Perceived insufficient milk supply in New Zealand mothers during the first-year postpartum

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Abstract

Background: Mothers rarely achieve breastfeeding (BF) recommendations and there are numerous reasons that may lead to early cessation. However, insufficient milk supply is a frequently reported cause. Current research on perceived insufficient milk supply (PIM) itself is limited. Numerous factors are suggested to play a part in the occurrence of PIM, including: demographic, psychological as well as feeding practices and management factors. **Aim.** To determine the factors associated with PIM and the impact that this has on BF practices. **Methods:** Secondary analysis of the data collected from Manawatu Mother and Baby Study. Sixty-one women were included. Interviews about maternal demographics, obstetric characteristics and BF practices were conducted on women approximately 2 weeks postpartum, then at 2 weekly intervals throughout the first three months, and finally once per month until the infants first birthday. Bivariate associations and logistic regression analyses were conducted to determine the relation of PIM with variables, as well as with BF duration. **Results:** PIM was reported by 44% of the participants and was the main reason for introduction of infant formula. Formula use was a significant predictor for PIM (R^2=0.22) and was explained by formula being used in response to PIM. We found that PIM was a significant predictor of BF duration (any BF 5 months R^2=0.44, full BF 5 months R^2=0.13, any BF 12 months R^2=0.32). Additionally, maternal importance of BF at 4 weeks can also predict the duration of BF. **Conclusion:** PIM plays a significant role in the introduction of infant formula and BF cessation. However, the absence of a significant relationship between PIM and demographic variables makes it difficult to identify mothers who may be at risk of PIM. Further research is required to try identify mothers at risk of PIM, in order to help prevent or resolve it.

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List of Abbreviations

PIM	Perceived Insufficient Milk Supply
BF	Breastfeeding/breastfed/breastfeed
NZ	New Zealand
AIM	Actual insufficient milk supply
WHO	World Health Organization

Chapter 1: Introduction

1.1 Background

Breastfeeding (BF) is classified as the gold standard of infant feeding and provides young infants with the essential nutrients they require for growth and development (WHO, 2010; Eglash, Montgomery & Wood, 2008). Current recommendations are to exclusively BF the infant until they are around six months of age, and then alongside complementary foods for at least one year (Ministry of Health, 2012). Both the mother and infant can gain numerous short and long term benefits when BF is carried out for the recommended duration (Victoria et al., 2016; Horta & Victoria, 2013a, b; Leon Cava, 2002; Eglash et al., 2008).

The number of infants receiving 'any' BF at the first Plunket visit (2 weeks) in New Zealand (NZ) declined following the commercial promotion of infant formula and hit a historical low of 48% during 1968-1969. Since this time, the number of infants receiving 'any' BF increased to 84% at their first Plunket visit by 2010 (Plunket Society, 2010). In NZ, the prevalence of BF initiation is high, yet the number of infants being BF declines over the first 6 months (Morton et al., 2012b; Plunket Society, 2010). Early BF cessation is prevalent and it is suggested that BF recommendations are often difficult for mothers to achieve (Morton et al., 2012b).

There are various factors that can lead a mother to early BF cessation, and these can be categorised into; social, demographic, psychological and biological factors (Eglash et al., 2008; Thulier & Mercer, 2009). Insufficient milk supply is one of the most commonly reported reasons for early BF cessation (Blyth at al., 2002; Eglash et al., 2008; Robert et al., 2014; Gatti et al., 2008).

Insufficient milk supply can either be actual (AIM) or perceived (PIM). The term PIM is used when report of insufficient milk supply is based on maternal perception with no objective measure. PIM may or may not be AIM. AIM is when the mother physically does not produce milk for the infant and this can be; primary or secondary. Primary insufficient milk supply is caused by biological factors that prevent a mother from producing milk. Whereas, secondary

insufficient milk supply is often caused by ineffective milk removal, which is largely caused by BF management factors. The confirmation of AIM generally requires an objective measurement of milk supply, which can be difficult and burdening (Robert et al., 2014; Kent et al., 2012). However, there are other easier indicators that can be suggestive of AIM, such as; infant weight gain and excretion (Wambach & Riordan, 2016).

It is thought that almost all mothers are capable of producing enough milk for their infant (Wambach & Riordan 2016). Yet, research indicates that PIM is reported by a quarter to half of mothers (Chan et al., 2000; Negayama, 2012; Robert et al., 2014). Though the risks and causes of PIM remain largely unclear, it can be assumed that a combination of psychological and feeding management factors is what often results in the mother feeling her milk supply is insufficient (Robert et al., 2012; Sheehan et al., 2001; Chan et al., 2000; Gatti et al., 2008).

Current literature on PIM itself is very limited and the studies investigating PIM often have conflicting outcomes. Nevertheless, there are some key factors that are often investigated in relation to PIM, and these include: past BF experience and parity, maternal self-efficacy and confidence, BF knowledge, attitudes towards BF, importance of BF, infant satisfaction, support, feeding practices, and formula use. Examining these factors may help to determine what led the mother to report PIM and whether it can be resolved.

1.2 Statement of the problem

Many mothers do not meet BF recommendations and PIM is a commonly cited reason for early BF cessation. However, there is limited research that focuses on PIM itself. There is currently little understanding around the factors related to PIM and how it impacts BF practices.

1.3 Study purpose

Significance of this research

Understanding and identifying the factors related to PIM and furthermore, the impact PIM has on BF practices would be extremely valuable. Firstly, as there is very limited research on PIM itself. Secondly, the outcomes of this study may motivate or guide future research on PIM.

Aim

To determine the factors associated with perceived insufficient milk supply and the impact that this has on breastfeeding practices.

Objectives

- To identify when PIM is most prevalent
- Explore and determine the relationships between maternal demographic factors and PIM
- Examine maternal psychological factors and infant feeding practices (2 weeks to 12 months) from questionnaires and explore the relationship that these have with PIM
- Explore the relationship between PIM and BF duration

Hypothesis

- PIM is influenced by demographic factors, psychological factors, and feeding practices
- PIM prevalence will be higher in mothers who use infant formula
- Mothers who experience PIM supply will have reduced BF exclusivity and duration.

1.4 Thesis structure

The thesis will be divided into the following chapters;

Chapter 1, Introduction: Gives background information which sets the scene and the scope of the study, while also adding focus to the importance and purpose.

Chapter 2, Literature review: Gives a thorough review of the current literature. This chapter also gives definitions of exclusive breastfeeding and detailed explanations of current practices, prevalence, barriers impacting breastfeeding exclusivity and duration and the differences between perceived, primary and secondary insufficient milk supply.

Chapter 3, Research Manuscript: this provides a complete and concise presentation of the study in a journal formatted style. It includes an abstract, introduction, methods, results, discussion, conclusion and references. Formatting guidance for this manuscript was obtained from the Journal of Nutrition.

Chapter 4, Conclusion: Provides a brief overview of the study, attainment of research aims and objectives, any impacts of the research, new knowledge gained, strengths and limitations of the study and final recommendations for future research.

Appendix A: Provides additional detailed methodology.

Appendix B: Provides additional results, including tables and figures that were not included in the manuscript.

Appendix C: Questionnaires used for the Manawatu Mother and baby study.

1.5 Research contributors

Micah Hintz	Performed statistical analysis and interpretation of the data, main author of the thesis.
Dr. Janet Weber	Academic supervisor, involved with the development and design of the Manawatu Mother and Baby study, revised and approved final thesis.
Dr. Louise Brough	Academic co-supervisor, involved with the development and design of the Manawatu Mother and Baby study, revised and approved final thesis.

Chapter 2: Literature Review

This chapter discusses the process of milk production and supply, and how it can be affected by varying factors to result in insufficient milk supply and reduced breastfeeding duration.

2.1 Breastfeeding

The term breastfeeding (BF) is the action of feeding the infant with breastmilk from the breast or as expressed milk. Lactogenesis is defined as the initiation of milk production, whereas lactation is defined as milk production and secretion (Wambach & Riordan 2016).

Lactogenesis is further divided into two stages and both are under endocrine control, which is hormone driven (Wambach & Riordan 2016). Lactogenesis 1, begins during the second trimester of pregnancy when prolactin simulates the growth and differentiation of breast tissue in preparation for future milk production. Lactogenesis 2, occurs after the birth of both the infant and placenta, which results in a drop of progesterone and allows prolactin to become the dominant hormone. This causes the stimulation of milk synthesis. Nipple stimulation and infant suckling during the early post-partum period is important for maintaining prolactin levels. More prolactin does not equate to more milk, but prolactin levels must be maintained to make sufficient amounts of milk for the infant (Eglash at al., 2008).

Milk production immediately after birth is driven by endocrine control. Volumes of colostrum during the first 24-48 hours are generally low (~100ml/day). Milk let down is stimulated by the release of oxytocin at approximately four days post-partum, which allows the infant to consume larger volumes of milk and meet their requirements. The release of oxytocin is prompted by a few stimuli, which include: suckling and stimulation of nipples, visual recognition of a hungry infant, and sound or thought of the infant. Impaired milk let down can result when these stimuli become reduced or absent (Eglash et a., 2008; Wambach & Riordan 2016).

It is important to note that most women are physically capable of producing adequate amounts of milk for their infant through good feeding management practices (Wambach & Riordan 2016). However, hormonal factors, absence of stimuli and presence of negative

stimuli may prevent lactogenesis 2 from occurring as intended. A hormonal factor that will delay or prevent adequate milk production is when progesterone remains at high circulating levels after birth due to factors such as, or remaining placenta fragments. Negative stimuli that can impact milk production through inhibiting or reducing oxytocin and therefore let down, can include: stress, tiredness, alcohol, drugs, obesity, or smoking (Eglash et al., 2008; Wambach & Riordan 2016; Babendune et al., 2015).

Milk production becomes established at approximately 10 day's postpartum, at which point milk has transitioned into mature milk and is produced at volumes that meet infant needs (Eglash et al., 2008). At this point the control of lactation shifts from endocrine to autocrine (Wambach & Riordan 2016). Autocrine control is a physical feedback, which is driven by the degree of breast fullness. Thus, milk production responds to the amount of milk removed by the infant. Wambach and Riordan (2016) state that milk production is generally a reflection of milk removal which is influenced by the infant's appetite, the quantity and quality of the infants suckling and latch, and the frequency of BF.

Breastfeeding recommendations

BF recommendations in NZ are set by the Ministry of Health and state for mothers to exclusively BF until the infant is around 6 months of age. Exclusive BF is defined as the infant consuming breastmilk only (from the breast or expressed) and prescribed medicines if required. Once the infant is around 6 months old, exclusive BF on its own becomes insufficient for optimal growth and development. Thus, BF should be continued alongside complementary foods until the infant is at least one year. World Health Organisation (2012) BF recommendations are similar, however they advise BF to be continued alongside complementary foods until the infant is 2 years old or beyond.

Separate to the BF duration guidelines, it is also recommended for mothers to feed their infant expressed breast milk opposed to formula if they are away and unable to BF (Ministry of Health, 2016). Other recommendations from WHO (2010) that can help establish and sustain exclusive BF practices include: avoidance of bottles, pacifiers, and teats, initiation of BF within the first hour after birth and demand BF.

Infant benefits of breastfeeding

Current BF recommendations are based on the robust body of evidence around the benefits that can be obtained from BF. Though exclusivity within the first 6 months is ideal, the benefits from practicing any BF are better than no BF (Horta & Victoria 2013a). The recent meta-analysis conducted by Victoria et al (2016) included 28 systematic reviews and meta-analyses and concluded how the protection from BF is important for both the mother and infant. Two systematic reviews that were conducted by Horta and Victoria (2013a,b), examined short and long term effects of BF. Reviews by Fewtrell (2005), Leon-Cava (2002), and Eglash et al. (2008) also present evidence of maternal and infant benefits. Key evidence points are summarized in Table 2.1.

Table 2. 1 Infant benefits from BF*

Significantly lower infant mortality	Six studies in low and middle income countries concluded that BF provided protection of infant mortality. Similar was found in high income countries (Victoria et al., 2016). Other meta-analyses and studies also found consistent evidence that there were lower rates of mortality in BF infants (Fewtrell 2004; Horta & Victoria 2013b; Leon-Cava, 2002).
Optimal nutrition	The gold standard for infant feeding. Nutritionally complete until the infant is 6 months. Assists optimal growth and development (Eglash et al., 2008).
Immunity	Transfers maternal immunoglobulins to the baby and provides anti-infectious properties that help to mature the immune system (Eglash et al., 2008)
Reduce the risk of common infectious diseases	Many studies show that BF provides significant protection against diarrhea morbidity and hospital admissions. This is particularly evident in younger infants. (Victoria et al., 2016). Furthermore, Horta & Victoria (2013b) concluded that BF was associated with decreased severity of diarrhea. Horta & Victoria (2013b) also concluded that BF protects against respiratory infection.
Reducing the risk of non-communicable diseases and obesity	Lower prevalence of overweight/obesity in later life (Fewtrell 2004; Horta & Victoria 2013b; Leon-Cava, 2002; Victoria et al., 2016). It was identified in 113 studies that longer periods of BF were associated with a reduction in the odds of overweight or obesity. Pooled results from 11 studies that were mostly set in high income countries, indicated that BF protection against type 2 diabetes is restricted. BF had resulted in a reduction in type 2 diabetes, however there may be residual confounding factors in high income countries. (Victoria et al., 2016). There was no convincing evidence that found BF to have a protective effect on systolic or diastolic blood pressure, and total cholesterol later in life (Victoria et al., 2016). Additionally, no clear evidence indicates protective effects from BF on incidence of urinary tract infections, atopic dermatitis and asthma (Horta & Victoria 2013b; Victoria et al., 2016; Fewtrell 2004).
Increased intelligence	Increased performance in intelligence tests for both childhood and adolescence (Horta & Victoria 2013b; Fewtrell 2004; Leon-Cava, 2002; Victoria et al., 2016).
Otitis Media	Suggested protection against otitis media in children <2 years old. However, this was mostly from high income settings (Victoria et al., 2016).

Maternal benefits of breastfeeding

BF can provide the mother with benefits far beyond emotional satisfaction. There are numerous maternal health benefits that can be gained from BF and these can begin directly after birth. Key evidence points are summarized in Table 2.2.

Table 2. 2 Maternal benefits from BF

Reduced incidence of postpartum bleeding	Immediate initiation after delivery will result in a release of oxytocin, which works to contract the uterus and expel the placenta (Eglash et al., 2008; Leon-Cava 2002).
Improve post-partum weight loss	The effect of BF on postpartum weight loss is uncertain. There were 45 studies reviewed and results were highly variable, furthermore, many studies had low methodological quality (Victoria et al., 2016).
Amenorrhoea	Predominant and exclusive BF was associated with longer periods of amenorrhoea (Victoria et al., 2016; Fewtrell 2004). This reduces the incidence of short birth spacing and the risks that are associated with this (Victoria et al., 2016).
Helps prevent post-partum depression	Oxytocin works as a potent anti-depressant and is in high concentrations in the body when BF (Eglash et al 2008). A qualitative review of 48 studies found convincing associations between BF and reduced maternal depression, however it is more likely that the association is reverse causality (Victoria et al., 2016).
Type 2 diabetes	All six studies reviewed in Victoria et al. (2016) were from high income countries and five of them showed BF had protective effects against type 2 diabetes. However, due to the low number of studies that investigate this, evidence is restricted as no low or middle income countries were included.
Lowered breast and ovarian cancer	Lowered risk for breast and ovarian cancer (Leon-Cava 2002; Victoria et al., 2016). There was strong consistent evidence from 47 well-designed studies including both low-middle and high income countries, showing that BF had a protective effect against breast cancer. There were 41 studies included in the meta-analysis that investigated the effect of BF on ovarian cancer and concluded a suggested protective effect from BF. However, parity may be confounding to results, as studies that adjusted for parity showed less protection. Additionally, only six of those were from low-middle income countries (Victoria et al., 2016).

Prevalence of breastfeeding in New Zealand

Promotion of infant formula, along with other factors resulted in the number of infants receiving 'any' BF at 2 weeks old, dropping to a record low of 48% during 1968-69. However, by 2010 this had increased to 84% (Plunket Society, 2010).

Table 2. 3 Percentage of mothers exclusively BF (2004-2016)*

	2004	2008	2012	2015
6 weeks	50%	53%	56%	57%
3 months	38%	40%	42%	44%
6 months	10%	16%	16%	19%

*Plunket Society, 2010; Plunket Society, 2017

Recent NZ Plunket data reveals an increasing trend in the number of exclusively BF infants from 6 weeks to 6 months between 2004 and 2015 (Table 2.3). However, while exclusive BF is increasing, less than a fifth (19%) of mothers are exclusively BF until 6 months. Additionally, Morton et al (2012) found that BF initiation rates (during the first week post-partum) are high (96%), yet the number of women BF declines over the first 6 months.

2.2 Factors affecting breastfeeding duration

Successful BF duration can be defined as achieving the BF recommendations *(outline in Section 2.1.1*) of exclusive BF until the infant is around 6 months old and then continue BF alongside complementary foods until the infant is at least one year (Ministry of Health, 2012). Recent NZ statistics have revealed that these recommendations are achieved by very few mothers (Plunket Society, 2017). There are many factors that can impact BF duration and they can be broken into four categories: social, demographic, psychological and biological. These are discussed in more detail below.

Social factors

Social factors are important when exploring BF duration, and can include: return to work, support, interactions and relationships, attitudes and cultural norms (Thulier & Mercer, 2009).

Returning to work and lack of maternal leave have shown an association with shortened BF duration (Hawkins, Griffiths, Dezateux, Law, 2007; Scott, Binns, Oddy, Graham, 2006). For example, Hawkins et al. (2007) found that the longer a mother delays her return to work the more likely she is to continue BF until the baby is 4 months old.

Support from the mother's partner had strong associations with BF duration. For instance, Morton et al. (2012b) found that BF occurs more frequently and for longer periods of time among women who are married, or in civil union relationships, compared to women who are not. A cohort study conducted by Scott et al. (2006), found that a husband's preference for BF over formula feeding was positively associated with BF initiation and longer duration of full BF.

There are multiple benefits that can be gained from health professional support and are listed in Table 2.4.

Table 2. 4 Benefits of health professional support*

- Early skin to skin contact to increase bonding between mother and infant
- Early BF initiation
- Rooming in (longer and more frequent feeds, higher maternal awareness and understanding of the infant)
- Establishing good maternal and infant relationships
- Maternal understanding normal infant behaviour
- Better BF support and education for mothers and their partners
- Higher maternal confidence

*Procianoy, 1983; Crenshaw, 2007; Kuan, 1999, Prabasiwi et al., [abstract] 2015; Sheehan et al., 2001.

Cultural norms and commonly perceived ideas on BF within a culture or community is another factor that can affect BF rates and duration. For example, women in Hong Kong receive a total of 6 weeks of maternity leave, therefore mothers resort to formula at a very young age of their infant's life. Thus, Chinese mothers tend to associate formula feeding with professionalism and being affluent, whereas BF is typically linked to domestic homemakers with poor social status (Loke & Chan, 2013). In NZ, Maori culture has influenced BF. The impact of colonization resulted in Maori culture becoming eroded by modern-day societal

attitudes and caused a greater negativity towards BF for Maori women (Ministry of Health, 2009). Since this time, the number of Maori infants being BF remains much lower than NZ European/Pakeha. In addition, research conducted by the Ministry of Health (2002) found that the lower numbers of Maori and Pacifica infants being BF, can be partly explained by the inequitable distribution of economic resources in NZ (Ministry of Health, 2002). This is discussed further in the following section.

Demographic factors

Demographic variables can often have significant relationships with BF duration, and these include: ethnicity, education, socioeconomic status and maternal age.

In NZ, there is a convincing relationship between ethnicity and BF rates. For example, Plunket data used to represent the '6 month' BF rates (16 weeks – 7 months) show that Maori infants had the lowest exclusive BF rate (16%), followed by Pacifica (18%). Whereas, the NZ European/Pakeha (other) category had almost double the number of infants being exclusively BF during this time (30%), followed by Asian (28%) (Plunket Society, 2017).

Lower socioeconomic groups have fewer infants being BF and shorter BF durations (Sheehan et al., 2001; Plunket Society, 2017). Deprivation, education and ethnicity are all aspects involved in socioeconomic classification (Ministry of Health, 2002). In NZ, statistics show that as deprivation levels increase, the exclusivity of BF decreases (Plunket Society, 2017). Some research shows that mothers with lower educational attainment will BF for shorter periods of time compared to those with higher educational (Avery et al., 1998; Sheehan et al., 2001; Ministry of Health, 2002). The relationship between ethnicity and socioeconomic status, and BF duration is illustrated in the NZ population, as Maori and Pacific have the lowest number of BF infants as well as being concentrated in lower socioeconomic groups (Ministry of Health, 2002).

Maternal age is associated with BF duration. Sheehan et al. (2001) found that younger mothers had lower BF initiation rates compared to older mothers. Similar in NZ, younger maternal age was associated with lower BF rates at four weeks (Ministry of Health, 2002).

Psychological factors

Psychological factors can lead to delayed BF initiation and early BF cessation, and include: maternal confidence, BF interest and intentions, stress, tiredness, and post-natal depression (Morton et al., 2012b; Kuan, 1999; Avery et al, 1998; Butler et al., 2002; Sheehan et al., 2001).

Maternal confidence is a commonly cited psychological factor and can impact the exclusivity and duration of BF. Maternal confidence is a modifiable factor and is easily influenced by social aspects (Blyth et al., 2002; Gatti et al., 2008). When the mother is not confident then she may feel an inability to BF (Blyth et al., 2002).

Maternal attitudes and intentions can determine how successful BF practices are. Sheehan et al. (2001) reported that mothers are at risk of premature BF cessation when their BF intentions are a shorter duration (<4 months). Avery et al. (1998) found that those that have negative attitudes towards BF and positive attitudes about bottle feeding are at increased risk for early BF weaning. Thus, the interest and intentions of a mother can impact the way a mother may choose to feed her infant.

Biological factors

Biological factors that can affect BF duration include aspects that can physically reduce the likelihood of a mother producing adequate milk. This can be further broken down into maternal or infant factors.

Infant factors that interfere with BF and are associated with increased risk of early BF cessation include: infant health problems, premature birth, and foetal macrosomia. Most commonly, physical abnormalities will prevent correct infant latching and suckling (Ministry of Health, 2002). The neonatal special care unit (NICU) is a stressful environment which results in emotional distress as well as physical separation, and infants in NICU can experience multiple problems initiating and maintaining BF (Eglash et al., 2008).

Maternal variables that may interfere with lactogenesis and lactation, include: obesity, diabetes, smoking, physical barriers and other factors. Obesity and diabetes are becoming increasingly common and both are associated with delayed or absent lactogenesis 2. Thus, obesity and diabetes may lead to AIM and therefore, can contribute to shorter BF duration (Amir & Donath, 2007). Similarly, maternal smoking is also associated with shorter BF duration as it causes an inhibition of milk ejection reflex (Ministry of Health, 2002). There are several physical barriers that can impact initiation, duration or exclusivity of BF, and these may include: flat/inverted nipples, plugged ducts, mastitis, breast abscesses or any factors resulting in maternal pain (e.g. sore nipples) (Eglash et al., 2008; Butler et al., 2002; Heath et al., 2002). Other biological factors that influence lactogenesis and lactation and can lead to reduced BF duration, include: retained placenta fragments, hormone imbalances, and damaged neurological pathways.

2.3 Insufficient milk supply

Insufficient milk supply is a commonly cited reason for infant formula supplementation and early BF cessation (Robert et al., 2014; Morton et al., 2012a; Heath et al., 2002; Gatti et al., 2008). Insufficient milk supply may arise if lactation does not occur as intended. This can happen when there are hormone imbalances that the endocrine control of lactation. Hormone imbalances can be caused by: psychological stress, alcohol, opioid use, obesity, and insufficient nipple stimulation. Due to autocrine control, milk supply can become impaired when there is inadequate milk removal (Eglash et al., 2008). Although insufficient milk supply is commonly reported, it is often difficult to determine what exactly the cause of it is (Robert et al., 2014). Understanding milk supply is necessary to then comprehend insufficient milk supply; what influences it, how to assess it and how to resolve it.

The gold standard method for measuring the infant's milk intake objectively is done through weighing the infant before and after every BF for 24-hours (Arthur, Hartmann & Smith, 1987). This provides information on the amount of milk the infant is taking, but does not necessarily indicate if the infant's need is being met. Other indicators of insufficient milk supply include: poor infant growth, excessive weight loss after birth, failing to regain weight loss in an appropriate time, sleepiness and in severe cases hypernatremia dehydration (Eglash et al.,

2008). If insufficient milk supply is confirmed, then it is classified as actual insufficient milk supply (AIM). There are two main causes of AIM; primary and secondary (Thulier & Mercer, 2009). Determining the type of insufficient milk supply can help decide if and how the insufficient milk supply can be alleviated (Robert et al., 2014; Kent et al., 2012).

Primary insufficient milk supply

Primary insufficient milk supply is defined as the physical inability to produce an adequate milk supply. An increasingly common cause of primary insufficient milk supply is obesity. Reviews by Babendure et al., (2015) and Eglash et al., (2008) investigate reduced BF rates among obese mothers and found that there are several factors that lead obese mothers to experience delayed onset of lactogenesis 2. Proposed factors that are associated with obesity and delayed lactogenesis 2 include: postpartum oedema, dysfunctional labour and cesarean birth, reduced oxytocin levels caused by high leptin concentrations, reduced prolactin levels, and insulin imbalance. In addition to delayed lactogenesis 2, obesity also increases the risk of type 2 diabetes, which is an independent risk factor for primary insufficient milk supply (Babendure et al., 2015; Eglash et al., 2008). Other causes of primary insufficient milk supply are summarized in Table 2.5.

Table 2. 5 Causes of primary insufficient milk supply*

- Inadequate prolactin
- Oxytocin and oestrogen concentrations or ratios
- Poly-cystic ovary syndrome
- Retained placenta fragments (preventing progesterone reduction)
- Hyper/hypothyroidism
- Obesity
- Diabetes
- Some maternal medications
- Damage in the neurological pathways
- Inadequate mammary and/or glandular tissue
- Damaged ducts
- Severe illness
- Breast surgery

*Eglash et al., 2008, Kent at al., 2012, Wambach & Riordan, 2016; Babendure et al., (2015)

Secondary insufficient milk supply

Secondary insufficient milk supply occurs when there is inadequate milk removal from the breasts. Infrequent feeds or inefficient milk removal causes the breast to only partially drain and leads to reduced milk synthesis capacity. Eventually this will result in milk synthesis failing to meet the requirements of the infant (Kent, 2012; Eglash et al., 2008). Frequent suckling during the first few days post-partum is important for stimulating milk production, as it maintains adequate prolactin but milk supply can decline in absence of this (Wambach & Riordan, 2016). Secondary insufficient milk supply is largely caused by BF management factors, which can include: use of nipple shields, bottles and pacifiers which can reduce suckling time and possibly infant demand, as well as the infant's latching and suckling ability to remove milk (Kent, 2012; Wambach & Riordan, 2016; Eglash et al., 2008).

Secondary insufficient milk supply can be resolved if mothers implement methods to increase their milk synthesis. Methods that have proven to be effective include: improvement of infant latch to increase milk removal, and increased removal of milk from the breast through increasing the frequency and/or duration of BF or expressing (Eglash et al., 2008; Wambach & Riordan, 2016; Kent, 2012).

Perceived insufficient milk supply

Perceived insufficient milk supply (PIM) is when a mother perceives her milk and/or supply to be inadequate for her infant's requirements. The term 'perceived' is used as it relies on maternal self-reporting, rather than an objective measure. PIM is based on maternal perception and may or may not be AIM (primary or secondary). However, if milk supply is insufficient, it is most likely a result of secondary insufficient milk supply, as primary insufficient milk supply is rare. Maternal report of PIM is often based on normal infant behaviors that are mistaken as insufficient milk supply by the mother, such as: crying babies, wakefulness, change in frequency and duration of feeds, settling better after formula feeds and infant fussiness (Prabasiwi et al., [abstract] 2015; Kent at al., 2012).

PIM is a commonly cited reason for both the introduction of infant formula, as well as early BF cessation (Health et al., 2002; Sheehan at al., 2001). A top up feed of infant formula is a

common response when the mother feels as though her infant is not receiving enough milk via breast milk (Sheehan et al., 2001; Robert et al., 2014). Though many mothers feel that responding to PIM with formula is the appropriate response, the use of formula can result in decline in milk removal and a reduced milk supply, which can then cause AIM (Eglash et al., 2008; Fraser & Cullen, 2009; Lau, Htun, Lim, Ho-Lim and Klainin-Yobas, 2015).

Prevalence of reported insufficient milk supply

Research indicates that PIM is reported in up to 50 % of BF mothers (Chan et al., 2000; Negayama, 2012; Robert et al., 2014). The growing up in NZ study reported that 38% of the mothers who stopped BF early did so as they felt they did not have enough milk, while a further 32% of mothers reported the baby did not seem satisfied with breastmilk alone (Morton. Et al., 2012b). The prevalence of reported PIM is suggested to be the highest during early stages of BF (Sheehan et al., 2001, Morton et al., 2012b). For example, Sheehan et al. (2001), found that 63% of mothers who stopped BF in the first week had done so in response to PIM.

2.4 Factors associated with PIM

There is limited research on factors associated with PIM. Furthermore, studies that have investigated PIM often have conflicting outcomes. Based on the understanding of milk synthesis, assumptions can be made about factors and BF practices that may increase the risk of insufficient milk supply. A review by Gatti et al. (2008) compiled evidence from 20 research articles and looked at maternal perceptions of insufficient milk supply, and summarized key factors that are often analyzed in relation to PIM. Factors summarized by Gatti et al. (2008) include: experience and parity, maternal self-efficacy and confidence, BF knowledge, attitudes and importance of BF, infant satisfaction, support, feeding practices, and infant formula use.

Demographic Factors

Maternal education is often investigated in relation to BF duration but the relationship with PIM has not been extensively examined. Robert et al. (2014) found that PIM as a reason for early BF cessation (<6 months) was more prevalent among mothers with lower education.

Whereas, Gatti et al. (2008) reported that majority of the studies included in their review did not investigate maternal education in relation to PIM. Similarly, most studies included in this literature review failed to assess the association between maternal education and PIM.

It is often predicted that first time mothers are at higher risk for PIM and/or early cessation, however, Gatti et al (2008) concluded that reporting of PIM was similar in mothers regardless of BF experience. McCarter-Spaulding and Kearney (2001) conducted a cross-sectional descriptive study that followed 60 mothers from 1 week to 11 weeks' post-partum, and found no difference in frequency of reporting PIM between mothers who had given birth before and those who had not. There is no clear evidence to suggest a relationship between parity and past BF experience with PIM.

Psychological Factors

Perceived infant satisfaction is a variable that is frequently related to PIM. Gatti et al. (2008) reported that in a substantial amount of the research they reviewed women who reported PIM also reported that their infant did not seem satisfied. A longitudinal study that followed 365 women in Australia for 3 months' post-partum, found that mothers who reported PIM were more likely to believe that their infant was not enjoying BF and was not satisfied (Cooke et al., 2003). Gatti et al. (2008) mentioned studies that examined infant satisfaction did not clearly define infant satisfaction or the measurement method, nor interpretation of infant satiety cues and the impact of infant temperament. Therefore, the differences between studies on the classification and measurement of qualitative factors that determine maternal perception of infant satisfaction, lessen the reliability and make it difficult to compare research.

Maternal confidence and self-efficacy are expressions that tend to be used synonymously (Gatti et al., 2008). McCarter-Spaulding and Kearney (2001) found a significant association between PIM and maternal BF self-efficacy and suggested that that low self-confidence may lead to PIM through the mother doubting her ability to produce adequate milk. Similarly, Blyth et al. (2002) conducted a prospective study including 300 mothers from 38 weeks' gestation to 4 months postpartum and found an association between maternal self-efficacy and BF

duration. They suggested that misinterpreting normal infant behaviour as PIM could be explained by lower maternal BF confidence. An important point raised by Gatti et al. (2008), is the inconsistency between studies on the definitions and methods of measurement of maternal confidence and self-efficacy. Overall, though some research mentions maternal confidence and self-efficacy in relation to PIM, further research that clarifies methods of measurement would form more robust evidence.

It is suggested that support from health professionals can influence BF duration. One possible influence is that health professionals can influence maternal BF knowledge which can impact the outcome of PIM (Prabasiwi et al., 2015; Kuan, 1999; Avery et al., 1998, Ministry of Health 2002). Prabasiwi et al., (2015) conducted a cross-sectional study that followed 88 mothers for 6 months in Indonesia, and found that mothers with lower BF knowledge scores had an increased risk of PIM. Sheehan et al. (2001) also suggested that it would be useful if health care practitioners to consider strategies for self-efficacy. Similarly, both Scott et al. (2006) and Robert et al. (2014), suggested that support from health professionals could help to modify the outcome of PIM. However, evidence lacks the examination of the relationship between maternal BF knowledge, health professional support and PIM (Sheehan et al., 2001; Scott et al., 2006; Prabasiwi et al., 2015). Overall, assumptions can be made about the influence of health professionals and occurrence of PIM as well as its resolution.

There are numerous aspects of maternal attitude associated with PIM. Essentially, if a mother has negative attitudes towards BF and positive attitudes towards bottle feeding, then she has a high chance of ceasing BF early (Avery et al., 1998). This suggests that these maternal attitudes could influence the way a mother will respond to PIM if arose. The importance of BF is another relevant aspect of maternal attitude and Sheehan at al. (2001) found a higher BF importance was associated with longer BF durations. These findings could suggest that maternal attitude towards BF importance plays a role in the determination to continue BF if PIM is experienced. Motivation to BF is another attitude that has been shown to have a relationship with PIM. Negayama et al. (2012) conducted a study comparing 310 Japanese, 756 French, and 222 American mothers. Negayama et al. (2012) found that Japanese mothers who terminated BF due to PIM were also those who were less motivated to BF, but this relationship was absent within French and American mothers. Negayama et al. (2012) then

went on to conclude that PIM was interpreted by the participants as a solution to the conflict between the social pressure to BF and the burden of BF. This suggests that specific maternal attitudes can lead to the report of PIM, regardless of actually experiencing PIM or not. Maternal attitude is challenging to analyze and difficult to examine in relation to PIM due to the numerous aspects of qualitative measurement. Overall, research is lacking in this area and therefore, it is difficult to determine a clear conclusion.

Feeding practices

All studies included in this literature review that examined the relationship between formula and PIM indicated an increased risk of PIM when formula is given when not necessary. Studies have found formula introduction within the first 4 weeks postpartum was related with PIM (Chan et al., 2000; Sheehan et al., 2001). Gatti et al. (2008) found that mothers are at the highest risk for PIM, early BF cessation and formula introduction during the first 4 weeks. Chan et al. (2000) assessed BF cessation in a group of 44 Chinese mothers, and found that 77% of babies had been given formula prior to hospital discharge, with many given the formula because of PIM. However, it is important to keep in mind that hospital BF policies and support in Hong Kong will vary to NZ. Similarly, Sheehan et al., (2001), found that early infant formula use in hospital was a result of PIM and is often accompanied with early BF cessation. For a small number of mother's, PIM and formula use during the first 4 weeks postpartum may be partly explained by delayed milk production, and lactogenesis 2. Although it is evident that responding to PIM with formula during early post-partum is common, it will most likely further reduce milk supply (McCarter-Spaulding & Kearney 2001; Eglash et al., 2008; Wambach & Riordan, 2016).

Infant formula introduction is one common response to PIM experienced at any time. Robert et al. (2014) raised point that it is difficult to determine if formula is a cause or effect of PIM, due to finding that many mothers in their study gave a top-up of infant formula as an effect of PIM. McCarter-Spaulding and Kearney (2001) stated the use of formula accompanied by reduced BF frequency may contribute to AIM. This is explained through a decline in milk production due to autocrine control and the reduced nipple stimulation (Robert et al., 2014;

Eglash et al., 2008). It is evident that the use of infant formula has a significant relationship with the prevalence of PIM.

Pacifier use and nipple shields can impact the establishment of lactation and production of prolactin (Eglash et al., 2008, Ministry of Health 2002). Pacifier use could increase the risk of PIM through reducing BF demand and feeding times (Eglash et al., 2008 Wambach & Riordan, 2016). Whereas, inappropriate use of nipple shields can reduce nipple stimulation (Eglash et al., 2008). There is no published research to our knowledge that assesses the relationship between pacifier use or nipple shields with PIM. However, based on the understanding of lactogenesis and lactation, it can be hypothesized that pacifier use and nipple shields could lead a mother to experience PIM.

2.5 Summary

Breast milk is the perfect infant food during the first 6 months after birth and provides significant benefits for both the mother and infant. Social, demographic, biological and psychological factors can often prevent mothers from achieving BF recommendations. The most commonly reported reason for early BF cessation is insufficient milk supply. Determining if milk supply is actually insufficient (AIM) is often difficult. Understanding the root cause of insufficient milk supply is an important aspect of determining how or if it can be alleviated. There is currently very limited research on PIM itself. Exploring some of the factors mentioned in this literature review could provide a better understanding of PIM as well as the impact that it has on BF practices.

Chapter 3: Research Manuscript

Perceived insufficient milk supply in New Zealand mothers during the first-year postpartum

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3.1 Abstract

Background: Mothers rarely achieve breastfeeding (BF) recommendations and there are numerous reasons that may lead to early cessation. However, insufficient milk supply is a frequently reported cause. Current research on perceived insufficient milk supply (PIM) itself is limited. Numerous factors are suggested to play a part in the occurrence of PIM, including: demographic, psychological as well as feeding practices and management factors. **Aim.** To determine the factors associated with PIM and the impact that this has on BF practices. **Methods:** Secondary analysis of the data collected from Manawatu Mother and Baby Study. Sixty-one women were included. Interviews about maternal demographics, obstetric characteristics and BF practices were conducted on women approximately 2 weeks postpartum, then at 2 weekly intervals throughout the first three months, and finally once per month until the infants first birthday. Bivariate associations and logistic regression analyses were conducted to determine the relation of PIM with variables, as well as with BF duration. **Results:** PIM was reported by 44% of the participants and was the main reason for introduction of infant formula. Formula use was a significant predictor for PIM (R^2=0.22) and was explained by formula being used in response to PIM. We found that PIM was a significant predictor of BF duration (any BF 5 months R^2=0.44, full BF 5 months R^2=0.13, any BF 12 months R^2=0.32). Additionally, maternal importance of BF at 4 weeks can also predict the duration of BF. **Conclusion:** PIM plays a significant role in the introduction of infant formula and BF cessation. However, the absence of a significant relationship between PIM and demographic variables makes it difficult to identify mothers who may be at risk of PIM. Further research is required to try identify mothers at risk of PIM, in order to help prevent or resolve it.

Key words: Breastfeeding, perceived insufficient milk supply, infant formula, breastfeeding duration**,** risk

3.2 Introduction

Breastfeeding (BF) is the gold standard of infant feeding. BF provides infants with the essential nutrients they require for growth and development, as well as providing other significant benefits to both the mother and infant (Victoria et al., 2016; WHO, 2010; Eglash et al., 2008). Current BF recommendations are to exclusively BF until the infant is around six months old and then continue BF alongside complementary foods until at least one year (Ministry of Health, 2002).

BF is the action of feeding the infant from the breast or with expressed breastmilk, while lactation is milk production and secretion. Initiation of milk production is controlled by the endocrine system, which is hormone driven. Control of breastmilk production then changes to autocrine control once established. Autocrine control is a physical feedback system which is based on the removal of milk from the breast (Eglash et al., 2008; Wambach & Riordan, 2016).

In NZ, BF initiation rates are high, but the number of infants being BF declines over time (Morton et al., 2012; Plunket Society, 2010). Morton et al. (2012) found BF initiation rates (first day postpartum) were high (96%), however, by 3 months it was 63% and at 6 months this had dropped to 6% (Morton et al., 2012). It is concerning how dramatically the number of women BF declines over the first 6 months (Plunket Society, 2010; Morton et al., 2012). There are many factors that may influence early BF cessation but insufficient milk supply is one of the most commonly reported reasons (Blyth, 2002; Heath et al., 2002; Robert et al., 2014; Gatti et al., 2008).

Insufficient milk supply may be actual (AIM) or perceived (PIM). The term PIM reflects maternal perception of milk supply with no objective measure. Insufficient milk supply whether actual or perceived can be alleviated in many cases but understanding the cause is essential. Current research on PIM lacks convincing evidence or fails to examine the relationship between PIM and possible impacting variables (i.e. pacifier use, EBM use, BF problems) (Robert et al., 2014; Sheehan et al., 2001; Negayama et al., 2012; McCarter &

Spaulding, 2001. Furthermore, much of the research focuses on BF duration and has less emphasis on PIM (Heath et al., 2002; Cooke et al., 2003; Chan et al., 2000).

The aim of this study is to determine the factors associated with PIM in BF mothers and the impact it has on BF practices. Considering how commonly PIM is experienced by mothers, the findings of this study could be the first step towards PIM awareness and prevention.

3.3 Method

This study is a secondary data analysis of data from the Manawatu Mother and Baby study. The methodology is fully described in Jia (2013). Following is a description of the study relevant to the current analysis.

Participants

This study uses secondary data collected from sixty-one participants for the Manawatu Mother and Baby study (*see Appendix A for recruitment details and inclusion criteria*). The primary research was ethically approved by the Massey University Human Ethics Committee: Southern A: 06/70, Palmerston North, NZ.

Data collection - Manawatu Mother and Baby study

Mothers were interviewed about BF practices approximately 2 weeks after birth, then every 2 weeks throughout the first three months, and finally once per month until the infant was 12 months old. Some interviews were conducted at the Massey University Nutrition research unit but majority were via telephone. Data was collected between 2007-2009.

Questionnaire - Manawatu Mother and Baby study

Three questionnaires were developed and used by researchers from the Manawatu Mother and Baby study (Appendix C). The first questionnaire was administered during the last trimester of pregnancy or at 2 weeks postpartum. The purpose was to collect information on the mother's demographic and obstetric characteristics. The second questionnaire was administered at 2 weeks postpartum and addressed the infant's' birth and delivery information. The third questionnaire was the infant follow up questionnaire, which was

administered at every interview over the duration of the study. The infant follow up questionnaire collected information about: BF problems, support people and/or systems, maternal attitude and knowledge, as well as a detailed description of infant feeding, sleeping, and any other activities from the past 24 hours.

Variable definition

Responses to open ended questions were reviewed and categorised, responses to some closed questions were combined and in some cases, new variables were generated from combining responses from closed and open questions. Categories used will be reported below.

Responses to the question about methods for increasing milk supply were categorized into evidence based and non-evidence based. Evidence based methods were defined as increasing BF frequency and expressing, while non-evidence based methods were anything else the women reported.

The variable 'milk feeding practices' did not take into account if complementary food was given. The term 'full BF' refers to breastmilk being the only source of milk. Mixed feeding refers to the use of both breast milk and infant formula. Finally, exclusive formula feeding refers to infant formula as the only milk. The milk feeding practices are measured at every interview, and are classified based on the type of milk(s) given to the infant during the 24-hour recall period.

Responses to the open-ended question about reasons for formula use were categorized using the following: 1) PIM, 2) Mother away/back to work, 3) Medication, 4) BF issues and 5) Other. The 'Other' category included: "don't want to BF", "Too busy with other children", "Don't like it", "post-natal depression", and birthing complications that required initial formula feeding.

The introduction of complementary food was assessed as a separate variable from milk feeding, and is based on the data collected from the 24-hour recall and the question "What changes have you noticed since we last talked?".

EMB use was categorised into regular use or non-regular use based on the mother's response to the 24-hour recall and the question "What changes have you noticed since we last talked?". Regular use of EBM use was defined as report at any one interview that the infant was receiving ≥4 bottles EBM/week.

Descriptions of BF problems were obtained from the question "Have you had any problems?" and this was asked in every interview. Problems were categorised as 1) physical breast or nipple issues (dry or cracked nipples, sore nipples, mastitis), 2) refusal to feed (upset, not wanting breast, sick infant), 3) latching issues, and 4) other; which included; mother going away/returning to work, ability to only feeding one side, insufficient weight gain, infant constipation.

Women were asked about the adequacy of their milk supply at every second interview. The variable 'PIM' was based on the question "Do you feel that you have/had enough milk for the baby?", and any report of PIM as a BF problem. The variable 'PIM (any time)' refers to if PIM was recorded in any one interview throughout the 12 months.

BF problems, formula use, EBM use, and pacifier use) were also categorized based on their timing in relation to the report of PIM: 1) occurrence with no report of PIM (at the time), 2) occurrence after PIM, and 3) no occurrence.

Data analysis

Information from questionnaires were coded and entered into SPSS version 24.0 (IBM). Descriptive statistics involved using frequencies and descriptive functions (cross tabs, range, means, standard deviations and medians) with SPSS. Statistical significance is defined as $p<0.05$. Bivariate associations were examined using chi-squared analysis. Fisher's exact test were used when $n<5$.

Logistic regression, binary step-wise, forward conditional method was carried out to determine the best predictors of PIM and BF duration, . The significance level set for entry into the equation was p-value <0.05. The assumptions for the logistic regression were met

(Laerd Statistics, 2018) (*Assumption details can be found in Appendix A*). Variables included in the multivariate analyses are:

- Predictors of PIM: formula use/formula use with no report of PIM (at that time), EBM use, pacifier use and BF problem(s).
- Predictors of BF duration: importance of BF, evidence based methods tried for increasing milk supply, parity and BF problem(s).

The case studies were chosen from the mothers who reported PIM the most frequently, as well as reporting numerous BF problems. The two selected had different BF outcomes. Case studies were compiled by reading interviews from birth to 12 months, to understand the mothers' experiences and noting significant events around PIM, problems, feeding and outcomes. Case studies are included to provide insight into a range of experiences and responses to PIM.

3.4 Results

Descriptive Statistics

Participants

A total of 61 women participated in the study. Participants were aged between 21 and 43 years, had a mean age 32.2$\pm$4.7 years and median of 32 years. Participants were predominantly NZ European/Pakeha (83%, n=48). Over half of the participants had a bachelor degree or higher (57%, n=34). 60% (n=41) of mothers had given birth before. All mothers who had previously given birth had BF experience and 54% (n=22) had BF for <6 months (Table 3.1).

Table 3. 1 Maternal and obstetric demographics

	N, (%)
Age (years)	58
<30	13 (22)
≥30	45 (78)
Education Level	60
<Bachelor	26 (43)
≥Bachelor	34 (57)
Ethnicity	58
NZ European	48 (83)
Other	10 (17)
Birth History	61
Primiparous	20 (30)
Multiparous	41 (60)
Past BF experience	41
<6 months	22 (54)
≥6 months	19 (46)

Maternal Attitudes and Knowledge

The rating of BF importance at 4 weeks had a mean rating of 4.6/5 (n=58), a mode of 5 (71%, n=41) and ranged between 1 and 5. The mean rating of BF importance at 6 months was 4.4 (n=44), and mode remained at 5 (57%, n=25). The mean then dropped to 3.4 (n=30) at 12 months, and had two modes; 3 (27%, n=8) and 5 (27%, n=8).

Many mothers reported they were aware of ways to increase their milk supply (87%, n=53), and 68% (n=36) gave an evidence based method. The most commonly reported method to increase milk supply was to BF more (27%, n=30) (Appendix B). 51% (n=27) of mothers had tried to increase milk supply and, 67% (n=18) of those had tried an evidence based method.

Milk feeding Practices

Most infants were fully BF (n=47, 80%) at 2 weeks but this gradually declined over 12 months postpartum; 60% (n=35) at 6 months then 49% (n=27) at 12 months (note: this only refers to milk feeding). Five infants received exclusive formula and no breast milk immediately after birth, however three went on to fully BF and mix feed, while the other two continued

with exclusive formula. The number of infants who received exclusive formula increased, starting at 8% (n=5) at 2 weeks, 22% (n=13) at 6 months and finally 47% (n=26) at 12 months (Figure 3.1).

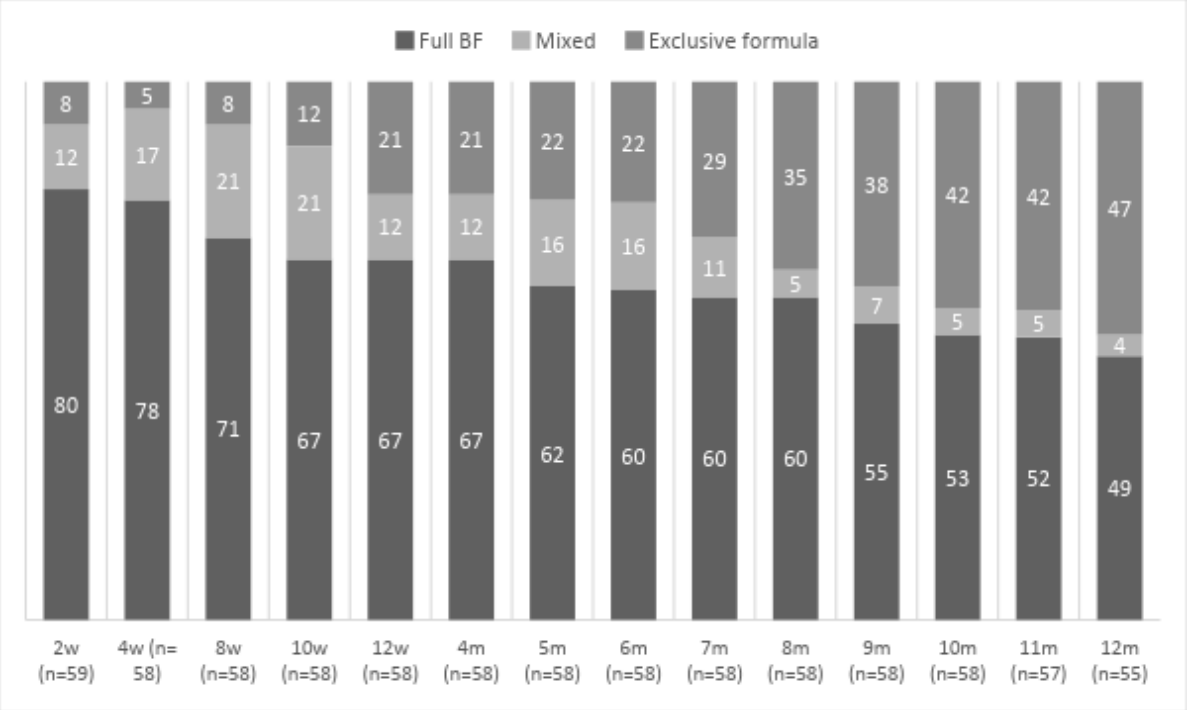
56% (n=19) of infants who were fully BF (*note- full BF refers only to their only milk source*) were receiving complementary feeding at <5.5 months, and therefore not meeting BF recommendations (table in Appendix B).

The leading reason for formula introduction was PIM (48%, n=13). Other reasons included; medication/medical condition, mother away or returning to work, BF issues, busy with other children and other (Appendix B). Formula was given to just under half (44%, n=26) of infants, and 92% (n=24) of them received it within the first 6 months. Nearly all infants who received formula, had it introduced alongside BF, i.e. as mixed feeding (96%, n=25). Half of the infants who were started on mixed feeding, then progressed to exclusive formula feeding (54%, n=14). Three out of the five participants who fed their infant exclusively with formula at birth did so due to health conditions that prevented them from BF, e.g. jaundice and emergency C-section complications. While the remaining two women did so due to medication and choosing to not BF.

Expressed Breast Milk

Just under half of infants received expressed breast milk (EBM) (44%, n=26), by cup or bottle, at some time during the 12 months. Furthermore, 61% (n=16) of them received EBM regularly. Regardless of regularity, the most common timing of introduction was 4 weeks (24%, n=6) and 6 weeks (24%, n=6). Reasons for EBM use included; more freedom for mother, trying to increase milk supply, returning to work, expressing due to mastitis and other (table in Appendix B).

Figure 1. Percentages of different milk feeding practices (2 weeks - 12 months)



Pacifier use

Pacifiers were used by 47% (n=29) of infants at some time in the 12 months. Almost all participants who gave a pacifier reported the reason was to settle the baby (90%, n=26). The other reported reasons for pacifier use included; increasing time between feeds and preventing the baby chewing on other objects.

Breastfeeding Problems

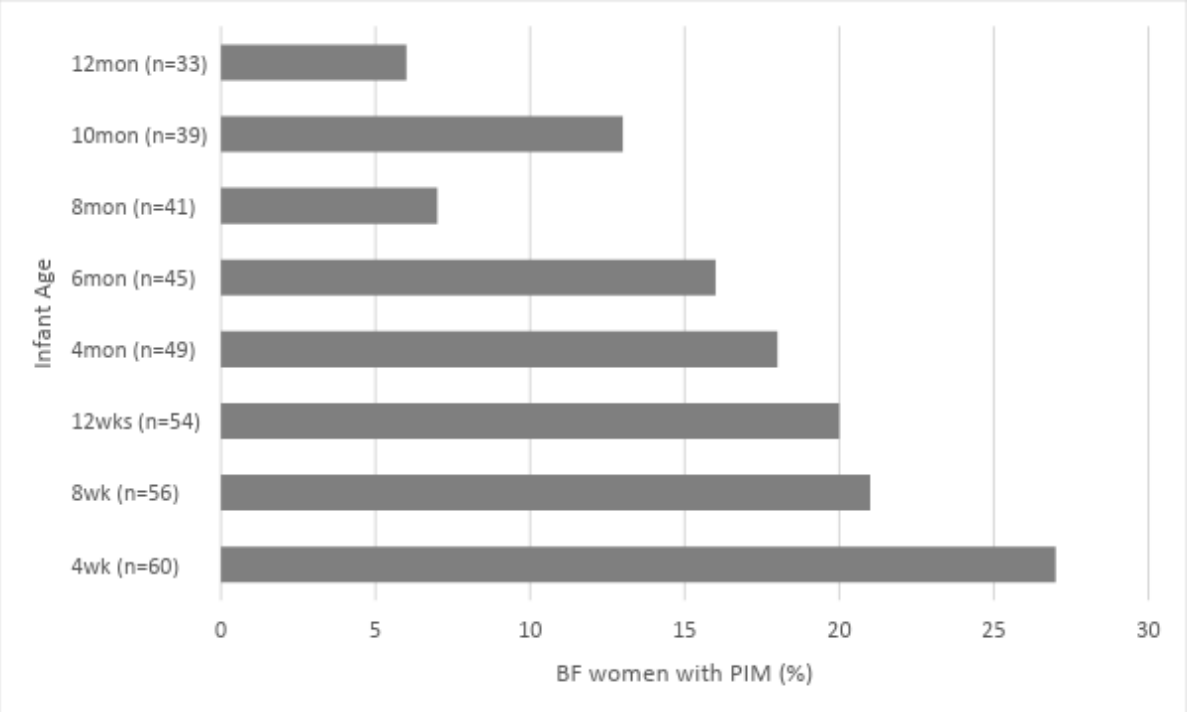
BF problem(s) were experienced by most mothers (72%, n=44). Out of the participants who experienced a BF problem(s), most reported a problem on more than one occasion (68% (n=30), while 32% (n=14) reported a problem on only one occasion (table in Appendix B). Out of those who reported a problem, 46% (n=28) reported one type of problem: e.g. physical OR refusal to feed OR latching OR. Two types of problems were experienced by 18% (n=11) of women and three types by 8% (n=4) (table in Appendix B).

Prevalence of PIM

49% (n=30) of mothers reported PIM at least once in the year and prevalence was highest at 4 weeks 25% (n=15) but decreased with the increasing age of the infant (Figure

3.2). It was common for a mother to report PIM more than once, i.e. five women reported PIM on 4 or more occasions (table in Appendix B).

Figure 2. Prevalence of PIM (4 weeks - 12 months)



Factors associated with PIM (Bivariate)

Demographic and social factors and PIM

There were no significant associations observed between reporting PIM at any time and the following variables: maternal age, maternal education, ethnicity, past BF experience and parity (table in Appendix B).

Maternal attitudes and knowledge and PIM

PIM was not associated with maternal rating of BF importance at 4 weeks (chi-squared, p-value=0.56) or knowledge of evidence based methods for increasing milk supply (chi-squared, p-value=0.85).

Feeding practices and PIM

There was a significant association between formula use (at any time) and PIM (chi-squared, p-value <0.01). 73% (n=19) of mothers who used formula also experienced PIM at some time during the 12 months, compared to the 34% (n=10) who did not use formula and reported PIM. There was no significant association between formula use (no reported PIM at that time) and PIM (chi-squared, p-value=0.76) (Table 3.2).

Table 3. 2 Formula use and PIM

	PIM any time, n (%)	
	No	*Yes*
Formula /No PIM reported (at the time)	7 (54)	6 (46)
No formula	22 (76)	10 (34)
Formula after report of PIM	0 (0)	13 (100)

EBM (at any time) and PIM

There was no significant association between PIM and EBM use (at any time) (chi-squared, p-value= 0.29) (table in Appendix B). The use of EBM with no report of PIM (at the time) was also not associated with PIM (chi-squared, p-value =0.90) (Table 3.3).

Table 3. 3 EBM use and PIM

	PIM any time, n (%)	
	No	*Yes*
EBM/No PIM reported (at the time)	11 (58)	8 (42)
No EBM	18 (56)	14 (44)
EBM after report of PIM	0 (0)	7 (100)

Pacifier use and PIM

PIM was not associated with pacifier use (at any time) (chi-squared; p =0.30) nor with pacifier use with no report of PIM (at the time) (chi-squared, p-value =0.62) (Table 3.4).

Table 3. 4 Pacifier use and PIM

	PIM any time % (n)	
	No	*Yes*
Pacifier/No PIM reported (at the time)	12 (63)	7 (37)
No pacifier	18 (56)	14 (44)
Pacifier after report of PIM	0 (0)	9 (100)

BF Problems and PIM

PIM had no significant association with BF problem(s) (at any time) (chi-squared, p-value =0.24) (table in Appendix B). BF problems(s) with no report of PIM (at the time) was also not associated with PIM (chi-squared, p-value=0.89) (Table 3.5).

Table 3. 5 BF problem and PIM

	PIM any time, n (%)	
	No	*Yes*
Problem/No PIM reported (at the time)	20 (61)	13 (39)
No Problem	10 (63)	6 (37)
Problem after report of PIM	0 (0)	11 (100)

BF duration and PIM

Women who did not report PIM had a significantly increased likelihood of infants who were full BF at 5 months, any BF at 5 months and any BF at 12 months compared to women who reported PIM (Table 3.6).

Table 3. 6 PIM and BF duration

	Full BF 5 months, n (%)		**Any BF 5 months, n (%)**		**Any BF 12 months, n (%)**	
	Yes	*No*	*Yes*	*No*	*Yes*	*No*
PIM any time						
Yes	9 (29)	20 (71)	19 (66)	10 (34)	11 (32)	18 (72)
No	22 (71)	8 (29)	27 (90)	3 (10)	23 (67)	7 (28)
P-Value		<0.01		0.02		<0.01

Factors influencing outcomes (Multivariate)

Factors influencing PIM

Forward stepwise regression was performed including the following potential explanatory variables: formula use (any time), EBM use, pacifier use and BF problem(s). The only significant predictor of PIM was formula use (R^2= 0.22, P<0.01). Remaining variables did not add significance to the model (Table 3.7).

Table 3. 7 Stepwise logistic regression: factors influencing PIM (formula any time)

	B	Exp (B)	Predicted correct classification (%)	R^2	Sig.
PIM				0.16 (Cox & Snell)	
Formula use				0.22 (Nagelkerke)	
	1.8	5.97	71		0.00

Another forward stepwise logistic regression was performed using 'formula use with no report of PIM (at that time)', along with the same potential explanatory variables used in the previous model (Table 3.7). None of the variables reached the (P<0.05) required for entry into the equation.

Influence of PIM on BF duration

Based on results of forward stepwise regression, the best set of predictor variables for full BF at 5 months were: PIM, importance of BF at 4 weeks and evidence based methods tried for increasing milk supply (R^2= 0.44, P<0.01). Remaining variables did not add any significance to the model.

PIM was the only significant predictor for any BF at 5 months (R^2= 0.13, P<0.01) and all remaining variables did not add significance to the model.

The best set of predictor variables for any BF at 12 months was PIM and importance of BF (R^2= 0.32, P<0.01). Again, all remaining variables did not have any significance within the model (Table 3.9).

Table 3. 8 Stepwise logistic regression: factors influencing BF duration

	B	Exp (B)	Predicted correct classification (%)	R^2	Sig. (p-value)
Full BF 5 months				0.33 (Cox & Snell)	
				0.44 (Nagelkerke)	
PIM	1.5	0.21	73		0.02
Importance of BF	1.5	4.68	73		
Evidence based method tried for increasing milk supply	1.6	0.19	76		
Any BF 5 months				0.08 (Cox & Snell)	
				0.13 (Nagelkerke)	
PIM	1.5	0.21	78		0.02
Any BF 12 months				0.23 (Cox & Snell)	
				0.32 (Nagelkerke)	
PIM	1.8	0.15	69		0.00
Importance of BF	1.5	4.37	71		0.00

Case studies *(see full case studies in Appendix B).*

Case study 1

The mother in case study 1 reported BF problems and PIM multiple times throughout the first 12 weeks. The mother's rating of BF importance remained 5/5 throughout the 12 weeks. However, there were no further BF problems or PIM reported following 12 weeks and the mother continued to BF. Throughout this journey, the mother attempted methods (both evidence based and non-evidenced based) to increase milk supply, including: expressing, feeding more frequently, increasing fluid consumption, and eating more foods high in carbohydrates and fat.

Case study 2

The mother in case study 2 experienced PIM repeatedly, as well as suffering from sore cracked nipples multiple times. The infant was BF within the first hour after birth, but was also experiencing latching issues due to jaundice. At 20 hours old, the infant required to be fed a mix of EBM and formula for 2 days. When the mother began BF again, the infant would not latch without a nipple shield, and this continued until 8 weeks. The mother's importance of BF was 5/5 throughout the period the mother was BF/expressing, although she stated that this applies to breastmilk rather than BF itself. The mother reported PIM every time she was

asked and decided to introduce a top of formula after BF or EBM when the infant was 10 weeks old. The mother increased the frequency of expressing in attempt to increase supply. At 12 weeks, she had completely stopped BF from the breast, and was expressing every 3 hours and alternating the feeds between breastmilk and formula, as she could not make enough milk to exclusive feed with EBM. PIM was ongoing during 4-5 months, which resulted in the mother having to increase the formula volume as the infant began grow and get hungrier. At 6 months, the infant was being fed exclusive formula and this continued until 12 months.

3.5 Discussion

Participants

Sixty-one healthy women were included in this study. The characteristics of this participant group are not representative in comparison to NZ national data. The median age of mothers in this study was 32, which was slightly older than the median age of women giving birth in NZ (30 years) (Ministry of Health, 2017). The education level of mothers in this study is higher than the national average for NZ women. In this study, 58% of participants have a Bachelor's degree or higher qualification, whereas the NZ national average is 27% (Ministry of Education, 2016). The ethnic make-up of participants in this study was predominantly NZ European/Pakeha (83%), compared to the overall NZ population (74%), and more importantly, the population of women giving birth in NZ (47%) (Census NZ, 2013; Ministry of Health, 2017). Parity rates in this study were similar to the overall NZ population statistics of women giving birth, with 60% of mothers multiparous (Ministry of Health, 2017).

Some characteristics that have shown significant associations with longer BF duration in previous research are also prevalent within our participant group. These include: older maternal age, higher education and NZ European/Pakeha ethnicity (Ministry of Health, 2002; Plunket Society, 2017; Sheehan et al., 2001; Avery et al., 1998) Therefore, it could be hypothesized that the average BF duration would be longer in this study than the NZ national average.

The number of infants who were BF in this study was difficult to compare to Plunket data, as this study classifies infants based on type of milk feeding (*not considering complementary food introduction*), while Plunket (and most definitions) defines exclusive BF to be breast milk with no other foods given to the infant. However, the data from this study is comparable to Plunket data at 3 months, because complementary food has not been introduced at this time. The number of infants being fully BF at 3 months was higher in this study (67%), compared to Plunket data (58%). While, the number of infants being partially BF at 3 months was higher in the Plunket data, 22%, compared to this study, 12% (Plunket, 2017).

Prevalence of PIM

This study found overall PIM prevalence to be 47%. Gatti et al. (2008) concluded that mothers are at the highest risk of experiencing PIM during the first 4 weeks postpartum, similar to the finding in this study. Furthermore, our study found that PIM prevalence decreased over the 12 months. This decline over time may be because mothers who experience PIM may stop BF, while more of the mothers who continue perceive their milk supply to be sufficient, or perhaps they resolve the cause of PIM. Overall, both previous research and the findings from this study confirm that PIM is prevalent, especially, within the early postpartum period. It is also important to consider that among mothers reporting PIM, there will be some who are experiencing AIM. The importance of considering AIM, is that unlike PIM, there may be no resolution for AIM if it has primary causes.

Factors associated with PIM

Maternal demographic factors

In this study, no significant association was found between maternal age and PIM. However, Prabasiwi et al. (2015) found mothers of a younger age (<20 years), reported PIM more. Lack of significance in this study may be due to the median age of this participant group (32 years), and had very few participants under 20 years of age.

Maternal education had no significant relationship with PIM in this study. Robert et al. (2014) found that one group of Belgium mothers who reported PIM as a reason for early BF cessation (<6 months) tended to have lower education level. Overall, there is no other research to our

knowledge that analyses the relationship between maternal education and PIM. The absence of a significant association within this study may be due to participants having a higher level of education (i.e. most participants having at least some form of tertiary education), while the 'lower' education mentioned in Robert et al., (2014) is less than tertiary level education.

There was little diversity in ethnicity in this study, which can explain why there were no significant associations between ethnicity with PIM.

Parity (primiparous vs multiparous) had no significant association with PIM in this study. Our findings, align with conclusions of a review by Gatti et al. (2008), that multiparous mothers report PIM at similar rates to primiparous mothers. Similarly, our finding of no difference in report of PIM between those who had past BF experience. aligns with the conclusion of Gatti et al (2008).

Overall, the absence of significant associations between PIM and maternal demographic variables in this study (maternal age, education, ethnicity, parity and past BF experience) may indicate that PIM is equally common amongst these groups. Additionally, it could be partly explained by the small sample size and little variation within some variables of this group.

Maternal attitude and knowledge

Women were asked in every interview to rate BF importance. The mean rating of BF importance was 4.6/5 at 4 weeks and dropped to 3.4 at 12 months. Rating of BF importance at 4 weeks was associated with BF duration. There was no significant association between PIM and rating of BF importance at 4 weeks.

Evidence based methods that increase milk supply most effectively are based on increasing milk removal from the breast; expressing breastmilk or increasing BF frequency (Eglash et al., 2008; Wambach & Riordan, 2016). Thus, it is expected that responding to PIM with methods other than increasing milk removal will have no impact on milk supply (Wambach & Riordan, 2016; Hillervik-Lindquist, 1992). We found, 88% (n=53) of mothers said they were aware of ways to increase their milk supply and of these, 68% (n=36) reported an evidenced based method. Twenty-seven mothers had tried to increase their milk supply, and over half of them

(n=18) had tried an evidenced based method. PIM was similar between those who were aware of evidence based methods and those who were not. This suggests that women may learn about evidence based methods to increase milk supply, however, may not necessarily apply these methods. Thus, it should be that all mothers receive education around how to correctly identifying PIM and use methods for increasing supply.

Feeding practices

The percentage of women fully and partially BF reduced gradually over 12 months post-partum in this study. A review by Gatti et al. (2008) reported that the prevalence of BF cessation was highest during 1-4 weeks post-partum. Similarly, Morton et al. (2012) found a decline in the number of mothers exclusively BF at one week postpartum (93%) compared to 4 weeks (82%). However, the decline was minimal in this study, with 80% of women fully BF at 2 weeks postpartum and 78% at 4 weeks. Similar to other research, we also found a decline (20%) in the number of women who were fully BF during the first 6 months postpartum (Gatti et al., 2008, Morton et al., 2012). Formula was used by 44% of participants in this study and the main reason for introduction was PIM. Similar to this study, research indicates that PIM is reported by a quarter to half of mothers and many mothers respond to this with infant formula (Chan et al., 2000; Negayama, 2012; Robert et al., 2014). It is undeniable that introduction of formula is a common response for PIM and furthermore, often leads to BF cessation (Robert et al., 2014; Gatti et al., 2008; Negayama et al., 2012).

We found that 44% of infants received EBM at some time during the year and 61% of those infants received it regularly (>4x/week), at least for a period of time. The three main reasons for EBM use were: to allow for more freedom for the mother, to try to increase milk supply and to allow the mother to return to work. There is little evidence about the effects of EBM on PIM, but BF guidelines suggest avoiding bottles, teats and pacifiers early post-partum WHO (2010). This is advised as the baby can become used to the different suckling action as well as causing less suckling time on the breast and therefore decrease milk production (Eglash et al., 2008; Wambach & Riordan 2016). EBM may also be given to the infant in a cup, which could also lead to interruption of feeding through similar reasons. This is especially concerning when lactation is still under endocrine control, and reduced suckling and time on the breast will

reduce prolactin and become problematic for milk supply. However, once lactation is established and under autocrine control, then expressing can maintain or increase milk supply due to the feedback system acting upon milk being removed from the breast (Eglash et al., 2008; Wambach & Riordan, 2016). Therefore, depending on whether milk production was under endocrine or autocrine control, EBM could have a negative or positive effect on PIM, respectively. However, it is evident that in case study 2, the use of EBM failed to increase milk supply. This raises the question whether expressing has no effect on increasing milk supply or if the mother in case study 2 had an underlying issue that prevented the expected increase in milk supply. In this study, there was no significant association between PIM and EBM use (at any time).

Pacifiers were used by 47% of infants in this study and the main reason for use was to settle the infant. Pacifier use was not significantly associated with PIM in this study. To our knowledge there are no studies that analyze the effects of pacifier use on PIM. Assumptions can be made that pacifier use will lead to PIM, based on the understanding that it can reduce suckling time and infant demand for BF (Eglash et al., 2008). Pacifier use could also 'solve' PIM if the perception was based on the infant being unsettled, which was resolved with a pacifier.

BF problems

BF problem(s) were reported by 47% of the participants in this study. Physical breast problems and refusal to feed were the most commonly reported problems. Although little prior research examines BF problem(s) in relation to PIM, Robert et al. (2014) suggests that if BF problems persist they could lead to AIM and possible early weaning. An example can be shown in this study (case study 2), when initial BF problems (jaundice and latching issues) may have prevented frequent feeding and correct suckling, which may have led to reduced milk supply and PIM. In this study, there was no significant association between PIM and BF problem(s), although there may be specific cases where BF problems lead to PIM it is not likely a common cause on a population level.

Most mothers who felt PIM was a problem reported it both in response to the question about PIM and in response to the open-ended question regarding BF problems. Interestingly, some mothers reported PIM, but did not list it as a BF problem, while others reported PIM as a BF

problem but did not report PIM when asked directly. This raises the question of how mothers define a 'problem' and why some did not consider PIM as a problem. This could suggest that mothers may only report PIM as a problem if it has reached an advanced stage. This should be kept in mind for future research.

PIM and AIM

This study did not distinguish between AIM and PIM, as milk supply was not measured objectively. Determining if PIM is AIM on a population level is difficult, as it requires an objective measurement of milk supply, along with infant growth and excretion, as well as investigating why the mother felt she had an insufficiency (Gatti et al., 2008). It is important to consider that if the issue is not actually insufficient milk supply, then an evidence based method for increasing milk supply will have no impact. For example, an infant may be unsettled due to oversupply, in which case these methods would lead to a more unsettled infant (Eglash et al., 2008; Wambach & Riordan, 2016).

Factors influencing PIM

Variable selection for the logistic regression model was guided by previous research.
The purpose of the variables 'formula use at any time' and 'formula use with no report of PIM (at that time)' in separate logistic regression models was to determine if formula use was a cause or an effect of PIM.

Formula use at any time was the only significant predictor of PIM (R^2= 0.22), none of the other variables were entered into the model. Formula use with no report of PIM (at that time) was not a significant predictor of PIM. Several studies have found formula use to be significantly associated with PIM, yet could not confirm if it was cause or an effect of PIM (Gatti et al., 2008; Robert et al., 2014; Hillervik-Lindquist, 1992; Chan et al., 2000; Cooke et al., 2003). Our findings indicate that the relationship is explained by formula being used in response to PIM, but it is still unknown if formula feeding leads to AIM, which then leads to exclusive formula feeding.

PIM influencing BF duration

There is a robust body of evidence indicating that PIM is a significant risk factor for early BF cessation (Robert et al., 2014, Chan et al., 2000, Cooke et al., 2003). Other variables included in the stepwise procedure for a logistic regression model were based on previous evidence suggesting a relationship with shorter BF duration.

Full BF at 5 months was predicted by the variables: PIM, importance of BF, evidence based method tried for increasing milk supply. It was found that report of PIM can be used as a predictor for BF cessation, however if the mothers rating of BF importance at 4 weeks was higher, then they are more likely to continue BF. Mothers who rated BF importance higher at 4 weeks, were more likely to be practicing both full BF at 5 months and any BF at 12 months. The mother's rating of BF importance at 4 weeks was not a significant predictor for any BF at 5 months. Overall, it can be suggested that BF duration will be longer if the mother feels BF is important and may explain how some women with PIM continue to BF.

Attempting an evidence based method opposed to a non-evidence based method was associated with a reduced likelihood of any BF at 5 months. This is an unusual relationship and is the opposite of what would be expected. A suggested explanation of this could be that the evidence based method of increasing BF frequency, fails to succeed due to underlying issues, i.e. the infant having a poor latch or inefficiently suckling. Over the early postpartum period, the infant may get adequate milk as it is easily withdrawn from the breast during milk let-down. However, as the infant grows they must learn to actively suckle the breast to withdraw milk and stimulate milk production. However, if an infant cannot suckle or latch correctly, then they will be unable to feed properly and fail to get enough milk. Therefore, the use of the evidence based method 'increasing BF frequency' will fail to succeed in cases where the infant cannot latch or suckle correctly. A physiological issue that interferes with oxytocin and milk ejection is another possible reason why an evidence based method (i.e. increasing BF frequency or expressing) would not work. Another possible explanation of these findings, may be that those who had tried an evidenced based method were mothers who sought professional help and had been experiencing a more severe case of PIM.

Strengths, limitations & recommendations

The longitudinal design of this study was one of the main strengths, as it provided insight into the mothers' attitudes around PIM and BF prior to report of BF cessation. Our longitudinal design also had a duration of 12 months, which allowed for comparison of BF rates to BF recommendations. Whereas, some studies that were reviewed used cross-sectional designs or had shorter study durations that prevented this. The small sample size of this study was an advantage, especially when combined with qualitative data, as it provided detailed understanding of the participant group and gave insight on more complicated cases. The use of qualitative open ended questions in the questionnaire was both a strength and limitation in this study. Qualitative questions are a strength, as it allowed for understanding women's reasons for formula introduction, EBM use, pacifier use. However, qualitative questions also lead some mothers to misinterpret some questions (specifically on PIM and BF problems) and caused inconsistencies among answers. Another limitation of this study was the lack of diversity within the participant group, as this made it less comparable to the NZ national population. The lack of significant associations between demographic variables and PIM in this study, makes it difficult to identify the women who are at risk of PIM and furthermore, at risk of early BF cessation secondary to PIM. In future research, it would be useful to have a larger and more diverse participant group as this may provide associations with PIM and some demographic variables, as well as making it more comparable to the NZ population. It would also be beneficial to use a validated PIM questionnaire as it could provide a more consistent and accurate method for assessing PIM. Identifying the mothers who may be at risk of PIM could help provide more specific advice and practical education on PIM prenatally, in hospital, and throughout regular Plunket visits and result in preventing early BF cessation caused by PIM.

3.6 Conclusion

In this study, the occurrence of PIM was not associated with demographic variables or infant practices. Nevertheless, this study concluded that formula use was a significant predictor variable for PIM and was explained by formula being given as a response to PIM, not causing PIM. Furthermore, our findings also indicated a convincing relationship between PIM and BF duration (any BF 5 months, full BF 5 months, any BF 12 months).

Chapter 4: Conclusion & Recommendations

4.1 Research outcomes

The aim of this study was to determine the factors associated with PIM in BF mothers and the impact that this has on BF practices. This study achieved all objectives that were set. It was hypothesized that PIM would be impacted by demographic, psychological factors and feeding practices. Though there is previous research that indicates relationships with these factors and PIM, this study only found significant relationships between PIM and infant formula use, and BF duration. It was also hypothesized that PIM prevalence will be higher in mothers who use infant formula. This was true, as formula use was associated with PIM and the relationship was explained by formula being used as a response to PIM. The final hypothesis was mothers who experience PIM will have reduced BF exclusivity and duration. This was also true, as PIM was associated with BF duration and was found to be the most significant predictor.

The significant outcomes of this study supported current evidence and generated new knowledge on formula use and the relationship that this has with PIM. The limited diversity within our participant group, make it difficult to compare our results to the NZ population. This is due to majority of this sample being selected from Manawatu and the sample having some characteristics that were different to the NZ population (i.e. education, age, ethnicity).

4.2 Strengths

The main strength of this study is the longitudinal design, as it provided an insight into BF journey over 12 months, this allows for the inclusion of the mothers' experiences around PIM and BF, which may have led to the report of PIM or BF cessation. The longitudinal design also allowed for measurement of the BF rates for comparison to BF recommendations. The longitudinal design provides the ability to examine the order of events and the early maternal attitudes that may come prior to PIM and /or BF cessation. Another major strength of this study is the dedicated focus on PIM, as it has allowed for the examination of associated factors and how mothers respond to it and its association with BF duration. The small sample size of this study was both a strength and a limitation. The small sample size enabled qualitative variables to be analyzed, including: reasons for formula introduction, EBM use and pacifier use.

4.3 Limitations

The small sample size was one of the main limitations of this study. Additionally, the sample was relatively homogenous. The small homogenous sample resulted in the study being underpowered to detect some potential associations between variables. The use of qualitative questions was also both a strength and a limitation. Some qualitative questions were interpreted differently by mothers and resulted in inconsistent answers. An example of this was, mothers who reported PIM but did not report a BF problem. There were only few mothers who reported PIM as both a problem and as PIM. This may be due to participants interpreting the question as a BF problem as only a physical or infant related problem, or perhaps that PIM experienced was not a big enough issue to classify it as a BF problem, yet the prospect of it impacting outcomes of this study is unlikely. Failing to analyze the frequency of BF (i.e. from the 24-hour recall) is a crucial limitation of this study. This is because BF frequency is a good reflection of supply and demand, which has proven to be strongly linked to PIM. Having a variable for BF frequency could have allowed for a much greater understanding of PIM.

4.4 Recommendations

Overall, there is limited research onto the causes or and responses to PIM, and further studies are required to gain a more comprehensive understanding around PIM, the factors associated and the impacts it has on BF practices. In this study, the lack of association between demographic variables and PIM, means it is difficult to identify the women who are at risk of PIM and furthermore, at risk of early BF cessation secondary to PIM. For future research, a bigger sample that has more diversity might detect associations between demographic factors with PIM. The use of a validated PIM questionnaire could also be beneficial, as it may quantify PIM better, and provide a more consistent and accurate method for assessing PIM. BF frequency was not analysed in this study but would be useful for further research, as it would help investigate the relationship between BF management and PIM. If mothers who are at risk of PIM can be successful identified, then more specific advice and practical education on PIM can be given. prenatally, in hospital, and throughout regular Plunket visits. This could help prevent mothers introducing formula as a response to PIM and therefore, reduce early BF cessation caused by PIM.

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Appendix A: Supplementary Methods

A.1 Participants continued

Recruitment of participants was done nationally through advertisements in public locations (GP clinics, midwifery premises and Plunket rooms), newspapers, newsletters and online. Women were recruited into the study in the last gestation (≥35 weeks), were no younger than 16 years old and had to be having a healthy pregnancy and healthy infant.

A.2 24-hour recall

The 24-hour recall involved mothers being asked what and how the infant was fed in the past 24 hours. For this study, the purpose of the 24-hour recall was for indication of the feeding method used. An advantage of the 24-hour recall method is the reduction in respondent burden (Bernard, 2011). However, it is important to note that the use of a 24-hour recall method has the potential to result in some disadvantages. Firstly, it is important to note that a 24-hour recall cannot represent habitual feeding practices and may possibly lead to overestimation of exclusive BF. This can arise when times that infants were fed other foods in addition to breastmilk but were excluded from the recall (Agampodi et al., 2011). Social desirability may also lead to an overestimation, as mothers may over report BF practices to give a more socially acceptable response that coincides with recommendations (Li at al., 2005). To address the possible overestimation, other questions were assessed to determine the feeding methods used. There were specific questions from the questionnaire where mothers would report changes in feeding or report the use of other feeding methods, these included; “What changes have you noticed since we last talked?”, “Overall, how do you feel about feeding the baby now?”, “Are you considering introducing any changes to feeding in the next week? What? Why?”, and “Did you consider supplementing the feed with a bottle of formula milk?”. Consideration of the questions mentioned acted as a preventative for possible overestimation of exclusive BF caused by the 24-hour recall.

A.3 Data analysis continued (Multivariate)

BF 5 months and any BF 12 months) were measured on a dichotomous scale. There was more than one independent variable being tested and these were categorical. There was independence of observations and the dependent variables had mutually exclusive and exhaustive categories (Laerd Statistics, 2018). The stepwise, forward condition method

involves entry testing based on the significance of the variable and removing based on the probability of a likelihood-ratio statistic based on conditional parameter estimates (IBM Knowledge Centre, 2018).

Appendix B: Supplementary results

Additional tables

Obstetric Characteristics

	N, (%)	Mean±SD
Gestational Duration (weeks)	38	37.4±1.2
<37 preterm baby	8 (21)	35.8±0.9
≥37 full term baby	30 (79)	38.0±0.8
Delivery mode		
Natural	43 (70)	
Caesarean	18 (30)	
Gender of Baby	61	
Female	27 (44)	
Male	34 (56)	

Reported methods for increasing milk supply*

Reported methods to increase milk supply	N, (%)
Increase BF frequency	30 (27)
Express	19 (16)
Diet/eating more	19 (16)
Increasing fluid consumption	19 (16)
Herbal/natural supplements	16 (14)
Rest	7 (6)

*Note: some women reported more than one method

Frequency of PIM reported (4 weeks – 12 months)

Number of times PIM reported	Frequency, n (%)
No PIM	31 (51)
One	12 (19)
Two	9 (15)
Three	4 (7)
Four	3 (5)
Five	2 (3)

Complementary food introduction

The mean infant age for solids to be introduced was 5.3 0.87 months. The most common age for introduction of solids was 5 months (34%, n=20). Over half of the infants were BF when solids were introduced (59%, n=35). Majority of the participants introduced solids prior to recommended age of 6 months (58%, n=34) (see Table below).

Introduction of solids alongside milk

	Full BF, n (%)	Mixed, n (%)	Exclusive formula n, (%)	Total, n (%)
Infant age of complementary food introduction				
< 5.5 months	19 (56)	7 (21)	8 (23)	34 (58)
5.5-6.5 months	14 (61)	3 (13)	6 (26)	23 (39)
>6.5 months	3 (100)	0	0	3 (5)
				100 (60)

Reasons for EBM use*

Reasons for EBM use	N, (%)
More freedom	8 (31)
Increasing milk supply	6 (23)
Return to work	6 (23)
Expressing due to mastitis	3 (11.5)
Other	3 (11.5)

**some women may have given more than one reason*

Pacifier use in the first 6 Months

Age	N, (%)
1 week	13 (22)
4 weeks	18 (30)
6 weeks	12 (30)
8 weeks	19 (32)
10 weeks	19 (32)
12 weeks	20 (33)
4 months	17 (27)
6 months	13 (22)

BF Problems in the first 12 months

Age	N, (%)
4 weeks	18 (30)
6 weeks	19 (34)
8 weeks	10 (17)
10 weeks	15 (25)
12 weeks	9 (15)
4 months	5 (9)
6 months	8 (14)
8 months	10 (17)
10 months	6 (10)
12 months	12 (21)

Number of BF problems reported (4 weeks - 12 months)

Frequency of ANY reported problem(s)	N, (%)
No problem	16 (27)
One	14 (23)
Two	10 (17)
Three	11 (18)
Four	3 (5)
Five	4 (7)
Six	2 (3)

Reasons for Formula Introduction

Reasons for formula introduction	N, (%)
PIM	13 (48)
Other	7 (26)
Mother going away/returning to work	3 (11)
Medication/medical condition	2 (7)
BF issues	1 (4)
Too busy with other children	1 (4)

Milk feeding and PIM

Feeding and PIM	**N, (%)**
No formula or PIM	21 (36)
Formula after PIM	13 (22)
No formula but PIM	11 (19)
Formula but no PIM	9 (16)
Formula before PIM	4 (7)

Maternal and obstetric demographics and PIM*

	PIM any time, n (%)		P-value
	No	Yes	
Maternal age			
<30 years	7 (58)	5 (42)	
≥30 years	20 (47)	23 (53)	0.46
Education			
<Bachelor's degree	13 (52)	12 (48)	
≥Bachelor's degree	17 (52)	16 (48)	0.97
Ethnicity			
Pakeha	28 (53)	25 (47)	
Non-Pakeha	4 (45)	5 (55)	0.72*
Parity			
Primiporous	8 (42)	11 (58)	
Multiporous	22 (55)	18 (45)	0.35
Past BF experience			
<6 months	12 (54)	10 (46)	
≥6 months	10 (56)	8 (44)	0.94

**Fishers exact test*

EBM use (at any time) and PIM

	PIM any time, n (%)		P-value
EBM any time	No	Yes	
No	18 (56)	14 (44)	
Yes	11 (42)	15 (58)	0.29

BF problem (at any time) and PIM

	PIM any time, n (%)		P-value
Problem any time	No	Yes	
No	10 (63)	6 (37)	
Yes	20 (45)	24 (55)	0.24

Knowledge of methods for increasing milk supply and BF at 6 months

		Still BF at 6 months N, (%)	
Evidenced based % (n)		*Yes*	*No*
	Yes	30 (81)	7 (19)
	No	11 (69)	5 (31)

Stepwise logistic regression: factors influencing PIM (formula before PIM)

	B	Exp (B)	Predicted correct classification (%)	R^2	Sig.
PIM				0.00 (Cox & Snell) 0.00 (Nagelkerke)	
Formula (no PIM reported at that time)	0.00	1.00	0		1.00

Case Studies

Case study 1: Repeated PIM continue BF to exceed 12 months

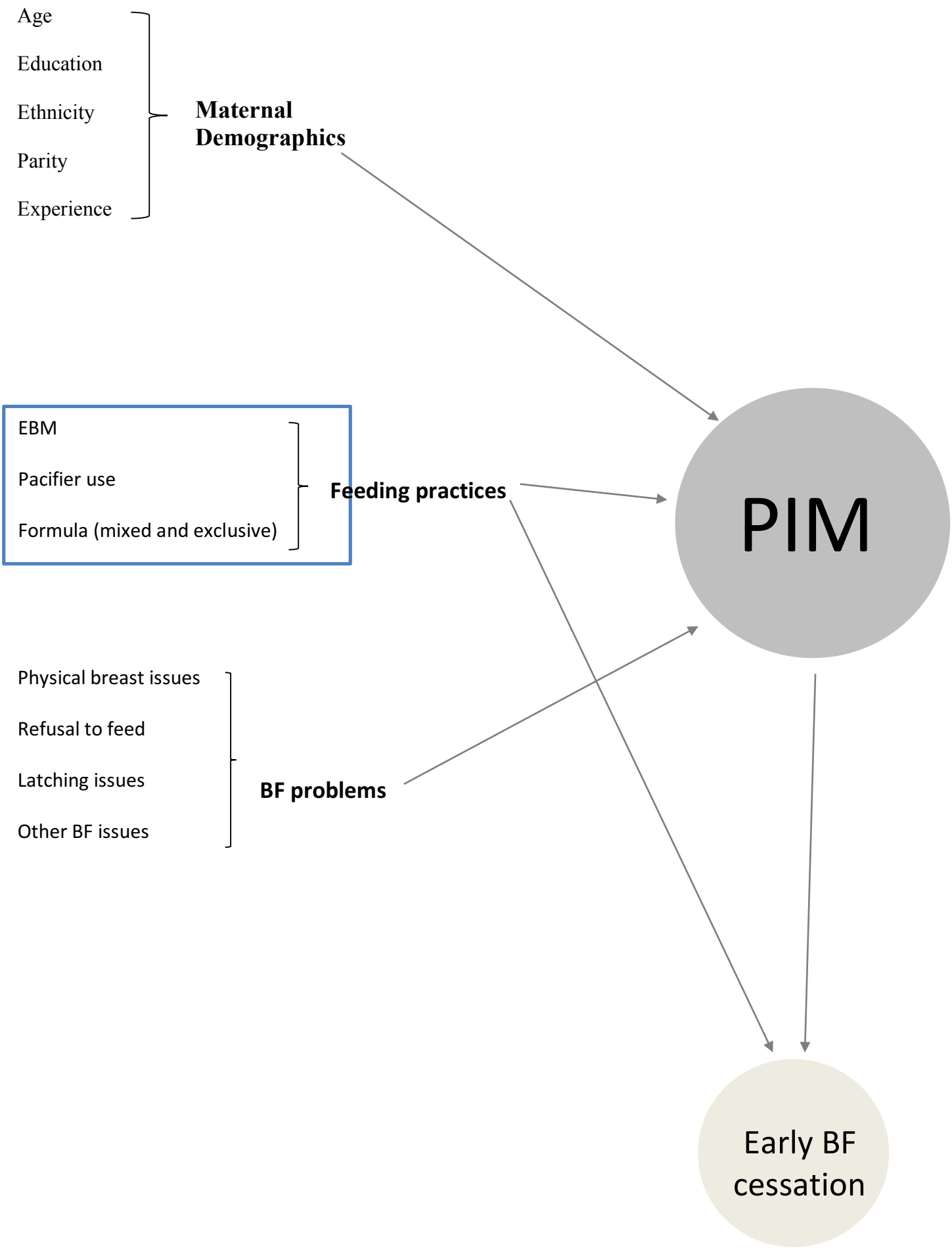
This participant experienced both problems, as well as PIM multiple times throughout the first 12 weeks. The infant began experiencing large volumes of vomit and wind after feeds; this problem began at 4 weeks and continued until 8 weeks. The mother scored the importance of BF 5/5 at 4 weeks. Alongside scoring BF importance, the question "What sorts of things are you thinking about when you say that?" was asked, and the mother answered "The health of the baby, ie. Immunity levels" and "It's convenient". The infant then began having latching issues at 8 weeks, and was initially occurring alongside the vomiting and wind. They then went to hospital, where they discovered that the infant had a hernia, which resulted in the infant having to be formula fed for one day. At 8 weeks, the mother scored BF importance as a 5/5 and reasoned it with "I am determined to keep BF", "makes me feel useful", "health reasons" and "I BF my other two". At 10 weeks, the infant still was not latching or feeding properly. At 12 weeks, the infant was struggling to feed properly due to

being unsettled. At 12 weeks, the mother still ranked the importance of BF as a 5/5 and reasoned it with “Nutrition wise for baby”, “It’s free, easy and portable”. The mother also experienced PIM during this time, reporting that she felt that she did not have enough milk for the baby. After the 12 weeks, problems began to resolve and there were no further BF problems or PIM reported. Throughout this journey, the mother was aware of ways to help increase milk supply and she tried some of these herself throughout the period of experiencing PIM. Things that she tried included; expressing, feeding more frequently, increasing fluid consumption, and eating more foods high in carbohydrates and fat. This is one case that shows BF can still be successful in meeting recommendations, even after numerous BF problems and experiencing PIM.

Case study 2: Repeated PIM leading to mixed feeding, then exclusive formula feeding

This participant experienced PIM repeatedly, as well as suffering from sore cracked nipples multiple times. The infant was BF within the first hour after birth, but was also experiencing latching issues due to jaundice. At 20 hours old, the infant required to be fed a mix of EBM and formula every 3 hours for 2 days. When the mother began BF again, the infant would not latch without a nipple shield, and this continued until 8 weeks. The mother reported PIM but was expressing in the morning after feeds and drinking herbal lactation tea to try increase milk supply. The mother rated importance of BF 5/5 and stated, “It is the best I can give him”, “It is what it is designed for” and that she was determined to continue BF. At 8 weeks, the mother reported PIM again, as well as cracked nipples and ongoing latching issues. She was continuing to express once a day in attempt to increase her milk supply, but reported to be struggling. She stated that she considered giving a top up of formula due to the infant having poor weight gain, but also stated that she does not really want to. At 10 weeks, the mother made the decision to introduce formula as a top up and was gave it after BF or EBM. The mother continued to experience PIM, cracked nipples and latching issues at 10 weeks. The mother increased the frequency of expressing in attempt to increase supply. She stated that she was only supplementing with formula until she could get her milk supply up high enough to go feed with full breast milk again. She rated her success of BF 3/5, as she felt “like a bad mother for giving formula”. At 12 weeks, she had completely stopped BF from the breast, but was expressing every 3 hours and alternating the feeds between breastmilk and formula, as she could not make enough milk to exclusive feed with EBM. The mother

stated, “Don’t think I’ll be BF again”. She began taking domperidone and fenugreek supplements to try increase supply. She ranked importance of BF a 5/5 and stated, “breast is best”. At 4 months, she was still experiencing PIM and expressing 5-6x per day and getting around 70-160mL of milk each express, but this was still not enough to give exclusive breastmilk. She increased formula volume as the infant began growing and getting hungrier. She mentioned that she would consider weaning the infant off EBM as it is “hard work expressing all the time, but I want to get to 5 months”. She ranked importance of BF 5/5 however said “this applies to breastmilk not BF itself”, as it is “good for him and his immunity”. At 5 months, the mother was still experiencing PIM but had increased formula volume and decreased EBM. She was not expressing as much and stated, “I’m over it”. She was now expressing 3-4x per day and getting around 500mL/day. The mother also stated that she “will stop expressing at 6 months”. At 6 months, the infant was being fed exclusive formula and this continued through until 12 months.


Age
Education
Ethnicity
Parity
Experience
Maternal Demographics
EBM
Pacifier use
Formula (mixed and exclusive)
Feeding practices
PIM
Physical breast issues
Refusal to feed
Latching issues
Other BF issues
BF problems
Early BF cessation

Appendix C: Questionnaires

Massey University

INSTITUTE OF FOOD, NUTRITION & HUMAN HEALTH

Massey Mother & Baby Study

Maternal data at recruitment

Date: Start time: End time:

DoB:	**Age:**	**Weeks pregnant:**
LMP	**EDD (LMP)**	**EDD (scan)**
Height (m):	**Weight (kg):**	**BMI**
Prepregnancy wt (actual):	**Prepregnancy wt (desired):**	**Confirmed?**

What do you think about your weight gain?

kg fat **% fat**	**% lean**	**Body vol**	
Waist (cm)	**Hip (cm)**	**W:H**	
Ankle circumference (cm) Left Right	**Calf circumference (cm)** Left Right	**Arm circumference** – relaxed **(cm)** Left Right	

Skinfold thickness - non-dominant side: **Left / Right** repeat girths & skinfolds x3 if necessary

triceps	**biceps**	**subscapular**	**iliac crest ***
supraspinale*	**abdominal ***	**thigh**	**calf**

Weight gained:

RMR

Note: * not taken at recruitment

1. **Have you given birth to any other children?**

   Yes = 1/ No = 0

No	**Sex**	**Age**	**Method delivery**	**Method of feeding** *(probe duration of bf)*

2. **Can you describe what you did yesterday,** I am particularly interested in all types of physical activity *(intentional and unintentional activity)*, such as hanging out the laundry, doing the gardening, dancing, walking, or going for a run.

   If we start with when you got up yesterday morning… (go through to same time today).

   _____

   ___

   _____

   ___

   _____

   _____

   _____

   _____

   ___

   _____

   ___

   _____

   _____

   _____

   _____

   ___

   _____

   ___

_____

_____

_____

_____

_____

_____

_____

_____

3. **Was yesterday a typical day in terms of physical activity?** If not, what was different?

_____

_____

_____

_____

_____

_____

_____

4. **How often do you do 15 minutes or more of <u>vigorous</u> activity? (Such you're your heart beat is raised and you are out of breath)**
_____times per week

How often would you do 30 minutes or more of continuous <u>moderate</u> activity? (such as brisk walking)?
_____times per week

5. **Has this changed if you compare your activity level now compared to before pregnancy?**
If "Yes", why /how

_____

_____

_____

_____

_____

_____

_____

6. How would you describe your fitness level <u>now</u>?

- ☐ 1 Extremely fit
- ☐ 2 Moderately fit
- ☐ 3 Moderately unfit
- ☐ 4 Unfit

Why do you say that? _____

_____

_____

_____

7. How would you describe your fitness level <u>before pregnancy</u>?

- ☐ 1 Extremely fit
- ☐ 2 Moderately fit
- ☐ 3 Moderately unfit
- ☐ 4 Unfit

I'd like to ask you a few questions about your diet. *When I use the term diet I mean what you eat and drink, not whether or not you are trying to loose weight.*

8. a. Who does most of the grocery shopping in your house?

_____

__

b. Who does most of the food preparation?

_____

__

9. Which of the following foods do you eat and how often? *(More than once per day, once per day, times per week, less than once per week).*

	No. of times per week/day	**Changes/ what /why**
Red meat:		
Chicken:		
Fish:		

Eggs		
Dairy (per day) – *number of glasses of milk/day? (not milk in tea x3)*		
fruit		
vegetables		
breakfast		

9a. How has your consumption of these changed since you became pregnant? *(will this work—or too long?)*

10. Are there any foods you are avoiding and why?

_____

_____

_____

_____

_____

_____

___

11 a. How else has what you eat and drink changed since you became pregnant?

(More healthy, same, less healthy….).

_____

__

_____

__

_____

__

b. If so, why have you made these changes? *(Probe for detail of change and understanding – look for food that is added and deleted, e.g. if no longer drinks coffee what is drunk instead, as well as changes in serve sizes).*

_____

_____

_____

_____

_____

__

_____

__

12. a. Who (else) has talked with you about what to eat and drink when pregnant?

_____

__

_____

__

_____

_____

_____

_____

Probe for:

_ midwife

_____

_ doctor

_____

_

partner_____

_

mother_____

_ mother-in-

law_____

_ other relatives

_____

_ friends

_____

_ other health professionals *(who?)*

_____

__

b. What other sources of information have influenced what you eat and drink during pregnancy? *(Probe for books, magazine info, advertisements….)*

_____

__

_____

__

_____

__

_____

__

c. Were you given any leaflets about dietary advice while pregnant, and if so what was most helpful to you? *(if not mentioned probe/ show Food Safety pamphlet?)*

_____

__

_____

__

_____

__

_____

__

d. (if not first pregnancy**) How are the changes to what you eat and drink similar or different from previous pregnancies?**

_____

__

_____

__

_____

__

_____

__

_____

__

_____

__

_____

__

13. Are you currently taking any vitamin or mineral supplements? *(Probe for folic acid and iron).*

Yes=1/No=0 If “Yes”:

(i) What? Why? How often?

_____

_____

_____

_____

_____

(ii) What? Why? How often?

_____

__

_____

__

_____

_____

____

(iii) What? Why? How often?

_____

_____

____

_____

__

_____

__

(iv) Has a health professional/ midwife recommended any other vitamins and/or minerals?

_____

_____

____

_____

__

_____

__

14. a. Do you currently smoke?

Yes/ No If "Yes":

What?

_____

___

How many? *(number per day/ week)*

_____

___

b. Did you smoke previously? *(get details)*

_____

___

15. a. Do you currently drink alcohol?

Yes/ No

(If "Yes"/ "Sometimes"): **How much and how often?** *(looking for amt and frequency)*

_____

___

_____

___

_____

___

☐ 0 Non-drinker
☐ 1 less than weekly
☐ 2 1-2 times per week
☐ 3 3-6 times per week
☐ 4 Daily

b. What type of drink(s)?

_____

c. Do you drink more on certain nights of the week?

_____

_____

___

d. Have you changed your alcohol consumption since becoming pregnant?
If yes, how? *(probe amount, frequency, why, advice?)*

_____

_____

_____

_____

_____

16. a. Do you drink coffee or tea?
Yes/ No If "Yes":

What?

_____

How often?

Coffee	***Tea (note herbal separately)***
☐ 0 Non coffee drinker	☐ 0 Non tea drinker
☐ 1 less than I cup per day	☐ 1 less than I cup per day
☐ 2 2-3 cups per day	☐ 2 2-3 cups per day
☐ 3 4-6 times per day	☐ 3 4-6 times per day
☐ 4 7 or more cups per day	☐ 4 7 or more cups per day

b. What sort of coffee do you usually drink? -

_____

_____

___

c. Have you changed your coffee or tea consumption since becoming pregnant?

Yes/ No (coffee) Yes/No (tea/ herbal)

If "Yes" how? *(probe amount and frequency)*

_____

_____

_____

_____

Now I'd like to ask a bit about your plans to feed the baby after birth.

17. a. What are your current thoughts about feeding the baby after birth? *(If just a short answer ask, "what are some of the things you considered when coming to that decision".*

If she says, "breastfeed if I can" probe as to what might stop her; e.g. what kinds of things are you thinking of when you say you'll breastfeed if you can?

_____

__

_____

__

_____

__

_____

__

_____

__

b. Thinking of (all) these reasons, what are the most important reasons for your choice*? (ask to rank if more than one?)_*

_____

__

_____

__

_____

__

_____

__

c. *(if planning to breastfeed*)**-- How important is it to you that you breastfeed your baby, on a scale of 1-10, with 10 being very important**. *(note any comments)*

_____

d. Do you have any plans to express milk if/ when you go back to work?

_____

__

_____

__

e. Who (else) have you talked to about how you will feed the baby? *(note down any comments she raises).*

_____

__

_____

__

_____

__

_____

__

Probe for those not mentioned:
_midwife
_doctor
_partner
_mother
_mother-in-law
_other relatives
_friends
_antenatal group

d. What are other sources of influence on your decision to feed? *Start with asking the question open ended so we can gather any thoughts she has along with it, e.g. my midwife hasn't been much help but she……*

_____

__

_____

__

_____

__

_____

__

_books
_magazines
_newspaper articles
_TV
_radio

e. *If she has other children ask* – **How are your thoughts about feeding different or the same from past pregnancies?**

_____

__

_____

__

_____

__

_____

__

Lastly I'd like to ask a few demographic questions, such as your occupation.

18. What is your current occupation? If not working, what was your previous occupation?

_____

__

_____

__

19. a. How many hours do you currently work each week?

_____

—

b. How many hours do you usually work each week?

_____

—

20. What was your highest *(or plans for your highest)* **educational level?**

_____

—

_____

—

21. Who are you living with now? *(get number of others, e.g. children, etc.)*

On own	☐	1
With partner	☐	2
With children	☐	3
With parents	☐	4
With others	☐	5

Note – can tick more than one box

22. What is your partner's occupation? *(if applicable)*

_____

—

23. Could you tell me which ethic group you identify with?

O	NZ European / Pakeha
O	NZ Maori
O	NZ Asian
O	Pacific Islander Polynesian
O	SE Asian
O	Chinese
O	Indian

O Japanese

O Other Asian

(*specify*)……...

O Mid Eastern

(*specify*)……....

O Other European

(*specify*)……

O Other
(*specify*)……

Massey University

INSTITUTE OF FOOD, NUTRITION & HUMAN HEALTH

Massey Mother & Baby Study

Maternal data at recruitment

Date:	Start time:	End time:

DoB:		**Age:**		**Weeks pregnant:**	
LMP		**EDD (LMP)**		**EDD (scan)**	
Height (m):		**Weight (kg):**		**BMI**	
Prepregnancy wt (actual):		**Prepregnancy wt (desired):**		**Confirmed?**	
kg fat	**% fat**	**% lean**		**Body vol**	
Waist (cm)		**Hip (cm)**		**W:H**	
Ankle circumference (cm)		**Calf circumference (cm)**		**Arm circumference** – relaxed **(cm)**	
Left	Right	Left	Right	Left	Right

Skinfold thickness - non-dominant side: **Left / Right** repeat girths & skinfolds x3 if necessary

triceps	**biceps**	**subscapular**	**iliac crest ***
supraspinale*	**abdominal ***	**thigh**	**calf**
Weight gained:			

RMR

Note: * not taken at recruitment

2. What is your current occupation? If not working what was your previous occupation?

_____

3. How many hours do you currently work each week? **QD2work** ☐

☐

_____

4. Do you work at weekends? **QD3wend**

☐

_____

_

Interviewer to clarify whether work is taken home or employed work at weekends.
Yes, take work home 1; Yes, employed 2; No 0

5. What is your partner's occupation? (if applicable)

_____

_

6. What do you do in your spare time?

_____

_____

_____

_____

Interviewer to clarify that this includes hobbies and other activities (e.g. housework and childcare).

6. Do you live on your own or with other people? **QD6live**

☐

On own	☐	1
With partner	☐	2
With children	☐	3
With parents	☐	4
With others	☐	5

Note – can tick more than one box

7. How would you describe your diet? **QH7diet**

☐

☐ 1 Eats meat frequently (4 or more times per week)
☐ 2 Sometimes eats meat (3 times or less per week
☐ 3 Avoids meat but eats fish
☐ 4 Avoids dairy products
☐ 5 Avoids eggs
☐ 6 Vegetarian
☐ 7 Vegan
☐ A Dieting to reduce weight
☐ B Another particular diet – please describe

Note – can tick more than one box

_____
_____
_____
_____
_____

8. Are you currently taking any vitamin or mineral supplements – or other substances to promote your health? **QH8vitam**

☐

Interviewer to clarify vitamin/mineral pills or tablets rather than supplemented foods.

Yes=1 / No=0

If "Yes": **What?**

_____
_____
_____
_____
_____
_____
_____

Why?

_____
_____
_____
_____
_____
_____
_____

9. What are your current thoughts about feeding the baby

_____
_____
_____
_____
_____
_____

Massey University

INSTITUTE OF FOOD, NUTRITION & HUMAN HEALTH

Massey Mother & Baby Study

Infant Feeding Follow-up @ _____ weeks

Phone Interview Schedule

Date:	Start time:	End time:

Before start check how baby was being fed at last interview and note /circle for question 5.

Hello, this is _____ from the Massey University Mother and Baby study.

Are you willing to be interviewed again?

Yes _____ This should take about 10 minutes. Is now a convenient time or would you prefer me to call back later (Record when _____).

No _____ I appreciate this is a busy time for you. Would you like me to call you at another time?

Yes ____--When?_____

No___ Thank you for your help to this point, if you would like to become involved again please phone on (06) 350 5532, or you can get me directly on 356 9099 ext: 7539, or alternatively you can send an email (Mother-babystudy@massey.ac.nz) Is there any feedback you would like to give about participating in the research?

As with the other interviews, you can stop or discontinue the interview at any time and you don't have to answer any questions you don't want to. Most of these questions are the same as in previous interviews, we want to know what the situation is with you and ____ (baby's name) today as sometimes things can change very quickly.

Can you please tell me about feeding _____(Baby) yesterday (starting at 6 AM until 6 AM today). I'm interested in when he/she fed, what was given and how long and sleeping patterns. *(record on grid)*

2. Does (baby) use a dummy? *(when/ why?)*

_____

_____

3. Was yesterday a normal day? *(if not how, why?)*

_____

_____

_____

_____

4. How do you decide when to feed _____?

_____

_____

_____

_____

5. What changes have you noticed since we last talked? *(previous 24 hrs babe was: fully breastfed/ expressed breastmilk in bottle/ artificial formula/ solids/ water/ _____)*

(If change initiated by mother/parents) What motivated these changes?

(depending on what said above probe for:)

a. use of feeding bottle and what was given in it
b. introduction of 'solids'
c. advice/ pressure from other people

_____

_____

_____

_____

6. Overall, how do you feel about feeding the baby now?

_____

_____

_____

_____

7. Have you had any problems?

Yes/ No If "Yes" who helped/ offered advice *(get details of advice offered)*

☐ your midwife

☐ hospital staff

☐ doctor

☐ partner

☐ mother

☐ mother-in-law

☐ other relatives

☐ friends

☐ other health professionals (plunket, child health workers)

☐ other, _____

_____

_____

_____

_____

8. Have you had any (other) support or comments related to feeding ____ (baby)? *(who, what , when, her response)*

_____

_____

_____

_____

9. Are you considering introducing any changes to feeding _____ (baby) in the next week? What? Why?

_____

_____

_____

_____

Only once per month for the following questions

10a. Do you always feel that you have/had enough milk for (baby)? Yes/ No

10b. What sorts of things are you thinking when you say that?

_____

_____

_____

_____

10c. Do you know what you can do to increase your milk supply? Yes/No

What can you do to increase milk supply?

_____

_____

_____

_____

10d. Have you tried any of these yourself? Yes/ No

10e. How did you know to do that? *(Probe for sources of information family, health professionals, friends, books, other.)*

_____

_____

_____

_____

10f. *(if she had been concerned about not enough milk)* Did you consider supplementing the feed with a bottle of formula milk? Yes/ No

_____

_____

_____

_____

11a. Has anyone suggested that you do not have enough milk for your baby? Yes/ No

11b. Who told you this (record any discussion about this)

_____

_____

_____

_____

11c. How did this make you feel about breastfeeding?

_____

_____

_____

_____

11d. What did you do about it? *(probe for asking others for opinion)*

_____

_____

_____

_____

12a. Has anyone told you that your milk is not good enough? Yes/ No

12b. Who told you this? *(record any discussion about this)*

_____

_____

_____

_____

12c. How did this make you feel about breastfeeding?

_____

_____

_____

_____

12c. What did you do about it? *(probe for asking others for opinion)*

_____

_____

_____

_____

13. How important is it, to you personally, to breastfeed (baby) *at this time/ as long as you did?* If you rate the importance on a scale of 1-5 with 5 as very important and 1 as not important.

1	**2**	**3**	**4**	**5**
Not important				***very important***

14. What sort if things are you thinking about when you say that?

_____

_____

_____

_____

15. Do you feel you are/ have been successful in your breastfeeding? What sort if things are you thinking about when you say that?

_____

_____

_____

_____

16. Can you rate the success on a scale of 1-5 with 5 as very successful and 1 as not at all successful.

1 2 3 4 5
Not important ***very important***

17. *(if no longer breastfeeding)* If you had another child would you breastfeed again? Yes/ no/ don't know (comments)?

_____

_____

_____

_____

Thank you for your help today. Are you willing for me to call you again in __ weeks*? (or arrange visit to Massey)*

Yes ___ Thank you, is there a time that would most likely be convenient for me to call you _____

No __ Thank you for your help to this point, if you would like to become involved again please phone me at (06) 350 5532 or send an email. Is there any feedback you would like to give about participating in the research?

Data Grid:

Description	Time 24 hr clock				Activity		Amount Tsp/ml			By
	0	6	0	0						

Coding:

Activity

Feed:
- 1 breast
- 2 ebm — cup/bottle
- 3 formula
- 4 cm — cows milk
- 5 juice
- 6 water
- 7 other fluids (specify)
- 11 solids (specify)

Sleep:
- 21 continuous sleep
- 22 asleep >50% time
- 23 asleep 50% time
- 24 asleep <50% time
- 25 fully awake and unsettled
- 26 fully awake and content
- 27 comfort sucking

By Whom

- 1 self
- 2 partner
- 3 sib
- 4 mother
- 5 minder
- 6 friend
- 7 health pro (specify)
- 8 other