THE RELATIONSHIP BETWEEN MATERNAL PRE-PREGNANCY WEIGHT AND BREASTFEEDING INITIATION

by

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ABSTRACT

In Canada, 37.2% of women of childbearing age are classified as overweight or obese. This percentage is alarming as excess body weight is not only a major risk factor for chronic diseases but it is also linked to maternal-child outcomes including breastfeeding initiation. This paper-based thesis is comprised of three sections. The first section provides a review of previous research examining the association between mothers' pre-pregnancy weight and breastfeeding initiation. The second section is a manuscript for publication describing an analysis of administrative data for 1,079 mother and newborn dyads. Regression analysis was used to predict breastfeeding initiation based on women's pre-pregnancy weight after adjusting for 10 variables reflecting attributes of the mothers, birth processes, and newborns. A statistically significant association was detected indicating obese mothers are less likely to initiate breastfeeding compared to normal weight mothers. The final section is a paper outlining the benefits and challenges of conducting secondary analysis of administrative data for research purposes.

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SECTION 1: INTRODUCTION

Background

Obesity rates worldwide have nearly doubled since 1980 (World Health Organization [WHO], 2014c). In 2008, 35% of adults older than 20 years were classified as overweight and 11% as obese (WHO, 2014c). During the same year, 62% of Canadians over 18 years of age were classified as overweight or obese: 37% overweight and 25% obese (Statistics Canada, 2009a). The percentages for Canadian women of childbearing age were slightly lower with 26% classified as overweight and 20% obese for a combined rate of 46% (Statistics Canada, 2009a). Looking specifically at the statistics for Prince Edward Island (PEI), the percentage of new mothers classified as overweight or obese increased from 41.6% in 1998 to 47.2% in 2011 (PEI Reproductive Care Program, 2013). This trend is noteworthy, as excess body weight is not only a major risk factor for chronic diseases, such as cardiovascular disease, diabetes, and cancer, it is also linked to maternal-child outcomes as there is evidence to suggest overweight and obese women are less likely to initiate breastfeeding (Turcksin, Bel, Galjaard, & Devlieger, 2014; WHO, 2014b).

The benefits of breastfeeding for mothers and newborns are well established. For mothers, some of the benefits include a quicker return to pre-pregnancy weight, a natural form of birth control due to a delay in the reestablishment of menstrual periods postpartum, and a decreased risk of breast and ovarian cancer (Kramer & Kakuma, 2012; WHO, 2014a). Benefits for children are even more significant as breast milk contains natural antibodies that decrease the risk of gastrointestinal and respiratory illnesses (WHO, 2014a). The WHO (2014a) also promotes breastfeeding as a strategy to ensure healthy weight gain in children as breast milk has the proper mix of nutrients for growth

and development. In 2007 and again in 2013, the WHO compiled findings from systematic reviews and meta-analyses examining the long-term health benefits for those who were breastfed. The WHO concluded that breastfeeding has a positive long-term effect on blood pressure, blood cholesterol, intelligence, body weight, and blood glucose; however the magnitude of this effect was relatively modest (WHO, 2007, 2013). Despite this, the recognized benefits of breastfeeding cannot be negated; therefore it is important to address factors that can potentially undermine its initiation.

Research has examined the effect of a number of maternal demographics; birth and newborn; as well as maternal health history and behavioural characteristics on mothers' initiation of breastfeeding. A potential contributing factor that has only recently received attention, however, is maternal weight. Various physiological, psychological, and sociological mechanisms have been hypothesized to explain the proposed association between maternal weight and breastfeeding. For example, lactation is a physiological process as milk production (i.e., lactogenesis) is triggered when progesterone levels fall quickly post-birth, while prolactin and cortisol levels remain stable (Nommsen-Rivers, Chantry, Peerson, Cohen, & Dewey, 2010; Rasmussen & Kjolhede, 2004). Nommsen-Rivers et al. (2010) found that lactogenesis was delayed in overweight and obese women, and Rasmussen and Kjolhede (2004) observed that prolactin levels fell rather than stabilized in these women. These physiological factors may hamper the establishment of breast milk in overweight and obese women. Anecdotal evidence has also been collected from healthcare providers that suggests obese women may feel embarrassed exposing their body and they may have difficulty establishing a proper latch due to their large breasts, large areolas, and flat nipples (Hilson, Rasmussen, & Kjolhede, 1997; Katz, Nilson, & Rassmussen, 2010).

Establishing the link between maternal body weight and breastfeeding is important given the increasing prevalence of obesity. Although an association between maternal weight and breastfeeding initiation has been observed in other countries, only one Canadian study was found that investigated this association using data from 22,131 women in Ontario (Visram et al., 2013). Although findings from this study support the existence of a negative association, suggesting that women who are overweight or obese are less likely to initiate breastfeeding, replication is warranted given provincial differences in breastfeeding initiation rates. For example the initiation rates reported by the Public Health Agency of Canada (2013) for 2009-2010 were 93% for British Columbia, 89% for Manitoba, 89% for Ontario, 78% for Nova Scotia, 75% for Prince Edward Island, and 62% for Newfoundland and Labrador (Figure 1.1). In general, rates of breastfeeding initiation are lower in Atlantic Canada. Further investigation is needed to uncover the factors contributing to breastfeeding initiation. One factor that warrants consideration is pre-pregnancy maternal weight given the increasing prevalence of overweight and obesity in adults internationally, nationally, and provincially. The purpose of this research was to examine whether the initiation of breastfeeding is affected by mothers' pre-pregnancy weight.

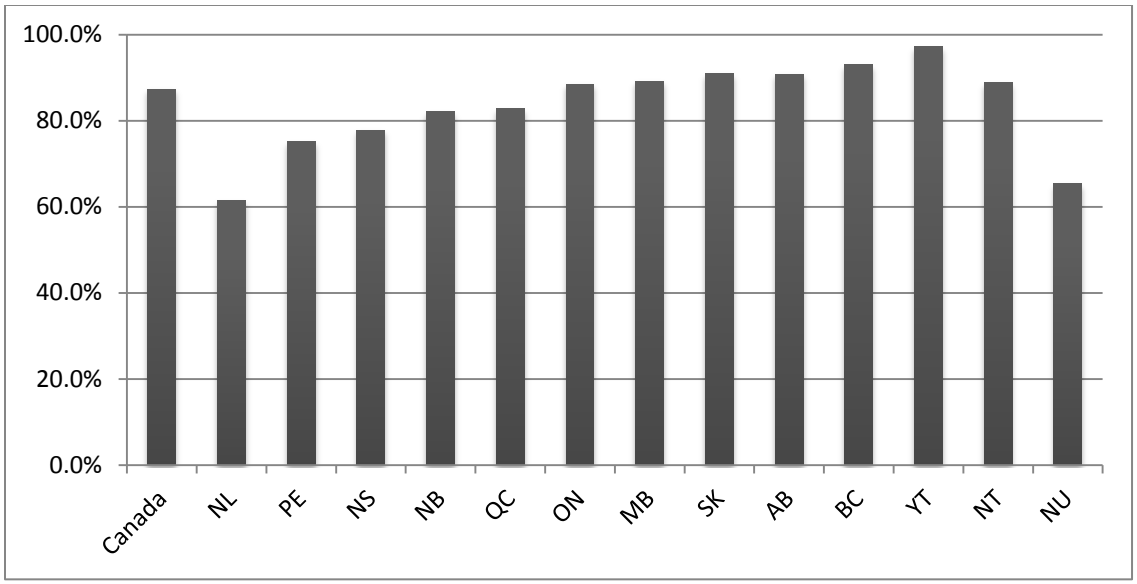

Figure 1.1. Percentage of women who initiated breastfeeding by province 2009-2010.

Breastfeeding initiation rates in Canada and by province/territory (Statistics Canada: Community Health Survey 2009-2010, as cited by Public Health Agency of Canada, 2013). Due to Statistics Canada's cautionary note regarding the accuracy of the 2012 data for PEI, I made a decision not to report statistics for that year.

Review of the Literature

To develop a better understanding of how other researchers have operationalized breastfeeding initiation and maternal weight and how the association between these variables has been investigated, a search of the Cumulative Index to Nursing and Allied Health (CINAHL) and PubMed bibliographic databases was conducted. In CINAHL the relevant subject headings were *breast feeding, obesity,* and *body mass index*. These subject headings were searched as major concepts, which means they were a focus of the paper. *Obesity* and *body mass index* were combined using the Boolean operator "OR" to retrieve citations using either term. These headings were then combined with *breast feeding* using the Boolean operator "AND" so only papers including both search components were retrieved. In PubMed *breast feeding*, *overweight*, and *body mass index* were identified as relevant medical subject headings (MeSH). *Overweight* rather than obesity was used as the subject heading in this database as obesity was positioned lower in the MeSH tree hierarchy and was automatically included in the search. Conversely *breast milk expression*, which appears below *breast feeding* in the MeSH hierarchy, was excluded from the search. Similar to the CINAHL search, *body mass index* was combined using "OR" with *overweight* and that search was then combined with *breast feeding* using "AND". In both databases, the subject heading was written as two words *breast feeding*. Although *lactation* was a search term used by other researchers (e.g., Turcksin, Bel, Galjaard, & Devlieger, 2014), this subject heading was not included when searching the databases as its definition focuses on the physiological process of milk production and secretion by the mammary glands rather than the feeding of the infant. All searches were limited to human subjects and English language.

Search Results

In total, 64 articles were retrieved in CINAHL and 273 in PubMed. Titles and abstracts of the retrieved articles were reviewed to identify research studies that examined the association between maternal weight and breastfeeding initiation. Articles were excluded if they were theoretical in nature or expressed opinions regarding why maternal weight may play a role in breastfeeding or how breastfeeding may impact childhood obesity. This resulted in 14 articles in CINAHL and 17 in PubMed. Once duplicates were removed, 18 articles were retained. Reference lists of the retrieved articles were also reviewed to identify other relevant publications, which resulted in eight additional articles. The MeSH terms used to catalogue these articles were reviewed to ensure no relevant terms were omitted in the search strategy. It was found that for a number of the articles, a MeSH pertaining to body weight or body mass index (BMI) was not included as maternal weight was merely one of the predictors examined.

Characteristics of Retrieved Studies

In total, 26 articles were retained for inclusion in this literature review: 3 systematic reviews, 10 prospective cohorts, and 13 retrospective cohorts (Appendix A). No randomized control trials or meta-analyses were retrieved. Despite no limits set for publication year, all articles were published between 1997 and 2014, and almost half (42%, n=11) were in the last 5 years (2009 to 2014). This reflects the increasing attention this topic area is receiving. A numbered list of the retrieved articles is included in Appendix B and articles are cited by their assigned number in the following section.

Findings from Systematic Reviews

The three systematic reviews were published in 2007[1], 2011[26], and 2014[24] with the number of articles focusing on breastfeeding initiation increasing in each subsequent review (10, 12, and 16 articles respectively). The existence of a negative association between breastfeeding initiation and maternal weight was reported in each review. However, a limitation identified in each review was the various ways in which breastfeeding initiation and maternal weight have been operationalized and the challenges this variability creates when attempting to explain the association between the variables. None of the systematic reviews specifically addressed how the observed association was affected by covariates examined in the primary studies. To provide a more detailed description of how research in this area has been conducted, the remainder of this literature review focuses on the 23 cohort studies.

Findings from Cohort Studies

The cohort studies offer an international perspective on this issue with nine countries represented; the United States was the most common with 12 studies [7-16, 18, 23]. Only one of the studies was conducted in Canada[25]. Sample sizes for the studies ranged from 200[6] to 1,161,949 [23]. Studies involving larger samples generally relied on the use of data from preexisting databases. Preexisting data were obtained from two main sources: national/state/provincial data repositories and administrative databases, which included data collected by organizations and individuals for tracking and record keeping purposes (e.g., office records, hospital charts). Seven studies [2-4, 13-16] relied on data from national/state/provincial data repositories, and another seven used locally collected administrative data[7, 8, 12, 19, 22, 23, 25]. Pre-existing data were either analyzed separately or

combined with primary data specifically collected for the study. Despite the recent publications, some studies analyzed data collected a number of years earlier. For example, Hilson, Rasmussen, and Kjolhede[8] published a study in 2006 but used data from 1988. Other studies examined data over more than a 1-year period, however no study conducted longitudinal analysis to examine change over time.

Operationalization of breastfeeding initiation. Despite all 23 of the articles using the term breastfeeding initiation, various operational definitions were utilized. In eleven studies, more than one measure was used[2, 4, 5, 7, 8, 12, 13, 15, 16, 21, 25]. Breastfeeding initiation was operationalized as breastfed ever in 17 of the 23 primary studies [2-11, 13-16, 18, 20, 23]. Breastfeeding initiation was also operationalized as breast milk ever [5, 15, 16], one out of the last five hospital feeds[12], any on hospital discharge[7, 8, 19, 22], any at 7 days postpartum [2, 4, 13, 21], and any within first 2 weeks[12]. One study did not provide details in terms of how the concept was measured[17]. Only four studies focused on exclusive breastfeeding[12, 13, 21, 25], which is interesting given the WHO emphasis on exclusivity (WHO, 2001, 2014a).

Operationalization of maternal weight. Maternal weight was typically expressed as body mass index (BMI), however, in most of the studies maternal weight was treated as a categorical variable. Only two studies examined maternal weight as a continuous variable[11, 16]. The majority of studies operationalized maternal weight according to the classification scheme developed by one of three health institutions: the Institute of Medicine (IOM), National Institute of Health (NIH), and WHO (Table 1.1). The WHO classification system, which is endorsed by Health Canada, was used in the only Canadian study[25].

The three health institutions categorize BMI similarly, with the exception of the IOM. The IOM classification system was used in nine studies, and of these, eight were conducted in the United States [7-10, 12, 14, 18, 23].The IOM's overweight category is narrower as it ranges from 26.1 to 29.0 compared to 25.0 to 29.9, which is endorsed by the other institutions. In addition, the IOM classification system does not include a category for the very or morbidly obese. The WHO classification system was used in seven studies[2, 4, 6, 13, 19, 20, 25], however only two discriminated between obese (class I) and very obese (class II or III) [2, 4]. Three studies either created their own categories[22] or did not define the category ranges used[5, 16].

Table 1.1
Criteria for Body Mass Index Categorization by Health Institution

Classification	BMI (kg per m^2)		
	IOM	NIH	WHO*
Underweight	<19.8	<18.5	<18.5
Normal weight	19.8-26.0	18.5-24.9	18.5-24.9
Overweight	26.1-29.0	25.0-29.9	25.0-29.9
Obese	> 29.0	30.0-34.9	30.0-34.9 Class I
Very obese		≥ 35.0	35.0-39.9 Class II
			≥ 40.0 Class III

Note. IOM = Institute of Medicine; NIH = National Institute of Health; WHO = World Health Organization; *Some studies group all BMI values greater than 30.0kg/m^2 together

In these studies the BMI was computed using both measured and self-reported heights and weights. The discrepancy between reported versus measured heights and weights has been reported by other researchers (Sheilds, Conner Gorber, Janssen, & Tremblay, 2011; Sagna, Schopflocher, Raine, Nykiforuk, & Plotnikoff, 2013). Only

two[11, 22] of the 23 studies used measured weights; however seven [6-8, 11, 14, 20, 22] used measured heights. Self-reported estimates of pre-pregnancy weights were used in 12 studies[2, 6-10, 14, 15, 17, 18, 20, 23]; whereas estimates of current weights were used in four studies[3, 4, 12, 13]. Five studies provided no or limited details about how weights were collected [5, 16, 19, 21, 25].

Another challenge with the operational definitions for BMI was the timing of the measurement. Of the two studies that used a measured weight, Krause, Lovelady, and Ostbye[11] measured weight at 6 weeks postpartum and Sebire et al.[22] at an unspecified time during the prenatal period. Of the 12 studies that used self-reported pre-pregnancy weights, three studies[2, 18, 20] collected the information during the prenatal period, four [8-10, 17] in the post-partum period, and five [6, 7, 14, 15, 23] did not state when this information was collected. Current weight was used in four studies and was obtained during the initial obstetrical appointment[12], 42 weeks postpartum[4], and even up to 4 to 6 years postpartum[3, 13]. The variability evident in the timing of these measures raises questions regarding recall accuracy and poses challenges when comparing findings across studies.

Association between maternal weight and breastfeeding initiation. Of the 23 studies, 19 provide evidence to suggest an association exists between maternal weight and breastfeeding initiation. The association reported in these studies was always negative indicating that overweight or obese women were less likely to initiate breastfeeding. It is important to note in studies that included more than one measure of breastfeeding initiation, a statistically significant association was not necessarily observed with each measure. For example of the 16 studies that operationalized breastfeeding as breastfed ever and examined its association with maternal weight, 10 reported a statistically significant negative association [3, 4, 6, 10, 11, 13-15, 18, 23] whereas the

remaining six did not[2, 5, 7, 8, 16, 20]. Of the four studies that looked at breastfeeding at 7 days[2, 4, 13, 21], all reported a negative association. However, two of these studies [13, 21] only found this association when examining exclusive breastfeeding at 7 days. Of the four studies that focused on exclusive breastfeeding[12, 13, 21, 25], all found a negative association. A statistically significant association was also observed between breastfeeding initiation and obesity in the six studies that analyzed obese and overweight mothers separately[2, 4, 6, 12, 15, 23].

Potential factors influencing breastfeeding initiation. Other factors have been shown to influence mothers' initiation of breastfeeding and may affect the ability to detect an association between maternal weight and breastfeeding. Because a theoretical model or framework was not used in any of the retrieved studies to organize the examination of these factors, I opted to group them into three categories: maternal demographics; birth and newborn characteristics; and maternal health history and behaviours (Appendix A, Figure 1.2). As illustrated in Figure 1.2, maternal weight is conceptualized as a component of maternal health history and behaviour. The arrows in the figure depict the hypothesized effect of each category on women's initiation of breastfeeding. Given the focus of this investigation, an additional arrow was added to highlight the proposed effect of maternal weight on breastfeeding initiation.

All 23 of the cohort studies reported descriptive statistics for factors that could affect breastfeeding initiation. Eighteen of the 23 studies conducted bivariate analysis to examine the association between each factor and breastfeeding initiation[2, 3, 5-8, 10, 11, 13-21, 23]. Twelve studies attempted to account for these factors while examining the association between breastfeeding initiation and maternal weight[4, 6, 7, 11, 12, 15-18, 22, 23, 25].

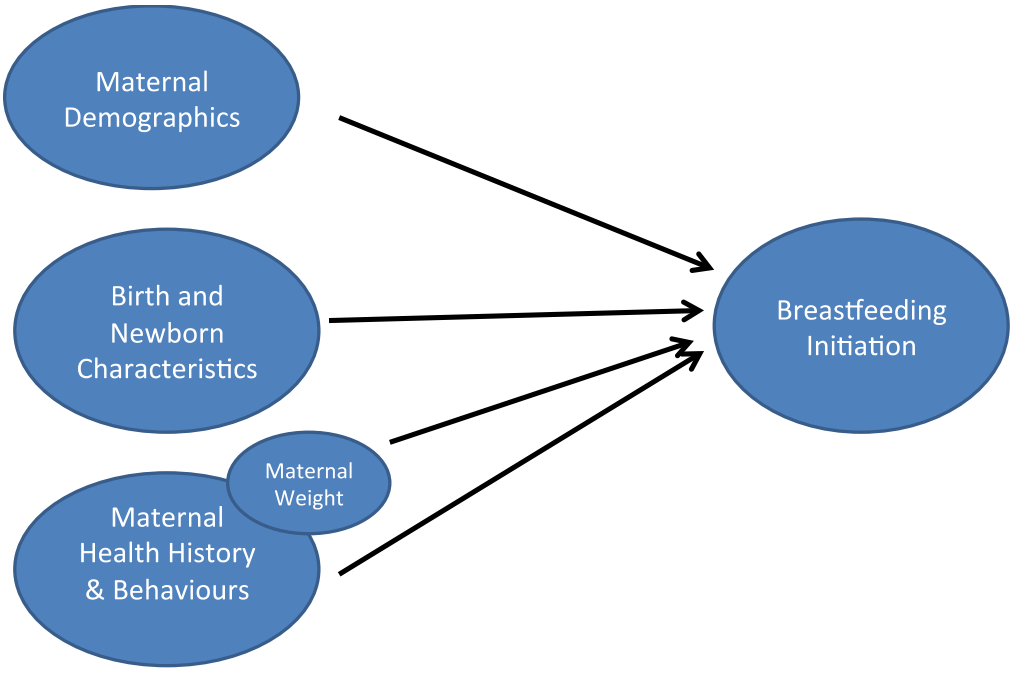

Figure 1.2. Diagrammatic representation of potential predictors of breastfeeding initiation.

Note. The arrows in the figure depict the hypothesized effect of each category on women's initiation of breastfeeding. Given the focus of this investigation, an additional arrow was added to highlight the proposed effect of maternal weight on breastfeeding initiation.

Maternal demographics. Demographic variables are characteristics such as age, sex, and ethnicity that are used to describe a population of interest. The most common demographic variables reported in the studies in relation to breastfeeding initiation were age, socio-economic status, education, and marital/partner status (Table 1.2). Descriptive statistics on the mothers' age were reported in all of the cohort studies; however only 15 examined its association with breastfeeding initiation. Eleven reported a statistically significant positive association suggesting that older mothers are more likely to initiate breastfeeding. Two of the four studies that reported no association had the smallest sample sizes (200[6] and 222[19] participants).

In six of the seven studies[7-10, 14, 18] examining the association between socio-economic status and breastfeeding, a positive association was observed suggesting that

women in higher income families are more likely to initiate breastfeeding. This association is similar to the one reported for education. In 11 of 14 studies, education was reported to have a positive association indicating that the initiation of breastfeeding is more likely to be observed in those with a higher level of education. Mok et al.[19] and Scott et al.[21] found the association not to be significant; however they had relatively small samples of 222 and 587 participants respectively. Manios et al.[17] was the only study to find a negative association. One possible explanation for this finding is that the study was conducted in Greece where the sociocultural beliefs and values surrounding breastfeeding may differ.

Having a partner was examined in 12 studies, with 10 reporting on the association. A statistically significant association was found in seven of the studies [5, 10, 11, 14-16, 18] suggesting that women with a partner are more likely to initiate breastfeeding. Three studies [2, 20, 21] found no association; however these studies were conducted outside North America. An association was not observed in two of the Australian studies that examined partner status[20, 21], which may suggest that the social support available to new mothers in Australia may differ from that available in other countries.

Birth and newborn characteristics. Characteristics of the birth and newborn that may affect women's initiation of breastfeeding include: type of birth (e.g., vaginal versus caesarean), birth complications (e.g., fetal distress as indicated by Apgar), and the newborns' birth weight, gestational age, and sex. Interestingly there is little evidence to suggest that these characteristics significantly affect the initiation of breastfeeding. For example, although the association between birth type (i.e., vaginal or cesarean) and breastfeeding initiation was examined in nine studies[2, 5-8, 10, 15, 20, 21], only two[2, 5] found a statistically significant negative association suggesting that women who gave birth by

cesarean were less likely to initiate breastfeeding. One reason why birth type may not have been found to contribute to breastfeeding initiation is that the majority of studies exclude premature births, complicated births, or newborns requiring specialized care (admission to intensive care), which may be more common with cesarean births.

Maternal health history and behaviours. This category includes characteristics pertaining to the mothers' health as well as behavioural choices that could impact their health. Although a number of characteristics were examined, limited evidence was found to suggest that these factors affect breastfeeding initiation. For example, the results for parity are conflicting. Six studies[2, 11, 15, 16, 20, 23] found a positive association indicating that multiparous women are more likely to initiate breastfeeding than primiparous women. In contrast, five studies [5, 6, 13, 17, 18] found a negative association and six others found no association [7, 8, 10, 14, 19, 21].

Two characteristics that have been found to predict breastfeeding initiation are smoking and early prenatal care. Of the 14 studies that examined the association with smoking, 11 found a negative relationship with breastfeeding initiation indicating women who smoke are less likely to initiate breastfeeding[2, 7, 8, 10, 11, 13, 14, 17, 18, 20, 21]. Kitsantas and Pawloski (2010) proposed that this may occur as women often feel that it is safer not to breastfeed if they smoke due to the perceived health risks to their newborn. There is evidence that prenatal care may have a positive effect on breastfeeding initiation[5, 14, 23]. Women's decisions to obtain prenatal care (prenatal classes or clinic appointments) and not to smoke may reflect an orientation to wellness for both themselves and their infant. Little consideration has been given to other behaviours that women engage in to promote their health or the health of their newborn. An exception is the study by Baker, Michaelson, Sorensen, and Rasmussen (2007) who examined women's level of physical

activity during pregnancy and observed that physically active women were more likely to initiate breastfeeding.

Predicting the Likelihood of Breastfeeding Initiation

Fourteen studies attempted to predict women's initiation of breastfeeding using pre-pregnancy maternal weight, while accounting for the effects of various maternal demographics; birth and newborn variables; as well as maternal health history and behavioural characteristics (i.e., covariates) [4, 6, 7, 9-12, 15-18, 22, 23, 25]. A decision was made to exclude the study by Kitsantas, Gaffney, and Kornides (2012)[9] because the focus of their investigation was on racial differences in breastfeeding initiation for women who were grouped as having either normal or elevated BMI and stratified by socio-economic status. While controlling for covariates, 11 of the remaining 12 studies continued to report a statistically significant negative association between maternal weight and breastfeeding initiation[4, 6, 7, 11, 12, 15, 17, 18, 22, 23, 25]. Only Ma and Magnus (2012)[16] found no effect after adjusting for covariates. The odds ratio for this study was 1.01 with a 95% confidence interval of 1.00 to 1.02. Explaining this finding is difficult because the classification system used to operationalize maternal weight was not reported.

Summary of Literature Review

This synthesis of the existing research provides evidence to suggest that breastfeeding initiation may be affected by the mothers' weight even after accounting for the effects of various covariates. However, this synthesis also highlights limitations in this body of research. One limitation is the variation in measurement of breastfeeding initiation. The majority of studies measured breastfeeding initiation as breastfeeding

ever. Outcome measures that might better reflect current WHO recommendations are breastfeeding within 1 hour of birth and breastfeeding exclusivity (WHO, 2014a). A second limitation is the reliance on self-reported measures of maternal weight and height. The discrepancy between self-reported compared to measured heights and weights has been well documented (Hill & Roberts, 1998; Sagna, Schopflocher, Raine, Nykiforuk, & Plotnikoff, 2013). Research in this area has also been hampered by the lack of an organizing structure or framework for the selection of relevant covariates. To address this limitation and help synthesize the findings from previous studies, I grouped the covariates into three categories: maternal demographics; birth and newborn characteristics; as well as maternal health history and behaviours. A final limitation is that only one study was found that examined the association between breastfeeding initiation and weight in Canadian women. Given the provincial variations in breastfeeding initiation rates and the increase in the percentage of new mothers classified as overweight or obese in Canada, further research is needed to determine if a similar association would be observed in other provinces.

Overview of Thesis Research

The goal of my research was to investigate whether breastfeeding initiation in PEI is affected by mothers' pre-pregnancy weight. This investigation involved the secondary analysis of the PEI Perinatal database, which is an administrative database maintained by the PEI Department of Health and Wellness. In preparation for my research I developed a paper outlining the benefits and challenges of using administrative databases for research purposes. This paper was completed as part of an independent study in research methods course and is included as a supplementary paper (Section 3). Data from the

administrative database were analyzed to examine the association between maternal weight and breastfeeding initiation after accounting for selected maternal demographics; birth and newborn variables; and maternal health history and behaviours. To help expedite the dissemination of my research I prepared a manuscript formatted according to the author guidelines for manuscript submission for the *Journal of Human Lactation*. This journal was selected based on its impact factor (1.985), the relevance of the research to the journal's target audience, and the opportunity for the manuscript to be considered for the student research section.

Table 1.2

Predictor Variables Examined in Previous Studies and Nature of Association Reported

Predictor Variables	Statistically Significant		
	Yes		No
	Nature of Association		
	Positive	Negative	
Maternal Demographics			
Age	11		5
Education	11	1	2
Employment	1		1
Has partner	7		3
Health insurance	1		
Geographical residence		1	1
Race, Black		4	
Race, Caucasian	5		2
Race, Hispanic	2		1
Social support	1		
Socio-economic (SES)	6		1
Type of work	1		
Birth and Newborn Variables			
Birth complications		1	1
Birth type, vaginal		2	7
Birth weight	3	1	3
Gestational age	3		8
Infant, female	2	1	3
Maternal Health History & Behaviours			
Maternal Weight, BMI		19	4
Alcohol			1
Diabetes		1	1
Gestational wt gain	1		2
Hypertension		1	1
Parity	6	5	6
Physical activity	1		
Prenatal care	3		1
Smoking		11	3

Note. Studies that included covariates but did not report the nature of the association are not included in this table

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(An asterisk indicates articles included in the systematic review)

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Appendix A – Synthesis of Retrieved Studies

Synthesis of Retrieved Studies Examining Body Mass Index as Possible Determinant for Breastfeeding Feeding Initiation

First Author, Year	Sample/Setting	Breastfeeding Initiation (BFI)	Pre-pregnancy Body Mass Index	Covariates (Nature of Association)
Systematic Review (n=3)				
Amir, 2007	N = 27 studies (10 on initiation) Years publication 1989 to 2006 Sample sizes 38 to 325,395 Country USA (n = 5) AUS (n = 3) GBR (n = 1) RUS (n = 1)	*Operationalized* BF ever BF at hospital discharge Breast milk ever BF at four days BF any last 5 hospital feeds	*Operationalized* IOM definition, n = 4 WHO definition, n = 4 Other, n = 2 Computed based on either: - Self-reported height and weight (time of interview) - Measured height and weight (pre-pregnancy, antenatal appointment) - Doctor diagnosed - Not specified *Findings* 1 study no effect 9 studies –ve effect (overweight and obese)	Covariates examined varied by study Not a focus of this systematic review

			Odds Ratio, range 1.19 to 2.17 overweight 1.38 to 3.09 obese	
Turcksin, 2014	N = 19 studies (16 on initiation) Years publication 1997 to 2011 Sample sizes 200 to 51,329 Country USA (n = 7) AUS (n = 4) BEL (n = 1) DNK (n = 1) FRA (n = 1) GRC (n = 1) RUS (n = 1)	*Operationalized* Breast milk ever	*Operationalized* IOM definition, n = 6 WHO definition, n = 9 Other, n = 1 *Findings* 1 study no effect 15 studies -ve effect Odds Ratio, range 1.19 to 3.65 obese	Not a focus of this systematic review
Wojcicki, 2011	N=13 studies (12 on initiation) Years publication 1997 to 2010 Sample sizes 111 to 51,329	*Operationalized* BF ever BF at hospital discharge	*Operationalized* IOM definition, n = 7 NIH definition, n = 5 Other, n = 1 Pre-pregnancy weight, not stated if measured or self-reported	Covariates examined varied by study Not a focus of this systematic review

	Country USA (n = 6) AUS (n = 2) RUS (n = 1) GRC (n = 1) FRA (n = 1) CAN (n = 1)		*Findings* 9 studies -ve effect 3 studies no effect	
Cohort, Prospective (n = 11)				
Baker, 2007	N = 37,459 Country: DNK Data from Danish National Birth Cohort (DNBC) Data period 1999-2002	*Operationalized* BF ever BF 1 week post-partum Asked at 6 months post-partum.	*Operationalized* WHO definition Computed based on self-reported pre-pregnancy height and weight, asked at 12 weeks gestation. *Findings* No effect BF ever 100% BF -ve effect BF, 1 week 96.5% Normal 85.6% Obese class III	*Maternal Demographic* Age (+ve) Has partner (~) Type of work (+ve) *Birth and Newborn Characteristics* Birth type, vaginal (–ve) Gestational age (~) Infant, female (+ve) *Maternal Health History and Behaviours* Parity (+ve) Physical activity (+ve) Smoking (-ve)
Kitsantas, 2010	N approx. 8,650 Country: USA	*Operationalized* BF ever	*Operationalized* IOM definition	*Maternal Demographic* Age (+ve) Has partner (+ve) Race, Black (-ve) Race, Hispanic (~)

	Data from Early Childhood Longitudinal Study-Birth Cohort (ECLS-B) Birth year 2001		Computed based on self-reported height and pre-pregnancy weight obtained 6 to 22 months postpartum. *Findings* -ve effect, obese No effect, overweight Odds Ratio only reported for groups stratified by medical complications	SES (+ve) *Birth and Newborn Characteristics* Birth complication (-ve) Birth type, vaginal (~) Birth weight (~) Gestational age (~) Infant, female (~) *Maternal Health History and Behaviours* Alcohol (~) Parity (~) Smoking (-ve)
Kugyelka, 2004	N = 640 Black N = 587 Hispanic Analyzed separately Country: USA Data from hospital records Two hospitals (one tertiary and one baby-friendly) Hispanic births 1998 to 2000	*Operationalized* BF within 2 hrs BF at least 1 out of last 5 hospital feeds BF exclusive before discharge	*Operationalized* IOM definition Computed using either self-reported or measured height and weight collected at initial obstetrical appointment. *Findings* Black -ve effect, BF 2 hrs 75.1% Normal 63.8% Obese No effect, 1 of 5 feeds No effect, exclusive BF	*Maternal Demographic* Age Education *Birth and Newborn Characteristics* Birth type, vaginal Birth weight Gestational age *Maternal Health History and Behaviours* Diabetes Parity Smoking

	Black births 1999 to 2000		Hispanic -ve effect, BF 2 hrs 71.8% Normal 61.5% Obese No effect 1 of 5 feeds -ve effect, exclusive BF Odds Ratio Hispanic exclusive 2.22, 95% CI 1.42 to 3.48 AOR Hispanic exclusive 1.92, 95% CI 1.20 to 3.08	No information on effect of covariates provided
Li, 2003	N = 51,329 Country: USA Data from Pediatric Nutrition Surveillance System (PedNSS) and Pregnancy Nutrition Surveillance System (PNSS) Data period 1996 to 1998	*Operationalized* BF ever	*Operationalized* IOM definition Computed from self-reported pre-pregnancy weight and measured height. *Findings* -ve effect, obese No effect, overweight Obese women regardless of their gestational weight gain were less likely to initiate BF than women with normal BMI (OR not reported)	*Maternal Demographic* Age (+ve) Education (+ve) Has partner (+ve) Race, Black (-ve) Race, Hispanic (+ve) SES (+ve) *Birth and Newborn Characteristics* Birth weight (+ve) Gestational age (~) *Maternal Health History and Behaviours* Parity (~) Prenatal care (+ve)

				Smoking (-ve) Effects of covariates examined in terms of interactive effects between pre-pregnancy BMI and gestational weight gain
Liu, 2010	N = 3,517 Caucasian N = 2,840 Black Analyzed separately Country: USA Data from Pregnancy Risk Assessment Monitoring System (PRAMS) Data period 2000 to 2005	*Operationalized* BF ever Breast milk ever	*Operationalized* NIH definition Computed from self-reported pre-pregnancy weight and height, asked via questionnaire at 2-6 months postpartum. *Findings* Caucasian -ve effect, very obese No effect, overweight No effect, obese Adjusted Odds Ratio 0.63, 95% CI 0.42 to 0.94 Black, No effect	*Maternal Demographic* Age (+ve) Education (+ve) Has partner (+ve) Health insurance (+ve) *Birth and Newborn Characteristics* Birth type, vaginal (~) Gestational age (~) Infant, female (~) *Maternal Health History and Behaviours* Diabetes (-ve) Gestational wt gain(+ve) Hypertension (-ve) Parity (+ve) Prenatal care (~) Smoking (~)

Mehta, 2011	N = 688 Country: USA Data from postpartum component if Pregnancy, Infection, and Nutrition (PIN) study and interviews by trained staff Data period 2001 - 2005	*Operationalized* BF ever Asked at 3 months post-partum.	*Operationalized* IOM definition Computed based on self-reported pre-pregnancy height and weight, asked at 15-20 weeks gestation. *Findings* -ve effect, overweight and obese combined Relative Risk 3.94, 95% CI 2.17 to 7.18	*Maternal Demographic* Age (~) Education (+ve) Has partner (+ve) Race, white (+ve) SES (+ve) *Maternal Health History and Behaviours* Gestational wt gain (~) Parity (-ve) Smoking (-ve)
Mok, 2008	N = 222 Country: FRA Data from medical records and telephone interviews Data period 2005	*Operationalized* BF on hospital discharge	*Operationalized* WHO* definition Computed from pre-pregnancy height and weight on medical chart. Unclear if self-reported or measured. *Findings* -ve effect 64.4% Normal 56.8% Overweight 48.2% Obese	*Maternal Demographic* Age (~) Education (~) *Maternal Health History and Behaviours* Parity (~)

Oddy, 2006	N = 1,803 Country: AUS Data collected from two antenatal clinics Data period 1989 to 1991	*Operationalized* BF ever	*Operationalized* WHO* definition Computed from measured height and self-reported pre-pregnancy weight. *Findings* No effect 91.8% Normal 88.6% Overweight 87.6% Obese	*Maternal Demographic* Age (+ve) Education (+ve) Has partner (~) Race, Caucasian (~) SES (~) *Birth and Newborn Characteristics* Birth type, vaginal (~) Birth complications (~) *Maternal Health History and Behaviours* Parity (+ve) Smoking (-ve)
Scott, 2006	N = 587 Country: AUS Data collected from questionnaire and telephone interview Data period 2002 to 2003	*Operationalized* BF 7 days post-partum (any or exclusive)	*Operationalized* Equivalent to NIH Not stated how or when height/weight data was collected *Findings* -ve effect, exclusive at 7 days 82.1% Normal 70.5% Overweight 63.1% Obese	*Maternal Demographic* Age (~) Education (~) Has partner (~) Race, Caucasian (~) Social support (+ve) *Birth and Newborn Characteristics* Birth type, vaginal (~) Infant, female (+ve)

			No effect, any BF at 7 days 91.8% Normal 89.3% Overweight 85.9% Obese	*Maternal Health History and Behaviours* Parity (~) Smoking (-ve)
Cohort – Retrospective (n = 13)				
Donath, 2000	N = 2,612 Country: AUS Data from Australian National Health Survey, conducted by the Australian Bureau of Statistics in 1995.	*Operationalized* BF ever	*Operationalized* Equivalent to NIH Computed from self-reported height and weight at time of interview (< 4 yr postpartum) *Findings* -ve effect, obese 89.0% Underweight 89.2% Normal 86.9% Overweight 82.3% Obese	*Maternal Demographic* Age Education Has partner SES *Maternal Health History and Behaviours* Smoking No information on effect of covariates provided
Donath, 2008	N = 3,075 Country: AUS Data from Longitudinal Study of Australian Children (LSAC) Data period 2003 to 2004	*Operationalized* BF ever BF 7 days post-partum	*Operationalized* WHO definition Computed from self-reported height and weight at approximately 42 weeks postpartum. *Findings* -ve effect, BF ever (obese) 95.1% Normal	*Maternal Demographic* Age Education Geographic residence SES *Birth and Newborn Characteristics* Birth type, vaginal Special nursery

			92.8% Overweight 87.1% Obese AOR overweight 1.30; 95 % CI 0.91 to 1.84 AOR obese 2.10; 95% CI 1.49 to 2.96 -ve effect, BF 7 days 91.7% Normal 87.1% Overweight 77.7% Obese AOR overweight 1.52; 95% CI 1.02 to 2.28 AOR obese 2.54; 95% CI 1.70 to 3.79	*Maternal Health History and Behaviours* Smoking No information on effect of covariates provided
Grjibovski, 2005	N = 1,399 Country: RUS Data from prenatal care center records Data period 1999	*Operationalized* BF ever Breast milk ever	*Operationalized* Categories not specified by authors *Findings* No effect 98.3% Underweight 98.7% Normal 100.0% Overweight	*Maternal Demographic* Age (+ve) Education (+ve) Employment (~) Has partner (+ve) *Birth and Newborn Characteristics* Birth type, vaginal (-ve) Infant, female (~)

				Maternal Health History and Behaviours Parity (-ve) Prenatal care (+ve)
Guelinckx, 2011	N = 200 Country: BEL Random sample of 50 women for each BMI category chosen from clinic files Data period 2006 to 2007	*Operationalized* BF ever	*Operationalized* WHO* definition Categorical and continuous Computed from self-reported pre-pregnant weight and measured height. *Findings* –ve effect, obese Odds Ratio 0.302, 95% CI 0.150 to 0.608	*Maternal Demographic* Age (~) *Birth and Newborn Characteristics* Birth type, vaginal (~) Gestational age (~) *Maternal Health History and Behaviours* Gestational wt gain (~) Hypertension (~) Parity (-ve) Smoking (~)
Hilson, 1997	N = 1,109 Country: USA One tertiary hospital Data period1992 to 1994	*Operationalized* BF ever BF at hospital discharge	*Operationalized* IOM definition Computed based on self-reported pre-pregnancy weight and measured height. *Findings* No effect, BF ever -ve effect, BF at discharge	*Maternal Demographic* Age (+ve) Education (+ve) SES (+ve) *Birth and Newborn Characteristics* Birth type, vaginal (~) Birth weight (+ve) Gestational age (~)

			Adjusted Odds Ratio 2.54 Overweight 3.65 Obese	*Maternal Health History and Behaviours* Diabetes (~) Parity (~) Smoking (-ve)
Hilson, 2006	N = 2,783 Country: USA Data from medical charts Data period 1988 to 1997	*Operationalized* BF ever BF at hospital discharge	*Operationalized* IOM definition Computed from self-reported pre-pregnant weight and measured height. *Findings* No effect, BF ever (100%) -ve effect, hospital discharge 90.1% Normal 88.4% Overweight 82.6% Obese	*Maternal Demographic* Age (+ve) Education (+ve) SES (+ve) *Birth and Newborn Characteristics* Birth type, vaginal (~) Birth weight (~) Gestational age (~) *Maternal Health History and Behaviours* Parity (~) Smoking (-ve)
Kitsantas, 2012	N = weighted sample Approx. 5,000 records Data analyzed separately for normal weight and overweight/obese Analysis focused on race and SES	*Operationalized* BF ever	*Operationalized* IOM definition Computed from self-reported pre-pregnant height and weight. *Findings* Reported rate BFI Low SES	*Maternal Demographic* Race, Black (-ve) Race, Hispanic (+ve) SES (+ve) No information on effect of covariates below: *Maternal Demographic* Age

	Country: USA Data from Early Childhood Longitudinal Study-Birth Cohort (ECLS-B) Data period 2001 to 2003		(normal BMI vs overwt/obese) Black 39.5% vs 34.0% White 49.1% vs 49.5% Hispanic 74.1% vs 75.2 Reported rate BFI Middle SES (normal BMI vs overwt/obese) Black 53.8% vs 50.0% White 70.7% vs 65.1% Hispanic 75.9% vs 69.8%	Has partner *Birth and Newborn Characteristics* Birth type, vaginal Birth weight Gestational age *Maternal Health History and Behaviour* Parity Smoking
Krause, 2011	N = 450 Country: USA Data from Active Mothers Postpartum (AMP) intervention program Only mothers with BMI $\geq$ 25 kg/m^2 were included Data period 2004 to 2006	*Operationalized* BF ever	*Operationalized* NIH definition BMI continuous variable Computed based on measured height and weight at 6 weeks postpartum. *Findings* -ve effect Odds Ratio 0.96; CI 0.92 to 0.99	*Maternal Demographic* Age (+ve) Education (+ve) Has partner (+ve) Race, Black (-ve) Race, Caucasian (+ve) *Birth and Newborn Characteristics* Gestational age (+ve) *Maternal Health History and Behaviours* Parity (+ve) Smoking (~)

Li, 2002	N = 7,712 Country: USA Data from Third National Health and Nutrition Examination Survey (NHANES III) Data period 1991 to 1994	*Operationalized* BF ever BF 7 days post-partum (any or exclusive)	*Operationalized* WHO* definition Computed from self-reported height and weight at the time of interview (2 months to 6 years post-partum). *Findings* -ve effect, ever 58.1% Normal 46.4% Overweight 44.8% Obese -ve effect, exclusive 7 days 52.5% Normal 39.5% Overweight 38.7% Obese	*Maternal Demographic* Age (+ve) Education (+ve) Race, Caucasian (+ve) Residence, rural (-ve) *Birth and Newborn Characteristics* Birth weight (-ve) Gestational age (+ve) *Maternal Health History and Behaviours* Parity (-ve) Smoking (-ve)
Ma, 2012	N = 2,036 Country: USA Data from Louisiana Pregnancy Risk Assessment Monitoring System (La PRAMS) established by the Center for Disease Control and Prevention (CDC)	*Operationalized* BF ever Breast milk ever	*Operationalized* No categories defined BMI continuous variable *Findings* No effect Crude Odds Ratio 1.01; 95% CI 1.00 to 1.02	*Maternal Demographic* Age (+ve) Education (+ve) Employment (+ve) Has partner (+ve) Race, Caucasian (+ve) Residence (~) *Birth and Newborn Characteristics* Gestational age (~)

	Data period 2000 to 2004			*Maternal Health History and Behaviours* Parity (+ve) Smoking (~)
Manios, 2008	N = 2,474 Country: GRC Data from interview and child's medical records brought in by parents Data period 2003 to 2004	*Operationalized* Initiation not defined	*Operationalized* IOM definition Computed from self-reported pre-pregnancy height and weight during interview at 12-60 months post partum. *Findings* -ve effect 54.1% Normal 41.4% Overweight 20.8% Obese AOR obese 2.86; 95% CI 1.74 to 4.70	*Maternal Demographic* Age (~) Education (-ve) *Birth and Newborn Characteristics* Birth weight (~) Gestational age (+ve) *Maternal Health History and Behaviours* Parity (-ve) Smoking (-ve)
Sebire, 2001	N = 287,213 Country: GBR Data from St Mary's Maternity Information System database Data period 1989 to 1997	*Operationalized* BF at hospital discharge	*Operationalized* Categories defined by authors Computed from measured height and weight at time of antenatal booking (usually before 20 weeks). *Findings* - ve effect	*Maternal Demographic* Age Race/ethnicity *Maternal Health History and Behaviours* Diabetes Hypertension Parity

			Odds Ratio Overweight 0.86; 99% CI 0.84 to 0.88 Obese 0.58; 99% CI 0.56 to 0.60	Effects of covariates examined in terms of the frequency observed in different weight groups
Thompson, 2013	N = 1,161,949 Country: USA Data from Florida birth certificate files Data period 2004 to 2009	*Operationalized* BF ever during "immediate post-partum period"	*Operationalized* IOM definition Computed from self-reported height and weight prior to conception. *Findings* -ve effect, obese Adjusted Odds Ratio 0.84; 95% CI 0.83 to 0.85	*Maternal Demographic* Age (+ve) Education (+ve) Race, Caucasian (-ve) *Birth and Newborn Characteristics* Birth weight (+ve) Infant, female (-ve) *Maternal Health History and Behaviours* Parity (+ve) Prenatal care (+ve)
Visram, 2013	N = 22,131 Country: Canada Data from Better Outcomes Registry & Network (BORN) Data period 2008 to 2010	*Operationalized* BF exclusive in hospital BF exclusive at hospital discharge	*Operationalized* WHO* definition Computed from pre-pregnancy height and weight on medical chart. Unclear if self-reported or measured.	*Maternal Demographic* Age Education Geographical residence SES *Birth and Newborn Characteristics* Birth complications

			Findings -ve effect, in hospital (excl.) AOR overweight & obese 0.67; 95% CI 0.60 to 0.75 -ve effect, hosp disch (excl) AOR overweight & obese 0.68; 95% CI 0.61 to 0.76	Birth type, vaginal Birth weight *Maternal Health History and Behaviours* Diabetes Parity Prenatal care No information on effect of covariates provided

Note. AOR = Adjusted Odds Ratio; BF = Breastfeeding; BFI = Breastfeeding Initiation; BMI = Body Mass Index; CI = Confidence Interval; IOM = Institute of Medicine; L&D = Labour and Delivery; NIH = National Institute of Health; NR = Not Reported; SES = Socio-Economic Status; SR = systematic review; WHO = World Health Organization; *WHO Class I, II, III combined; -ve = Negative Association; +ve = Positive Association; ~ = Association not statistically significant

Appendix B – References for Literature Review

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SECTION 2: MANUSCRIPT FOR PUBLICATION

The Relationship Between Maternal Pre-pregnancy Weight and Breastfeeding Initiation

Note: This paper was developed and formatted according to the author guidelines for manuscript submission to the *Journal of Human Lactation*.

Abstract

Background: Globally, overweight and obesity rates continue to rise. This is concerning for many reasons, one of which is the proposed link between maternal body weight and breastfeeding initiation, which can negatively impact the health of both newborns and mothers.

Objectives: This study examines the association between maternal weight and breastfeeding initiation using an administrative database and expands international research on the topic by providing a second Canadian study.

Methods: Secondary analysis of the Prince Edward Island (PEI) Perinatal Database was performed using data for women and their newborns born between January 1, 2012 and December 31, 2012. Sequential logistic regression was performed to investigate the ability to predict those mothers who initiated breast milk feedings.

Results: Analysis of administrative data for 1,079 PEI women provides further evidence to support that excess maternal weight is negatively associated with both breast milk initiation and the provision of breast milk at hospital discharge. This association was observed even after accounting for the effects of 10 variables reflecting attributes of the mothers, birth processes, and the newborns.

Conclusion: The link observed between maternal weight and breastfeeding is concerning given increasing rates of obesity. To help avert future problems, healthcare providers need to increase their efforts to not only encourage mothers to maintain a healthy body weight but also to encourage and support mothers who are overweight and obese in their efforts to breastfeed.

Keywords: body mass index, obesity, breastfeeding

Well Established

Breastfeeding is the best way to provide newborns with the nutrients for healthy growth and development. Although excess body weight is a known risk factor for many chronic diseases, it may also negatively affect maternal-newborn outcomes.

Newly Expressed

Obese mothers were less likely to initiate breastfeeding than normal weight mothers. Further research is needed to identify factors contributing to this lower rate of initiation. Meanwhile, healthcare providers need to work with obese mothers to support their efforts to breastfeed.

Background

The World Health Organization (WHO) began sounding alarms of a global obesity epidemic in the 1990s.[1] Despite these warnings, overweight and obesity rates have continued to rise.[1] Excess body weight is not only a major risk factor for chronic diseases, such as diabetes, cancer, and cardiovascular disease, it is also linked to maternal-child outcomes.[2] For example, there is evidence to suggest that increased maternal weight may negatively affect breastfeeding practices,[2, 3] which is a concern given that 37.2% of Canadian women of childbearing age are classified as overweight or obese.[4]

The benefits of breastfeeding for mothers and newborns are well established. For mothers, benefits may include a quicker return to pre-pregnancy weight, a natural form of birth control due to a delay in the reestablishment of menstrual periods postpartum, and a decreased risk of breast and ovarian cancer.[5, 6] Benefits also extend to newborns. Early initiation of breastfeeding protects newborns from infections (e.g. gastrointestinal, respiratory) and decreases mortality rates as breast milk contains natural antibodies.[6] The WHO promotes breastfeeding as a strategy to ensure healthy weight gain in children as breast milk has the proper mix of nutrients for growth and development.[6] Because of these benefits, it is important to determine if a link exists between maternal body weight and breastfeeding initiation.

Literature Review

A search of the Cumulative Index to Nursing and Allied Health (CINAHL) and PubMed bibliographic databases was conducted to develop a better understanding of how other researchers have conceptualized and operationalized breastfeeding initiation and

maternal weight and how the association between these variables has been investigated. This search yielded 27 articles including 3 systematic reviews[3, 7, 8] and 24 cohort studies[9-32] published between 1997 and 2015. No randomized controlled trials or meta-analyses were retrieved. The retrieved articles suggest that there is international interest in this topic as papers originated from nine countries, including one from Canada.[31] The Canadian study included administrative data for 22,131 mothers and examined their intention to breastfeed as well as exclusivity. Visram et al. reported that obese mothers were less likely to intend to breastfeed than overweight or non-overweight mothers; however, both overweight and obese mothers were less likely to exclusively breastfeed.

All of the systematic reviews[3,7,8] and 20 of the 24 cohort studies provide evidence to support the existence of a negative association between maternal weight and breastfeeding initiation suggesting that women with excess body weight are less likely to initiate breastfeeding than normal weight women.[9-11, 13-15, 17-22, 24-26, 28-32] Despite this, considerable variability is evident in the strength of the reported association. For example, odds ratios in the cohort studies range from 1.01[23] to 5.98[32]. One explanation for this variability is the range of body weights for women in the study samples. In their 2007 systematic review, Amir and Donath reported that ORs for overweight women ranged from 1.19 to 2.17; whereas ORs for obese women ranged from 1.38 to 3.09.[7] A second possible explanation for the observed variability is the inclusion of other potential predictors of breastfeeding initiation. The samples were described in terms of variables pertaining to mothers and newborns in all of the cohort studies; however attempts to account for these variables while examining the association between breastfeeding initiation and maternal weight were made in only 14 of the studies.[11, 13, 14, 17-19, 22-25, 29-32]

Data analysis in each of these 14 studies involved the use of logistic regression; however different approaches were used to enter the variables into the analyses. Variables were entered using stepwise selection in one study;[23] whereas simultaneous entry appears to have been used in the remaining studies. [11, 13, 14, 17-19, 22, 24, 25, 29-32] In three of the studies, variables were only included in the analysis if they satisfied a predetermined condition for inclusion (e.g., $p \leq .05$).[23, 25, 30]

Other predictors of breastfeeding initiation that have been examined in combination with body weight can be categorized as: maternal demographics; birth and newborn variables; and maternal health history and behaviours. Demographic characteristics that have been commonly examined in previous studies are the mothers' age at delivery and marital/partner status. Findings from these studies suggest that breastfeeding initiation is more likely in older mothers[9, 12, 14, 15, 17, 18, 20-23, 27, 30, 32] and those who have a partner.[12, 17, 18, 20, 22, 23, 25, 32] Variables pertaining to the birth and newborn that are commonly believed to affect women's initiation of breastfeeding include: birth complications, type of birth, and the newborns' birth weight and gestational age. It is generally believed that breastfeeding is more likely to be initiated when the mother and newborn are in good health. The evidence to support this belief is limited because premature or complicated births, and newborns requiring specialized care (admission to intensive care) are often excluded from studies.

A number of variables pertaining to mothers' health history and behaviours have been hypothesized to affect breastfeeding initiation. These include parity, gestational weight gain, prenatal care, physical activity, alcohol consumption, smoking, diabetes, and hypertension. However few studies have been conducted to examine the effect of these

variables on breastfeeding. One health behaviour that has been investigated in a number of studies is cigarette smoking. The evidence suggests women who smoke are less likely to initiate breastfeeding.[9, 14, 15, 17, 20, 21, 24, 25, 27, 28, 32] Although having a previous completed pregnancy was a statistically significant predictor in 11 studies; results are conflicting as to whether having a previous pregnancy increases or decreases the likelihood of women initiating breastfeeding. There is also some evidence to suggest that early prenatal care can positively affect breastfeeding initiation.[12, 20, 30] Best practice guidelines recommend prenatal care be initiated by 10 to 12 weeks (i.e., prior to the end of the first trimester)[33] to increase opportunities for physical assessments (e.g., checking for inverted nipples), breastfeeding education, and nutrition counseling. Given the possibility to modify mothers' health behaviours with early intervention, these variables warrant further investigation in order to optimize outcomes for the birthing process and the newborn, and to encourage breastfeeding.

Building on existing research, the purpose of this study was to examine the association between women's pre-pregnancy weight and their initiation of breastfeeding after accounting for variables reflecting maternal demographics, the birth and newborn, as well as maternal health history and behaviours that have been hypothesized to affect breastfeeding.

Methods

This study involved a secondary analysis of administrative data for all women who gave birth on Prince Edward Island (PEI) in 2012. PEI is a predominantly rural province located in eastern Canada with 53% of its population residing outside of an urban centre[34] and less than 3.1% of its population self-identifying as a visible minority.[35]

Based on data from the 2011 Canadian Census, women of childbearing age (15-49 years) comprise 22.9% of the population.[36] Although breastfeeding initiation rates in Canada (89%) are high compared to other countries,[37, 38] significant provincial variability exists with PEI having one of the lowest rates for breastfeeding initiation (78%).[39] The PEI Perinatal Database contains administrative data on behavioural, lifestyle, and clinical characteristics for women who give birth on the Island, as well as obstetrical outcomes and characteristics of their newborn(s).[39-41] High-risk births that are transferred out of the province for delivery in a tertiary care facility are only partially captured in the database. Data included in the data file are extracted from patients' health records by coders. For the purposes of this study, a sub-file was created with the variables of interest and the data for the mothers and newborns merged. The data file included information for all singleton, term ($\geq$ 37.0 weeks), live births on the Island from January 1, 2012 to December 31, 2012.

Prior to commencement of the study, the statistical power was estimated using the Power and Precision® software program version 2. This estimate was calculated based on a projected cohort of 1,000 cases, a two-tailed test with alpha preset at .05, and a relatively equal split in the percentage of cases grouped as normal and overweight/obese. The results of this computation suggested the study would have sufficient statistical power (.80) so that an 8% difference in breastfeeding initiation between the two weight groups or an Odds Ratio of 0.64 (or 1.56 if reverse coding of response options) would yield a statistically significant difference ($p \leq .05$).

Approval for this study was obtained from the University of New Brunswick Research Ethics Board and the PEI Research Ethics Board. In addition, approval was

obtained from the PEI Reproductive Care Program Joint Planning Committee, which is responsible for ensuring the database is appropriately used and the privacy of personal health information is maintained.[42]

Study Variables

Decisions for variable selection were informed by: (a) a review of findings from previous research; (b) examination of the data dictionary for the database; and (c) discussions about the nature and quality of the data as well as the amount of missing data with the Provincial Epidemiologist responsible for the database (C.S.) and a former database coordinator (J.B.). Consideration was given to how the outcome of interest (breastfeeding initiation), the primary predictor variable (pre-pregnancy maternal weight), and secondary predictors (covariates; maternal demographics, birth and newborn variables, and maternal health history and behaviours) could best be operationalized using the data available.

In the database, breastfeeding is defined in terms of breast milk. No distinction is made between newborns fed directly from the breast versus those fed by an alternative method (e.g., cup, bottle). Dichotomous data (yes/no) on three indicators of breastfeeding are available: breast milk initiation, breast milk feeding at hospital discharge, and breast milk exclusivity at discharge. Because the Database Administrator (C.S.) reported inconsistencies in the collection of data on breastfeeding exclusivity, this variable was not used. Breastfeeding initiation was, therefore, operationalized as breast milk initiation and breast milk feeding on hospital discharge. The primary predictor variable of maternal weight was operationalized in terms of pre-pregnancy body mass index. This variable was computed using mothers' pre-pregnancy weight and height.

Details on the source (self-reported or measured) and timing (gestational period) of these measurements are currently not captured in the database. However, according to the Database Administrator (C.S.), the majority of these measures are self-reported. A second variable for maternal weight was created by grouping the computed BMIs into four categories based on the WHO's classification system.[43] For the purpose of this investigation; obese classes I, II, and III were combined to form a single category. Because the focus was on excess body weight, a decision was also made to exclude cases involving underweight mothers (BMI <18.5). Due to the nature of the distribution of BMI values (i.e., positively skewed with an extreme outlier), a decision was made to use the categorical variable in the bivariate and multivariate analyses. This approach is consistent with the approach used in previous investigations as only 2 of the 23 reviewed cohort studies analyzed BMI as a continuous variable.[13, 18]

In addition to the primary predictor of maternal weight, 10 covariates were included in the analysis. Two maternal demographic characteristics (age at delivery in years and having a partner), four variables for describing the birth and newborn (type of birth, gestational age, birth weight, and newborn stability), and four variables conveying information about mothers' health history and behaviours (previous completed pregnancy, prenatal care during the first trimester, abstinence from smoking, and presence of a smoke free environment). For ease of interpretation, all of the covariates were recoded to create dichotomous variables with the attribute hypothesized to increase the likelihood of breastfeeding initiation assigned a value of 1 (absence of the attribute coded as 0). For example: age at delivery in years was recoded into two groups with women 25 years of age or older assigned a value of '1' and those less than 25 years of

age assigned a '0'. For this study, an uncomplicated birth was defined as a vaginal birth of a term (37 to 41 weeks) newborn, weighing between 2,500 to 3,999 grams, with an Apgar at 1 minute between 7 and 10 (indicating newborn stability and a high probability of survival).

Data Analysis

Data were analyzed using IBM SPSS ™ Statistics version 23 for Macs. Descriptive statistics (frequencies and valid percentages) were computed to summarize the characteristics of each study variable, assess the amount of missing data, and ensure the assumptions underlying the statistical tests were satisfied. Separate analyses were conducted with the two measures of breastfeeding initiation: breast milk initiation and breast milk feeding at hospital discharge. Chi Square analyses were conducted to examine the bivariate associations between breastfeeding initiation and each of the predictor variables. Hierarchical or sequential logistic regression analyses were performed to investigate the ability to predict those mothers who initiated breast milk feeding (initially and at hospital discharge). Covariates and the primary predictor variable were entered into the hierarchical regression in four sequential blocks: (1) maternal demographics; (2) birth and newborn variables; (3) maternal health history and behaviours; and (4) maternal weight. For the analysis, normal weight was treated as the referent or comparison group. The results of each block were examined to determine whether the set of variables improved the predictive capability of the model, as well as which variables made a statistically significant contribution.

Results

Preliminary Inspection of Data

The data file included information from the health records for 1,176 mother and newborn dyads. Cases that were missing data for the mother's weight or height were excluded (n = 56), as were those cases involving underweight women (n = 41). This resulted in 1,079 cases for statistical analysis. A preliminary check of the data was conducted to identify any data errors or extreme values. One case had a computed BMI of 66.2. This value is extreme but possible so no change was made.

Cohort Characteristics

Although mothers ranged in age from 16 to 45 years (Median = 29.6), most (79.2%) were 25 years of age or older and had a partner (83.9%; Table 2.1). The majority of cases involved a vaginal (69.6%), term (37 to 41 weeks; 87.3%) birth of a stable (Apgar $\geq$ 7; 88.1%) newborn weighing between 2,500 and 3,999 grams (82.3%). In general, the cohort was comprised of mothers who exhibited positive health behaviours as the majority had sought prenatal care during the first trimester (78.1%), abstained from smoking (81.5%), and reported no exposure to second-hand smoke during the prenatal period (80.5%). Approximately 60% of the mothers had other children (previous completed pregnancies).

Table 2.1
Descriptive Statistics for Secondary Variables of Interest (N = 1,079)

Variable	Frequency (Valid Percentage)
Demographic Characteristics of the Mothers	
Maternal Age 25 Years or Older	
No	224 (20.8%)
Yes	855 (79.2%)
Has Partner	
No	174 (16.1%)
Yes	905 (83.9%)
Birth & Newborn Variables	
APGAR $\geq$ 7 at 1 minute indicating stable infant (*n = 1,076*)	
No	128 (11.9%)
Yes	948 (88.1%)
Vaginal birth	
No	328 (30.4%)
Yes	751 (69.6%)
Birth Weight 2,500 to 3,999 grams (*n = 1,078*)	
No	191 (17.7%)
Yes	887 (82.3%)
Term Delivery (37 - 41 weeks)	
No	137 (12.7%)
Yes	942 (87.3%)
Maternal Health History and Behaviours	
Previous Completed Pregnancy	
No	434 (40.2%)
Yes	645 (59.8%)
Prenatal care during 1st trimester (*n = 1,021*)	
No	224 (21.9%)
Yes	797 (78.1%)
Abstained from Smoking	
No	200 (18.5%)
Yes	879 (81.5%)
Smoke Free Environment (*n = 1,017*)	
No	198 (19.5%)
Yes	819 (80.5%)

Body Mass Index Category (kg/m^2)	
Normal Weight 18.5 to 24.9	528 (48.9%)
Overweight 25.0 to 29.9	268 (24.8%)
Obese ≥ 30.0	283 (26.2%)

Note. Body mass index (BMI) calculated by dividing women's pre-pregnancy weight by the square of their height (kg/m^2). BMIs categorized according to the World Health Organization classification system.[43]

BMIs for mothers ranged from 18.5 to 66.2, with a median of 25.1 (Figure 2.1). Approximately half of the mothers (48.9%) had a pre-pregnancy BMI that fell within the WHO's category for normal weight. However, 51.0% of mothers had excess body weight with 24.8% classified as overweight (25.0 to 29.9 kg/m^2) and 26.2% as obese (≥ 30.0 kg/m^2). In 81.9% of the cases, breast milk was initiated (n = 883). This percentage dropped to 77.1% by the time of hospital discharge (n = 830; note 1 case omitted at hospital discharge due to missing data).

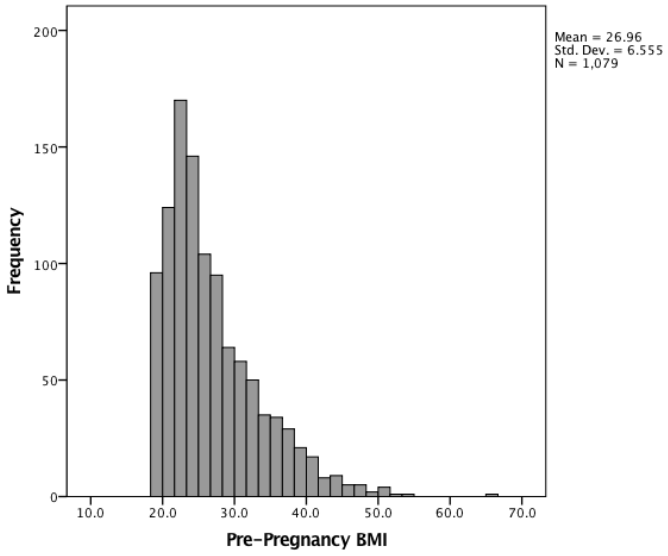

Figure 2.1. Histogram of Body Mass Index (N = 1,079)

Factors Associated with Breastfeeding Initiation

Bivariate analysis. Chi Square analyses produced similar results for both measures of initiation (breast milk initiation and breast milk feeding at hospital discharge; Tables 2.2 & 2.3). Statistically significant associations were observed between the two measures of breast milk initiation and both demographic characteristics (maternal age $\geq$ 25 years and has partner), as well as three of the four measures of maternal health history and behaviours (previous completed pregnancy, abstained from smoking, and smoke free environment). Statistically significant associations were not observed between the measures of breast milk initiation and early prenatal care or any of the four birth and newborn variables. Bivariate analysis findings also suggested that of the normal weight women, 85.2% initiated breast milk compared to 82.8% of overweight mothers and 74.9% of obese mothers (breast milk feeding at hospital discharge was observed in 81.8% of normal weight, 77.6% of overweight, and 67.7% of obese mothers).

Table 2.2
Comparison of the Percentage of Mothers Who Initiated Breast Milk by Selected Covariates Using Chi-Square Analysis (n = 1,078)

Variable	Initiated Breast Milk		Chi-Square (df) *p*-value
	No (n = 195)	Yes (n = 883)	
Demographic Characteristics of the Mothers			
Maternal Age 25 Years or Older			
No	61 (27.2%)	163 (72.8%)	15.95
Yes	134 (15.7%)	720 (84.3%)	(1)
			p <.001
Has Partner			
No	46 (26.4%)	128 (73.6%)	9.76
Yes	149 (16.5%)	755 (83.5%)	(1)
			p =.002
Birth & Newborn Variables			
APGAR ≥ 7 at 1 Minute Indicates Stable Infant (*n = 1,075*)			
No (0 – 6)	22 (17.3%)	105 (82.7%)	0.07
Yes (7 – 10)	173 (18.2%)	775 (81.8%)	(1)
			p =.799
Vaginal Birth			
No	63 (19.3%)	264 (80.7%)	0.44
Yes	132 (17.6%)	619 (82.4%)	(1)
			p =.508
Birth Weight 2,500 to 3,999 grams (*n = 1,077*)			
No	37 (19.5%)	153 (80.5%)	0.29
Yes	158 (17.8%)	729 (82.2%)	(1)
			p =.590
Term Delivery (37 to 41 weeks)			
No	26 (19.0%)	111 (81.0%)	0.08
Yes	169(18.0%)	772 (82.0%)	(1)
			p =.772
Maternal Health History and Behaviours			
Previous Completed Pregnancy			
No	52 (12.0%)	382 (88.0%)	18.29
Yes	143 (22.2%)	501 (77.8%)	(1)
			p <.001
Prenatal care during 1st trimester (*n = 1,020*)			
No	46 (20.5%)	178 (79.5%)	1.42
Yes	136 (17.1%)	660 (82.9%)	(1)
			p =.233

Abstained from Smoking			
No	77 (38.7%)	122 (61.3%)	69.93
Yes	118 (13.4%)	761 (86.6%)	(1)
			p <.001
Smoke free environment (*n = 1,016)*			
No	49 (24.9%)	148 (75.1%)	8.59
Yes	131 (16.0%)	688 (84.0%)	(1)
			p = .003
Body Mass Index			
Normal	78 (14.8%)	450 (85.2%)	13.41
Overweight	46 (17.2%)	221 (82.8%)	(2)
Obese	71 (25.1%)	212 (74.9%)	p =.001

Table 2.3
Comparison of the Percentage of Mothers Who Provided Breast Milk at Hospital Discharge by Selected Covariates Using Chi-Square Analysis (n = 1,077)

Variable	Breast Milk at Hospital Discharge		Chi-Square (df) *p*-value
	No (n = 247)	Yes (n = 830)	
Demographic Characteristics of the Mothers			
Maternal Age 25 Years or Older			
No	86 (38.4%)	138 (61.6%)	38.24
Yes	161 (18.9%)	692 (81.1%)	(1)
			p <.001
Has Partner			
No	65 (37.4%)	109 (62.6%)	24.42
Yes	182 (20.2%)	721 (79.8%)	(1)
			p <.001
Birth & Newborn Variables			
APGAR ≥ 7 at 1 Minute Indicates Stable Infant (*n = 1,074*)			
No (0 – 6)	31 (24.2%)	97 (75.8%)	0.12
Yes (7 – 10)	216 (22.8%)	730 (77.2%)	(1)
			p =.727
Vaginal Birth			
No	81 (24.7%)	247 (75.3%)	0.83
Yes	166 (22.2%)	583 (77.8%)	(1)
			p =.363
Birth Weight 2,500 to 3,999 grams (*n = 1,076*)			
No	48 (25.3%)	142 (74.7%)	0.70
Yes	199 (22.5%)	687 (77.5%)	(1)
			p =.405
Term Delivery (37 to 41 weeks)			
No	32 (23.4%)	105 (76.6%)	0.02
Yes	215 (22.9%)	725 (77.1%)	(1)
			p =.900
Maternal Health History and Behaviours			
Previous Completed Pregnancy			
No	83 (19.1%)	351 (80.9%)	5.97
Yes	164 (25.5%)	479 (74.5%)	(1)
			p =.015
Prenatal care during 1st trimester (*n = 1,019*)			
No	61 (27.5%)	161 (72.5%)	3.58
Yes	171 (21.5%)	626 (78.5%)	(1)
			p =.058

Abstained from Smoking			
No	96 (48.2%)	103 (51.8%)	88.45
Yes	151 (17.2%)	727 (82.8%)	(1)
			p <.001
Smoke free environment (*n = 1,015)*			
No	67 (34.0%)	130 (66.0%)	19.48
Yes	159 (19.4%)	659 (80.6%)	(1)
			p <.001
Body Mass Index			
Normal	96 (18.2%)	431 (81.8%)	20.59
Overweight	60 (22.4%)	208 (77.6%)	(2)
Obese	91 (32.3%)	191 (67.7%)	p<.001

Multivariable analysis. Results of the two logistic regression analyses are presented in Tables 2.4 and 2.5. The two maternal demographic covariates (age group and has partner) were entered into the analysis in the first block and this set of covariates made a statistically significant contribution to predicting cases in which breastfeeding was initiated. Only the odds ratio for age group was statistically significant for breast milk initiated (OR 1.78, 95% CI 1.17 to 2.71); whereas the odds ratios for both age group (OR 2.25, 95% CI 1.53 to 3.30) and has a partner (OR 1.53, 95% CI 1.00 to 2.33) were statistically significant for breast milk feeding at discharge. Results suggest that the odds of breast milk being initiated and being continued at hospital discharge was almost twice as likely for mothers who were 25 years of age or older than for younger mothers. Although having a partner did not significantly affect the initiation of breast milk, the odds of breast milk being provided at hospital discharge was approximately 1.5 times as likely for mothers with a partner.

Table 2.4
Results of Hierarchical Logistic Regression Examining Mothers Who Initiated Breast Milk, Variables Entered in Blocks (n = 963)

Independent Variables	B-weight (SE)	Odds Ratio	95% Confidence Interval, Odds Ratio
Block 1: Maternal demographics			
Model Fit: Chi-Square 12.69, df 2, p =.002			
Age 25 years or older	0.58 (0.22)	1.78	1.17 to 2.71
Has partner	0.25 (0.24)	1.29	0.81 to 2.05
Block 2: Birth and newborn variables			
Model Fit: Chi-Square 4.12, df 4, p =.390			
Apgar $\geq$ 7 at 1 minute	-0.32 (0.28)	0.73	0.42 to 1.27
Vaginal birth	0.27 (0.18)	1.31	0.92 to 1.87
Normal birth weight	0.17 (0.23)	1.19	0.76 to 1.86
Term delivery (37 to 41 weeks)	0.06 (0.25)	1.06	0.64 to 1.74
Block 3: Maternal health history and behaviours			
Model Fit: Chi-Square 76.78, df 4, p <.001			
Previous pregnancy	-1.19 (0.23)	0.31	0.20 to 0.48
Prenatal care during 1st trimester	0.16 (0.22)	1.17	0.76 to 1.80
Abstained from smoking	1.46 (0.23)	4.32	2.74 to 6.82
Smoke free environment	-0.20 (0.25)	0.82	0.50 to 1.34
Block 4: Maternal weight (Normal weight as the reference group)			
Model Fit: Chi-Square 8.52, df 2, p =.014			
Overweight	-0.04 (0.23)	0.96	0.61 to 1.52
Obese	-0.58 (0.21)	0.56	0.37 to 0.85
Constant	0.23 (0.52)		

Nagelkerke R^2 = .17; Model Fit: Chi-Square 102.12, df 12, p<.001

Table 2.5
Results of Hierarchical Logistic Regression Examining Mothers Who Provide Breast Milk at Discharge, Variables Entered in Blocks (n = 962)

Independent Variables	B-weight (SE)	Odds Ratio	95% Confidence Interval, Odds Ratio
Block 1: Maternal demographics			
Model Fit: Chi-Square 32.84, df 2, p <.001			
Age 25 Years or Older	0.81 (0.20)	2.25	1.53 to 3.30
Has partner	0.42 (0.22)	1.53	1.00 to 2.33
Block 2: Birth and newborn variables			
Model Fit: Chi-Square 5.65, df 4, p =.227			
Apgar $\geq$ 7 at 1 minute	-0.17 (0.25)	0.84	0.52 to 1.37
Vaginal birth	0.30 (0.17)	1.35	0.97 to 1.88
Normal birth weight	0.29 (0.21)	1.34	0.89 to 2.02
Term Delivery (37 to 41 weeks)	-0.00 (0.24)	1.00	0.63 to 1.59
Block 3: Maternal health history and behaviours			
Model Fit: Chi-Square 73.73, df 4, p <.001			
Previous pregnancy	-0.91 (0.20)	0.40	0.27 to 0.60
Prenatal care during 1st trimester	0.22 (0.20)	1.24	0.84 to 1.84
Abstained from smoking	1.38 (0.22)	3.97	2.60 to 6.05
Smoke free environment	0.03 (0.23)	1.03	0.66 to 1.60
Block 4: Maternal weight (Normal weight as the reference group)			
Model Fit: Chi-Square 13.26, df , p =.001			
Overweight	-0.16 (0.21)	0.86	0.56 to 1.30
Obese	-0.71 (0.20)	0.49	0.33 to 0.73
Constant	-0.68 (0.48)		

Nagelkerke R^2 = .19; Model Fit: Chi-Square 125.52, df 12, p<.001

After partialling out the effects of the maternal demographic variables, entry of the four birth and newborn variables did not make a statistically significant contribution

to predicting breastfeeding initiation. Next, the four covariates for maternal health history and behaviours were entered into the analysis. Entry of this set of covariates significantly improved the ability to predict cases of breastfeeding with two of the covariates (i.e., previous completed pregnancy and abstaining from smoking) making significant contributions. The odds ratios indicate the effects of these two covariates were similar in both analyses. The odds ratio for previous pregnancy suggests that breast milk initiation was less likely to be observed in mothers with a previous completed pregnancy. For example, the odds of breast milk initiation in cases involving mothers with a previous pregnancy was 70% less than for first time mothers. Abstinence from smoking was also a significant predictor of breast milk initiation with the odds of breast milk initiation being almost 4 times more likely in non-smokers than smokers.

After partialling out the effects of the 10 maternal demographic, birth and newborn variables, and maternal health history and behaviour covariates; maternal weight was entered and made a statistically significant improvement in the ability to predict cases for both measures of breastfeeding initiation. A statistically significant association was observed for only one of the weight groups. Although results suggest that there was no statistically significant difference in the odds of breast milk initiation by mothers classified as overweight compared to those classified as normal weight, the odds of breast milk initiation by women classified as obese was approximately 44% less than that for normal weight mothers and 51% less when examining breast milk provided at hospital discharge.

Discussion

Findings from this analysis of administrative data for 1,079 PEI women who gave birth to a singleton newborn on the Island during 2012 provide further evidence to support that excess maternal weight is negatively associated with both breast milk initiation and the provision of breast milk at hospital discharge. This association was observed even after accounting for the effects of 10 variables reflecting the maternal demographics, the birth and newborn, and the maternal health history and behaviours. Findings from this investigation raise questions as to the processes by which mothers' pre-pregnancy weight influence the initiation of breastfeeding. This research is timely given the global obesity epidemic and it expands the international research on the role of maternal weight on breastfeeding practices by providing a second Canadian study.

Excess body weight is an increasing concern in Canada given its negative effects on health outcomes.[1] In 2012, 37.2% of Canadian women of childbearing age (18 to 49 years) were considered to be overweight or obese and the rate for PEI women was even higher at 46.2%.[4] In this study, 51% of the mothers were classified as overweight or obese (25% and 26% respectively) based on their self-reported pre-pregnancy weight and height.

The rate of breast milk initiation on the Island in 2012 was 82%, which is higher than previously reported (78.3% in 2011) but still lower than the average rate of 89% reported for Canada.[38, 39] Why breastfeeding rates for women in Atlantic Canada have consistently been lower than the rest of the country[39] is unknown, however, one possible explanation is that household incomes (socio-economic status)[44] and levels of education[45] tend to be lower in this region. Research has consistently demonstrated that women with

lower levels of education or socio-economic status are less likely to initiate breastfeeding.[12, 14-18, 20-23, 25, 27, 30]. A second possible explanation stemming from the findings of this investigation is that the rate of breastfeeding initiation is lower due to the higher percentage of overweight and obese women.

In this study, approximately 1 out of every 5 new mothers did not initiate breast milk feeding. By the time of hospital discharge, an additional 53 mothers (5%) had stopped providing breast milk. With the average length of hospital stay in the province ranging from 2.4 days for vaginal births to 3.7 days for caesarian or complicated births,[39] it appears the decision to stop breastfeeding was made very quickly and perhaps before breast milk production was fully established. Although considerable research has been conducted examining reasons for cessation, few studies have focused specifically on mothers who make this decision while in hospital with healthcare providers available to assist with the establishment of breastfeeding.[46]

Possible predictors of breastfeeding initiation were grouped into three categories: maternal demographics; birth and newborn variables; and maternal health history and behaviours. The two maternal demographic variables of age 25 years and older and having a partner were observed to have predictive roles in explaining breastfeeding initiation. Study findings support the hypothesis that mothers aged 25 years and older are more likely to initiate breastfeeding, which is consistent with previous research suggesting maternal age is positively associated with breastfeeding initiation.[9, 12, 14, 15, 17, 18, 20-23, 27, 30, 32] Interestingly, although having a partner was significantly associated with the provision of breast milk at hospital discharge, this association was not observed with breast milk initiation.

Despite literature indicating birth and newborn variables may impact breastfeeding,[47,48] none of the birth and newborn variables examined in this study made a significant contribution to predicting breastfeeding initiation. This finding may reflect that the cohort was primarily comprised of mothers with healthy, term newborns. Given the amount of accumulated evidence suggesting birth and newborn variables do not play a role in breastfeeding practices for healthy, term, singleton newborns, [13, 15, 22, 27] perhaps it is time to recommend the exclusion of these variables from future investigations. By omitting these variables the effect of other predictors that may play a role in breastfeeding might be examined. Alternatively, research involving these variables could be conducted to examine their effect with more high-risk populations such as pre-term, post-term, or multiple births.

Two of the four maternal health history and behaviours covariates examined in this study helped predict those women who initiated breastfeeding. Surprisingly, prenatal care during the first trimester was not found to be a significant predictor. This finding contradicts those of three studies reporting women who received prenatal care were more likely to initiate breastfeeding. Two of these studies were conducted in the United States and had very large sample sizes (> 50,000) which increases the ability to attain statistical significance.[20, 30] The third study was conducted in Russia where the norms for prenatal care may differ from those in North America.[12] These conflicting findings may also reflect differences in the amount and type of education offered to women during these visits.

Although both abstinence from smoking and living in a smoke free environment were significantly associated with breastfeeding at a bivariate level, only abstinence from

smoking was significant in the multivariable analysis, which suggests possible overlap in their predictive ability. The finding that women who abstained from smoking are more likely to initiate breastfeeding is consistent with other studies. [9, 14, 15, 17, 20, 21, 24, 25, 27, 28, 32] This may reflect the belief that breastfeeding is contraindicated when smoking due to the health risks to the newborn.[17, 49] This belief is not consistent with the Canadian Pediatric Society's current position statement which encourages smoking cessation but recommends breastfeeding for all mothers.[50] To reduce newborn's exposure to potential toxins, it is recommended that mothers who smoke avoid smoking near their newborn and within the home.[50]

In this study, a previous completed pregnancy was also a significant predictor of breastfeeding initiation. Findings indicate mothers who had a previous completed pregnancy were less likely to initiate breastfeeding. It is possible that the influencing factor is not whether women have had a previous pregnancy but whether they have successfully breastfed in the past. Mothers who have successfully breastfed in the past have been found to be more likely to repeat this behaviour with subsequent pregnancies.[51]

Even after accounting for the effects of 10 variables that previous research suggests affects breastfeeding, mothers' pre-pregnancy weight made a statistically significant contribution to predicting the initiation of breast milk feeding. This finding is noteworthy as it helps establish the importance of considering women's weight both in research and in clinical practice and emphasizes the need for consistent and accurate measurements. Currently only the pre-pregnancy weight and height are captured in the PEI Perinatal Database. Inclusion of women's measured weights and their weeks gestation in the database, would permit analysis to examine both the independent and

interactive effects of pre-pregnancy weight and gestational weight gain on breastfeeding initiation.[15, 22, 24, 32] Hilson et al. found women who exceeded pregnancy weight gain recommendations were less likely to initiate breastfeeding than women who stayed within recommended ranges.[15]

Interestingly, the effect of maternal weight on breastfeeding initiation was observed only for mothers classified as obese (BMI $\geq$ 30). This is not the first study that has reported an association between breastfeeding initiation and maternal weight for obese women, [10, 13, 15, 17, 19, 20, 28, 30] but there are also some studies that have reported the association for both overweight and obese women. [11, 14, 24, 26, 29, 31, 32] Possible explanations for the apparent discrepancy are differences in the number of cases in the normal weight, overweight, and obese categories as well as the lack of a standardized approach for the measurement and classification of BMIs. However, what is clear from these studies is the importance of considering the mechanisms by which body weight may affect women's initiation of breastfeeding.

Hilson et al. emphasized the importance of considering both biological (physical and physiological) and non-biological (psychological and social) factors.[54] Physically, obese women may have larger breasts and/or areolas which may present challenges when positioning the newborn or attempting to establish an effective latch. From a physiological perspective, excess adipose tissue may result in an over-supply of progesterone which may delay the lactogenesis process in obese women.[54] It has been estimated that milk production may be delayed by 0.5 hour for each 1kg/m^2 of excess body weight.[54] For mothers with a BMI of 30 (obese), this could mean a delay in milk production of 5 hours compared to normal weight mothers. From a psychological

perspective, a delay of 5 hours could cause obese mothers to experience feelings of self-doubt or to have concerns about their ability to supply needed nutrition to their newborn. Obese women may also be dissatisfied with or self-conscious of their appearance leading to reluctance to expose their breasts.[54-56] Further quantitative as well as qualitative research is needed to examine the physical, physiological, and psychological factors affecting breastfeeding.

Implications for Practice

Healthcare professionals who help prepare expectant couples for parenthood or support them during the early postnatal period need to be aware of the potential effect of mothers' weight on breastfeeding. An opportune time to discuss the effect of body weight on women's health, as well as to discuss potential challenges they may experience with breastfeeding, is during prenatal visits and the routine measurements of weight. Prenatal education needs to include discussion not only about the importance of breastfeeding but also the importance of healthy eating in order to attain targets for gestational weight gain. During the early postnatal period, women who are obese may require additional education and support. Due to the unique challenges that obese women may encounter with breastfeeding as a result of the size of their breasts and the delay in milk production, these women may require additional support and help from healthcare providers. This help may include demonstrating alternative options for positioning the newborn to help establish an effective latch, encouraging frequent breastfeeding to stimulate milk production, monitoring the newborn's hydration status, and providing reassurance to prevent parents from becoming frustrated. Until mothers feel comfortable

and confident with breastfeeding, supports need to be available for them both in the hospital and the community.

Strengths and Limitations

This study was possible because of the availability of the PEI Perinatal Database, which contains information for all births occurring in PEI. The PEI Medical Society and Department of Health and Wellness created this database over 30 years ago. To date use of this database has been limited primarily to the creation of biannual reports summarizing the data. This study helps demonstrate how this database can be used for more in-depth analysis to explore the inter-relationships among variables reflecting attributes of the mothers, birth processes, and newborns. Given the ongoing nature of this database, it also offers the opportunity for longitudinal studies to examine changing trends in breastfeeding and the health of mothers and newborns. This study builds on the methodologies used in previous studies, which assisted in the interpretation of findings. This study is based on a predominantly rural and ethnically homogeneous group. Although this may limit the generalizability of the findings, findings are representative of the population of interest (PEI women who gave birth).

A limitation of this study includes the decision to exclude underweight women and to group obese classes I, II, and III together. Although these decisions were driven by the cohort, an examination of BMI as a continuous variable or the inclusion of more weight categories might have enhanced our understanding of the association between maternal weight and breastfeeding initiation. A final limitation was how breastfeeding is measured in the database. A more comprehensive examination of breastfeeding practices

would be possible by the availability of data not only on the initiation of breastfeeding but also its duration and exclusivity.

Conclusion

This study expands the international research on the role of maternal pre-pregnancy weight on breastfeeding practices and provides a second Canadian study on the topic. The link observed between maternal weight and breastfeeding is concerning given increasing rates of obesity, as it may undermine recent gains in the number of mothers who choose to breastfeed. To help avert future problems, healthcare providers need to increase their efforts to not only encourage mothers to maintain a healthy body weight but also encourage and support overweight and obese mothers in their efforts to breastfeed. Although the provision of such support takes time and patience, it is important to keep in mind that even though breastfeeding is instinctual for many newborns, it is a learned process for the mother and newborn dyad [46,57] and some may encounter more challenges than others. Obese mothers and their newborns may require additional intervention to ensure effective breastfeeding is established.

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SECTION 3: SUPPLEMENTARY PAPER

Benefits and Challenges of Administrative Databases

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Benefits and Challenges of Administrative Databases

INTRODUCTION

Evidence-based practice is integral to the attainment of high quality healthcare and improved patient outcomes (Melnyk & Fineout-Overholt 2011). However, acquiring the evidence to inform practice can be a time consuming and labour intensive undertaking. A potential source of evidence that can be used to plan, design, and evaluate healthcare services is administrative data (Bibb 2007). Research involving the analysis of administrative data is more likely to influence practice because the data encompass the entire population of interest and provide a record of the practices in a particular setting. The ability to influence changes in practice is further enhanced by the establishment of collaborative partnerships between the researchers and the healthcare decision makers who are responsible for the database. This paper highlights the benefits and challenges associated with using an administrative database through a review of the literature and a discussion of a database accessed for a thesis research project.

Background

An increasing volume of data is being collected by healthcare institutions and stored electronically which makes it easier to access for research purposes. Despite this, the analysis of administrative data poses challenges not encountered in investigations involving primary data (i.e., data collected by a researcher for a specific study). An understanding of the potential benefits and challenges associated with the analysis of administrative databases is, therefore, required before undertaking such investigations.

Secondary analysis and the types of databases. The analysis of administrative databases for research purposes is commonly referred to as secondary analysis. Data used in secondary analysis come from three main sources: (a) other researchers who previously collected and analyzed the data; (b) national agencies such as Statistics Canada, United States Census Bureau, or United Kingdom Office of National Statistics that collect, compile, and analyze data to monitor changing demographic, economic, and social trends but also store these data so they can be accessed by others; and (c) organizations and individuals who collect data for tracking and record keeping purposes. The latter source of data encompasses administrative databases, also referred to as health or medical records. Numerous healthcare administrative databases (e.g., client/patient files; disease surveillance records; billing, insurance or social assistance claims) exist including those maintained by provincial/state, regional, community, or institutional health departments and by private organizations and interest groups (e.g., family resource centers, La Leche League) or individual practitioners. Since more and more data are being collected and stored electronically, secondary analysis of administrative data is becoming a more feasible and cost effective approach for acquiring evidence to support clinical decisions.

Data Sources

To gain a better understanding of what constitutes secondary analysis, the benefits and challenges associated with it and how to successfully use administrative databases for research purposes, a search of the Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, and Scopus bibliographic databases was conducted with the assistance of an academic librarian. Initially the terms “secondary analysis” and

"administrative database" were searched separately in the PubMed and CINAHL databases to identify relevant subject headings (i.e., Medical Subject Headings [MeSH] and CINAHL headings). Interestingly, although secondary analysis is not a MeSH term found in PubMed, it is a CINAHL heading. The CINAHL definition for secondary analysis is "research that involves the re-analysis of previously collected data for the purpose of either addressing the original research question with better statistical techniques or asking new questions of the original data".

In PubMed relevant MeSH for administrative databases were "Medical Records" and "Electronic Health Records". Three relevant subject headings were found in CINAHL: "Medical Records", "Computerized Patient Record", and "Databases, Health". In both bibliographic databases the various subject headings for administrative databases were combined using the Boolean operator "OR" to retrieve citations that used any of these terms. Using the Boolean operator "AND" (to only retrieve citations that included terms from both searches), this search was then combined with "secondary analysis" searched as a keyword in PubMed and as a subject heading in CINAHL. In addition a second keyword search was conducted in each database using the terms administrative, secondary analysis, and data* (the asterisk is the symbol for truncation which expands the search by capturing alternate endings of the root word such as database) with all three terms combined using the Boolean operator "AND". Because Scopus does not make use of subject headings, the same search strategy was repeated however the terms were searched as keywords. All searches were limited to English language only.

Titles and abstracts of the retrieved articles were reviewed to identify those that provide information on the benefits, challenges, and/or use of administrative databases.

Reference lists of the retrieved articles were also reviewed to identify other relevant publications. Many of the retrieved articles were excluded because they focused on either the implementation of an electronic data collection system or on the reporting of descriptive statistics for electronically stored data following implementation of a program.

DISCUSSION

Retrieved Articles

Eleven articles were found that addressed the quality of the data found in administrative databases or the potential challenges associated with the use of these databases for research (Appendix A). All of the retrieved articles were published in the last 15 years and the first authors were located in North America. Interestingly all of the first authors were nurses with the exception of two (Kluwin & Morris 2006; Ladouceur, Rahme, Pineau, & Joseph 2007). The titles for two of the retrieved articles emphasized the potential challenges of working with administrative databases: Kluwin and Morris (2006) described it as "Lost in a Giant Database" while Vance (2012) discussed "Troubles and Triumphs". Although the retrieved papers provide useful information about the secondary analysis of large databases, none focused solely on the analysis of administrative data or provided a comprehensive summary of the challenges associated with these databases and strategies to help ensure their successful use.

Benefits and Challenges

Benefits of secondary analysis are typically discussed in terms of the time and cost of data acquisition (Clarke & Cossette 2000; Kluwin & Morris 2006). For graduate

students attempting to complete their research project in a timely and low budget manner, the availability of a pre-existing data file containing variables relevant to their area of interest has great appeal. Administrative databases typically contain more cases and variables than graduate students would have access to if they collected their own data. The availability of large data files permits the use of multi-variable statistical procedures that are better able to explain the complex interrelationships among factors impacting health outcomes. Analysis of administrative data may also increase the potential impact of student-initiated research as decision makers have a vested interest in the findings because they helped create the database. Because of this, decision makers are more likely to assume an active role in shaping research questions and subsequently in using the findings to inform health policy changes and guide healthcare practices.

Unfortunately the benefits of these databases can be reduced by a number of potential challenges. The first challenge is locating a database that contains data that are relevant to the topic area of interest. Fortunately the availability of such databases is increasing due to the amount of health data being collected electronically. Once a potential database is located careful scrutiny is required to determine if it contains data elements (i.e., variables) that capture key study concepts. A second challenge or a reality associated with administrative databases is that 'what you see is what you get' which means that changes may need to be made to the study concepts and/or research question(s) based on the available data. In some situations, study concepts may need to be excluded from the planned analysis because a comparable data element does not exist within the data file or it is not measured with the necessary level of specificity. There may also be financial costs associated with the acquisition of administrative data. In

most cases only a portion of the administrative database will be made available to the researcher as a sub-file is created containing only the agreed upon variables and cases. When members of the healthcare organization are actively involved in the research project, the costs incurred in the creation of this sub-file may be viewed as an in-kind expenditure and provided at no cost.

Some administrative databases may not be appropriate for research due to insufficient documentation or lack of availability of a resource person with in-depth knowledge of the database, which presents a third challenge. Without details of the history of the database, definitions for data elements, data collection methodology, processes used for entering, coding, and ensuring consistency or quality of the data, as well as any changes made to the database over time, the appropriateness of using the database for research purposes must be questioned. The absence of such detail can negatively impact the reliability of study findings and the ability to use these findings to inform practice decisions. Attention also needs to be given to the type and amount of missing data especially for key study concepts.

A final challenge is gaining access to the data. Similar to all research projects, studies involving secondary analysis must satisfy institutional ethical requirements. The requirements for research involving humans in Canada are governed by the Tri-Council Policy Statement, which is based on the principles of respect for persons, concern for welfare and justice (CIHR, NSERC, & SSHRC, 2014). In addition there are legal considerations associated with gaining access to administrative databases, especially those maintained by provincial/state or regional health authorities, due to changing legislation regarding freedom of information and protection of privacy. Privacy

regulations frequently require data elements that might identify specific individuals be removed (e.g., health number, date of birth, and postal code) (Windle, 2010). If such information is essential to the research project, special safeguards need to be put in place to address the requirements of the research project while ensuring the privacy of individuals. Delays may be avoided by reviewing current legislation surrounding access to information and contacting local or regional privacy office/commission early in the research process. Information on current privacy and data access legislation can generally be found on provincial/state websites by searching "freedom of information". An issue that also needs to be addressed during preliminary discussions with database administrators pertains to the dissemination of findings and any restrictions that the organization may impose. Establishment of a data-sharing agreement that explicitly states the intended data use and any requirements pertaining to the dissemination of results is recommended (Vance 2012).

Implications for Nursing

An example may further illustrate the potential benefits and challenges associated with the use of administrative data for research purposes. My thesis research involved an investigation of the association between maternal weight and breastfeeding initiation while accounting for several maternal and newborn characteristics. In a systematic review, Turcksin, Bel, Galjaard, and Devlieger (2014) found evidence to suggest overweight and obese women are less likely to initiate breastfeeding. Since none of the studies examined by Turcksin and colleagues (2014) were Canadian, further research was deemed necessary. Conducting such an investigation in the province of Prince Edward Island (PEI) was viewed to be important as 47% of new mothers are classified as

overweight or obese and provincial breastfeeding initiation rates are among the lowest in Canada at 75% (PEI Reproductive Care Program 2013; Public Health Agency of Canada, 2013).

During discussions with colleagues in maternal-child health, I became aware of the PEI Perinatal Database. This database was established in 1990 by the PEI Department of Health and Wellness and the PEI Medical Society as a mechanism for improving reproductive healthcare within the province. I formulated eight questions to consider when evaluating the suitability of an administrative database for research purposes:

1. Does the database contain data relevant to the research questions and in particular does it include data for the key concepts?
2. Is there supporting documentation that defines the data elements including their response options?
3. What changes have been made to the data elements and to the process for data collection and entry over the proposed study period?
4. How many people collect and enter data into the database and what training do they receive to increase consistency?
5. What steps are taken to monitor data quality and ensure the completeness of data?
6. Are there data elements that may prove problematic based on the amount of missing data or possible inconsistencies in the data collection or coding processes?
7. What is the current policy and procedure for accessing data for research purposes?

8. Have researchers outside of the organization analyzed the data and were any problems encountered?

These questions were considered during the planning stage of my thesis research. Key to my research was the availability of data describing women's breastfeeding practices and pre-pregnancy weight. The PEI Perinatal Database provides these data as well as information on behavioural, lifestyle, and clinical characteristics for women who give birth on the Island as well as obstetrical outcomes and characteristics of their newborn (Deloitte & Touche LLP 2010; PEI Reproductive Care Program 2010, 2013). Annually, information for approximately 1,400 mother and newborn dyads are added to the database. Although the database has been used to generate bi-annual reports on provincial breastfeeding rates, researchers outside the Department of Health and Wellness have never used it. The potential to use this database for my thesis research was enhanced by the availability of a data dictionary which provided a detailed description of the data elements and coding options as well as database administrators who were interested in seeing the database used for research purposes. The availability of these resources allowed me to gain an understanding of the database, the nature and quality of the data and its suitability for research.

A data element that posed challenges both conceptually and operationally was breastfeeding. The database contains three measures of breastfeeding (initiation, at hospital discharge, and exclusivity at discharge). A conceptual challenge was that breastfeeding is defined in terms of breast milk, which does not discriminate whether the newborn is fed breast milk directly from the breast or by an alternative method (e.g., cup, bottle). Operationally, the database administrator reported inconsistencies in how, and if,

data on breastfeeding exclusivity were collected which prevented its use, which is unfortunate given the current World Health Organization recommendation for exclusive breastfeeding (WHO 2001; WHO 2014).

Assessing the suitability of the PEI Perinatal Database in terms of the eight formulated questions increased my confidence in using this database for my thesis research. In light of the data available, modifications were made to the original research questions and some of the study variables; however it was deemed that the database provided sufficient information to examine the association between the key concepts of maternal weight and breastfeeding initiation.

CONCLUSION

Electronically available administrative data facilitate opportunities for basing clinical decisions on relevant evidence. An in-depth understanding of the data and potential challenges associated with their use is required if the data are to be used to derive reliable and valid decisions (Aponte, 2010; Doolan & Froelicher, 2009). The suitability of an administrative database for answering specific research questions must be made on a study-by-study basis. Confidence in the use of an administrative database can be enhanced by collaborating with database administrators who have in-depth knowledge of the data. Such collaboration may also help determine how findings can best inform practice.

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