause is defined as a factor that when present increases the likelihood of an outcome and when absent decreases the likelihood of an outcome. The magnitude of cause can vary. Causes can be necessary and sufficient where the factor in question is enough in and of itself to develop the outcome. Cause may be necessary where the absence of the factor prevents the outcome. Cause may also be sufficient where presence of the factor will result in both the absence and presence of the outcome but the outcome may exist in absence of the factor. Hill's Criteria for causality[35] is often used to determine cause. The criteria are: strength, specificity, consistency, temporality, biological plausibility, dose-response and intervention. Strength is the magnitude of the association and provides increased support

with increased strength. Specificity provides better support for cause when the definition of the primary predictor and outcome variables is accurately described. Consistency provides support for cause when an association is found across multiple studies and within multiple subgroups. Temporality is important for describing cause to ensure the outcome is a result of the factor in question and not the reverse. Biological plausibility provides a tangible explanation of the association in question. Dose-response and intervention examine how the outcome changes with changes in the factor of interest via varying amounts and presence or absence of that factor. When combined these criteria provide evidence that a causal relationship is possible.

Methods

PRAMS

This project used data from 2007 Oregon Pregnancy Risk Assessment Monitoring System (PRAMS). The PRAMS survey is an epidemiologic survey used to evaluate maternal health behaviors with the goal of improving the health outcomes of mother and infants. Implemented by the Oregon Public Health Division (and other state health departments) in conjunction with the Centers for Disease Control and Prevention, the survey collects information regarding maternal experience before, during, and after pregnancy. The goal of PRAMS is to improve the health of mother and infants through identification of adverse outcomes including maternal morbidity, and infant morbidity and mortality. The Oregon PRAMS survey is designed to oversample women in underrepresented race, ethnicity, and low birth weight strata to ensure adequate sample size for these subsets of population.

Selecting from a stratified random sample of Oregon mothers who have delivered live-born infants in Oregon, the Oregon PRAMS sample is selected from available birth certificates approximately 60 day after delivery. The survey is mailed out two to four months after delivery. Surveillance is conducted via mail in two parts with telephone follow-ups for non-responders. Eligible participants for the 2007 PRAMS survey were Oregon resident mothers who delivered a live infant in Oregon during the surveillance period. Birth certificates were used to identify resident Oregon mothers who delivered in the prior two to four months. The PRAMS survey was conducted as a series of eighty self-administered questions. The written survey and telephone interview asked the same

questions and were completed in either Spanish or English. The 2007 survey questionnaire is included in Appendix A.

PRAMS Sampling Weights

The PRAMS data set uses complex sample weights to adjust for oversampling of underrepresented racial and ethnic populations, and low birth weight infants, and to adjust for non-respondents. Underrepresented racial and ethnic groups and low birth weight infants are oversampled in order to examine a particular interest of public health. Oversampling (sampling at higher rates than other subpopulations) ensures adequate sample sizes for subgroup analyses of a particular group or comparisons of several groups. The Oregon PRAMS survey uses the same race/ ethnicity definition from the CDC: Hispanic, Non-Hispanic White, Non-Hispanic African American, Non-Hispanic Asian/ Pacific Islander, and Non-Hispanic American Indian/ Alaskan Native. In 2007 Oregon PRAMS also oversampled low birth weight white infants. Due to Oregon's race/ ethnic composition the sampling of low birth weight infants from the "white" strata is reasonable.

In addition to oversampling of underrepresented populations, Oregon PRAMS also adds a nonresponse weight to account for women who may be less likely to respond to the survey. This weight is devised within each sampling stratum after comparing non-respondents with respondents. Additionally, a non-coverage weight is applied to account for women who may have been excluded from the sampling frame due to accidental duplication in birth certificate records and missing files. The CDC determines this weight after collection of all PRAMS data. Unless otherwise specified, all numbers in this thesis are unweighted, and all percentages are weighted.

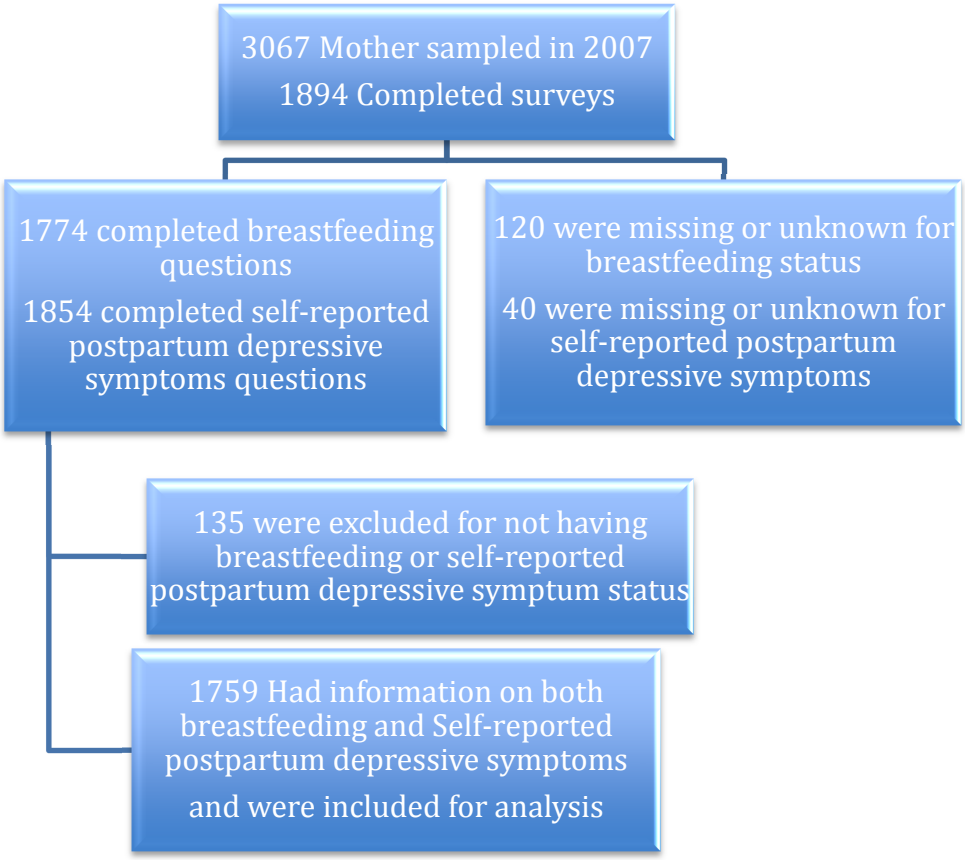
Response Rates

In 2007 surveys were sent to 3067 women. The following groups were oversampled: normal birth weight White, low birth weight White, Hispanic, African American, Asian/ Pacific Islander, American Indian/ Alaskan Native groups. Of those, 1,894 women completed surveys via mail or telephone with the unweighted response rate of 61.8%. The weighted response rate was 67%.

Inclusion and Exclusion Criteria for this Analysis

Of the 3,067 women sampled, the analysis set included 1,759 women who responded to survey questions regarding depressive symptom and breastfeeding status summarized below. Of the 1,894 women who completed the survey, 120 did not have enough information to determine their breastfeeding status at eight weeks. Forty did not have enough information to determine self-reported postpartum depressive symptom status. Of the unknowns, 15 with breastfeeding information did not have information on self-reported postpartum depressive symptoms, and 95 did not have information on breastfeeding but did have information on self-reported postpartum depressive symptoms. An additional 25 did not have information on either breastfeeding or self-reported postpartum depressive symptoms. In total 135 participants were excluded from the dataset leaving 1759 with breastfeeding status at eight weeks and self-reported postpartum depressive symptoms status. Figure 1 below diagrams the inclusion and exclusion of respondents. The determination of depressive symptom and breastfeeding status is explained in detail below.

Figure 1: Inclusion and Exclusion of participants for analysis



Variable Coding

Self-Reported Postpartum Depressive Symptoms

The primary dependent of interest was self-reported postpartum depressive symptoms. Self-reported postpartum depressive symptoms (SRPPDS) were coded as a dichotomous variable with options of present vs. absent, or unknown. The PRAMS survey asked two questions regarding self-reported postpartum depressive symptoms. These two questions together are highly sensitive for detection of depressive symptoms.[45]

The following are results of each question and combinations of those questions to create the SRPPDS variable. Table 2 gives an overview of each question.

The first question asked, "Since your new baby was born, how often have you felt down, depressed, or hopeless?" Possible responses were "Always," "Often," "Sometimes," "Rarely," or "Never." 1,863 (98%) responded to the questions (Table 2). A histogram of this response revealed a skew with a peak around those responding "Rarely" (Appendix B).

The second question asks, "Since your new baby was born, how often have you had little interest or little pleasure in doing things?" Possible responses to this question were: "Always", "Often", "Sometime", "Rarely", "Never." 1,856 of 1,894 (97%) responded to this question (Table 2). A histogram of the responses reveled a skew with a peak around those responding to "rarely" (Appendix C).

Table 2 : Questions used in analysis of self-reported postpartum depressive symptoms

Question	Always	Often	Sometimes	Rarely	Never	Missing
"Since your new baby was born, how often have you felt down, depressed, or hopeless?"	30	165	474	628	566	31
"Since your new baby was born, how often have you had little interest or little pleasure in doing things?"	57	117	436	649	597	38

The responses to these two questions were combined to create the variable of self-reported postpartum depressive symptoms (Table 3). SRPPDS was considered unknown if respondents answered "sometimes", "rarely", or "never" to one question and did not

respond to the other question (n=11, <0.01%). Additionally, respondents were classified as unknown if they did not respond to either question (n=29, 1.5%).

SRPPDS was considered present if respondents answered "Always" or "Often" to either question. If a responded answered "Always" or "Often" to one question and did not respond to the other question they were also considered present. This classification is consistent with CDC 2008 classification of SRPPDS categorization. There were no respondents who fit the criteria for this classification. A total of 268 respondents were classified as present for self-reported postpartum depressive symptoms based upon the above criteria. SRPPDS was considered absent if both questions were answered as "Sometimes", "Rarely", or "Never." 1,586 respondents fit these criteria and were considered absent for SRPPDS. Table 3 below contains the cell counts for each question and the cell totals. Table 4 gives the final counts for the self-reported postpartum depressive symptoms variable.

Table 3. Classification of self-reported postpartum depressive symptoms

Question		"Since your new baby was born, how often have you felt down, depressed, or hopeless?"			
		Present	Absent	Missing	Total
"Since your new baby was born, how often have you had little interest or little pleasure in doing things?"	Present	101	94	0	174
	Absent	73	1586	9	1682
	Missing	0	2	29	38
	Total	195	1668	31	1894

Table 4. Total numbers of self-reported postpartum depressive symptoms used in analysis

Present	Absent	Missing	Total
268	1586	40	1894

Independent Variables

Any breastfeeding at least 8 weeks duration

The primary independent variable of interest is any breastfeeding with a specific duration cutoff of less than eight weeks and at least eight weeks. This variable was developed using responses to six questions from the PRAMS survey in conjunction with the infant birthdate. The questions followed a skip pattern. Each question had a possible response of yes or no. A yes response led to the next question in the series. Any response of no indicated a skip to the next section of questions. Each question in the skip pattern is detailed below. Table 5 gives an overview of responses to each question in the skip pattern used to classify breastfeeding status.

The first question asked, "Is your baby alive now?" Of the responses, 1808 infants were alive at the time of the survey, 26 were dead, and 60 did not provide an answer to this question. From these responses, only those who answered yes were included in the next part of analysis. Those with infants who were not living were excluded (n=26).

The next question asked, "Is your baby living with you now?" Of the entire sample, 1800 mothers reported the infant was living with them currently, 7 reported the infant was not living with them, and 87 did not respond to the question. Of those where the infant was not reported as dead, 1800 (99.6%) mothers reported the infant was living with them, 7 mothers reported the infants were not living them, and 61 did not respond to this question. Those women who responded the infant was living with them were included for further analysis (n=1800).

The next question in the skip pattern asked, “Did you ever breastfeed or pump breast milk to feed your new baby after delivery?” Of those who reported that the infant was living with them, 1,661 mothers (92.3%) reported ever breastfeeding, 133 mothers (7.4%) reported no attempt of breastfeeding and 6 mothers (0.3%) did not respond to the question. The 133 who reported no attempt at breastfeeding were counted as zero for duration of breastfeeding. The six who did not respond were categorized as unknown in analysis because of lack of information regarding breastfeeding practices. The 1,661 that reported any breastfeeding were included for further analysis.

The next question asked, “Are you still breastfeeding or feeding pumped milk to your new baby?” Of the 1,661 that reported any breastfeeding, 1,096 (66%) reported still breastfeeding, 55 (3.3%) reported stopping breastfeeding, and 10 (0.6%) did not respond to the questions. The 10 who did not respond were listed as unknown because duration could not be determined. The 1,096 who reported still breastfeeding and the 564 who reported not breastfeeding were converted into breastfeeding duration in the following ways.

Respondents who stopped breastfeeding were asked, “How many weeks or months did you breastfeed or pump milk to feed your baby?” Possible responses were numerical as either weeks, months (1 month = 4 weeks), or less than one week. Of those who reported infant living with mother, breastfeeding initiation, and stopped breastfeeding 545 of 555 responded to the breastfeeding length question. Of the respondents, 47 reported breastfeeding less than one week. The average breastfeeding duration of the 498 who stopped breastfeeding but breastfed more than one week was 6.18 weeks (SD ± 4.43 weeks).

The second determination of breastfeeding duration included respondents who reported still breastfeeding. Length of time breastfeeding was determined as the difference between date of survey completion and infant birthdate (calculated in days). This was converted to weeks (1 week=7 days) for purposes of analysis. When combined with breastfeeding duration calculated above as well as those who did not initiate breastfeeding the average duration of breastfeeding was 10.70 weeks (SD +- 6.09 weeks).

The primary interest of this project was breastfeeding eight weeks, thus the above breastfeeding duration was categorized as mothers that breastfed at least eight weeks, and mothers who breastfed less than eight weeks. Histogram analysis of mothers who breastfed at least one week or longer showed normal distribution around the mean (Appendix D).

One hundred twenty survey respondents were categorized as unknown due to inability to clarify responses to missing information or incomplete information about breastfeeding. Of these 120, 26 were excluded because the infant was not living. Seven were excluded because the infant was not living with the mother, and 61 were excluded because information about where the infant resided was missing. Six were excluded because of missing information regarding breastfeeding initiation and ten were excluded because of missing information regarding if they were still breastfeeding. Finally, 10 were excluded because of lack of information regarding duration of breastfeeding.

Table 5: Summary of responses used to determine breastfeeding status

Question	**Yes**	**No**	**Missing**	**Total**
Is your baby alive now?	1808	26	60	1894
Is your baby living with your now?	1800	7	61	1868
Did you ever breastfeed or pump breast milk to feed your new baby after delivery?	1661	133	6	1800
Are you still breastfeeding or feeding pumped milk to your new baby?	1096	555	10	1661

How many weeks or months did you breastfeed or pump milk to feed your baby?	< 1 week >= 1 week Missing	47 498 10
Total valid for analysis **Missing/ Unknown**		1774 120

Covariates

Covariate associated with breastfeeding and postpartum depressive symptoms were selected for evaluation as confounders and effect modifiers. These covariates included maternal behaviors and experiences related to pregnancy and birth outcomes. Prior literature review directed selection of covariates that were associated with breastfeeding and self-reported postpartum depressive symptoms and accessible via the PRAMS dataset. Covariates were analyzed first as multiple categories and later refined based on weighted percent reporting depression, overlapping confidence intervals, and small cell sizes where applicable. Any covariate with only two possible responses was left as such for analysis. Each variable considered is detailed below including variable coding for analysis. Table 6 and 7 give an overview of each variable and its categorization for analysis.

Potential Confounders

Variables from Birth Certificate Data

Maternal age was initially categorized in the dataset as six groups, younger than 18, 18-19, 20-24, 25-29, 30-34, 35-39, and greater than 39 years. Initial analysis showed maternal age was normally distributed, but there was no linear trend in weighted percent reporting depression. The weighted percent reporting depression was less than 10% in categories older than 25 years, thus those 25 and older were grouped together for ease of analysis. For bivariate analysis, maternal age was categorized dichotomously as younger

than 25 years and 25 years or older. The use of 25 years as a cutoff was based on literature review as well as differences in weighed percentage reporting depression and to ensure sufficient cell counts. Bivariate analysis suggested the dichotomous categorization of maternal age was a more significant representation, thus is was that form used for model building.

Marital status was initially grouped into three categories, married, not married with father on the birth certificate, and not married with father not on the birth certificate. Initial analysis indicated the not married categories could be collapsed based on similarities in weighted percent reporting depression and overlapping confidence intervals. For model building, marital status was considered dichotomously as married or not married.

Maternal race and ethnicity was coded in five groups: Hispanic, Non-Hispanic white, Non-Hispanic African American, Non-Hispanic Asian/ Pacific Islander, and Non-Hispanic American Indian/ Alaskan Native. For purpose of sampling women were allowed to choose one racial category: White, African American, Asian/Pacific Islander, or American Indian/ Alaskan Native. For ethnicity, women chose from Hispanic or Non-Hispanic. When entered into the database, women were grouped by ethnicity first then by race if they self-identified as non-Hispanic. Maternal race and ethnicity was initially considered as a confounder. Some evidence suggests that rates of postpartum depression and breastfeeding differ among race/ethnicity categories; maternal race and ethnicity will also be considered as an effect modifier.

Maternal education was coded in the dataset as 8^{th} grade or less, 9^{th} grade -12^{th} grade no diploma, high school graduate or GED, college credit up to an Associate degree,

and Bachelor's, Master's, PhD, or other professional degree. For initial analysis, maternal education was grouped into three categories, <12th grade, 12th grade/ GED, and >12th grade based upon prior literature review. Bivariate analysis showed similar weighted percent reporting depression as well as overlapping confidence intervals between the less than high school and high school/ GED categories. These were combined for ease of analysis during model building.

Table 6. Coding of independent variables derived from birth certificate data		
Demographic Variables	Possible Responses	Coding for Analysis
Maternal Age	Continuous	0= >=25 1= <25
Marital Status	Married, not married. Father's name on birth certificate (yes, no).	0=Married 1=Not Married
Maternal race/ethnicity	Hispanic, NH White, NH African American, NH Asian/Pacific Islander, NH American Indian/ Alaskan Native	0=Non Hispanic White, 1=Hispanic, 2=Non Hispanic African American, 3=Non Hispanic Asian/Pacific Islander, 4= Non Hispanic American Indian/ Alaskan Native
Maternal Education	Less than 12th grade, 12th grade/ GED, Greater than 12th grade	0= >12th grade 1= <=12th grade

Variables from Oregon PRAMS

Variables considered in analysis from Oregon PRAMS included pregnancy intention, family income, insurance before pregnancy, parity, current smoking status, body mass index, and stressful life events. Each variable is detailed below. Table 8 gives an overview of each variable and categorization.

Pregnancy intention was coded dichotomously as intended or not intended based on a combination of responses to the question: "Thinking back to just before you became

pregnant with your new baby, how did you feel about becoming pregnant?" Possible responses included: "I wanted to be pregnant sooner" "I wanted to be pregnant then" "I wanted to be pregnant later" or "I didn't want to be pregnant then or anytime in the future". Responses of "I wanted to be pregnant soon" and "I wanted to be pregnant then" were coded as pregnancy intended. Responses of "I wanted to be pregnant later" or "I didn't want to be pregnant then or anytime in the future" were coded as pregnancy not intended.

Family income was created using the question, "During the 12 months before your new baby was born, what was your total household income before taxes? Including self and partner's income and any other sources of income." The possible responses were grouped in $5,000 increments from less than $10,000 to more than $50,000. Based on the response the variable was coded based on the 2006 federal poverty level (FPL) guidelines using the reported income and household size. Initial coding was 50% FPL or less, 50-99% FPL, 100-199% FPL, and 200% FPL or more. Analysis with self-reported postpartum depressive symptoms outcome showed similar weighted percent reporting depression and confidence intervals in levels less than 200%, so the variable was further categorized as <200% FPL and 200% FPL or more for analysis and model building.

Insurance before pregnancy was determined based upon the questions, "Just before you got pregnant, did you have health insurance?" and "Just before you got pregnant, were you on Oregon Health Plan or Medicaid?" with possible responses of yes or no. If respondents answered no to both questions they were coded as no to insurance before pregnancy. If respondents answered yes to either question they were coded as yes to insurance before pregnancy.

Parity was considered in two ways. First, women were categorized into first child, second child, or third or more children. These categories were collapsed into first child or second or more children based on similar weighted percent reporting depression and overlapping confidence intervals.

Smoking after pregnancy was based on the question, "How many cigarettes did you smoke on an average day now?" Women were categorized as non-smoker and smoker. Those who reported smoking zero cigarettes now were classified as non-smokers. Those who reported anything above zero were classified as smokers.

Body mass index was calculated using two questions. The first was "Just before you got pregnant with your new baby, how much did you weigh?" and "How tall are you without shoes?" For initial analysis, body mass index (BMI) was divided into four categories: underweight, normal weight, overweight, and obese. These categories corresponded to standard groupings of body mass at <18.5, 18.5-<25, 25-<30 BMI, and 30 or greater BMI, respectively consistent with literature and medical classification. Similarities in weighed percent reporting depression led to dichotomous grouping of body mass index into less than 25 BMI and greater than or equal to 25 BMI. For model building the dichotomous variable was used.

Stressful life events were considered in multiple ways. The PRAMS survey has a list of 13 statements identifying various stressful events that happened in the 12 months before infant birth. Examples of events include "I was homeless," "My husband or partner lost his job" with possible responses of yes or no to each event (Table 7). The first categorization involved grouping number of events as 0, 1-2, 3-4, 5-6, 7 or more. Stressful life events was categorized as 0 events, 1-2 events and 3 or more events as well

as dichotomous categories of 0 event or at least 1 event, and less than 2 events or at least 2 events.

Consideration was also give to type of stressful life event following the principal component analysis procedure of Ahluwalia et al. 2001. In this categorization, stressful life events are grouped into four constructs. Emotional (including very sick family member, or someone very close died), partner associated (argued more than usual with partner or husband, separated or divorced, or husband or partner said he did not want pregnancy), financial (mother lost job, husband or partner lost job, moved to a new address, bill could not be paid), and traumatic (homeless, involved in a physical fight, mother, husband, or partner went to jail, or someone very close had a problem with drinking or drugs) (Table 7). If the mother answered yes to one of the events within a category then that category is defined as present. If no events within a category were answered as yes, then that category is defined as absent. Based upon the small cell sizes for partner and traumatic stress (n=53, n=47, respectively) these were condensed when considered for effect modification. Both the numerical grouping and type grouping were considered in analysis.

Table 7. Coding of stressful life events by type

Stressful Event	Possible Response	Type grouping
A close family member was very sick and had to go to the hospital	Yes or No	Emotional
I got separated or divorced from my husband or partner	Yes or No	Partner Associated
I moved to a new address	Yes or No	Financial
I was homeless	Yes or No	Traumatic
My husband or partner lost his job	Yes or No	Financial
I lost my job even though I wanted to go on working	Yes or No	Financial
I argued with my husband	Yes or No	Partner Associated

or partner more than usual		
My husband or partner said he didn't want me to be pregnant	Yes or No	Partner Associated
I had a lot of bills I couldn't pay	Yes or No	Financial
I was in a physical fight	Yes or No	Traumatic
My husband or partner or I went to jail	Yes or No	Traumatic
Someone very close to me had a bad problem with drinking or drugs	Yes or No	Traumatic
Someone very close to me died	Yes or No	Emotional

Table 8. Coding of variables from the 2007 Oregon PRAMS dataset		
PRAMS Measures	Possible Responses	Coding for Analysis
Pregnancy Intention	I wanted to be pregnant sooner, I wanted to be pregnant later, I wanted to be pregnant then, I didn't want to be pregnant then or any time in the future	0=No if response is "I wanted to be pregnant later" or "I didn't want to be pregnant then or any time in the future" 1=Yes if response is "I wanted to be pregnant sooner" or "I wanted to be pregnant then"
Family Income	Less than $10,000, $10,000-$14,999, $15,000-19,999, $20,000-24,999, $25,000-$34,999, $35,000-$49,999, $50,000 or more	0= 0% - 200% Federal Poverty Level 1= 200% Federal Poverty Level or greater
Insurance before pregnancy	No Yes	0= Yes 1= No
Parity	First child, second child, third child, fourth child, fifth child or more	0=First child 1= Second child or more
Smoking Now	41 or more cigarettes 21-40 cigarettes 11-20 cigarettes 6-10 cigarettes 1-5 cigarettes Less than 1 cigarette	0= 0 cigarettes 1=1 or more cigarettes

	0 cigarettes	
Body Mass Index	A ratio of weight before pregnancy and height without shoes	0=<25 BMI 1=25 or greater BMI
Stressful Life Events	No Yes	0=0 Events 1=1-2 Events 2=3 or more Events or 0=0 Events 1=1 or more Events or 0=Less than 2 Events 1=2 or more Events

Descriptive Analysis

The analysis set population was evaluated for potential differences between the included versus excluded subjects. Chi-squared tests were used to evaluate possible bias in the analysis set population from exclusion of respondents. All variables were initially examined using cross tabulation to check their cell counts and weighted frequencies and to ensure sufficient sample size for variable inclusion in analysis.

Bivariate Analysis

Bivariate logistic regression analysis was used to evaluate each individual confounder. Unweighted and weighted percent reporting depression were calculated for each variable to determine referent categories and to examine the prevalence of reported depression among individual variables. Bivariate logistic regression was conducted to determine variables that were significantly associated with self-reported postpartum depressive symptoms. These variables were included in model building via multivariate logistic regression analysis.

Using bivariate logistic regression, potential confounding variables were assessed for correct categorization. Variable categories with similar weighted percent's or overlapping confidence intervals were combined for further analysis.

Multivariate Analysis

Multivariate logistic regression was conducted to quantify the association between breastfeeding at least eight weeks and SRPPDS using techniques outlined by Hosmer and Lemeshow 2000. All variables with p-values less than 0.25 in bivariate analysis were considered for inclusion in the multivariate model. Multi-categorical variables were collapsed based upon p-values, confidence intervals, and similarities in odds ratios from bivariate logistic regression where applicable.

Forward Stepwise Model Building

Forward stepwise model building was conducted to determine significant confounders for inclusion in the final model. Significant variables were determined based on the highest absolute value of the t-statistic and significant p-values. Logistic regression analysis was run with all variables considered individually with SRPPDS outcome and the most significant variable retained in the model. The most significant variable was included in the model first. For example with A, B, C, and D variables, A was added first. Then a comparison between the models with AB, AC, and AD is done to determine whether B, C, or D was significant. That variable was then added to the model and the selection continued until no added variables retained significance once in the model. If at any point a variable added in prior stages became insignificant during the growth of the model, it was removed and variable selection continued. The removed variables were added again at the end of model building to confirm their removal.

Backward stepwise elimination was used to compare with the forward selection model. Backward elimination began with a full model where all variables of interest were included. Then one by one the variables with the least significant p-value and smallest absolute t-statistic value were removed until the remaining variables in the model were all significant. This procedure should confirm the same model as the forward stepwise procedure. These two procedures were used to create the preliminary main effects models. This model was further assessed for effect modification and finalization.

Effect Modification

Effect modification was assessed in the following covariates: Maternal race/ ethnicity and stressful life events categorized by type of stress and by number of stressful events. Effect modification was examined to test for differences in the association among variable categories. To determine the presence or absence or effect modification, an interaction term was created with the main predictor of breastfeeding. Significance of the effect modifier was determined for the interaction term using the "testparm" command in Stata (a Wald test), which provides an f-statistic and p-value among multi-categorical variables. Maternal race/ethnicity was chosen based on prior literature suggested breastfeeding and depression differed among race/ethnicity categories. Stressful life events were considered to determine if the association between breastfeeding and depressive symptoms differed based on number of stressful life events or types of stressful life events.

Data Management

This study used a data set released by DHS that contained no personal identifiers. The Oregon Department of Human Services conducted all data entry verification and

telephone interview-monitoring, data correction, and editing of PRAMS data files. The CDC checked all data for consistency via automated processes and created the PRAMS analysis file with weights provided to the Oregon State Health Department. The data file for analysis was acquired in STATA format. All analysis was conducted using STATA version 12.1 software. All analysis was conducted using appropriate sampling and non-response weights. This study was determined by OHSU IRB to be non-human research and to be exempt from need of full review.

Results

The following results are reported based on weighted analysis of the included subset sample. Included is a description of the population, weighted percent reporting postpartum depressive symptoms of each variable followed by results of logistic regression analysis.

Demographics of the population

In the sample, respondents tended to be married (61%), and younger than 25 years old (66.5%) and approximately half had education of 12^{th} grade or less (54%). Of the respondents, 33% were non-Hispanic White, 23.5% were Hispanic, 16.7% were non-Hispanic Asian/ Pacific Islander, 11.5% were non-Hispanic African American and 14.6% were non-Hispanic American Indian/ Alaskan Native. Approximately 54.4% reported a family income below 200% FPL.

Primary dependent and independent variables of interest

Postpartum depressive symptoms were self-reported in 237 of the 1,759 respondents with a prevalence of 13.5%. Of all respondents, 72.2% reported breastfeeding at least eight weeks. Among those who breastfed at least eight weeks, the weighted percent reporting depressive symptoms was 7.9% compared with 16.2% reporting depression of those who did not breastfeed at least eight weeks. Each variable

Table 9 provides an overview of each variable including unweighted and weighted percent reporting depression, odds ratios, and p-values.

Other variables Proportions

Pregnancy intention was reported in 1,739 of the respondents used in analysis. Of the 59% who intended pregnancy (n=1,042) 8.3% reported postpartum depressive symptoms. Among those reporting unintended pregnancy 12.5% reported postpartum depressive symptoms.

The majority of respondents were married (60.8%). Among married mothers, the prevalence of self-reported postpartum depressive symptoms was 8.2%. Among single mothers, 13.3% reported postpartum depressive symptoms.

Among mothers younger than 25 years 15.9% reported depressive symptoms while 7.1% of women 25 years or older reported postpartum depressive symptoms. The majority of the sample was over 25 years old (66.5%).

Education information was provided for 1,749 of the respondents. Postpartum depressive symptoms were reported in 7.1% of those with education beyond high school while 12.6% of those with a high school education or less reported postpartum depressive symptoms.

African American and American Indian/ Alaskan Native populations reported the highest prevalence of postpartum depressive symptoms at 20.2% and 16.6% respectively. Hispanic and Asian/ Pacific Islander reported similar prevalence of postpartum depressive symptoms at 11.9% and 11.5%, respectively. Weighted percent reporting depressive symptoms was lowest in the non-Hispanic White group with 8.6% reporting depressive symptoms.

Equal numbers of respondents reported having and not having insurance before pregnancy. Of those without insurance, 12.2% self-reported postpartum depressive symptoms compared with 8.2% of those with insurance.

Information on parity was available for 1,757 mothers. For 1,018 mothers (58%) this was a second or greater child. Among those with a first child, 9.0% reported postpartum depressive symptoms, 10.7% reported depression with their second child, and 10% reported postpartum depressive symptoms with their third child.

Current smoking was reported in 13.5% of mothers. Of those who smoked, 16.6% reported postpartum depressive symptoms. Of those who did not smoke 8.9% reported postpartum depressive symptoms.

Questions used to determine body mass index (BMI, kg/m2) were reported by 1,613 of 1,759 respondents. Among those with BMI less than 25, 6.9% reported postpartum depressive symptoms. Of those women with BMIs at least 25, 12.4% reported depressive symptoms.

Stressful life events were reported in 1,217 respondents. Of those reporting no stressful life events 6.1% reported postpartum depressive symptoms. Of those reporting 1-2 stressful life events. 9.2% reported postpartum depressive symptoms. Of those reporting 3 or more stressful life events 15.1% reported postpartum depressive symptoms.

When considering stressful life events by type, financial stress was the most common type of stressful event (36.7%). Among the stress categories, 10.6% of respondents reporting partner-associated stress also reported postpartum depressive symptoms. 12% of respondent reporting traumatic stress also reported postpartum

depressive symptoms. Of those reporting financial stress 13.9% reported postpartum depressive symptoms, and 8.1% of those reporting emotional stress also reported postpartum depressive symptoms.

Table 9. Postpartum depressive symptom outcomes by maternal characteristics						
Variable	N (total 1759)	Unweighted % Reporting Depression	Weighted % Reporting Depression	Weighted Univariate Odds Ratio	95% CI	p-value
Any breastfeeding At least 8 weeks						
Yes	1271	11.17	7.9	Referent		
No	488	19.47	16.2	2.245	1.37, 3.67	0.003
Missing	0					
Pregnancy Intention						
Yes	1042	11.42	8.27	Referent		
No	497	16.79	12.49	1.58	1.25, 2.01	0.001
Missing	20					
Family income (%FPL)						
Continuous						
<50%	370	20.00	14.48	3.00	1.92, 4.69	<0.001
50-99%	265	16.98	14.69	3.05	1.86, 5.02	<0.001
100-199%	322	12.73	12.05	2.42	0.97, 6.07	0.057
200+%	681	7.49	5.34	Referent		
Missing	127					
Dichotomous						
<200%	957	16.72	13.67	2.81	1.97, 3.99	<0.001
>=200%	681	7.49	5.34	Referent		
Marital Status						
3-Category						
Married	1070	10.93	8.22	Referent		
Not married: father on BC	525	14.86	12.42	1.58	0.97, 2.57	0.063
Not Married: father not on BC	164	25.61	16.11	2.14	0.93, 4.94	0.071
Missing	0					
Dichotomous						

Married	1070	10.93	8.22	Referent		
Not Married	689	17.42	13.28	1.71	1.01, 2.89	0.046
Maternal Age						
Dichotomous						
<25	590	18.98	15.91	2.48	1.62, 3.80	<0.001
>=25	1169	10.69	7.08	Referent		
Missing	0					
Multi-categorical						
<18	59	18.64	24.2	4.19	0.79, 22.10	0.087
18-19	124	18.55	12.35	1.86	0.81, 4.23	0.135
20-24	407	19.16	16.19	2.533	1.66, 3.86	<0.001
>=25	1169	10.69	7.08	Referent		
Maternal Education						
3-Category						
< High School	402	16.67	12.09	1.93	1.175, 3.16	0.012
High School Diploma/GED	545	16.15	12.85	1.80	0.907, 3.56	0.088
>High School Diploma/GED	802	9.98	7.1	Referent		
Missing	10					
Dichotomous						
<=High School Diploma/GED	947	16.37	12.56	Referent		
> High School Diploma/ GED	802	9.98	7.1	1.879	1.09, 3.22	0.025
Maternal Race						
Hispanic	415	11.81	11.87	1.43	0.845, 2.42	0.171
NH White	588	12.24	8.61	Referent		
NH API	293	10.58	11.52	1.38	0.49, 3.92	0.523
NH African American	203	20.69	20.24	2.72	1.59, 4.67	0.001
NH AI/AN	258	16.28	16.55	2.10	1.16, 3.82	0.018
Missing	2					
Insurance Before Pregnancy						
Yes	951	10.45	8.22	Referent		
No	796	17.09	12.22	1.55	0.55, 4.42	0.387
Missing	6					
Parity						
3-Category						
1st	739	12.58	8.99	Referent		
2nd	532	12.97	10.68	1.21	0.62, 2.35	0.554
3rd or more	486	15.43	10.04	1.13	0.57, 2.42	0.713
Missing	2					

Dichotomous						
1st	739	12.58	8.99	Referent		
2nd or more	1018	14.15	10.4	1.17	0.64, 2.17	0.588
Smoking Now						
Yes	238	23.11	16.63	2.04	1.55, 2.69	<0.001
No	1494	11.78	8.91	Referent		
Missing	27					
Body Mass Index						
All Categories						
Underweight <18.5	88	9.09	7.0	1.02	0.14, 7.36	0.987
Normal Weight 18.5-<25	785	11.72	6.9	Referent		
Overweight >=25-<30	386	15.28	12.25	1.88	1.42, 2.49	<0.001
Obese >=30	357	15.97	12.66	1.95	1.04, 3.66	0.037
Missing	146					
Dichotomous						
BMI <25	873	11.45	6.91	Referent		
BMI≥25	743	15.61	12.42	1.91	1.46, 2.48	<0.001
Stressful Life Events						
All Categories						
0	529	6.62	6.05	Referent		
1-2	696	10.78	9.18	1.57	0.72, 3.43	0.24
3-4	337	18.65	11.25	1.98	0.47, 8.35	0.33
5-6	137	31.39	19.76	3.84	0.70, 21.14	0.114
>6	57	33.33	28.69	6.28	2.01, 19.66	0.003
Missing	13					
3-Category						
0	529	6.62	6.05	Referent		
1-2	696	10.78	9.18	1.57	0.72, 3.43	0.241
3 or more	521	23.61	15.12	2.77	0.68, 11.31	0.146
0 vs. all else						
0	529	6.62	6.05	Referent		
>0	1217	16.27	11.5	2.02	0.742, 5.49	0.157
<2 vs. all else						
<2	941	7.76	6.04	Referent		
>=2	805	19.88	14.39	2.62	1.03, 6.67	0.045
Stressful life events						
None 0	529	6.62	6.05	Referent		
Partner 1	53	11.32	10.59	1.84	0.33, 10.22	0.464
Traumatic 2	47	12.77	11.97	2.11	0.22, 20.22	0.495
Financial 3	645	16.59	13.91	2.51	1.25, 5.04	0.012
Emotional 4	472	16.74	8.10	1.37	0.25, 7.36	0.699

Bivariate Logistic Regression Analysis

Bivariate logistic regression analysis was conducted to examine significance of confounders and ensure correct categorizations. Among the risk factors considered, body mass index, current smoking, maternal age and family income had the highest significance with self-reported postpartum depressive symptoms. Maternal race, marital status, parity, insurance status, and stressful life events had categories that were marginally significant or not significantly associated with self-reported postpartum depressive symptoms. These variables were included for analysis based on prior literature review. Table 9 below gives cell counts, unweighted and weighted percent reporting depression, and univariate analysis with self-reported postpartum depressive symptoms. This table also includes each categorization considered for confounders of interest.

Multivariate logistic regression analysis

Multivariate logistic regression analysis was conducted using a manual forward stepwise model building technique. The most significant variable from univariate analysis, family income, was added into the model first. Then the model was run again with the remaining variables added one at a time. Current smoking status was the next most significant variable followed by BMI, and maternal age. Maternal race/ ethnicity and stressful life events were considered as effect modifiers. Stressful life events were a significant effect modifier of the relationship between breastfeeding and self-reported postpartum depressive symptoms. Insurance before pregnancy, parity, maternal education, and marital status were not significant confounders of the primary

relationship. Table 10 show the forms of the covariates used in model building based on their t-statistic and p-values.

Table 10. Model building variable evaluation				
Variable*	**Weighted % Reporting Depression**	**Univariate OR (weighted)**	**95% CI**	**T-statistic****
Any breastfeeding At least 8 weeks				
Yes	**7.9**	**Referent**		
No	**16.2**	**2.245**	**1.37, 3.67**	
Pregnancy Intention				
Yes	**8.27**	**Referent**		
No	**12.49**	**1.58**	**1.25, 2.01**	**-4.04**
Family income (%FPL)				
<200%	**13.67**	**2.81**	**1.97, 3.99**	**-6.15**
>=200%	**5.34**	**Referent**		
Marital Status				
Married	**8.22**	**Referent**		
Not Married	**13.28**	**1.71**	**1.01, 2.89**	**2.05**
Maternal Age				
<25	**15.91**	**2.48**	**1.62, 3.80**	**4.47**
>=25	**7.08**	**Referent**		
Maternal Education				
<=High School Diploma/GED	**12.56**	**Referent**		
> High School Diploma/ GED	**7.1**	**1.879**	**1.09, 3.22**	**2.45**
Maternal Race				
Hispanic	**11.87**	**1.43**	**0.845, 2.42**	**1.43**
NH White	**8.61**	**Referent**		
NH API	**11.52**	**1.38**	**0.49, 3.92**	**0.65**
NH African American	**20.245**	**2.72**	**1.59, 4.67**	**3.91**
NH AI/AN	**16.55**	**2.10**	**1.16, 3.82**	**2.62**
Insurance Before Pregnancy				
Yes	**8.22**	**Referent**		
No	**12.22**	**1.55**	**0.547, 4.422**	**-0.387**
Parity				
1st	**8.99**	**1.17**	**0.64, 2.17**	**0.55**
2nd or more	**10.4**	**Referent**		

Smoking Now				
Yes	**16.63**	**2.04**	**1.55, 2.69**	**5.44**
No	**8.91**	**Referent**		
Body Mass Index				
<25	**6.91**	**Referent**		
>=25	**12.42**	**1.91**	**1.46, 2.48**	**5.10**
Stressful Life Events				
3-Category				
0	**6.05**	**Referent**		
1-2	**9.18**	**1.57**	**0.72, 3.43**	**1.36**
3+	**23.61**	**2.77**	**0.68, 11.31**	**3.38**
0 vs. All Else				
0	**6.05**	**Referent**		
>0	**11.5**	**2.02**	**0.742, 5.49**	**0.157**
<2 vs. All Else				
<2	**6.04**	**Referent**		
>=2	**14.39**	**2.62**	**1.03, 6.67**	**0.045**
Type Categories				
None 0	**6.05**	**Referent**		
Partner 1	**10.59**	**1.84**	**0.33, 10.22**	**0.75**
Traumatic 2	**11.97**	**2.11**	**0.22, 20.22**	**0.70**
Financial 3	**13.91**	**2.51**	**1.25, 5.04**	**2.77**
Emotional 4	**8.10**	**1.37**	**0.25, 7.36**	**0.39**

*Highlighted variables indicated form used in model building (chosen based on T-statistic)
** Multiple forms of variables were used for model building where T-statistics were similar

Forward Stepwise Model Building

After stepwise analysis for final model variable selection, breastfeeding was added into the model. The preliminary main effects model for women with self-reported postpartum depressive symptoms included the covariates maternal age, current smoking status, family income, and body mass index. Within the model family income and maternal education were found to be collinear. Table 10 shows the stages of forward stepwise model building variable inclusion. When maternal education was added into the model it was highly correlated with family income. Models were compared exchanging income and education variables. Family income was found to be of slightly higher significance as determined by the t-statistic and p-value, thus it was chosen for the model

over maternal education. As both are markers of socioeconomic status, family income level is mostly likely indicative of maternal education.

Table 11. Stages of forward stepwise model building					
Characteristic*	Stage 1 OR (T-stat) P-value	Stage 2 OR (T-stat) P-value	Stage 3 OR (T-stat) P-value	Stage 4 OR (T-stat) P-value	Stage 5 OR (T-stat) P-value
Family income					
<200% FPL	2.81 (6.15)	2.66 (5.97)	2.46 (3.80)	1.93 (2.46)	**1.96 (2.23)**
	<0.001	<0.001	0.001	0.024	**0.039**
200% FPL or more	*Referent*	*Referent*	*Referent*	*Referent*	***Referent***
Smoking Now					
Yes		1.73 (5.82)	1.69 (6.98)	1.44 (4.06)	**1.43 (4.43)**
		<0.001	<0.001	0.001	**<0.001**
No		*Referent*	*Referent*	*Referent*	***Referent***
BMI					
BMI <25 (Ref)			*Referent*	*Referent*	***Referent***
BMI >=25			1.80 (4.06)	1.99 (5.12)	**2.04 (5.23)**
			0.001	<0.001	**<0.001**
Maternal age					
<25 years				2.15 (2.96)	**2.19 (3.16)**
				0.008	**0.005**
25 years or older				*Referent*	***Referent***
Maternal education					Not significant
<=12th/GED					-1.75 (0.098)
>12th/ GED					*Referent*
Pregnancy Intention					Not significant
Yes					*Referent*
No					-0.23 (0.823)
Maternal race					Not significant
Hispanic					-0.31 (0.764)
NH White					*Referent*
NH API					2.11 (0.049)
NH African American					1.61 (0.124)
NH AI/AN					1.14 (0.270)
Insurance before pregnancy					Not significant
Yes					*Referent*
No					0.78 (0.445)
Parity					Not significant
1st Child					Referent
2nd or more					1.64 (0.117)
Marital status					Not

Married					significant *Referent*
Not Married					-0.17 (0.870)
Stressful life events					Not significant
O Events					*Referent*
1-2 Events					0.58(0.571)
3+ Events					1.40(0.180)
0 Events					*Referent*
1+ Events					0.61(0.551)
<2 Events					*Referent*
2+ Events					1.05(0.306)
0 Events					*Referent*
Partner Stress					0.43(0.672)
Traumatic Stress					0.56(0.580)
Financial Stress					1.18(0.254)
Emotional Stress					0.06(0.950)

Backward stepwise elimination confirmed forward stepwise variable selection. Variables removed included stressful life events, maternal education, marital status, insurance, pregnancy intention, and maternal race/ethnicity from the model. The remaining covariates included family income, current smoking status, body mass index, and maternal age. These four variables were retained in the model for further analysis of effect modification.

Effect Modification

Two variables were considered as effect modifiers in the model. The first was maternal race/ ethnicity. Several studies have shown significant differences in breastfeeding practices as well as postpartum depression prevalence in mothers categorized by race and ethnicity. Liu 2012 found for some race/ethnicity categories the association between the two can be explained completely by socioeconomic considerations, while in others the association holds after adjustment for socioeconomic considerations.

The second variable considered for effect modification was stressful life events categorized by type: Partner, Traumatic, Financial, and Emotional. Due to small cell sizes of partner and traumatic (n=61, n=49, respectively) these two type categories were combined. Three of the four traumatic questions (my partner or I went to jail, I was homeless, and someone very close to me had a bad problem with drinking or drugs) could be considered similar to partner associated based on stress type. The combination of these two categories did not create an entirely unrelated grouping. For evaluation as an effect modifier, stressful life events were considered by type (partner associated/ traumatic, emotional, and financial) or number of events (0, 1-2, 3 or more).

For evaluation, interaction terms were created between the variables in question and the main predictor variable breastfeeding eight weeks. Maternal race/ethnicity overall was not a significant effect modifier in the model [F (4, 15); P-value 0.1154]. Stressful life events were found to be a significant effect modifier. SLE categorized by type (partner/ traumatic, emotional, financial) and numerically (0, 1-2, 3+) were both significant forms for effect modification.

The numerical grouping of stressful life events was highly significant as an effect modifier (F (2, 17); $p<0.0001$). Among mothers who reported no stressful life events, the odds of SRPPDS in mothers who breastfed less than eight weeks was 4.8 times the odds of SRPPDS in mother who breastfed at least eight weeks (95%: 2.28-10.17). When mothers reported one to two stressful life events the odds of SRPPDS in mothers who breastfed less than eight weeks compared with mothers who breastfed at least eight weeks was non-significant (OR: 1.89; 95%: 0.91, 3.92). For those reporting three or more stressful life events, the odds of SRPPDS were highly insignificant between mothers who

breastfed less than eight weeks and those who breastfed at least eight weeks (OR: 0.77; 95%: 0.23-2.5). Breastfeeding less than eight weeks has a strong association with self-reported postpartum depressive symptoms among women without stressful life events, but not in women with one or more stressful life events.

When mothers reported at least one financial stressful life event, the odds of SRPPDS among mothers who breastfed less than eight weeks was 1.18 times the odds of SRPPDS among mothers who breastfed at least eight weeks (95%: 1.02-1.37). Financial stressful life events included moving to a new address, mother or partner losing their job, or inability to pay bills. The association between breastfeeding and SRPPDS was not significant among mothers reporting partner-associated/ traumatic stressful life events (OR: 5.38; 95%: 0.28-104.89) or emotional stressful life events (OR: 0.728; 95%: 0.23-2.28). Table 7 contains the type classification of stressful life events. Breastfeeding was statistically significantly associated with self-reported postpartum depressive symptoms among women with at least one financial stressful life event, but not significant among mothers reporting partner-associated, traumatic, or emotional stressful life events.

Goodness of fit (GOF) is difficult to determine using survey data in the STATA software package. Archer 2001 created a command to overcome the inability to use the estat gof command for goodness of fit model analysis. The command produces highly variable results that are altered when using a subpopulation command based upon other software syntax used within the software's logistic regression analysis. This command makes use of the pseudomaximum likelihood estimator (PMLE), which is a value that maximized the pseudolog-likelihood function. The survey goodness of fit estimator is based entirely upon residuals using an "f-corrected Wald statistic instead of a chi-squared

distribution. Where as the maximum likelihood estimation (MLE) is a product of individual contributions to likelihood, the PMLE is the product of clusters sampled and observations within a cluster.

Comparison of included and excluded data

Excluded respondents were compared with the sample population used in analysis via chi-square to examine differences in population demographics. Results showed significant differences in the groups in income, marital status, maternal education, maternal race, insurance before pregnancy, and current smoking status. Table 11, below, gives the results of the analysis including frequency, chi-squared values and p-values.

Table 12. Characteristics of included vs. excluded sample respondents

Variables	Excluded Sample N=135	Weighted Frequency (%)	Included Sample N=1759	Weighted Frequency (%)	X2 F-statistic	P-value
Pregnancy Intention						
Yes No Missing	72 61 2	3.2 1.887	1042 72 20	57.35 37.56	0.2312 F (1, 18)= 0.1354	0.7172
Family Income						
<200% FPL >=200% FPL Missing	63 34 38	2.424 1.245	957 681 121	50.44 45.89	4.6264 F (1,18)= 7.5883	0.0310
Marital Status						
Married Not married Missing	78 57 0	2.574 2.487	1070 689 0	64.81 30.13	12.5377 F (1, 18)= 12.0753	0.0027
Maternal Age						
<25 >=25 Missing	78 57 0	3.094 1.967	1169 590 0	65.42 29.52	2.5470 F (1, 18)= 0.9590	0.3404
Maternal Education						
<= 12th Grade/ GED >12th Grade/ GED Missing	91 42 10	3.539 1.31	947 802 2	47.68 47.47	18.1881 F (1, 17)= 7.5883	0.0135
Maternal Race						

Hispanic NH White NH African American NH Asian/Pacific Islander NH American Indian/ Alaskan Native Missing	38 44 18 20 14 1	1.742 2.479 0.1886 0.3562 0.0878 	415 588 203 293 258 2	19.04 67.28 2.061 5.148 1.611 	17.1605 F (1.14, 20.60)= 9.2398	0.0049
Insurance before pregnancy						
Yes No Missing	65 70 0	1.913 3.151	957 796	56.74 38.2	18.1014 F (1, 18)= 46.4699	<0.0001
Parity						
1st Child 2nd Child or More Missing	57 78 0	1.798 3.265	739 1018 2	38.44 56.5	0.9383 F (1, 18)=0.26	0.6134
Smoking Now						
Yes No Missing	22 97 16	1.113 3.357	238 1494 27	12.13 83.4	10.2265 F (1, 18)= 6.6722	0.0188
Body Mass Index						
<25 >=25 Missing	65 54 16	2.278 2.472	873 743 143	50.81 44.44	0.9151 F (1, 17)= 0.8479	0.3700
Stressful Life Events						
0 1-2 3+ Missing	36 50 34 15	18.35 41.5 60.22	529 1160 57 13	6.02 10.99 28.69	4.0688 F (1.95, 35.09)= 3.1700	0.0554
None Partner Traumatic Financial Emotional Missing	36 8 2 45 29 15	1.055 0.4665 0.0629 2.075 0.757	529 53 47 645 472 13	29.12 3.288 2.442 35.83 24.9	16.4843 F (1.65-29.62)= 3.2407	0.0620

Discussion

Summary

Among those who breastfed for at least eight weeks the prevalence of self-reported postpartum depressive symptoms was 7.9% (weighted) compared with 16.2% (weighted) reporting depression of those who did not breastfeed at least eight weeks.

After adjusting for maternal age, family income, current smoking status, and body mass index the odds of self-reported postpartum depressive symptoms in women who breastfed less than eight weeks was 1.6 times the odds of self-reported postpartum depressive symptoms in women who breastfed at least eight weeks (95% CI: 1.004, 2.57). This study found that pregnancy intention, marital status, maternal education, insurance before pregnancy, maternal race/ ethnicity, parity, and stressful life events were not significant confounders of the relationship between breastfeeding at least eight weeks and self-reported postpartum depressive symptoms. Women who breastfed for less than 8 weeks were 60% more likely to report postpartum depressive symptoms than women who breastfed for at least eight weeks.

Stressful live events were found to be a significant effect modifier when categorized by number of events and by type of events. Women who reported no stressful life events and breastfed less than 8 weeks were 381% more likely to report postpartum depressive symptoms. Stressful life events were also a significant effect modifier when categorized by type. When women reported at least one financial stressful life event and breastfed less than 8 week they were only 18% more likely to report postpartum depressive symptoms.

In women with no stressful life events, breastfeeding less than 8 weeks is highly predictive of depressive symptoms. However, among women who report one or more stressful life event, the association between breastfeeding for at least eight weeks and postpartum depressive symptoms is not statistically significant. This finding is not surprising since the presence of stressful life events may contribute to depressive

symptoms and decrease a mother's confidence in her ability to breastfeed or persevere through difficulties with breastfeeding.

Interestingly, the association between breastfeeding and postpartum depressive symptoms only remained significant if women reported one or more financial stressful life events. The association was not significant if women reported other types of stressful life events (see Table 7 for types of stressful life events). Financial stressors included lots of bills, relocation to a new address, or loss of job by self or partner. It is possible that financial stressors may only provide mild stress or typical stress in the lives of mothers whereas emotional, partner-associated, or traumatic stressful life events may be more difficult to overcome contributing to postpartum depressive symptoms and inhibiting breastfeeding practices.

Causality

The following discussion will summarize the literature of breastfeeding and depressive symptoms and consistencies with this study's findings. Causality will then be explored using the literature. Table 12 below gives an overview of the literature including directionality, measure of association, and time point of the association. The articles have been categorized according to those that used postpartum depressive symptoms as an outcome and those that use breastfeeding as an outcome.

Table 13. Overview of literature used to evaluate causality

1st Author, Year	Sample Size	Method	Direction	Measure of Association	Time Point of Association	Study contribution
Postpartum Depressive Symptom Outcomes						
Warner 1996	2375	Cross-sectional	Not BF -> EPDS >12	OR: 1.52 (1.12-2.06)	6 weeks	Magnitude of association
Chaudron 2001	465	Longitudinal	Worry about BF -> Diagnosed depression (DSM/treatment)	Relative Risk: 3.0 (1.04-9.22)	4 weeks	Magnitude of association
Yonkers	297	Cross-	Any BF ->	OR: 0.60	3 weeks	Magnitude of

2001		sectional	EDPS >12	(0.44-0.81)		association
Mezzacappa 2002	24	Longitudinal	BF vs. not BF-> Neg Mood	ANOVA: t(21)= 2.30; p<0.05	During breastfeeding session 1-7 months	Difference in Exposure groups
Groër 2005	183	Cross-sectional	Exclusive BF vs. not BF -> Mood Scores, Stress scores	ANOVA t=2.89 p=0.004	4-6 weeks	Difference in Exposure groups
Hatton 2005	185	Longitudinal	Any BF vs. not BF -> EPDS ≥14	ANOVA p<0.05	6 weeks	Difference in Exposure groups
Watkins 2011	2185	Longitudinal	Dislike BF -> EPDS >12	OR= 1.42 (1.04-1.93)	8 weeks	Magnitude of association
Tashakori 2012	150	Case-control	Not BF vs. BF -> EPDS >12	X2(t=-2.9,df=148); p=0.004	8 weeks	Difference in Exposure groups
Ystrom 2012	42,225	Longitudinal	BF or Mixed BF Form-> Anx & Dep Symptoms	β=0.08(0.05-0.11) (Mixed) β=0.24(0.21-0.29) (Form)	6 months	Difference in amount of BF
Zubaran 2012	89	Cross-sectional	BF self-efficacy -> EPDS >12,	R^2=0.125; F(1,87)-12.43 p=0.001	2-12 weeks	Dose-response association
Breastfeeding Outcomes						
Henderson 2003	1410	Longitudinal	EPDS >12 -> BF Cessation	HR=1.25 (1.03-1.52)	Prior to 8 weeks	Magnitude of association
Dennis 2007	594	Longitudinal	EPDS >12 -> BF duration	OR: 0.57 (0.34-0.95)	EPDS 1-week BF 4-8 weeks	Magnitude of association
Gaffney 2012	1447	Longitudinal	EPDS > 9 -> Low BF intensity	OR: 1.57 (1.16-2.13)	8 Weeks	Magnitude of association

*Anx- Anxiety; Dep-Depression; EPDS Dep- Depression determined by self-reported EPDS; PDSS Dep- Postpartum Depression Screening scale

**BF-Breastfeeding predominantly; Mixed BF-Mixed breastfeeding and formula feeding/ solids; Form-Formula feeding predominantly and solids: Any BF- Any reported breastfeeding; BF self-efficacy- Breastfeeding self-efficacy scale short form; IFP- Infant feeding practices (breastfeeding intensity0

***Age-maternal age; Inc-Income; Edu-education; Race-Maternal Race; Dep-Antenatal depression; MOD-mode of delivery; Par-Parity; Sex- infant sex; SES-Socioeconomic status; Smoke-Maternal smoking postpartum; Mar- Marital status; Inc- Family income; WIC-Participation in Women Infant Child; BMI-Body mass index; PgInt=Pregnancy Intention; Neg thoughts- thoughts of death and dying; Sleep diff- difficulty falling asleep; Employ-employment status of mother or spouse; Living- who is living in the household

Warner 1996 reported, after adjustment for pregnancy intention, maternal employment and head of household employment, breastfeeding less than six weeks was significantly positively associated with postpartum depression (EPDS >12) compared with women who breastfed beyond six weeks (OR: 1.52; 95%: 1.12-2.06). The study included a substantial sample of 2375 mothers. Early onset depressive symptoms may

have decreased duration of breastfeeding and may suggest reverse causality; however, these symptoms were not found to be significant in the multivariable model assessing risk factors for postpartum depressive symptoms.

Chaudron 2001 evaluated 465 women who were not depressed at 1 month postpartum. At 4 months postpartum breastfeeding women who worried about breastfeeding had an increased risk of postpartum depression (defined by diagnosis of depression, Center for Epidemiologic Scale for Depression >16 and/or receiving antidepressants) compared with breastfeeding women who did not worry (RR: 3.0; 95%: 1.04-9.22). The absence of depression at one month postpartum provides some directional inference in that breastfeeding practices were established before diagnosis of depression. However, there was no significant difference in postpartum depression among breastfeeding and non-breastfeeding mothers.

Yonkers 2001 assessed 802 women in inner-city health clinics. They found women who were breastfeeding at three weeks postpartum were less likely to have depressive symptoms at three weeks postpartum (EPDS >12, Inventory of Depressive Symptomology >18) (OR: 0.60; 95%: 0.44-0.81). At four weeks only 83 of 297 women continued to report depressive symptoms. At 5 weeks only 67 of 83 women continued to report depressive symptoms. An association between breastfeeding and depressive symptoms was not examined at 4 and 5 weeks postpartum.

Hatton 2005 found that women who breastfed at least six weeks had significantly lower EPDS scores than women who breastfed less than six weeks ($p<0.05$; $n=185$) after controlling for age, income, education, race and prior history of depression. Additionally

non-breastfeeding mothers had the greatest likelihood of early major depressive symptoms (EPDS >13) ($p<0.05$).

Watkins 2011 found the odds of postpartum depressive symptoms (EPDS >12) in women who reported severe pain with breastfeeding on day 1 was 1.96 times the odds of postpartum depressive symptoms in women without pain breastfeeding on day 1 (95%: 1.17-3.29). Watkins also found that women who disliked breastfeeding were 1.42 times more likely to have postpartum depressive symptoms than women who like breastfeeding (OR: 1.42; 95%: 1.04-1.93) after adjustment for age, parity, education ethnicity, and WIC participation

Tashakori 2012 found mothers who exclusively breastfed eight weeks (n=78) had significantly different EPDS scores than mothers who did not breastfeed (n=72). Mothers who did not breastfeed had a higher prevalence of EPDS scores 12 or greater than mothers who exclusively breastfed (t (2.9), df=148; p=0.004). Among the 150 women included for analysis 4 had history of previous depression or postpartum depression among exclusively breastfeeding women and 7 had history of previous depression or postpartum depression among non-breastfeeding mothers at time of recruitment. This suggests prior history of depression was not a confounding factor of the association between breastfeeding and depressive symptoms at eight weeks.

Ystrom 2012 found self-reported depressive symptoms (SCL-8) during pregnancy were related to breastfeeding cessation and breastfeeding cessation was predictive of increased postpartum depressive symptoms when compared with mothers who only formula fed even after adjustment for baseline depressive symptoms (n=42,225). Mothers were only assessed for postpartum depressive symptoms at 6 months, but gestational

analysis of depressive symptoms gave a baseline to assess the change in depressive symptoms and association with breastfeeding. This study provides support of directionality, specifically that infant feeding practices lead to postpartum depressive symptoms.

Zubaran 2012 recruited mothers to participated in an at home interview. They found mothers who exclusively breastfed had higher self-efficacy scores and those scores were negatively associated with EPDS scores (R^2=0.125; F(1,87)-12.43 p=0.001). The mothers were interviewed only once between two and twelve weeks postpartum (n=89).

Henderson 2003 examined the relationship between breastfeeding and postpartum depressive symptoms overtime at 2, 6 and 12 months. They found that women with postpartum depression (EPDS >12 and diagnostic interview) had a 1.25 times greater risk of stopping breastfeeding then women without postpartum depression. In the majority of cases postpartum depression preceded breastfeeding cessation (82%) with the majority of symptom onset at 2 months (63%). This provides evidence of a temporal relationship with postpartum depressive symptoms preceding changes in breastfeeding practices providing evidence of a causal association. The author notes that the number of women with depression who continued to breastfeed decreased rapidly at six months compared with women who did not have depression. When depression onset was less than eight weeks women breastfeed for shorter durations (26 weeks) than when onset occurred after eight weeks (28 weeks) (p=0.005).

Dennis 2007 found mothers with EPDS scores above 12 at one-week postpartum were significantly more likely to stop breastfeeding at 8 weeks postpartum (F=2.84, p=0.01). Of women with EPDS scores above 12 at one-week the odds of breastfeeding

was 0.57 times the odds of bottle-feeding at eight weeks (95%: 0.34-0.95). They also noted that bottle-feeding did not significantly increase EPDS scores above 12 at 1 4 or 8 eight weeks. Feeding method was not significantly related to mean EPDS scores at 1, 4, or 8 weeks.

Gaffney 2012 found in a longitudinal study that mothers with postpartum depressive symptoms (EPDS >9) were 1.57 times more likely to use breast milk as less than 20% of total infant diet than women without depressive symptoms at two months postpartum. Both measures were assessed at two months postpartum

Biological Relationship

Mezzacappa 2002 studied 24 mothers who were both breastfeeding and bottle-feeding found women who breastfed had decreased negative mood scores from 10 minutes before breastfeeding to 10 minutes after breastfeeding when compared with their negative mood score when bottle-feeding (paired t-test:$t(21)=2.30$ $p<0.05$). Additionally, women had decreased positive mood scores from 10 minutes before bottle-feeding to 10 minutes after bottle-feeding compared to their breastfeeding sessions (paired t-test: $t(22)=4.38$ $p<0.01$). Biologically this study suggests that using a bottle to feed may prevent the release of Oxytocin and other hormones linked to mood.

Groër 2005 found among mothers who exclusively breastfed had lower depressive mood scores, anger, and anxiety scores compared with women who exclusively formula fed ($p=0.004$, $p=0.01$, $p=0.008$, respectively) ($n=183$). They also found that negative life events and anger were negatively correlated with prolactin in formula-feeding mothers. Prolactin (a proxy for breastfeeding) was significantly different and inversely associated between the highest and lowest levels of depressive mood. There was a significant

difference in the income of mothers with majority of mothers with incomes less than $10,000 who also reported depressive mood scores.

Stuebe 2012 hypothesized the relationship of neuroendocrine hormones with failed lactation and perinatal depression. Hormones discussed included gonadal (progesterone, estrogen), lactogenic (oxytocin, prolactin), and stress reactivity (hypothalamic-pituitary adrenal axis, autonomic nervous system, pain perception, hypothalamic-pituitary-thyroid axis). Stuebe suggests that each of these is modified in some way and connected to breastfeeding and depression in mothers around their infant's birth.

Stuebe 2013 evaluated the association between maternal mood, oxytocin and breastfeeding. At eight weeks oxytocin during breastfeeding was inversely correlated with maternal EPDS scores ($p<0.01$). Additionally, among mothers with higher depression symptoms lower oxytocin levels were found during and after feeding compared to mothers with lower depression symptoms ($p<0.05$). Mothers with higher depressive symptoms are correlated with lower oxytocin levels suggesting changes in oxytocin contribute to mood disorders. Stuebe also found that higher depressive symptoms and antidepressant treatment was associated with lower oxytocin levels during feeding. These are preliminary findings in a small sample size ($n=47$) of generally higher socioeconomic status women.

Results of this study are consistent with previous findings of statistically significant associations between breastfeeding and self-reported postpartum depressive symptoms. Of the 13 articles summarized in Table 12, ten found that breastfeeding preceded depressive symptom outcomes. Of the ten, two found statistically significant

differences in mood scores between breastfeeding and non-breastfeeding women. Two found statistically significant differences in EPDS scores between breastfeeding and non-breastfeeding women. Two studies reported odds ratios above one when examining the association between not breastfeeding and dislike of breastfeeding and EPDS score outcomes. One study reported an odds ratio less than one when examining the association between any breastfeeding and EPDS score outcomes.

The remaining three studies found statistically significant association between depressive symptoms and breastfeeding outcomes. Two of these three studies reported odds ratios and hazard ratios above one when considering EPDS measures of depressive symptoms and outcomes of breastfeeding intensity and cessation. The other found an odds ratio less than one when considering EPDS measures of depressive symptoms and breastfeeding duration. The 13 studies combined suggest several types of associations exist including: any breastfeeding is associated with decreased postpartum depressive symptoms, not breastfeeding is associated with increased postpartum depressive symptoms, and postpartum depressive symptoms are associated with decreased breastfeeding intensity and duration.

The findings of the above studies will be used to evaluate a causal association between breastfeeding and postpartum depressive symptoms. All of the 13 studies found a statistically significant association between breastfeeding and depressive symptoms. One study found that breastfeeding was protective for depressive symptoms. Nine found not breastfeeding or low intensity of breastfeeding to be predictive of postpartum depressive symptoms. Three found that the presence of postpartum depressive symptoms was associated with decreased breastfeeding duration, breastfeeding intensity, and earlier

discontinuation of breastfeeding. The following section explores the possibility of a causal association using the articles listed in table 13 above.

Evaluating Cause

The possibility of a causal relationship between breastfeeding and postpartum depressive symptoms is evaluated below using Hill's Criteria for cause described in the introduction. Each of the seven criteria will be explored below with reference to the studies followed by a summary and public health implications.

The strength of the association between breastfeeding and postpartum depressive symptoms is moderate to strong. This thesis found that the women who breastfeed less than 8 weeks were 60% more likely to have postpartum depressive symptoms than women who breastfed at least 8 weeks. Warner 1996 found women who did not breastfeed were 52% more likely to develop postpartum depressive symptoms than women who breastfed at six weeks. Yonkers 2001 found that women who breastfed were 40% less likely to develop postpartum depressive symptoms. Watkins 2011 and Chaudron 2001 also found strong associations. Henderson 2003, Dennis 2007, and Gaffney 2012 all found moderate to strong associations (HR: 1.25, OR: 0.57, OR: 1.57, respectively). P-values suggest strong confidence in the significance of the association and the difference of the outcome between breastfeeding and non-breastfeeding mothers. Confidence intervals suggest precise estimates of the association. The strength of the association provides moderate support for a causal relationship.

There is limited specificity of the association. Across studies there are multiple measures of breastfeeding and depression. Chaudron 2001, Watkins 2011, and Zubaran 2012 examined feedings towards breastfeeding as a measure of breastfeeding. Warner

1996, Tashakori 2012 examined the effect of not breastfeeding. Yonkers 2001 and Hatton 2005 examined any breastfeeding. Ystrom 2012 compared any breastfeeding, mixed breastfeeding, and formula feeding. Henderson 2003, and Dennis 2007 evaluated breastfeeding duration and Gaffney 2012 examined breastfeeding intensity. Each of these studies used multiple evaluations of depressive symptoms and mood disorders. The specificity of the association provides mild support for a causal relationship. The many definitions of breastfeeding practices make it difficult to determine whether breastfeeding or not-breastfeeding or both are affecting postpartum depressive symptoms.

There is strong consistency among studies of measures of breastfeeding and depressive symptoms. Multiple measures of breastfeeding suggest that breastfeeding and not breastfeeding are contributing to protection or risk (depending upon the measure) for postpartum depressive symptoms. Additionally studies consistently found depressive symptoms associated with changed in breastfeeding duration and intensity. Mezzacappa 2002 found that breastfeeding reduced negative mood scores from pre-feeding to post-feeding and bottle-feeding decreased positive mood scores from pre-feeding to post feeding. Tashakori 2011 and Mezzacappa 2002 found that the most common reason for breastfeeding cessation, perceived inadequate supply of milk followed by returning to work or school. The studies examined the association between breastfeeding and depression in several subpopulations and multiple countries. Typically mothers were excluded if they had any disorder preventing breastfeeding or mothers with serious medical conditions that may interfere with breastfeeding. The association was found in mothers with various levels of education, and income, at various ages, and with varying

histories of prior depression. Consistency provides moderate to strong support for a causal association.

The temporal relationship is the most difficult to assess for this association. Henderson 2003 found that onset of depressive symptoms preceded cessation of breastfeeding for most women. Chaudron 2001 found that of women who were not depressed at one month postpartum, women who were worried about breastfeeding at four months were at increased risk of postpartum depression (diagnosed). Watkins 2011 found that women with severe breast pain on day one and women who disliked breastfeeding were more likely to have postpartum depressive symptoms (EPDS) at 2 months. Mezzacappa 2002 examined change in symptoms over a feeding period and found that pre-post bottle-feeding positive mood scores (positive and negative affect scale) decreased and when breastfeeding negative mood scores decreased. Ystrom 2012 provides the most support for breastfeeding preceding depressive symptoms. The Hopkins SLC depressive symptoms questionnaire was taken at six months after a history of feeding practice month by month prior to 6 months. Henderson 2003 found that women who experienced postpartum depressive symptoms were more likely to have stopped breastfeeding at that same time point, and that onset of depressive symptoms preceded cessation of breastfeeding. Hatton 2005 examined breastfeeding and SRPPDS at 6 weeks and 12 weeks and found a significant association at 6 weeks after controlling for prenatal depression. Dennis 2007 found mothers with EPDS >12 at one-week postpartum were more likely to discontinue breastfeeding at 8 weeks postpartum compared to mothers with scores ≤12 at one-week.

For most studies including the longitudinal studies, the association was measured at a single point in time. The cross-sectional nature of these studies limits the ability to infer direction, but provides insight to possible direction at that time point i.e. breastfeeding begins immediately where as onset of depressive symptoms is more delayed. Ystrom 2012, Dennis 2007, Henderson 2003, and Mezzacappa 2002 provide insight to the association across time. These studies suggest that two directionalities exist. In the first direction, perinatal depression leads to early breastfeeding cessation, or non-initiation and contributed more intense postpartum depressive symptoms. In the opposite direction, the absence of breastfeeding leads to an increase postpartum depressive symptoms later. Other studies using longitudinal data provide only minimal evidence of the directional relationship between breastfeeding and postpartum depressive symptoms. This decrease in evidence comes from cross-sectional analysis of the longitudinal data which limits confidence in which factor preceded the other. Longitudinal studies provide stronger evidence of timing supporting the presence of a causal association.

Several studies examined the potential underlying mechanisms facilitating the association between breastfeeding and depression. Mezzacappa 2002 found decreased negative mood scores among breastfeeding women. Groer 2005 found formula feeding was associated with lower levels of prolactin and prolactin was associated with the highest depressive mood scores. Stuebe 2012 reported that lower levels of prolactin increased maternal anxiety and inhibits maternal behaviors. Stuebe 2013 found oxytocin levels in the last trimester of pregnancy, and during and after feeding were inversely correlated with EPDS scores. Stuebe 2012 noted oxytocin stimulates the let down of milk for feeding and is also associated infant bonding and protective feelings. Low

oxytocin may contribute to negative mood in mothers. Kendall-Tackett 2010 reported that stress and inflammation caused by stress via proinflammatory cytokines triggers depression during and after pregnancy. Breastfeeding down regulated the stress response and improves sleep quality in mothers. Poor sleep is related to high proinflammatory cytokine levels and risk of depression in mothers. Biological mechanisms provide moderate support for a causal association.

A dose-response relationship was noted in Ystrom 2012 who found bottle-feeding was associated with greater risk for postpartum depressive symptoms than mixed feeding. Dose-response provides mild support for a causal association. None of the above studies examined an intervention effect of breastfeeding on postpartum depression. Evidence of a intervention effect or dose-response association would provide stronger evidence in support of a causal association.

Three possible causal directions are present in the literatures. Articles supporting each directional association are described below with physiological evidence present in this literature review to support each possibility. When examining the possible directional associations, all articles provided consistent odds ratio findings.

Ystrom 2012 provides strong support for breastfeeding decreasing depressive symptoms. When compared with bottle-feeding, women who provided mixed feeding (breastfeeding and formula feeding) were less likely to suffer from depressive symptoms and women who were predominantly breastfeeding were least likely to suffer from depressive symptoms. Yonkers 2001 found at 3 weeks postpartum, women who were breastfeeding at any levels were less likely to have EPDS scores above 12. Stube 2013 found women who were breastfeeding had higher levels of oxytocin and lower levels of

depressive symptoms. These articles provide evidence that breastfeeding precedes depressive symptoms. These articles also give evidence of a protective effect of breastfeeding on postpartum depressive symptoms.

There is also evidence that not breastfeeding or difficulty with breastfeeding leads to increased depressive symptoms. Warner 1996 found at 6 weeks postpartum not breastfeeding is associated with EPDS scores above 12. Chaudron 2001 found that worry about breastfeeding at 4 weeks was associated with diagnosed depression. Watkins 2011 found that women who disliked breastfeeding were more likely to have EPDS scores above 12. Groer 2005 found not breastfeeding was associated with lower prolactin levels. Prolactin levels were inversely correlated with depressive mood scores in mothers. These articles provide evidence that not breastfeeding precedes depressive symptoms. Additionally, these articles provide support to suggest that not breastfeeding increases the risk of postpartum depressive symptoms among mothers.

Evidence also exists that suggest postpartum depressive symptoms inhibit breastfeeding practices. Henderson 2003 and Dennis 2007 found EPDS scores above 12 are associated with early breastfeeding cessation. In most cases the onset of depressive symptoms precedes breastfeeding cessation. Gaffney 2012 found that EPDS scores above 9 are associated with decreased levels of breast milk as part of the total milk diet. Stuebe 2013 found higher depressive symptoms were associated with lower levels of oxytocin during feeding. Oxytocin is involved in the let down of milk during breastfeeding. These article provide support that postpartum depressive symptoms also precede breastfeeding practices and that postpartum depressive symptoms inhibit breastfeeding practices.

Of the articles used for causal analysis, some were longitudinal and others were cross-sectional. These two study types provide varying levels of insight into causality. Cross-sectional studies rarely provide insight to causality since exposure and outcome measures are taken simultaneously limiting the ability to determine the direction of the association. Longitudinal studies provide a better assessment of direction with multiple measures of exposure and outcome over an extended duration of time consistent with a causal hypothesis. In the 13 articles listed above several used longitudinal datasets including Chaudron 2001, Mezzacappa 2002, Hatton 2005, Watkins 2011, Ystrom 2012, Henderson 2003, Dennis 2007 and Gaffney 2012. In several of the studies using longitudinal datasets, measures of breastfeeding and depressive symptoms for analysis were taken at one time point limiting the ability of these studies for use in directionality analysis. Although cross-sectional studies suggest directionality, for many there are no further measures to assess a causal relationship i.e. breastfeeding inhibits depressive symptoms or depressive symptoms inhibit breastfeeding practices. Cross-sectional studies included Warner 1996, Yonkers 2001, Groer 2005 and Zubaran 2012.

Several longitudinal studies do provide insight in the direction of the association, consistent with a causal relationship. Ystrom 2012 evaluated feeding practices monthly for six months and assessed depressive symptoms at six months. At six-months depressive symptoms were predicted by increase bottle-feeding and mixed breastfeeding practices in the months prior. Watkins 2011 found women with severe breastfeeding pain in the first day, first week and second week were more likely to be depressed at two months. Mezzacappa 2002 found a statistically significant decrease in negative mood

from 10 minutes before breastfeeding to 10 minutes after breastfeeding. These articles provide evidence that breastfeeding practices affect depressive symptoms.

Henderson 2003 and Dennis 2007 provided support for postpartum depressive symptoms affecting breastfeeding practices. Henderson 2003 found women who experienced postpartum depression at any time in the year after birth were more likely to stop breastfeeding at that same time point. In most cases onset of depressive symptoms preceded breastfeeding cessation. Dennis 2007 found that mothers with postpartum depressive symptoms at one-week were more likely to discontinue breastfeeding at eight weeks postpartum. These articles provide evidence that postpartum depressive symptoms decrease breastfeeding practices. When combined with the above articles, these findings suggest it is likely that causality is working in both directions. It is likely that these effects are intermingling at multiple points in the postpartum period.

Based upon the above analysis there is evidence for a causal relationship between breastfeeding and postpartum depressive symptoms. Consistency, biological plausibility, and strength of the association provide strong support for a causal association that is most likely bidirectional. Women who develop depressive symptoms early on in the postpartum period may discontinue breastfeeding earlier especially when mothers have negative breastfeeding experiences.

Many questions still remain preventing the conclusion of a causal relationship between breastfeeding and postpartum depressive symptoms. Among them are the role of both breastfeeding and not breastfeeding on depressive symptoms, variations in breastfeeding intensity and duration and depressive symptoms, and the effect of antenatal depression on early breastfeeding practices and depressive symptoms.

Strengths and Limitations

Strengths of this study include the PRAMS population based data that oversamples and weights to provide adequate sample size allowing analysis of often overlooked minority populations. This allows great generalizability of the research findings to women throughout Oregon. The PRAMS dataset provide several behavioral and demographic measures that allow evaluation of a wide variety of variables including stressful life events, maternal demographic factors, and variables associated with both self-reported postpartum depressive symptoms and breastfeeding.

Limitations of this study include the cross sectional nature of the PRAMS survey analysis. Since this study uses cross-sectional data it is difficult to define directionality and cause cannot be inferred; However, used of cross sectional data is well suited for the intention of this study, to determine the association of breastfeeding at least eight weeks with the self-reported postpartum depressive symptoms outcome. The unweighted and weighted response weights below 70% may create a bias in characteristics associated with self-reported postpartum depressive symptoms and breastfeeding although non-response weights should minimized this effects.

There are several potential sources of bias in this thesis. The first is recall bias possible with this survey since women are asked to recollect information that occurred up to 15 months earlier than the date of the survey. Women who are classified as depressed based on our classification at the time of the survey may be more likely to recall events in a negative fashion. Misclassification bias may result from the definition of self-reported postpartum depressive symptoms as well as the classification of race/ethnicity. A 2011 study of PRAMS found postpartum depressive symptoms reported at three months were

often underreported.[46] Women may have reported incorrect weight before pregnancy leading to misclassification according to BMI. Additionally, women may have underreported smoking during the last three months of pregnancy. Depressive symptoms during pregnancy were not considered as a confounder since it is highly correlated with postpartum depressive symptoms.

Additional bias comes from exclusion of 135 respondents due to lack of information regarding breastfeeding practices and self-reported postpartum depressive symptoms outcomes. Chi-square analysis suggested that the excluded population differed significantly in marital status (p-value <0.001), maternal education (0.031), maternal race (0.017), insurance before pregnancy (<0.001), smoking in the last three months of pregnancy (0.008) and stressful life events (0.043). Unfortunately, there is no way to rectify this bias in the sample. The large unweighted sample size of 1769 should help reduce the loss of generalizability.

In the articles used to evaluate cause, several sources of bias and potential for confounding exist. Bias and confounding may alter the strength of the associations found in these studies. Possible bias comes from small sample sizes, non-response, and loss to follow up.[20,23,29] Many of these studies subsets of larger study populations not geared towards evaluation of this particular relationship. This limited the ability to evaluate and control for multiple factors affecting precision and accuracy. The possibility for differential misclassification bias is present in exclusion of mothers based on mixed breastfeeding status and lack of reevaluation for confirmed classification.[25] Multiple measures of depressive symptoms may have excluded women with mild to moderate depressive symptoms.[19,29] Confounders not considered include transition from

breastfeeding to solid foods and return to employment which may have explained changes in breastfeeding practices.

Fitelson 2010, Moretti 2012, and DelRosario 2013 all note that for infants antidepressant exposure of less than 10% of weight adjusted dose is considered safe when breastfeeding. For many antidepressants, most are undetectable in infants with less than 10% of the maternal weight adjusted dose secreted into human milk. With the exception of a few, most antidepressants convey no negative side effects on the infant and are recommended during postpartum to help promote maternal bonding and breastfeeding.

Future Studies

Various future studies are necessary to evaluate the three potential causal associations. First, if breastfeeding causes decreased postpartum depressive symptoms then interventions to increase breastfeeding may be found to decrease risk and/or severity of postpartum depressive symptoms. Women with and without prenatal depression could be randomized to receive or not receive additional breastfeeding support. Secondly, if PPD causes decreased breastfeeding then interventions to decrease PPD, including psychosocial support and anti-depressants may increase breastfeeding practices. Studies would evaluate early screening and recognition of depressive symptoms followed by longitudinal evaluation of multiple methods of support to determine methods of intervention to decrease depressive symptoms.

If the association between breastfeeding and postpartum depressive symptoms is bidirectional then early recognition of depressive symptoms as well as support of breastfeeding practice may confer improved mental health as well as other health outcomes in mother and infants. Among women who are hesitant to breastfeed or having

difficulty breastfeeding, encouraging continued attempts has the potential to aid in decreasing poor mental health outcomes for mothers as well as provide other positive health outcomes. Simultaneously, providers hoping to alleviate postpartum depressive symptoms in mothers may find added success through the encouragement of continued breastfeeding or feeding of expressed milk.

Summary and Conclusion

This thesis found a strong association between breastfeeding and depressive symptoms consistent with the literature. Based upon current literature, there is evidence to suggest a causal relationship between breastfeeding and postpartum depressive symptoms. However, major questions still exist regarding direction of the association, the effect of breastfeeding and not-breastfeeding on postpartum depressive symptoms, and the severity of depressive symptoms affected by these breastfeeding practices. This causal association is worthy of further investigation. A causal association in both directions would provide further support for encouraging breastfeeding practice as a strategy to improve maternal mental health outcomes.

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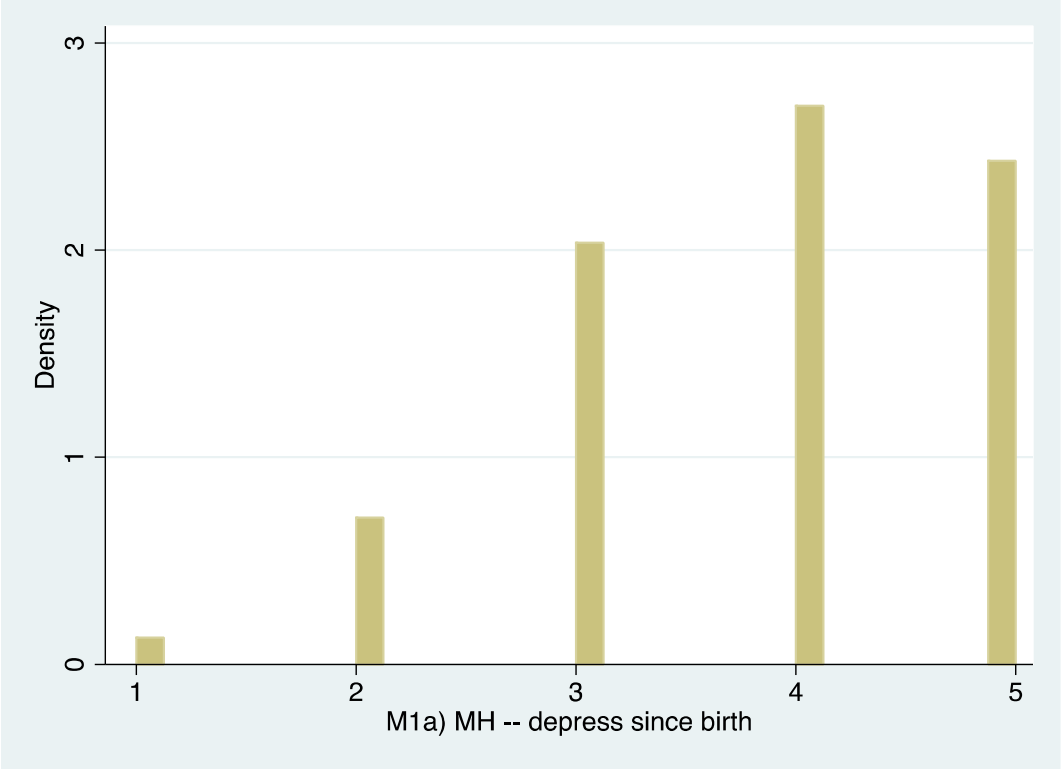
Appendix A

2007 Oregon Pregnancy Risk Assessment Monitoring System Questionnaire

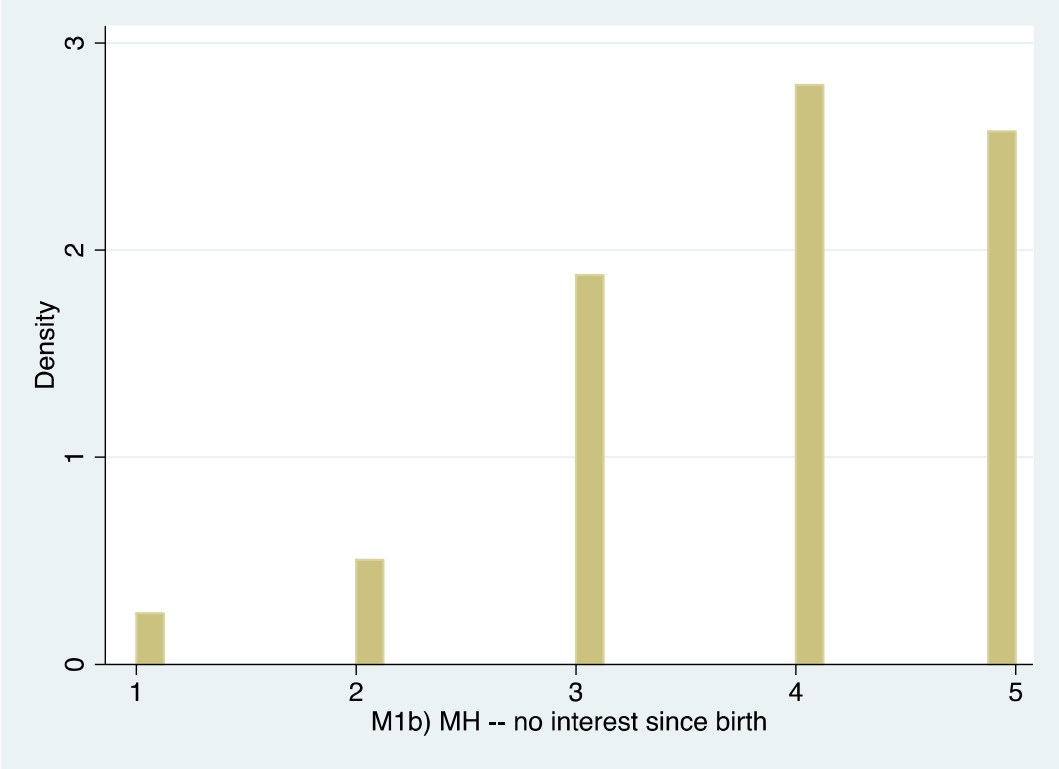
Appendix B:

Graph 1. Histogram of responses to “Since your new baby was born, how often have you felt down, depressed, or hopeless?”



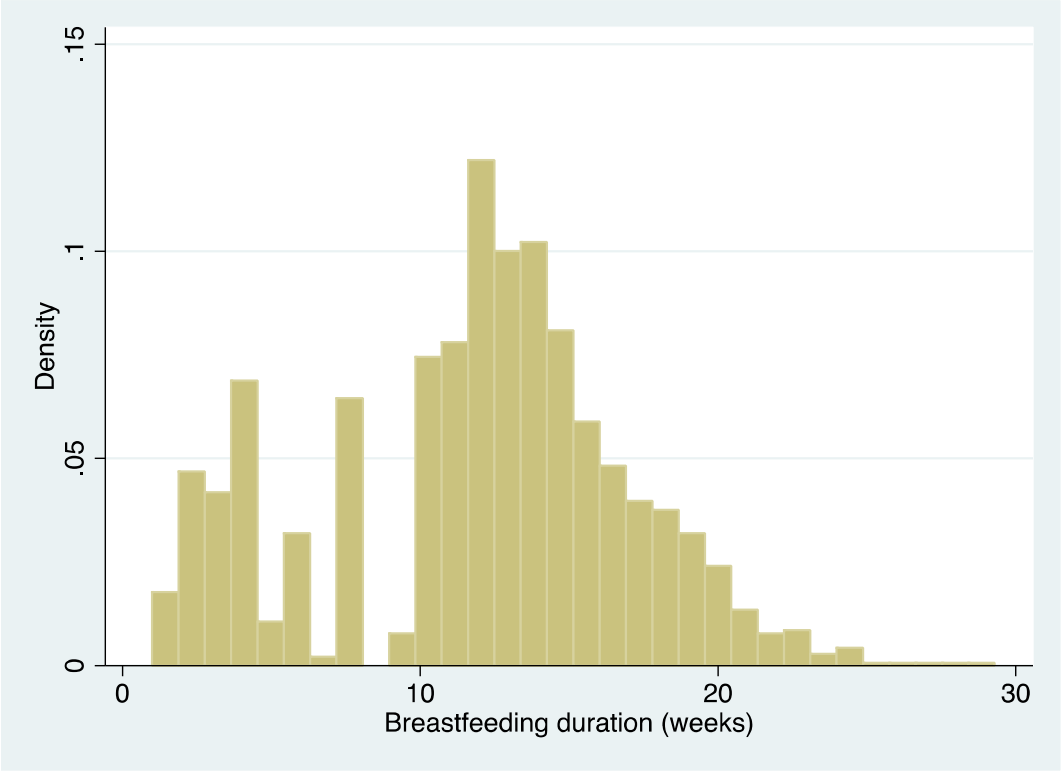
Appendix C:

Graph 2. Histogram of response to “Since your new baby was born, how often have you had little interest or little pleasure in doing things?”



Appendix D:

Graph 3. Histogram of breastfeeding duration



Appendix E:

Graph 4. Histogram of Maternal Age