PREDICTORS AND DOCUMENTED REASONS FOR FORMULA SUPPLEMENTATION OF BREASTFED BABIES IN A NEW ZEALAND, 'BABY-FRIENDLY' HOSPITAL

By

Stefanie Kalmakoff

A thesis submitted in fulfilment of the degree of Master of Midwifery at Otago Polytechnic, Dunedin New Zealand

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DECLARATION

Declaration Concerning Thesis Presented for the Degree of Master of Midwifery

I, Stefanie Kalmakoff

Of 8 Beaconsfield Road, Portobello, Dunedin

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ABSTRACT

Exclusive breastfeeding is seen as the gold standard in infant feeding. The Baby-Friendly Hospital Initiative (BFHI) has been adopted globally to support exclusive breastfeeding from birth. Formula supplementation is known to be negatively associated with breastfeeding establishment and duration especially if given during the hospital stay. Little research has been done on the BFHI and breastfeeding outcomes in New Zealand, particularly in relation to formula supplementation.

The aim of the study was to determine predictors and explore documented reasons for formula supplementation of breastfed babies in a large Baby-Friendly hospital.

Electronic hospital records of all healthy term or near term, singleton, mother/baby pairs birthed in 2012 (n = 1530) and records of formula supplementation were examined retrospectively and analysed to find factors associated with formula supplementation of breastfed babies during the hospital stay.

Fifteen percent of these breastfed babies were supplemented during the hospital stay. Analysis by multiple regression found supplementation was independently associated with overweight BMI category, primiparity, use of analgesia, earlier gestation, shorter duration of skin-to-skin contact, and use of postpartum uterotonics. Reasons for supplementation were recorded for 170/234 babies (73%). The most common reasons were for insufficient milk, maternal request and hypoglycaemia.

Determination of the risk factors for formula supplementation of babies in hospital may assist practitioners to identify mothers and babies which need greater support, antenatally, during labour, and in the first hours and days after birth. The findings support the Baby-Friendly policies and practices of early skin-to-skin contact for at least an hour in duration. The results highlight the need for targeted support to be given to mothers of high BMI, mothers and babies exposed to analgesia during birth and to uterotonics post birth and also for babies who are late preterm, but cared for in the postnatal ward. The findings also expose areas in which further research may ultimately lead to less supplementation of breastfed babies in hospital.

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I dedicate this work to all the mothers and babies who have inspired this research.

DEFINITIONS AND ABBREVIATIONS

Breastfeeding definitions (Source: NZBA, 2011: part 1, p 7) http://www.babyfriendly.org.nz/fileadmin/documents/goingbabyfriendly/DownloadBFHIdocumentspage/Part%201.pdf).

Exclusive breastfeeding: The infant has never, to the mother's knowledge, had any water, formula or other liquid or solid food. Only breastmilk, from the breast or expressed, and prescribed* medicines from birth.

*Prescribed as per the medicines Act 1981

Fully breastfeeding: The infant has taken breastmilk only, no other liquids or solids except a minimal amount of water, or prescribed medicines in the past 48 hours.

Partial breastfeeding: The infant has taken some breastmilk and some infant formula or other solid food in the past 48 hours.

Artificial feeding: The infant has had no breastmilk but has had alternative liquid such as infant formula with or without solid food in the past 48 hours.

Facility definitions (MOH, 2013)

Primary facility: Small, community maternity units staffed by midwives, designed for women and babies without any complications expecting a normal birth.

Secondary facilities: Designed for women and babies who may require care from an obstetrician, anaesthetist, paediatrician as well as a midwife.

Tertiary facilities are for women and babies who may require access to a multidisciplinary specialist team.

Midwife definitions (http://www.midwife.org.nz/women-in-new-zealand/about-midwives)

Core midwife: midwife who works rostered shifts in a hospital setting providing 24 hour core service supporting LMC midwives, obstetric medical staff and a specialized service in a secondary or tertiary facility.

LMC midwife: lead maternity care midwife who provides continuity of care and is responsible for the care of the woman and baby throughout pregnancy, labour and birth and postnatally up to 6 weeks. LMC midwives have access to hospital facilities via an access agreement and accompany the woman into hospital to continue care under her responsibility as an autonomous practitioner.

Birthing practice descriptions & definitions

Normal vaginal: woman births her infant vaginally without instrumental assistance of ventouse or forceps.

Ventouse (suction): woman is assisted to birth her infant vaginally with a suction cup with a handle applied to the infant's head. Suction is created by vacuum machine (ventouse) and traction is applied.

Forceps: woman is assisted to birth her infant vaginally with a set of metal instruments shaped like curved salad tongs. These are fitted around the infant's head and traction applied.

Elective caesarean: Woman is scheduled to birth her baby by caesarean section on a date planned by her obstetric team.

Emergency caesarean: Woman births her baby by caesarean section in an emergency situation due to maternal or infant factors.

Syntocinon: Synthetically made oxytocin preparation used for induction or augmentation of labour by means of an intravenous infusion. Administered as an intramuscular injection or intravenously for postpartum prophylaxis to facilitate the third stage of labour, birth of the placenta and to reduce postpartum bleeding. Used to treat postpartum hemorrhage as a uterotonic.

Uterotonic: An agent used to induce uterine contractions or increase tonicity of the uterus.

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1 INTRODUCTION

1.1 BACKGROUND

Since the increase in popularity of infant formula as an alternative to breastfeeding early last century (Apple, 1994), breastfed babies have been given 'top-ups' of formula during the hospital stay. This supplementation can impact the mother's and the infant's health (Ip et al., 2007), the establishment of lactation (De Carvalho, Robertson, Fiedman, & Klauss, 1983) and the duration of breastfeeding (Bloomquist, Jonsbo, Serenius, & Persson, 1994; Howel & Ball, 2013; Vogel, Hutchison, & Mitchel, 1999), especially when it occurs during the hospital stay (Biro, Sutherland, Yelland, Hardy, & Brown, 2011; DiGirolamo, Grummer-Strawn, & Fein, 2008; Gagnon, Leduc, Waghorn, Yang, & Platt, 2005; Gubler, Krahenmann, Roos, Zimmermann, & Ochsenbein-Kolble, 2013; McAllister, Bradshaw, & Ross-Adjie, 2009; Perrine, Scanlon, Li, Odom, & Grummer-Strawn, 2012; Semenic, Loiselle, & Gottlieb, 2008; Wright, Parkinson & Scott, 2006). For these reasons, the American Academy of Paediatrics (AAP) recently stated that exclusive breastfeeding can no longer be seen as a lifestyle choice but a public health issue (AAP, 2012).

This investigation examines factors associated with formula supplementation of breastfed babies in a Baby-Friendly hospital. The Baby-Friendly Hospital Initiative (BFHI) has been adopted globally as the standard of care to support exclusive breastfeeding from birth using the 'Ten Steps to Successful Breastfeeding' (The United Nations Children's Fund [UNICEF], 2012) listed in Appendix A. These focus on hospital practices and policies, which affect breastfeeding initiation, exclusivity and duration. Exclusive breastfeeding is seen as the gold standard. The World Health Organisation (WHO) suggests that from birth, maternity services should ensure breastfed infants receive no other food or fluids other than mother's milk (unless medically indicated) and encourage mothers to continue exclusive breastfeeding until the infant is around six months of age, and continue breastfeeding (along with complementary food) until two years of age (WHO/UNICEF, 1989). There is an abundance of evidence to support exclusive breastfeeding, and infant breastfeeding practices rank among the top interventions to improve infant health world-wide (WHO, 2009).

Literature indicates that the implementation of the BFHI into hospitals has increased the rate of breastfeeding initiation, exclusivity and duration in many parts of the world (Cattaneo & Buzzetti, 2001; DiGirolamo et al., 2008; Kramer, Chalmers, Hodnett, & et al., 2001; Merewood, Mehta, Chamberlain, Philipp, & Bauchner, 2005; Merten, Dratva, & Achermann-Liebrich, 2005; NZBA, 2012; Perrine et al., 2012). The BFHI has strict guidelines for formula supplementation of breastfed babies (see Appendix B) and in order to be eligible for accreditation, the exclusive breastfeeding rate on discharge from hospital must be over 75% (New Zealand Breastfeeding Authority [NZBA], 2011). There is however, a scarcity of research on the reasons why breastfed babies are supplemented in the environment of a Baby-Friendly hospital.

This research examines breastfeeding rates in Dunedin Hospital, a tertiary facility located in the South Island of New Zealand which has had Baby-Friendly accreditation since 2004. In 2011, the exclusive breastfeeding rate of primary care babies (see Definitions and Abbreviations, page vi) discharged from the postnatal ward was 82.5% (Kalmakoff, 2011). The remaining babies were either 'fully' or 'partially' breastfeeding (12.5%) or were artificially feeding (5%) (see Definitions and Abbreviations, page vi for breastfeeding definitions) (Kalmakoff, 2011). While it is not known how many of the mothers who were artificially feeding, initially intended to breastfeed, these figures indicate at least 12.5% of breastfed babies received infant formula.

1.2 PERSONAL JOURNEY

I have been employed as a lactation consultant for the past seven years and as a BFHI coordinator for the past four. In this role, I have been involved in keeping statistics of breastfeeding rates and conducting breastfeeding education sessions for medical, midwifery, nursing and other staff as well as students. Keeping up to date with the literature is essential in this role in order to provide evidence-based information and practices as well as for updating breastfeeding policies and guidelines. Throughout my Master of Midwifery journey I have considered the impact the BFHI has had on New Zealand hospitals and how our unique lead maternity care (LMC) model (see Definitions and Abbreviations, page vi) contributes to our high breastfeeding initiation rates. Breastfeeding promotion is written into the service specifications for all midwives, implementation of the BFHI is mandated for all hospitals, and all major

hospitals employ International Board Certified Lactation Consultants (IBCLCs). Daily, however, I see mothers and babies struggling to breastfeed in the hospital setting and there is a decline in breastfeeding rates upon discharge from hospital. Supplementation of breastfed babies continues for various reasons many of which can be complex, ill-defined and seem to be associated with multiple factors. The promotion of immediate skin-to-skin contact sustained for a duration of at least an hour, has been a big focus especially at caesarean births, however, research to support this practice is scarce. This study aims to address these gaps in the research.

The literature suggests supplementation of breastfed babies can be associated with socio-demographic, biomedical, intrapartum, and postpartum factors. Supplementation can also be influenced by hospital policies and practices. In a Baby-Friendly hospital where policies and practices are designed to optimise exclusive breastfeeding from birth, the incidence of formula supplementation is reduced. However, there is very little research investigating Baby-Friendly hospitals to determine predictors of formula supplementation of breastfed babies. This research aims to investigate these variables in relation to formula supplementation in order to be able to identify women and babies at high risk for supplementation, raise awareness of modifiable factors and highlight a need for extra support for mothers and babies at risk.

1.3 RESEARCH QUESTIONS AND HYPOTHESES:

1.3.1 Primary question:

What are the biomedical, socio-demographic, intrapartum and postpartum factors associated with supplementation of breastfed babies during the maternity hospitalisation in a Baby-Friendly hospital?

1.3.2 Secondary questions:

1. Is there an association between delayed (more than one hour) initiation of skin-to-skin contact between mother and baby at birth and formula supplementation of breastfed babies during the hospital stay?

2. Is there an association between duration of skin-to skin contact between mother and baby during the first two to three hours after birth and breastfeeding exclusivity during the hospital stay?

3. What are the most prevalent documented reasons for formula supplementation during the hospital stay?

4. What are the associations of maternal/infant socio-demographic biomedical or intrapartum variables with the most prevalent reasons documented for formula supplementation?

The aim is to answer these research questions through testing the following hypotheses:

Hypothesis 1: Labour and birth interventions will be associated with increased formula supplementation of breastfed babies during the hospital stay.

Hypothesis 2: Delayed (more than one hour) initiation of skin-to-skin contact between mother and baby at will be associated with formula supplementation during the hospital stay.

Hypothesis 3: Duration of skin-to-skin contact between mother and baby for at least an hour in the first two to three hours of birth will be associated with exclusive breastfeeding during the hospital stay.

1.4 OUTLINE OF THESIS

Chapter one has introduced the topic and presented my personal insight and context to the research. Chapter two will explore and review the literature and identify gaps in the research. Chapter three presents the methodology including ethical and cultural considerations, data collection and analysis utilised in this study. The results are reported in chapter four and in chapter five the results will be discussed in the light of current literature

2 REVIEW OF THE LITERATURE

2.1 INTRODUCTION

This chapter outlines the history of the Baby-Friendly Hospital Initiative (BFHI) in New Zealand (NZ), looks at the current rates of exclusive breastfeeding and reviews the literature on the impact of the BFHI on the initiation, exclusivity and duration of breastfeeding. It explores current literature on how supplementation of breastfed babies is influenced by biomedical, socio-demographic, intra-partum and postpartum factors of the mother and infant. These factors include age, ethnicity, parity, body mass index (BMI) and the gestation and birth-weight of the baby. In addition, smoking status of the mother, birth method, use of analgesia and oxytocin in labour and birth, and finally, the immediate post-partum practices namely the initiation and duration of skin-to-skin contact at birth between mother and infant are reviewed in relation to supplementation. The practice of supplementation with infant formula, the impact on the health of the mother and baby, the impact on breastfeeding establishment and duration, and the reasons breastfed babies are supplemented are also reviewed.

2.2 HISTORY OF THE BABY FRIENDLY HOSPITAL INITIATIVE IN NZ

The United Nations Children's Fund (UNICEF) and the World Health Organisation (WHO) developed the BFHI which they launched in 1991. It is a global initiative aimed at health-care facilities to improve the care of pregnant women, mothers and babies by promoting, protecting and supporting breastfeeding. This is achieved by following 'The Ten Steps to Successful Breastfeeding' (see Appendix A), a set of best practice standards which focus on eliminating policies and practices detrimental to the initiation and establishment of breastfeeding. It also bans the promotion and advertising of breastmilk substitutes in maternity facilities. Implementation of the BFHI has been associated with an increase in breastfeeding initiation, exclusivity and duration in other parts of the world (Kramer et al., 2001**;** Merewood et al., 2005; Merten et al., 2005).

In 2001, the New Zealand Ministry of Health (MOH) directed all hospitals to become Baby-Friendly. The process began with all hospitals developing a breastfeeding policy based on the 'Ten Steps to Successful Breastfeeding'. Moore, Gould, and Williams (2007) described the institutional challenges involved in the implementation process

in New Zealand. It took three years before the first hospital achieved Baby-Friendly accreditation (Martis & Stufkens, 2013).

To be considered for Baby-Friendly accreditation, hospitals are required to have a 75% exclusive breastfeeding rate at discharge from the maternity ward. Formula supplementation for breastfed babies must follow strict guidelines for medically-acceptable reasons (NZBA, 2011). Sound clinical reasons (Appendix B) or evidence of mothers' giving informed consent for 80% of breastfed babies given formula must be documented. Staff must fully explain the mother the benefits of exclusive breastfeeding and the risks of formula feeding. The mother is then asked to sign a consent form before the baby is given formula.

In 2001, before implementation of the BFHI into New Zealand hospitals, the New Zealand Breastfeeding Authority (NZBA) assessed the average exclusive breastfeeding rate on discharge to be 56.6% (NZBA, 2012). Currently, with all major hospitals being accredited, the average exclusive breastfeeding rate is 84.4%, with the rate for primary facilities being 91.6%, for secondary facilities 83.3% and tertiary facilities 81.0% (NZBA, 2012). This increase in the exclusive breastfeeding rate on discharge from hospital may be due to several possibilities. For example, women may be more informed of the importance of exclusive breastfeeding and hospitals may be more supportive of exclusive breastfeeding, however, research is scarce in this area. Furthermore, no research into reasons why breastfed babies are given formula in Baby-Friendly hospitals is available.

2.3 BREASTFEEDING RATES IN NZ

Despite the admirable breastfeeding initiation rates in NZ hospitals, the exclusivity and continuation of breastfeeding declines steadily between birth and six weeks, six weeks and three months and markedly thereafter. Morton et al., (2012) found 96% of pregnant women in a cohort from Auckland, Counties Manukau and Waikato, intended to breastfeed. Exclusive breastfeeding rates were 96% at birth, but declined to 93 % at one week, 82% at one month, 72% at two months, 63% at three months, 47% at four months, 28% at five months and 9% at six months. By the age of nine months, 78% of babies had been given infant formula. The median age for formula exposure was three months. At nine months, 52% of babies were no longer having any breastmilk. In this study, the most common reasons women gave for

breastfeeding cessation were insufficient milk (38%), baby not satisfied with breastmilk (32%), baby had weaned (19%) or mother had gone back to work and expressing was not practical (19%) (multiple responses were allowed). It is suggested these first three responses may be related to perceived or real insufficient milk supply which is a reason given worldwide for breastfeeding cessation (Li Bai, Wu, & Tarrant, 2013; Perrine et al., 2012). This is concerning, considering that antenatally, the reported intention for 68% of the NZ women was to breastfeed for greater than six months. The authors of this NZ longitudinal study state they intend to investigate the enablers and impediments to continued breastfeeding in the next part of their study (Morton et al., 2012).

According to national data, the rates in NZ for exclusive breastfeeding at six weeks have remained fairly static at 54, 56, and 57% respectively for the last three years. A similar pattern is also found at three months where the rate has been static at 42%, and at six months 15, 17, and 16% for the last three years. The rates in our local region of Otago for the same time period were slightly higher than the national rates at 67, 71, and 68% at six weeks, 54, 58 and 57% at three months and 26, 32, and 27% at six months over the same three year period (NZ Plunket, 2012). The data collection times were slightly different from those reported by Morton et al., (2012) however, the three and six months times were similar. At three months, the rates reported by Plunket (2012) for national, (42%) and Otago (54%) were somewhat lower than those reported by Morton et al., (2012) (63%). At six months, most infants are having some complementary foods, therefore the actual timing of data collection could explain the differences reported for the six month report. The NZ Ministry of Health, sourcing data from lead maternity carers (LMCs), reports exclusive breastfeeding at two weeks at 73% (NZ MOH, 2010). The overall trend is for exclusive breastfeeding to decline from about 96% initiation at birth, to 84% on discharge from hospital (NZBA, 2012) then drop by 10% at two weeks, drop further by about 10% per month, with a greater drop at between four and five months.

Breastfeeding problems during the first week are associated with decreased breastfeeding duration (Chantry, Dewey, Peerson, Wagner, & Nommsen-Rivers, 2014; DiGirolamo et al., 2005). As most babies are in hospital at this time, hospital practices may thus impact on breastfeeding duration (Biro et al., 2011; Brodribb, Kruske, & Miller, 2013; DiGirolamo et al., 2008; Gagnon et al., 2005; McAllister et

al., 2009; Merten et al., 2005; Nickel, Labbok, Hudgens, & Daniels, 2013; Perrine et al., 2012; Vogel et al., 1999).

2.4 Effect of BFHI on Breastfeeding Initiation, Duration and Exclusivity

Various studies have looked at the impact of Baby-Friendly practices in hospitals (the Ten Steps) across the USA. DiGirolamo et al., (2008) explored the association between the number of baby friendly practices experienced by women and duration of breastfeeding. They found that women who experienced six Baby-Friendly practices were more likely to breastfeed for longer than women experiencing none. Women who experienced no Baby-Friendly practices were thirteen times more likely to stop breastfeeding before six weeks even after adjusting for a variety of demographic, attitudinal and behavioural variables. Perrine et al., (2012) found that breastfeeding initiation within one hour of birth was protective of exclusive breastfeeding and if mothers experienced six Baby-Friendly practices, they had 2.7 (95% CI 1.5-5.8) times the odds of achieving their breastfeeding intentions compared to those mothers experiencing zero to one Baby-Friendly practices. Not receiving supplemental feeds was associated with a 2.3 (95% CI 1.8-3.1) odds of achieving breastfeeding intention. The supplementation rate of breastfed babies in this study was 40%. These hospitals were in various stages of transition to becoming Baby-Friendly.

In Switzerland, Merten et al., (2005) studied breastfeeding rates of babies born in BFHI-accredited hospitals versus non-accredited hospitals and found that if a baby was born in a Baby-Friendly hospital it was more likely to be exclusively breastfed and for a longer duration (twelve weeks compared to eight weeks). They also compared babies born in facilities in the process of becoming Baby-Friendly which showed an intermediate improvement. They looked at compliance with six of the Ten Steps for Successful Breastfeeding (exclusive breastmilk, rooming-in, first suckling within one hour, breastfed on demand, no pacifier, and no free supplements) and found that each of them had a significant impact on exclusive, full and any breastfeeding rates. The more compliant with the Ten Steps the hospital was, the higher the rate of exclusive breastfeeding and the longer the duration of exclusivity. For example, the adjusted hazard ratio for not exclusively breastfeeding if born in a low compliance

hospital was 0.85 (95% CI 0.75 - 0.95) and 0.79 (95% CI 0.70 - 0.90) if born in a high compliance hospital compared to being born in a non-accredited hospital.

In the USA, Nickel et al., (2013) looked at the way in which non-compliance with the Ten Steps influenced breastfeeding duration. They looked at the influence of having six out of the Ten Steps, each step individually and in two step combinations. This study found that having a baby in a hospital which did not adhere to Step Six (Give newborn infants no food or drink other than breastmilk, unless medically indicated) was associated with a 10.5 week shortened duration of breastfeeding.The combination of two steps with the greatest influence on breastfeeding was Step Four (skin-to-skin and breastfeeding initiation within one hour) and Step Nine (give no artificial teats or pacifiers). They also found a dose –response between the number of steps they were exposed to and the duration of breastfeeding. Mothers and babies who had been exposed to six of the steps breastfed for the longest duration compared mothers and babies exposed to only four to five or two to three of the steps. Taylor, Nickel and Labbok (2012) found a similar result in hospitals serving low income populations where implementation of Steps Four, Six and Nine had the greatest positive impact on breastfeeding rates.

Australian researchers explored nurses' and midwives' perceptions of the BFHI. They found staff were committed to implementing the BFHI, but focused on the Ten Steps as a list of tasks to be checked off, rather than a strategy to improve hospital practices to support exclusive breastfeeding (Schmied, Gribble, Sheehan, Taylor, & Dykes, 2011). In another Australian study, where there were very high rates of breastfeeding initiation (96%), researchers found that women who experienced four Baby-Friendly practices (skin-to-skin, early initiation of breastfeeding, rooming in and no supplementation) had increased odds of breastfeeding at one month (adjusted OR 2.20; 95% CI 1.78-2.71) and four months, (adjusted OR 2.93; 95% CI 2.40-3.60) compared to when they experienced less than four Baby-Friendly practices (Brodribb et al., 2013). Furthermore, Biro et al., (2011) reported that birth at a non-Baby-Friendly hospital had increased odds of formula supplementation (adjusted OR 1.53, 95% CI 1.2-1.94) compared to a Baby-Friendly hospital.

This study will look at these particular hospital practices, early skin-to skin initiation and duration, and supplementation (rooming in is standard practice in New Zealand

hospitals). However, supplementation of breastfed babies can also be influenced by biomedical, socio-demographic, intra-partum and postpartum factors Smith, 2007). These are important confounding variables to be considered in order to obtain meaningful results when looking at breastfeeding rates.

2.5 BIOMEDICAL AND SOCIO-DEMOGRAPHIC FACTORS

2.5.1 Age, Parity, Ethnicity, Gestation and Birth-weight

Increasing age and or parity is associated with exclusivity of breastfeeding (Al-Sahab, Lanes, Feldman, & Tamim, 2011; Biro, et al., 2011; Declercq, Labbok, Sakala, & O'Hara, 2009; DiGirolamo et al., 2005; Gubler et al., 2013; Hauck, Fenwick, Dhaliwal, & Butt, 2011). Biro et al., (2011) reported greater odds for supplementation if the mother was primiparous (adjusted OR 2.16, 95% CI 1.76-2.66). Declercq et al., (2009) found an interaction between Baby-Friendly practices and parity. When there were six to seven Baby-Friendly practices in place, the difference in primiparous and multiparous mothers fulfilling their intention to exclusively breastfeed was not significant compared to when there were only zero to one, or two to three Baby-Friendly practices in place, suggesting supportive hospital practices can help to overcome this difference in breastfeeding associated with increasing parity. Primiparas experiencing six to seven Baby-Friendly practices were six times more likely to fulfil their intention to exclusively breastfeed than those experiencing zero to one. Multiparas were more than twice as likely in the same comparison.

Swedish researchers (Wiklund, Norman, Uvnäs-Moberg, Ransjö-Arvidson, & Andolf, 2009) found an association of exclusive breastfeeding with multiparity (OR 0.44, 95% CI 0.24-0.82) and birth-weight greater than 3kg, (OR 0.42, 95% CI 0.19-0.89) compared to less than 3kg. By contrast to the situation in Western countries, in rural Northern Thailand, where breastfeeding is the cultural norm, there was no reported difference in breastfeeding outcomes between pimiparae and multiparae (Amatayakul, et al., 1999), both being highly successful. Nommsen-Rivers, Chantry, Peerson, Cohen, and Dewey, (2010) found a significant incidence of delayed lactation in women over the age of 30 compared to under 30 years. They also found increased incidence of delayed lactation when the baby weight was greater than 3.6kg. Delayed lactation was associated with formula supplementation (Nommsen-Rivers et al., 2010).

There can be substantial differences in breastfeeding rates by ethnicity, especially when looking at duration of exclusive breastfeeding. In NZ, the breastfeeding rates for Māori are nearly 10% lower than those of non-Māori (NZ Plunket 2010). Breastfeeding initiation rates reported from NZ Baby-Friendly hospitals tend to be relatively high. In NZ the national average rates of exclusive breastfeeding on discharge from hospital in 2012-3013 by ethnicity were, Māori 83.3%, Pasifika 81.7%, Asian 73.0% and Other 84.6% (NZBA data, Julie Stufkens, personal communication. 2014). At six months the rates were, Māori 9%, Pasifika 12%, Asian 18% and Other 19%. To address these differences, there have been initiatives to increase the rates for Māori and Pasifika (Glover Waldon, Manaena-Biddle, Holdaway, & Cunningham, 2009; MOH, 2002; Thornley, Waa & Ball, 2007) and a call for research which may identify the barriers to initiation and maintenance of breastfeeding for different ethnic groups (Butler, Williams, Tukuitonga, & Paterson, 2004).

Shorter infant gestation and lower birth weight are risk factors for formula supplementation (Biro et al., 2011; Walker, 2008). Donath and Amir (2008a) found breastfeeding initiation was lower with infants born at 35 to 36 weeks gestation (88%) than infants born at 37 to 39 weeks (92%) and infants born at greater than or equal to 40 weeks (94%). Hospital protocols for infants who are late preterm (35-37 weeks) and or less than 2.5kg, include sampling of blood glucose levels to test for hypoglycaemia. If the blood glucose levels are below a certain threshold, supplementation with formula may be medically indicated (Wight & Marinelli, 2006), therefore, we would expect these babies to have a higher supplementation rate than babies born beyond 37 weeks and greater than 2.5kg.

2.5.2 Body Mass Index (BMI)

Increasing BMI has become an increasing health concern and NZ has one of the highest rates in the world with 28% of the adult population considered obese (MOH, 2012). Increasing BMI is often reported to be associated with reduced breastfeeding initiation and duration (Al-Sahab et al., 2011; Amir & Donath, 2007; Biro et al., 2011; Donath & Amir, 2008b; Gubler et al., 2013; Jevitt, Hernandez, & Groer, 2007; Visram et al., 2013).

An Australian study (Biro et al., 2011) reported babies born to obese (BMI >30) mothers had an adjusted odds ratio of 2.3 (95% CI 1.76-2.95) for formula supplementation. A Canadian study found similar results (Visram et al., 2013), as did a Swiss study (Gubler et al., 2013). Overweight and obese mothers may experience a delay in lactogenesis II associated with sub-optimal breastfeeding (Nommsen-Rivers et al., 2010), altered glucose metabolism (Nommsen-Rivers, Dolan, & Huang, 2012), reduced response to prolactin, increased rate of caesarean delivery and issues with body image and anatomy (Jevitt et al., 2007). The present study looks at associations between BMI and breastfeeding outcomes.

2.5.3 Smoking Status

Smoking is often associated with lack of breastfeeding initiation and reduced duration (Al-Sahab et al., 2010; Butler et al, 2004; Collins, DiSantis, & Nair, 2011). In New Zealand, maternity data is collected by LMCs and collated by the MOH. The report from 2010 showed a national smoking rate of 16.2% at the first maternity booking visit (NZ MOH, 2010). This rate varied between those identified with different levels of deprivation and between ethnicities. For groups in high deprivation areas, the rate was 26% and for women of Māori ethnicity the rates were 38.4%, whereas Pasifika were 11%, NZ European 10% and Asian 1% (NZ MOH, 2010). In a recent large NZ longitudinal study, Morton et al., (2012) found prior to pregnancy, 20% of the women were smoking. Subsequently, those who continued smoking during pregnancy reduced to 10%. Collins et al., (2011) found that among mothers who had a history of smoking, breastfeeding initiation was associated with a longer period of abstinence from smoking. The present study looks at smoking status at booking. It includes, never smoked, smoking cessation longer than four months ago and less than or equal to four months ago and currently smoking.

2.6 Labour and Birth Characteristics

2.6.1 Birth Method

The impact of birth method on breastfeeding initiation and exclusivity has been identified in many studies (Al-Sahab et al., 2011; Biro et al., 2011; Bramson et al., 2010; Butler et al., 2004; Parry, Ip, Chau, Wu, & Tarrant, 2013; Prior et al.,2012; Rowe-Murray & Fisher, 2002), although this may have not been a primary objective in the studies. In their review and meta-analysis of 53 studies involving 554,568

women, Prior et al., (2012) found rates of early breastfeeding initiation were lower after caesarean than vaginal birth, but among those women who did initiate breastfeeding early, they found there was no difference in breastfeeding duration between having a caesarean and having a normal birth. The authors commented that none of the women delivered in Baby-Friendly accredited hospitals and thus may not consistently have had staff support them to facilitate immediate skin-to-skin contact and early initiation of breastfeeding.

An Australian study (Rowe-Murray & Fisher, 2002) compared breastfeeding rates by mode of birth among 203 first-time mothers recruited from four different hospitals, one of which was Baby-Friendly. Women who had a caesarean or an instrumental birth experienced a longer delay until breastfeeding initiation than those who had spontaneous vaginal births. Although the babies born in the Baby-Friendly hospital experienced significantly less delay, the effect of birth mode on initiation of breastfeeding remained significant.

In another study, Ahluwalia, Li, and Morrow (2012) found no difference in breastfeeding initiation between spontaneous vaginal, induced vaginal, planned caesarean or emergency caesarean birth. However at 6 months, compared with spontaneous vaginal births, those with induced vaginal and emergency caesarean births were least likely to still be breastfeeding. Other studies (Asole, Spinelli, Antinucci, & de Lallo, 2009; Zanardo et al., 2010) found caesarean birth positively associated with formula supplementation in hospital.

A New Zealand study (Butler et al., 2004) examined the association of maternal socio-demographic and infant care variables on exclusive breastfeeding in a cohort of Pasifika infants. Consistent with many other studies, they found caesarean delivery had a negative impact on exclusive breastfeeding, along with smoking and other variables. Data was collected in 2000, before the BFHI was implemented in New Zealand hospitals. The present study looks at breastfeeding outcomes by birth method, whether normal vaginal, instrumental vaginal (ventouse, forceps) elective caesarean, or emergency caesarean.

2.6.2 Skin-to-Skin Contact at Birth

One of the most crucial steps to support breastfeeding initiation is Step Four, immediate skin-to-skin contact between mother and baby at birth (Nickel et al., 2013;

Moore, Anderson, Bergman, & Dowswell, 2012; Saloojee, 2008; Taylor et al., 2012). Exclusive breastfeeding is reported to be associated with immediate skin-to-skin contact at birth for at least one hour as the baby is in an alert and responsive state and is more likely to latch onto the breast successfully and effectively, which results in fewer breastfeeding problems (Bramson et al., 2010; Moore & Anderson, 2007; Moore et al., 2012; Rigard & Alade, 1990) and increased duration of breastfeeding (Mikiel-Kostyra, Mazur, & Boltruszko, 2002; Suzuki 2013).

An Australian study (Carberry, Raynes-Greenow, Turner, & Jeffery, 2013), investigated the importance of the first hour for breastfeeding initiation and found that for every hour breastfeeding initiation was delayed, there was a marked increase in breastfeeding difficulties. The rate ratio for poor feeding when breastfeeding was initiated after one to two hours was 2.39 (95% CI 1.54 - 3.70) compared to within one hour. Furthermore, initiation after two to four hours had a rate ratio of 3.75 (95% CI 2.38 - 3.70) for poor feeding and similarly, delaying initiation until over four hours resulted in a rate ratio of 5.59 (95% CI 3.27 - 9.72) (Carberry et al., 2013).

A randomised controlled trial was conducted in Iran on 114 primiparous women to determine the effect of immediate and continuous (at least two hours) skin-to-skin contact on breastfeeding self-efficacy (Aghdas, Talat, & Sepideh, 2014). Breastfeeding self-efficacy is a determined by a 14 question tool which measures a mother's confidence in aspects of breastfeeding. This tool has been shown to correlate well with initiation and duration of breastfeeding (Dennis, 2006). The researchers found a significantly higher self-efficacy score in mothers who were in the skin-to-skin group where babies were placed naked between their mother's breasts and routine procedures were delayed, compared to the control group, where the baby was weighed, measured, given vitamin K prophylaxis and wrapped before giving to their mothers (53.4 compared to 49.8; $p = 0.0003$) (Aghdas et al., 2014). In addition, skin-to-skin contact during the first weeks can be associated with a resolution of latching problems (Svensson, Velandia, Matthieson, Welles-Nystrom, & Widstrom, 2013) and a reduction in breastfeeding cessation at one, two and three months (Alex & MacLellen-Peters, 2013).

Babies born by caesarean typically are delayed in going skin-to-skin for a number of reasons often related to staff routine procedures (Gouchon et al., 2010). Reports have

indicated that, having a caesarean or swaddling a baby without skin-to-skin contact, is associated with poorer breastfeeding rates (Asole et al., 2009; Biro et al., 2011; Carberry et al., 2013; Hung & Berg, 2011; Moore & Anderson, 2007) unless there is early initiation of breastfeeding (Carberry et al 2013; Prior et al., 2012). Recent studies have looked at the challenges of facilitating skin-to-skin at caesarean and whether skin–to-skin with the father is an effective alternative. In one study, infants were found to cry less when in skin-to-skin with their father, compared to being placed in a cot and appeared much more settled (Erlandsso, Dsilna, Fagerberg, & Christensson, 2007). Another study investigated the onset of vocal interaction between baby and parents, when in skin-to-skin with each parent after an elective caesarean (Velandia, Matthisen, Uvnäs-Moberg, & Nissen, 2010). Infants initiated communicative noises sooner when in skin-to-skin contact with either parent compared to those who did not have skin-to-skin. Both mothers and fathers communicated earlier with their infant when in skin-to-skin. The authors propose an increased level of oxytocin release from both mothers and fathers during skin-to-skin provoked parental responsiveness to infant cues. Immediate skin-to-skin with mother at caesarean has also been shown to reduce mothers' anxiety and improve maternal satisfaction (Zauderer & Goldman, 2012).

During the past eight years, the BFHI audit requirement in New Zealand for skin-to-skin has changed. Initially, the requirement was to, "*place the baby in skin-to-skin contact with mother as soon as possible after birth for at least 30 minutes*" for normal vaginal births, and for caesarean births, "*as soon as mother is able to respond to baby*" (NZBA, 2004). However, recently this has changed to, "*place the baby in skin-to-skin contact within 5 minutes of birth for at least one hour*" (NZBA, 2011, Part 2, p 14) regardless of birth type. At a caesarean birth, there is now the expectation to facilitate skin-to-skin upon the operating table in theatre. Any effects of this change in practice on breastfeeding rates have not been documented in the literature. Requirements for this step differ around the world in Baby-Friendly hospitals, therefore reports on this practice must be interpreted with this in mind. The effects of immediate skin-to-skin contact and the effects of leaving newborns in undisturbed skin-to-skin contact for at least an hour are seldom examined separately and in combination within the same study. The impact of skin-to-skin initiation and duration were examined separately in a previous study (Kalmakoff, 2012). With a common denominator of skin-to-skin

contact within an hour of birth, it was found that other factors became more significant predictors of exclusive breastfeeding.

It has been shown, that it takes on average 62 minutes for a baby to go through the nine identifiable behavioural phases to locate the breast when left in undisturbed skin-to-skin contact immediately post-birth (Widstrom et al., 2011). Recently, it was found that allowing infants to pass though all these nine phases during skin-to-skin contact was associated with exclusive breastfeeding on discharge from hospital (Crenshaw et al., 2012), however, the sample size was small. Furthermore, Bramson et al., (2010) looked specifically at early breastfeeding initiation and the duration of skin-to-skin contact and found a dose-response relationship of increasing skin-to-skin contact duration and exclusive breastfeeding. Other studies (Carfoot, Williamson, & Dickson, 2005; Pincombe et al., 2008; McAllister, 2009; Rowe-Murray & Fisher, 2002) however, have not shown skin-to-skin contact to be associated with significantly increased breastfeeding duration, but these did not examine the effects of the timing of initiation of skin-to-skin and the duration of skin-to-skin separately, nor were they conducted in Baby-Friendly hospitals. Further investigation into the relationship between skin-to-skin practices at birth and the rates of exclusive breastfeeding on discharge from hospital would be useful. The present study looks at the timing of skin-to-skin initiation as well as the duration of skin-to-skin contact within the first two to three hours post birth.

2.6.3 Effect of Analgesia

The effect of labour analgesia and anaesthesia on breastfeeding has been investigated by many authors, but results have been difficult to evaluate and are inconclusive. The use of various combinations and dosages of epidural medications has changed over the years and the amount of both narcotic and anaesthetic in the mixture have reduced substantially, rendering older studies not as relevant. Several studies found an association of epidural use and poor breastfeeding behaviour or an increased use of formula supplementation (Baumgarder, Muehl, Fischer, & Pribbenow, 2003; Beilin et al., 2005; Dozier et al., 2013; Gizzo et al., 2012; Jordan et al., 2009; Ransjo-Arvidson et al., 2001; Riordan, Gross, Angeron, Krumwiede, & Melin., 2000; Wiklund et al., 2009). Studies use various methods to evaluate infant breastfeeding behaviours. Some use video recordings (Ransjo-Arvidson et al., 2001), behavioural and latching scales (Baumgarder et al., 2003; Belin et al., 2005; Riordan et al., 2000), or a combination

(Chang & Heaman, 2005; Gizzo et al., 2005; Radzyminski, 2003). Ransjo-Arvidson et al., (2001) and Baumgarder et al., (2003) found breast-seeking and breastfeeding behaviours were reduced in babies exposed to epidural medications. Belin et al., (2005) found a dose-response effect to increasing levels of fentanyl (a narcotic analgesic). With greater levels of fentanyl, the neuro-behavioural scores were significantly lower, and at six weeks, the higher the fentanyl level, the less likely the babies were to be breastfeeding. A confounding problem of this study however, is that almost all the babies were also exposed to pethidine during labour. Pethidine has long been known to affect breastfeeding initiation and duration (Nissen et al., 1995).

Investigating the effect of ultra-low dose fentanyl and bupivicaine, Radzyminski (2003) found no difference in breastfeeding behaviours between babies exposed to epidural medications and those not exposed. These babies were placed in skin-to-skin contact immediately after birth and none were given supplements or pacifiers in hospital. As mentioned above, these practices are also protective of breastfeeding which makes it difficult to compare to other studies which do not engage in these practices. The mothers in the study were multiparous which also may have contributed to the successful breastfeeding. Nevertheless, the infants were observed for breastfeeding behaviours at one hour of age and 24 hours post birth, and no differences were found between those who had been exposed to epidural and those who had not. The author concluded that the ultra-low dose epidural used in the study had reduced the impact on infant breastfeeding behaviour. The sample size was quite small in this study, 28 in each of the unmedicated and medicated groups which may have contributed to the lack of significant differences.

Gizzo et al., (2005) reported that when early skin-to-skin contact and initiation of breastfeeding is encouraged, primiparous women of term infants who had an epidural for labour (n = 64) were just as likely to breastfeed as women who elected to have no epidural pain relief during labour (n = 64) however, early breastfeeding was the only breastfeeding outcome measured and a greater percentage of newborns exposed to epidural had a significantly shorter first feed (<30 minutes). Chang and Heaman (2005) found no differences in breastfeeding initiation between mothers who had epidural (n = 52) and no-epidural (n = 63) in their hospital which supported early breastfeeding initiation, rooming-in and breastfeeding on demand.

While early breastfeeding initiation is important to measure, breastfeeding establishment may be more indicative of long term success. Emerging evidence suggests, that some of the differences in breastfeeding establishment between mothers who had an epidural and those that did not, may be explained by an increased likelihood of delayed lactation in mothers who have had an epidural (Lind, Perrine, & Li, 2014). In a large longitudinal study, (n = 2366) mothers were asked when their milk came in (≤3 days, > 3 days) and researchers analysed eight different pain relief/birth method groups to control for pain relief - birth method interactions. They also adjusted for maternal socio-demographic variables, breastfeeding intention and number of Baby-Friendly hospital practices. Mothers who received labour pain relief medications were two to three times more likely to report delayed onset of lactation (vaginal birth with spinal/epidural only aOR 2.05, 95% CI 1.43 - 2.95; emergency caesarean with spinal/epidural and another medication aOR 1.77, 95% CI 1.77 - 5.18) (Lind et al., 2014). These researchers also found an association of delayed lactation with mode of birth, BMI, parity, intended breastfeeding duration and number of Baby-Friendly practices experienced.

A study by Dozier et al., (2013) looked at associations of epidural and breastfeeding cessation at one month in 772 breastfeeding mothers who had vaginal births of healthy, term, singleton babies. They adjusted for many confounding variables, including standard demographics and intrapartum factors, and also labour induction with intravenous synthetic oxytocin (Syntocinon). They found both epidural and intravenous Syntocinon were significant risk factors for breastfeeding cessation (hazard ratio 1.34 [95% CI 1.00 - 1.79]). They also found that the negative effects of epidural analgesia on breastfeeding were significantly reduced in a Baby-Friendly hospital, compared to a non-Baby-Friendly hospital, and concluded that the association between epidural anaesthesia and breastfeeding was affected by the complex interrelationships between maternal-infant socio-demographic factors and hospital and practitioner practices (Dozier et al., 2013).

2.6.4 Oxytocin Use

Studies are emerging which implicate Syntocinon with reduced breastfeeding. Recent research has shed light on how both epidural anaesthesia and exogenous oxytocin administration can negatively affect the release of maternal endogenous oxytocin (Jonas et al., 2009; Rahm, Hallgren, Högberg, Hurtig, & Odlind 2002), which may

subsequently impact negatively on breastfeeding initiation and outcomes. It can be difficult to disassociate the effect or impact of interventions such as analgesia and Syntocinon, particularly in retrospective studies, as these two treatments are often used together. Syntocinon is commonly used to induce or augment labour, and for the third stage of labour to assist in the birth of the placenta, and also as a uterotonic to control bleeding after a normal birth or after caesarean birth. It has been hypothesised, that use of Syntocinon may be contributing to the discrepancy between the breastfeeding intentions and the breastfeeding outcomes experienced by many mothers (Odent, 2013).

A large cohort study (n> 48,000) examined the administration of oxytocin alone, or in combination with other agents used routinely for the prevention of postpartum haemorrhage, with breastfeeding at 48 hours of age and found it to be associated with a significant reduction in breastfeeding of 6 to 8% (Jordan et al., 2009). These researchers found the associations were maintained for subgroups that did not have epidural analgesia. Induction or augmentation of labour with oxytocin was not associated with a significant reduction of breastfeeding. Women who experienced a post-partum haemorrhage were excluded from the study. Limitations of the study include that women who intended to artificially feed were not excluded and the hospitals were not Baby-Friendly designated, therefore support for breastfeeding may not have been optimal.

Jonas et al., (2009) demonstrated that maternal release of oxytocin in response to suckling on day two was reduced among women who were exposed to Syntocinon augmentation of labour which could indicate a down-regulation of oxytocin production. Another theory is that exposure to intravenous Syntocinon during augmentation of labour could down-regulate production or desensitise the oxytocin receptors in the breast (Odent, 2013). Furthermore, Syntocinon can cross the placenta and may affect the baby (Malek, Blann, & Mattison 1996).

Two recent pilot studies have shown a significant effect of Syntocinon on newborn behaviour. In Spain, researchers (Fernández et al., 2012) looked at the effect of oxytocin administration in labour on newborn feeding reflexes. They analysed video recordings of 20 newborns born to primiparous mothers. The mothers had been given various doses of Syntocinon to augment labour. They found a negative association

between dose of Syntocinon and suckling (p = 0.03) and at three months, women who were still breastfeeding had received a significantly lower dose of oxytocin. This was only a pilot study however, and mothers had also received epidural analgesia and furthermore there was no control group. The next study of note examined prefeeding cues of healthy, full-term infants exposed (n= 36) and unexposed (n = 11) to synthetic oxytocin. Infants were recorded on video from 45-50 minutes of age when in a crib before being given to their mothers (Bell, White-Traut, & Rankin, 2013). The infants exposed to synthetic oxytocin displayed lower scores on prefeeding cues than those unexposed (OR 11.5, 95% CI 1.8 - 78.3). This study did not find an effect of epidurals on prefeeding cues (OR 0.3, 95% CI 0.1 - 1.7). The numbers in this study may not have been sufficient to show an effect of epidural and there was a very wide confidence interval in the effect of synthetic oxytocin. Further studies are needed in this area.

Investigating the interactions of birthing interventions (opioid pain relief, induction of labour, epidural administration and emergency caesarean) on breastfeeding duration, among a large sample of mother-infant pairs (n = 1280), Li Bai et al., (2013) found that while any one intervention did not appear to predict shortened breastfeeding duration, there was a significant association when there were at least three interventions (nine weeks for no interventions versus five weeks for at least three intrapartum interventions). In the present study, use of pethidine, labour epidural analgesia, labour spinal analgesia, delivery epidural analgesia, delivery spinal analgesia, labour induction/augmentation with Syntocinon and postpartum administration of uterotonics was included in the analysis.

2.7 FORMULA SUPPLEMENTATION

Exclusive breastfeeding is seen as the gold standard. Under the BFHI, maternity services are required to ensure that from birth, breastfed infants receive no other food or fluids other than mother's milk (unless medically indicated) and encourage mothers to continue exclusive breastfeeding until the infant is around six months of age (WHO/UNICEF, 1989). There is an abundance of evidence to support the risks of giving breastmilk substitutes in the form of infant formula. In a systematic review, Ip et al., (2007) reported that use of infant formula is associated with increased long-term diseases such as asthma and other atopy, otitis media, type I diabetes, coeliac disease,

Crohn's disease, obesity, leukaemia, and cardiovascular diseases. For the mother, not breastfeeding is associated with breast and ovarian cancer, type II diabetes, osteoporosis and obesity (Ip et al., 2007). Exclusive breastfeeding compared to mixed breast and formula feeding, is also associated with less diarrhoeal, fewer lower respiratory tract diseases and lower rates of sudden infant death syndrome, (SIDS) (Ip et al., 2007).

There may be long-term effects of formula supplementation on adult weight. One study (Stettler et al., 2005) followed to adulthood 653 people who were fed formula at birth. Interestingly, greater weight gain during the first eight days of life was associated with increased incidence of overweight 20 to 30 years later. These researchers proposed that the first eight days may be a "critical period" during which human physiology is programmed. This may indicate that the normal weight loss experienced by breastfed babies' after birth and the slower return to birth weight, may be implicated in a healthier metabolic programming, which reduces the risk of overweight and obesity during childhood and into adulthood (Koletzko, Dodds, & Akerblom, 2006).

2.7.1 Effect of Formula on the Gut Flora

Infant formula can affect the infant gut flora, called the microbiome (Azad et al., 2013; O'Sullivan et al., 2013), the complex ecosystem of bacteria, which inhabit the gut of a host organism. There has been a lot of interest in the differences between the microbiome of breastfed infants compared to formula fed infants and also the differences that mode of delivery can make (Azad et al., 2013; Biasucchi et al., 2010; Donovan et al., 2012). Furthermore, there has been found to be over 700 different types of bacteria present in human milk which 'seed' the infant gut (Cabrera-Rubio et al., 2012). These change over the course of lactation and are more diverse in women of normal BMI than those of obese women, and are less diverse in women having a planned caesarean than those who have laboured (Cabrera-Rubio et al., 2012). Vaginal delivery and exclusive breastfeeding ensure the early acquisition of favourable bacteria (Penders et al., 2006), which promote development of the infant immune system (Schwartz et al., 2012), and are important for normal metabolic function (O'Sullivan et al., 2013). Breastmilk contains human milk glycoproteins which have specific biological functions protecting the neonate from disease (Liu & Newburg, 2013) and human milk oligosaccharides, previously called the 'bifidus factor,' which

promote the growth of beneficial *Bifidobacterium* and *Lactobacillus* species (Donovan et al., 2012), the predominant bacteria in the exclusively breastfed infant, which promote gut closure (Ahrne & Hagslatt, 2011). Gut permeability is associated with immune mediated diseases such as type I diabetes, irritable bowel syndrome, coeliac disease and allergies (Förster, 2008). Formula contains no human milk oligosaccharides and can alter metabolic function causing metabolic stress, which may subsequently contribute to metabolic diseases such as obesity, cardiovascular disease and type II diabetes (O'Sullivan et al., 2013).

2.7.2 Effect of Supplementation on Breastfeeding

There has been some suggestion, that supplementation for medically justifiable reasons may not be detrimental to breastfeeding duration and that supplementation may merely be a marker for breastfeeding difficulties. This has been borne out in only one Swedish study (Ekström, Widström, & Nissen, 2003) and not supported in a recent Finnish study which found supplementation, whether medically indicated or not, was equally associated with reduced breastfeeding self-efficacy in new mothers compared to exclusively breastfeeding ($p = 0.001$) (Koskinen, Aho, Hannula, & Kaunonen, 2014). Other studies have also found early formula supplementation to be an independent risk factor for early breastfeeding cessation. (Bloomquist et al., 1994; Vogel et al., 1999), especially when it occurs during hospital stay (Chantry et al., 2014; Declercq et al., 2009; Gagnon et al., 2005; McAllister et al., 2009; Nickel et al., 2013; Parry et al., 2013; Perrine et al., 2012; Semenic, Loiselle, & Gottlieb, 2008; Wright et al., 2006), and may interfere with the establishment of lactation (De Carvalho et al., 1983). Merten et al., (2005) found that if a baby was exclusively breastfed in hospital, the median breastfeeding duration was significantly longer than if it had been supplemented in hospital. The introduction of formula or any water-based supplements was the strongest predictor of breastfeeding cessation.

In the UK one study found one third of breastfed infants were given supplementary feeds in the hospital, which was associated with a 10-fold increase in the odds of giving up breastfeeding by discharge (Wright et al., 2006).

Investigating 110 Australian hospitals, some with BFHI accreditation, Biro et al., (2011) found in-hospital formula supplementation of breastfed babies to be 23%. This included babies who were admitted to special care. Primiparity, caesarean birth and

high BMI were associated with greater likelihood of formula supplementation, while being born in a Baby-Friendly accredited hospital was protective of exclusive breastfeeding.

A Canadian study (Gagnon, et al., 2005) looked at reasons for in-hospital formula supplementation of breastfed babies. Supplementation rates were 47.9%. Babies born at night were at increased risk for supplementation. Nurses' reasons for supplementing were based on maternal fatigue and infant behaviour. This was not a Baby-Friendly accredited hospital and while some of the babies may have required infant formula for medical reasons, these were healthy, term babies. In Hong-Kong, researchers looked at predictors and consequences of in-hospital formula supplementation in the first 48 hours and found 82.5% of breastfeeding newborns were supplemented with infant formula (Parry et al., 2013). Supplementation was associated with assisted vaginal birth, caesarean birth and higher birth-weight. Any supplementation in hospital was detrimental to the duration of breastfeeding, but they did not find a dose-response effect. They did not assess the reasons for giving formula, but the high rate suggests it was routine practice rather than for medically justifiable reasons.

In a recent US study (Chantry et al., 2014), the effect of in-hospital formula use was evaluated in first-time mothers intending to exclusively breastfeed. In the study, 210 (53%) babies were exclusively breastfed in the hospital, while 183 (47%) were supplemented. Over the next two months, breastfeeding declined dramatically in the supplemented group. Between the first and second month, 68% of the babies receiving in-hospital formula were not fully breastfed, compared to 37% of babies who were in the exclusively breastfed group (adjusted RR 1.8 95% CI 1.4 - 2.3). After two months, 33% of the supplemented babies were not being breastfed at all. By contrast, only 10% of the exclusively breastfed group had stopped breastfeeding (adjusted RR 2.7 95% CI 1.7 - 4.5). They found a 'dose dependent' response with increasing amounts of formula given in hospital associated with earlier cessation of breastfeeding ($p = 0.011$).

2.7.3 Medically Justified Reasons for Supplementation of Breastfed Babies

The medically justifiable reasons for formula supplementation as outlined by the NZBA for the BFHI (NZ) (see Appendix B) are, in summary, for when the baby is very premature or small for gestational age and cannot maintain blood glucose levels,

has a low blood glucose level and there is insufficient breastmilk available, has experienced greater than 10% weight loss and there is insufficient breastmilk available, or there are medical contra-indications for breastmilk feeding (NZBA, 2011). A study of low-income breastfeeding women in the USA, investigating reasons given for formula supplementation, found that of the 78% of babies who were supplemented, only 13% of these fulfilled the criteria for medical indication. The main reasons were maternal request, need for rest, and mother felt she didn't have enough milk (Tender et al, 2008). In the UK, a qualitative study discussed the healthcare professional's desire to protect the mother from tiredness and distress, even when it conflicted with the role of protecting breastfeeding (Cloherty, Alexander, & Holloway, 2004).

There is very little research available which discusses the acceptable level for medically indicated supplementation of breastfed babies. The Joint Commission on Breastfeeding in the USA states that top performing Californian hospitals have a supplementation rate of less than 10% (United States Breastfeeding Commission, 2010). In NZ, there appears to be higher rate of supplementation in tertiary hospitals compared to secondary and primary when the exclusive breastfeeding rates are compared (exclusive breastfeeding rates 81%, 83.3% and 91.6% respectively) (NZBA, 2012), but actual rates of supplementation are not published and reasons for supplementation have not been explored in NZ hospitals.

The NZBA (2011) have outlined reasons for medically acceptable formula supplementation as outlined above (see Appendix B). These can be categorised as maternal reasons or infant reasons. There have been a couple of studies published recently, which have explored maternal reasons and infant reasons and discussed the various strategies used to overcome breastfeeding problems, for example, when the infant is not able to latch onto the breast and the effect this has on breastfeeding both during the hospital stay, and on the duration of breastfeeding.

2.7.4 Supplementation for Other Reasons

In an Australian study, (Keemer, 2013) breastfeeding difficulties were described as 'maternal challenges' which included difficulties latching due to nipple shape, pain, damage, perceived insufficient milk supply and engorgement; other problems due to birth related pain, pain relief used in labour, and fatigue. 'Infant challenges' included

sleepy baby, poor or disorganised suck, unsettled 'demanding' behaviour, dehydration, and hypoglycaemia. All the women (n = 128) initiated breastfeeding and 93% had skin-to-skin contact at birth. The hospital was working toward becoming Baby-Friendly. When a mother or baby was having difficulties feeding the study described using 'first line strategies' and 'second line strategies'. First line included unlimited skin-to-skin contact and unrestricted access to the breast in order to prevent or reduce problems. Second line strategies included using alternative feeding devices and techniques to support a mother to overcome the initial challenges and meet her breastfeeding goals. If an infant is unable to directly breastfeed, expressing breastmilk and feeding baby by means other than by bottle and teat is recommended by the BFHI, such as feeding by syringe, cup, finger-feeding, supplemental supply line or nipple shields. These could be termed 'second line strategies'.

Keemer (2013) found a high rate of second-line strategies (48%) were used. 'Nipple pain' (40%), 'baby would not settle' (40%), 'not enough breastmilk or colostrum' (37%), 'fatigue' (37%) and 'baby could not latch' (37%) were the most common reasons reported by mothers (multiple reasons could be chosen). Second line strategies were found to be supportive of a high rate of breastfeeding as at day seven, there was a 97% rate of breastfeeding in the total sample, however women using second line strategies had significantly lower breastfeeding self-efficacy scores which has been shown to predict poorer breastfeeding outcomes (Dennis, 2003). Subsequent follow up would have been useful.

A US study, (Chantry et al., 2014) also described categories of maternally reported reasons for in-hospital formula supplementation among 393 primiparous women intending to exclusively breastfeed. Of the 43% of women whose babies who were supplemented, the most common reasons reported were 'low maternal supply' (18%), 'signs of inadequate intake' (weight loss and hypoglycaemia) (16%) and 'poor infant behaviour' (14%), (multiple reasons could be chosen). The increased odds of not fully breastfeeding at 60 days were significant for all reasons of in-hospital formula use except for 'concern about mother's medication'. The present study uses a data collected by a tool with a range of 14 different reasons for formula supplementation which covers both maternal and infant reasons. While some of the reasons are clearly for medical indications, such as infant hypoglycaemia and clinical dehydration, other reasons are less well defined, in particular 'maternal request' and 'delayed lactation'.

The concept of insufficient milk supply or 'not enough breastmilk or colostrum' mentioned in the previously described studies (Chantry et al., 2014; Keemer, 2013; Tender et al., 2009) and the diagnosis of delayed lactation as discussed by Nommsen-Rivers (2010) particularly in relation to abnormal glucose metabolism and insulin resistance (Nommsen-Rivers et al., 2012), appears to be a recurring theme amongst new mothers. Some argue that mothers appear unprepared for what the early postpartum period would be like for a healthy infant breastfeeding on demand (DaMota, Bañuelos, Goldbronn, Vera-Beccera, & Heinig, 2012; Gagnon et al., 2005). In a study of 114 Dunedin mothers (Harris, 2011), 61% of mothers thought that they had insufficient milk at some time during the study period from birth to four months. The present study also investigates this reason for supplementation of newborns during the hospital stay.

2.8 SUMMARY

Research published to date is from diverse settings and presents a variety of outcomes. There is clearly a need to investigate what happens in a Baby-Friendly accredited hospital within the New Zealand context. This study will pull together variables present in the first hours of birth, taking a close look at the association of maternal-infant biomedical, socio-demographic variables and intrapartum factors with breastfeeding outcomes and in-hospital formula supplementation, and will examine the reasons for supplementation to see if they are consistent with the BFHI recommendations. The results could provide evidence to inform policies and practices. While there are many factors which cannot be modified, women could be informed that their baby is at increased risk of receiving infant formula in light of these results. Mothers with babies at risk can often be identified before birth and these mothers can be given extra education and support antenatally and postnatally.

3 METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the rationale for the methodology chosen for this investigation and discusses the cultural and ethical considerations. It describes the study population, the process of data collection and the methods of analysis. This research used quantitative methods to retrospectively analyse data collected in a cohort of mothers and babies to examine the prevalence of, reasons for, and predictors of formula supplementation in breastfed babies. The quantitative approach was considered the most effective methodology to answer the research questions as it enabled analysis of a large data set with the ability to provide statistically significant results with the potential to inform practice.

3.2 RESEARCH QUESTIONS AND HYPOTHESES

After performing an extensive literature review it became evident that a large number of variables can influence the feeding outcome for mothers who intend to exclusively breastfeed their babies. Many babies are supplemented with infant formula during the hospital stay. Maternal and infant characteristics, birthing outcomes and birthing practices can impact on feeding outcomes. In order to satisfy specific areas of enquiry, specific questions were formulated. These primary and secondary questions are listed below.

Primary question:

What are the socio-demographic, biomedical, intrapartum and postpartum factors associated with supplementation of breastfed babies during the maternity stay in a Baby-Friendly hospital?

Secondary questions:

1. Is there an association between delayed (more than one hour) initiation of skin-to-skin contact between mother and baby at birth and formula supplementation of breastfed babies during the hospital stay?
2. Is there an association between duration of skin-to skin contact between mother and baby during the first 2-3 hours after birth and supplementation of breastfed babies?

3. What are the most prevalent documented reasons for formula supplementation during the hospital stay?

4. Is there an association of any maternal/infant socio-demographic biomedical or intrapartum variables with the most prevalent reasons documented for formula supplementation?

To answer some of these questions the following hypotheses would be tested:

Hypothesis 1: Labour and birth interventions will be associated with increased formula supplementation of breastfed babies during the hospital stay.

Hypothesis 2: Delayed (more than one hour) initiation of skin-to-skin contact between mother and baby at will be associated with formula supplementation during the hospital stay.

Hypothesis 3: Duration of skin-to-skin contact between mother and baby for at least an hour in the first two to three hours of birth will be associated with exclusive breastfeeding during the hospital stay.

3.3 METHODOLOGICAL CONSIDERATIONS

Breastfeeding is in the domain of public health (American Academy of Pediatrics, 2012; Centres for Disease Control, 2011; Martens, 2013). Research methodology for public health can include both quantitative and qualitative methods (Baum, 1995). Each has their own merits and can be useful as tools to further knowledge (Baum, 1995). Quantitative methodologies are described as empirical and positivist as they work on the principle of reductionism (Carr, 1994). While this method can be criticised for reducing an individual's experience to a set of numbers, nevertheless, data from a large number of individuals can be analysed and statistical significance can be attained. This renders the results more generalizable and produces a robust level of evidence which can inform midwifery and or medical practice (Haines & Donald 2002). Some issues require initial quantification such as 'how much?', 'how many?' and 'how often?' before questioning 'why'. The 'why' may need qualitative as well as quantitative methodology.

Qualitative methodologies seek to gain insight and understanding into the lived experience of the human condition. Qualitative research does not focus on a cause and

effect relationship rather it explores the human experience and involves a close relationship between participant and researcher. It does not rely on statistical significance by sampling a predetermined number of subjects, but rather, data is collected until saturation of understanding is reached (Jackson, Daly, & Chang, 2003).

In order to answer my research questions, quantitative methodology was required. I wanted to examine the relationship between specific variables and determine associations and predictors, which requires analysing large numbers to obtain statistical significance. In order to complete the study within the time frame for a master's thesis, I decided to use retrospectively collected data, also taking into consideration firstly my research questions and secondly, the study population. Pregnant and new mothers in Otago are the subjects of many research investigations from a number of departments at the Otago University. These include, Anatomy and Physiology, Human Nutrition and Psychology Departments and the Medical School, therefore seeking permission to recruit participants from this well researched, vulnerable population was advised against by the Hospital Research Office. However, using data which had already been collected as part of routine, hospital requirements would not involve direct contact with participants and would be permissible and feasible.

With the growth of the evidence-based medicine movement, there has been more emphasis on the strength of evidence used to inform practice. In my role as lactation consultant and Baby-Friendly Hospital Initiative (BFHI) coordinator I have the responsibility to educate medical and midwifery staff and students with evidence-based information, and to use this information to update hospital policies and guidelines.

The different types of evidence can be viewed as a pyramid with several levels. The lowest level of evidence is at the bottom and the highest, most credible level at the top (University of Illinois at Chicago, 2006). At the bottom level of the pyramid, considered level five evidence, is evidence given in the form of opinion by experts or expert groups; clinical experience and judgement of a respected healthcare professional. More and more, common hospital routines and practices are being questioned as to their evidence base (Mercer, Erickson-Owens, Graves, & Haley, 2007). An example of this is immediate cord clamping at the birth of the newborn.

Recently, with the growth of evidence-based medicine, this common practice has been questioned and been found to have potentially harmful, long-term effects (Mercer et al., 2007). Similarly, the practice of separating the newborn from the mother at birth for drying, weighing, vitamin K injection and other procedures has been questioned. Immediate skin-to-skin contact is now seen as evidence-based practice in view of the identified benefits of this practice or rather, the potential harms of separation (Moore et al., 2012).

The next level of evidence on the pyramid, considered level four evidence, comes from case studies. These are descriptive, observational studies from individual cases with an outcome of interest where there is no manipulation of treatment and no control group. These cases may be used to describe rare events of interest and as each is reported in the literature, they can be compared and similarities can be found, contributing to knowledge (Gehlbach, 1993). Moving up the pyramid, the third level of evidence is the case-control study. This is a type of observational study where the subjects are not randomised into the exposed or unexposed groups. The subjects (cases) are identified as already having the outcome of interest (disease or condition), and are compared to a similar group without the outcome (controls), with respect to their prior exposure to the factor of interest, risk factor or treatment (Straus, Richardson, Glasziou, & Haynes, 2005). For example, comparing people with lung cancer (cases) to those without lung cancer (controls) and investigating whether they had the same exposure to smoke (exposure of interest). Analysis would determine whether there was a significant difference between the proportion of exposed subjects between cases and controls.

The next level of evidence is from cohort studies. A cohort is a group of subjects which share a common characteristic, exposure or experience within a particular timeframe. This type of study is also observational and involves identifying two groups of people where one group received the exposure of interest and the other did not, and following them forward, collecting data at specified time points for the outcome of interest (Straus et al., 2005). Longitudinal studies are an example of cohort studies. They can be prospective, defining the group before the study commences or retrospective, where the groups are defined after the data is collected. The comparison group can be a cohort drawn from the general population, or alternatively, subgroups within the cohort can be compared with each other.

Second level evidence is near the top of the pyramid. This is the randomised controlled trial, (RCT) considered the gold standard for a clinical trial in determining cause and effect relationships. This method uses experimental techniques where participants are randomly assigned to a treatment group, or a control group and data is collected prospectively for the outcome of interest. Randomisation of participants into each group helps to ensure that the effect of the treatment is not affected by confounding factors (Kirkwood & Sterne, 2003). However, the RCT is not always the appropriate research design as it may not be possible, feasible or ethical to randomise participants to the treatment group or control group. For example it is not ethical to randomise women into two groups, one to have a normal birth and the other to have a caesarean birth, or one group to breastfeed and the other to artificially feed their babies.

At the top of the pyramid, considered the strongest level of evidence, are the systematic review and the meta-analysis. These use existing research from many studies found through an extensive literature search and by using specific quantitative methods, the results can be combined or reanalysed into one, large analysis. This strengthens the evidence, as the numbers in the samples are combined and the statistical power increases, thus giving more credibility than single studies on their own (Straus et al., 2005).

Many factors need to be taken into consideration when deciding the most appropriate research design and methodology to obtain clinically meaningful results. For example, the research questions, ethical considerations, access to data and the available time and budget need to be taken into account. The literature review is used to identify gaps in the research and important variables to be included. To answer my research questions, access to appropriate data and use of particular methodology was considered.

My research falls into the category in the middle of the pyramid, the cohort study. I have investigated a cohort of mother –infant pairs birthed in 2012 who were exposed to a range of variables during their hospital stay and observed feeding outcome on discharge: exclusive breastfeeding or supplemented breastfeeding (the outcome of interest). In order to answer my research questions, quantitative methodology was considered the most appropriate because the outcome of interest, supplementation, was a relatively rare event (15%). I therefore needed to collect data from a large

number of mothers and babies in order to be able to identify associations between the various variables with supplementation. While this method does not determine causation, it can identify associations, predictors and risk factors.

3.4 ETHICAL CONSIDERATIONS

This section describes how the processes relating to cultural considerations, anonymity of participants and ethics approval were achieved in this study. The Southern District Health Board (SDHB) deemed that informed consent was not required for this study as the data I was going to be using was data collected routinely for purposes of audit and fell under the category of 'audits and related activity' described in the National Ethics Advisory Committee's (NEAC) 'Ethical Guidelines for Observational Studies: Observational Research, Audits and Related Activities' (NEAC, 2012, sections 6.47 & 8.42).

3.4.1 Cultural Considerations

Mothers and babies of Māori ethnicity have been identified as having lower exclusive breastfeeding rates in New Zealand (NZ Plunket, 2010). It is suggested, that this has resulted in part from the loss of traditional infant feeding and care practices, as Māori have been influenced by Western and modern care practices (Glover et al., 2009). This research has looked at breastfeeding rates by ethnicity. The results may help identify barriers to exclusive breastfeeding for Māori and non-Māori. Improved breastfeeding rates will make a significant contribution to the reduction of inequalities between the health status of Māori and non-Māori. Breastfeeding is connected to tinana (physical health), wairua (spiritual), hinengaro (mental and emotional health), and whānau (health of the family) (Durie, 1994). All these aspects of health are intertwined, and need to be effectively addressed to achieve optimum health potential.

Otago Polytechnic has a Memorandum of Understanding with the local Māori, Kai Tahu, to facilitate implementation of the principles of the Treaty of Waitangi: participation, protection and partnership. In relation to breastfeeding, health professionals can involve Māori in decision-making, planning, and development of policies and practices to support breastfeeding (participation); work with whanau, hapu and iwi to develop culturally appropriate and accessible services (partnership) and work in a way to protect traditional breastfeeding practices (protection). As partners to the Treaty, Māori have the right to enjoy a health status that is at least the

same as that enjoyed by non-Maori. The SDHB consults with local Māori in review of its breastfeeding policy every three years in order to address the requirements of the Treaty in participation, partnership and protection of breastfeeding.

3.4.2 Anonymity

As I am employed by the SDHB and was accessing patient information in the form of electronic data, it was imperative I undertook measures to retain patient confidentiality and anonymity of participants. The original data set was retained on the server at the hospital that I accessed through my personal log-in and password. This data I subsequently altered to de-identify and anonymize by deleting the names and national numbers of all patients; this then became my working data set. Any data I sent out electronically to work on at home was thus de-identified. Additional safety measures included a password protected system on my laptop and on the hospital computer.

3.4.3 Ethics Approval

The initial research proposal was firstly approved by the Health Research Office at the SDHB (project ID 00847, Appendix C) and the Otago Polytechnic School of Midwifery Postgraduate Committee (Appendix D). As a non-Māori researcher, I have read and reflected on the Māori Strategic framework (Otago Polytechnic, 2012) and the Te Ara Tika Guidelines for Māori research ethics: A framework for researchers and ethics committee members (Hudson, Milne, Reynolds, Russell, & Smith, 2010). Ethical approval was gained from the University of Otago Ethics Committee (approval number 12/210, Appendix E). As part of ethical approval for the SDHB, consultation was sought from the Ngai Tahu Research Consultation Committee as per hospital research protocol (Appendix F). Consultation was also sought from Professor Khyla Russell, Kaitohutohu of Otago Polytechnic (Appendix G). Both parties offered support and had no further requirements. The Otago Polytechnic Ethics Committee was informed of the approval from the University of Otago Ethics Committee (Appendix H).

3.5 METHOD

This section describes the study population, definitions, data collection and data analysis process.

3.5.1 Study Population

Data was collected from mother-infant pairs that birthed at Dunedin Hospital, located in the southern region of the South Island of New Zealand. Data were available for births which occurred during January to December of 2012 (n = 1876). The calendar year was used to determine the convenience sample as breastfeeding statistics are collected yearly and presented to the New Zealand Breastfeeding Authority for audit purposes. The large sample size was considered adequate to give statistical significance when identifying associations between the variables under investigation for formula supplementation. All mother-infant pairs were considered for inclusion when the infant's postnatal care was regarded as primary care, that is, well babies able to be cared for in the postnatal ward. Exclusion criteria were newborn admission to Neonatal Intensive Care Unit (NICU) (secondary/tertiary care), and multiple births. Mothers who did not initiate breastfeeding nor gave their infants any breastmilk during the hospital stay and were recorded as 'artificially feeding' on discharge were also excluded. If a mother initiated breastfeeding but was artificially feeding on discharge, she was included in the study.

3.5.2 Hospital Setting

Dunedin hospital is a publically funded, tertiary facility (see Definitions Abbreviations, page ix) within the Sothern District Health Board (SDHB). It is located in the South Island region of Otago and is the only birthing facility available to women in Dunedin. There are primary facilities located within the rural towns of the Otago region but if women need a tertiary facility, Dunedin is the closest option. Facility statistics state there are approximately 1800 births per year with some of those (~60) being emergency transfers in from outlying areas and the average stay in the postnatal ward is 56 hours (Klemp, 2013).

The University of Otago Medical School has close affiliations with Dunedin Hospital which provides the clinical setting for medical students and staff. The hospital also has teaching agreements with the Otago Polytechnic School of Midwifery. Midwifery students work in the maternity facility alongside core midwives while on hospital placement and also with lead maternity care (LMC) midwives (see Definitions and Abbreviations, page vi for an explanation of core and LMC midwives). LMC midwives care for women in the maternity facility under an access agreement, which requires them to abide by hospital policies. The Dunedin hospital maternity unit has

had Baby-Friendly accreditation since 2004 with three-yearly reassessments. The Ten Steps to Successful Breastfeeding are an integral part of the hospital breastfeeding policy and all policies and guidelines relating to infant feeding. In accordance with Step Two, all staff working with mothers and babies including midwifery, nursing, medical, clerical, and ancillary have one to four hours breastfeeding education per year according to level of involvement (NZBA 2011). In accordance with the compliance with the WHO code of marketing of breastmilk substitutes, no advertising or free gifts of breastmilk substitutes, bottles or teats are permitted in the hospital (NZBA 2011). Women who plan to artificially feed their babies are advised to bring in their own breastmilk substitute, bottles and teats. Written informed consent must be obtained from a mother if her breastfed baby is to have a breastmilk substitute.

The various types of breastfeeding recognised by the New Zealand Ministry of Health are classified as exclusive, fully and partial (NZBA, 2011) (see Definitions Abbreviations, page vi). These definitions are used by the New Zealand government for the duration of infant feeding data collection. Newborn infants are not given water or glucose-water in hospital as per SDHB protocols as this has been shown to have negative consequences on breastfeeding (Akre, 1991; Williams, 2006), and at the time of writing there are no human milk banks in NZ. If extra fluids are required, infant formula is the only other liquid besides prescribed medicines given in the postnatal ward as per SDHB protocols. A baby is classified as 'fully breastfeeding' if he/she received infant formula at some time after birth then went on to breastfeed without supplementation for the next 48 hours and beyond. The difference between 'fully' and 'partial' breastfeeding is often only dependent on the timing of data collection in relation to discharge as a 'partially breastfeeding' baby can go on to become 'fully breastfeeding' but only 'exclusively breastfed' babies can ever be 'exclusive' and will remain so until they receive something other than mother's milk (excepting prescribed medicines).

3.5.3 Data Collection

There were two data sets collected for analysis. The primary data set was obtained from the Maternity Plus (Solutions Plus, 2011) electronic data collection system through a request to the hospital's statistics data manager. These data were entered by trained maternity unit staff responsible for the care of the mother on booking, birth and discharge from hospital. For example, booking data were entered by reception

staff, labour and delivery data by core and lead maternity care midwives and discharge data by core postnatal midwives. Demographic/biomedical variables of the mothers examined were age, parity, ethnicity, body mass index kg/m^2 (BMI) (at initial booking visit) and smoking status (at initial booking visit). For the baby, the data collected were gestational age, birth-weight and ethnicity. Maternal ethnicity was determined by the mother. Where more than one ethnicity was identified, the ethnicity of the respondent was determined by default in the following order: Māori, Pasifika, Asian, other groups except NZ European, and European (NZBA, 2011). Infant ethnicity was determined by the parent(s), it does not default to that of the parents. Where no ethnicity was provided it was recorded as 'not stated' (NZBA, 2011).

Independent variables considered were birth method, (normal vaginal, ventouse [suction], forceps, elective caesarean and emergency caesarean), labour/birth analgesia (pethidine, spinal, epidural), use of synthetic oxytocin (Syntocinon) during labour, postpartum treatment with uterotonic, timing of initiation of skin-to-skin contact with mother, and duration of skin-to-skin contact. Skin-to-skin data were recorded during the first two to three hours post birth.

The second set of data was collected over the same time period from charts kept on top of the fridge where the formula is kept in the ward baby treatment room. Reasons given for formula supplementation are documented by midwives each time a baby is given formula on a chart called 'Reasons for Formula Use'. This tool was developed in 2011 in order to keep a record of formula usage and indications for use as part of the requirements for Baby-Friendly accreditation. Data sheets are stored in a folder in the lactation consultant's office and are available for audit if requested by the BFHI assessors. Observing entries on this chart sparked my interest in this area and the tool was refined over time with the view to future research. Every time an infant is given formula the midwife records the date, the amount given, the room number and the reason using a list of options. The options evolved into a list of fourteen possible reasons over the years 2008-2012 when midwives would write in reasons under the 'other' option and most common themes were chosen. These options with a brief explanation are listed below:

- 'hypoglycaemia', Blood glucose level less than 2.5 mmol/L and insufficient expressed milk available

- ‘clinical dehydration’, minimal or no urine output, dry mucosa, elevated temperature
- ‘small for gestational age (SGA)’, includes small, and/or late preterm well babies
- ‘breastmilk contra-indicated’, due to maternal condition/medications
- ‘mother unwell’, mother too sick/unavailable to breastfeed or provide expressed milk
- ‘delayed lactation’, insufficient breastmilk available or delay in lactogenesis II
- ‘other maternal condition’, other condition directly impacting breastfeeding
- ‘maternal request’, mother requests formula once fully informed, for example may include nipples too sore to put baby to breast and unable to express any milk
- ‘doctor’s order’, doctor has reviewed baby and ordered supplementation, may include hypoglycaemia or other clinical indication where not enough breastmilk available, or hypoglycaemia has resolved, but baby is still considered at risk.
- ‘jaundice’, according to jaundice policy, babies are not routinely supplemented, but may need supplementation if for example, dehydration associated with jaundice.
- ‘formula feeding’, mother has initiated breastfeeding but switched to formula as did not bring own supply
- ‘baby not latching & no expressed breastmilk (EBM)’, includes when baby not latching due to maternal or infant reason and no EBM is available
- ‘10% weight loss’ baby has experienced a 10% weight loss
- ‘other’, any other reason not listed above

Multiple reasons could be chosen. Because the sheets were kept in a place frequented by patients, to protect anonymity the only identifying features on the charts were the

date and bed space occupied. The entries included all babies who were given formula some of which were admitted to secondary care (NICU), twins and some babies whose mothers intended to formula feed from birth or changed to formula feeding during the hospital stay.

The supplemented babies in the primary data set were traced back to the supplementation data chart through the national health index number (NHI), date, room occupation and bed number(s) during the hospital stay, thereby making it possible to link the fourteen possible reasons for formula use to the individual babies and in turn, to the maternal/infant socio-demographic, intrapartum and postpartum data in the analysis. This also identified babies who were excluded from the primary dataset.

3.5.4 Analysis

Primary data set: For this analysis, the outcome variable was breastfeeding status during the hospital stay. Breastfeeding status was described in two categories exclusive (yes, no). 'No' included both partial and fully breastfeeding, and artificially feeding when breastfeeding initiation was recorded.

Statistical analyses were performed using Stata 12.1 (StataCorp, 2011) and checked by Patricia Haden, Principal Lecturer at the School of Information and Technology at Otago Polytechnic using Statistical Package for Social Sciences (SPSS) to ensure appropriate techniques and interpretation of the analyses. Descriptive statistics were used to compare the effect of each variable. Statistical analysis included t-test for continuous variables, Pearson's Chi-square test (Chi^2) or analysis of variance (ANOVA) for categorical variables, bivariate and multivariate logistic regression to obtain odds ratios (ORs) of the association between the socio-demographic, biomedical and birthing practice variables and formula supplementation during the hospital stay. The influence of potentially confounding variables was considered by placing all variables which were significant ($p < 0.05$) in the bivariate analysis or critical variables, which were identified from the literature, into a multivariate logistic regression analysis to obtain adjusted odds ratios (aORs) with 95% confidence intervals and p-values to determine the best predictors for formula supplementation.

The delay in skin-to-skin contact initiation and the skin-to-skin duration were analysed as continuous variables and were also divided into categories. Initiation of skin-to-

skin contact after birth was divided into categories which reflected present and past recommendations form Step Four of the BFHI 'Ten Steps' and categories reported in the literature (initiation: 1-5, 6-30, 31-60, 61+ minutes; duration: 1-15, 16-30, 31-60, 61+ minutes). In addition, initiation of skin-to-skin was analysed by peak values in frequency distribution and finally in fifteen minute intervals (1-15 16-30, 31-45, 46-60, 61-75, 76-90 and 91+ minutes). There were 17 cases for which '0 minutes' was recorded for skin-to-skin initiation and duration, these cases were omitted from the skin-to-skin analyses. Other variables were also analysed as continuous variables (BMI, age, birth-weight, gestation) and some were reanalysed as categorical variables where appropriate. Breastfeeding status was recorded at time of discharge from hospital.

Secondary data set: Descriptive statistics were used to determine the frequency of each reason option. The most common reasons were analysed by Chi-square test or binary logistic regression with the socio-demographic/biomedical, intrapartum and postpartum factors of both mother and baby.

3.6 SUMMARY

This chapter has addressed the methodological considerations, outlined the rationale for using quantitative methodology, delineated the ethical and cultural considerations and the process of ethics approval. The study population, setting, access to and the collection of data and the process of data analysis have been described.

The following chapter will present the results of the data analysis on the factors associated with formula supplementation of breastfed babies and the recorded reasons given for the supplementation.

4 RESULTS

4.1 INTRODUCTION

In this chapter the results of the analyses are presented. The first section describes the sample population and exclusions. The next three sections contain the descriptive analyses of the mothers' characteristics, the labour and birth characteristics, and then the infant characteristics in relation to feeding outcome. Associations between variables and supplementation of breastfed babies are presented in the next section with bivariate logistic and multivariate logistic regression analysis. Results from the analysis of recorded reasons for supplementation are presented in the final section.

4.2 SAMPLE POPULATION

The total number of babies born in Queen Mary Maternity Unit in the 2012 calendar year was 1876. After exclusions there were 1530 eligible mother-baby pairs. Exclusions were pairs where babies were of multiple births (27 sets of twins and 2 sets of triplets); babies admitted to the secondary care unit (n = 252); babies stillborn and/or neonatal deaths (n = 12); babies who had a congenital abnormality (n = 4) and mother-baby pairs from homebirths transferred in as they had missing data (n = 6). Mothers who intended to artificially feed their babies from birth and did not initiate breastfeeding (n = 63) were excluded. Mothers who were classed as artificially feeding their babies on discharge but who had initiated breastfeeding (n = 17) were included in the study.

4.3 DESCRIPTIVE ANALYSIS

4.3.1 Maternal Characteristics

Table 4.1 presents the descriptive analysis of maternal characteristics with respect to feeding outcome, babies were either exclusively breastfed or they were supplemented at some time during the hospital stay. The percentage of breastfed babies who were supplemented within the total sample of 1530 babies was 15.3%. Chi-square test or analysis of variance (ANOVA) was used to identify any statistical difference between the means of the demographic characteristics of the exclusively breastfeeding and the supplemented groups. The characteristics examined were age, ethnicity, body mass index (BMI), parity and smoking. The variables which showed significance were BMI

and parity. In each case, the percentage of babies exclusively breastfed or supplemented within a category was determined by using the total exclusive or total supplemented as the denominator in order that the columns each add up to 100%. In this way the similarities between the exclusive column and supplemented column can be compared for similarities and differences. The graphs present this information more visually.

4.3.1.1 Maternal Age

The average age of mothers whose babies were supplemented was 30.3 years. This was not significantly different from mothers who exclusively breastfed (30.5 years).

4.3.1.2 Maternal Ethnicity

The predominant ethnicity in the total sample was New Zealand European (70%) followed by European (11%) and New Zealand Māori at 7.5%, while other ethnicities were represented in smaller numbers at less than 3%. There was no evidence that ethnicity of the mother was associated with supplementation when compared by Chi-square test.

4.3.1.3 BMI

The mean BMI for mothers in the study was 25.3 kg/m^2. Treated as a continuous variable, BMI was a significant predictor of supplementation ($p = 0.023$). These results are shown graphically in Figure 1. There appears to be a trend of an increased likelihood of supplementation when mother has a low BMI, between 16 to 21 kg/m^2, or a BMI over 25 kg/m^2, and a decreased likelihood of supplementation when the mother has a BMI between 22 to 25 kg/m^2.

BMI was also divided into categories commonly used to define underweight (<18.5 kg/m^2), normal weight (18.5 – 24.9 kg/m^2), overweight (25 – 29.9 kg/m^2), obese (30 – 39.9 kg/m^2) and high risk obese (also called morbidly obese) ($\geq$ 40 kg/m^2). Overall, 43% of mothers were above the cut-off for normal weight BMI category. Fifty-two percent of mothers fell into the normal BMI category which represented the group with the lowest rate of supplementation while the overweight and obese categories represented the groups with the highest rates of supplementation. There were 44 mothers for whom BMI was not recorded; these were not included in the analysis.

Table 4-1. Maternal characteristics and feeding outcome at discharge.

Variable		**Exclusive**	**Supplemented**	**Chi² or F**	**p value**
Feeding at Discharge n (%)	n =1530	1296 (84.7)	234 (15.3)		
Age (Mean years ± sd)	30.5	30.5 ± 5.9	30.3 ± 6.3	Chi² = 0.32	p = 0.57
Ethnicity	n (%)	n (%)	n (%)	Chi² =12.4	p = 0.14
NZ European	1073 (70)	912 (70)	161 (69)		
European	172 (11)	154 (12)	18 (7.7)		
NZ Māori	114 (7.5)	94 (7.2)	20 (8.5)		
Pasifika	32 (2.1)	23 (1.8)	9 (3.8)		
Chinese	23 (1.5)	17 (1.7)	6 (2.6)		
Indian	19 (1.2)	16 (1.2)	3 (1.3)		
Other Asian	30 (2.0)	22 (1.7)	8 (3.4)		
Other	20 (1.3)	17 (1.7)	3 (1.3)		
Not stated	47 (3.1)	41 (3.2)	6 (2.6)		
BMI (Mean)	25.3	25.15	26.09	F = 5.2	P =0.023
BMI category	n (%)	n (%)	n (%)	Chi² = 8.8	P =0.064
Underweight	54 (3.5)	45 (3.6)	9 (3.8)		
Normal	777 (51)	679(52)	98 (42)		
Overweight	383 (25)	314 (24)	69 (30)		
Obese	236 (15)	193 (15)	43 (18)		
High risk obese	36 (2.5)	30 (2.3)	6 (2.6)		
Not known	44 (3)	35 (2.7)	9 (3.8)		
Parity	n (%)	n (%)	n (%)	Chi² = 16.2	p = 0.003
0	642 (42)	523 (40)	119 (51)		
1	581 (40)	514 (40)	67 (29)		
2	215 (14)	177 (14)	38 (16)		
>2	92 (6)	82 (6.3)	10 (4.3)		
Smoking status	n (%)	n (%)	n (%)	Chi² = 4.05	p = 0.4
Never	1027 (67)	873 (67)	154 (66)		
Quit >4mo ago	230 (15)	190 (15)	40 (17)		
Quit ≤4mo ago	16 (1)	12 (1.0)	4 (1.7)		
Current smoker	213 (14)	186 (14)	27 (11)		
Not known	44 (3)	35 (2.3)	9 (3.8)		

Note: sd = standard deviation

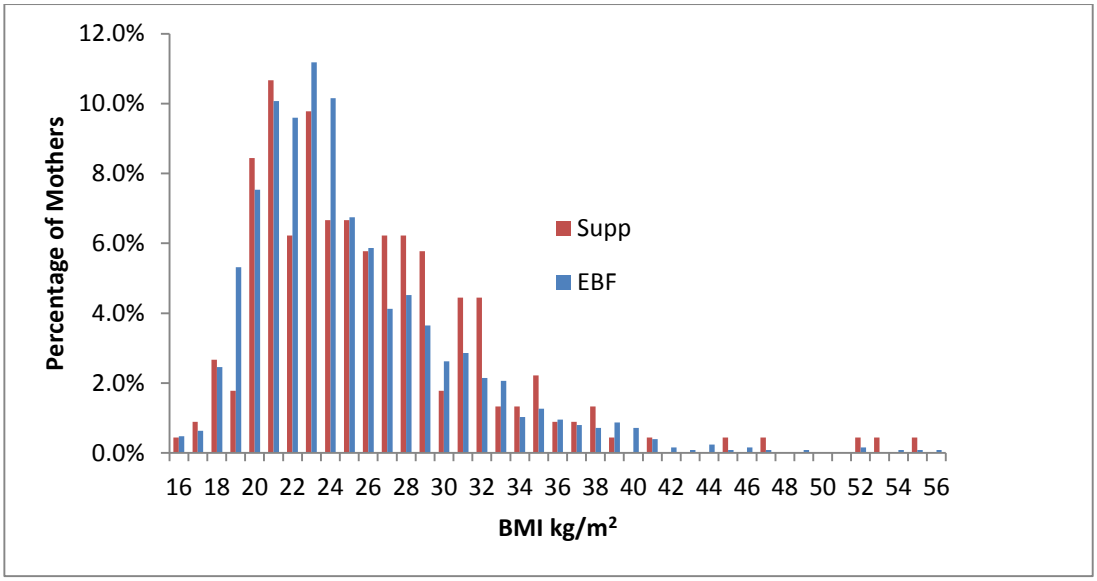

Figure 1. Percentage of mothers supplementing and exclusively breastfeeding by BMI.

Note: Supp = supplemented, EBF = exclusive breastfeeding.

The percentage of mothers whose babies were supplemented and those whose babies were exclusively breastfed is illustrated for each BMI category as shown in Figure 2. The percentage of exclusive breastfeeding is reduced in all BMI categories relative to normal. This effect is not significant by Chi-square test (p = 0.064).

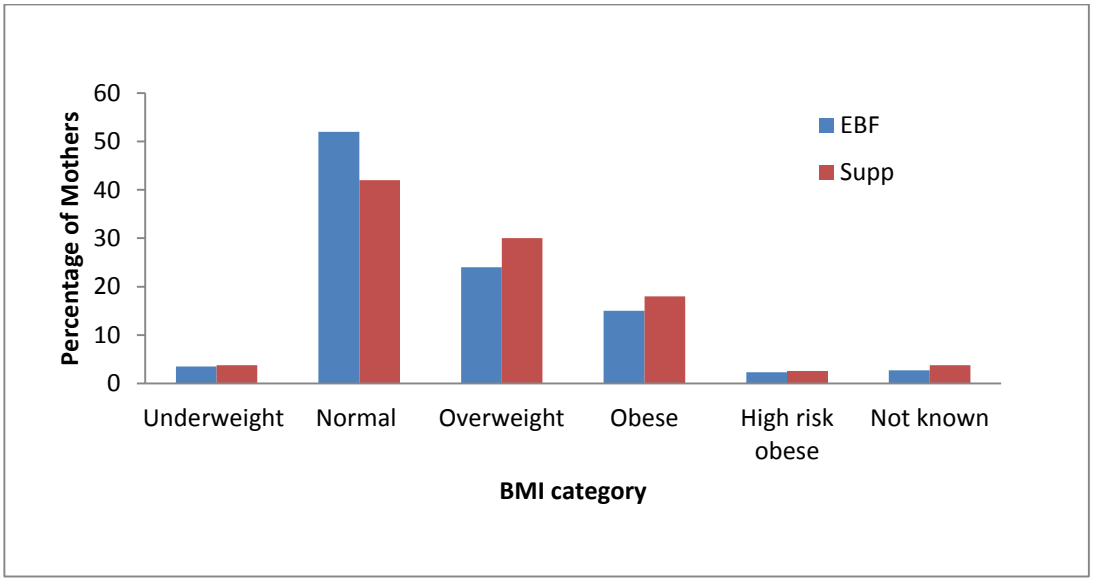

Figure 2. Percentage of mothers exclusively breastfeeding and supplementing by BMI category.

Note: Supp = supplemented, EBF = exclusive breastfeeding.

There were significant differences between maternal ethnicity for BMI category as shown in Figure 3 (Chi^2 = 158, p <0.001). Mothers of Chinese ethnicity had a high representation in the underweight category; approximately 70% of mothers of European, Indian and Other Asian ethnicity were in the normal BMI category, while 50% of mothers of Pasifika ethnicity had a BMI in the obese category.

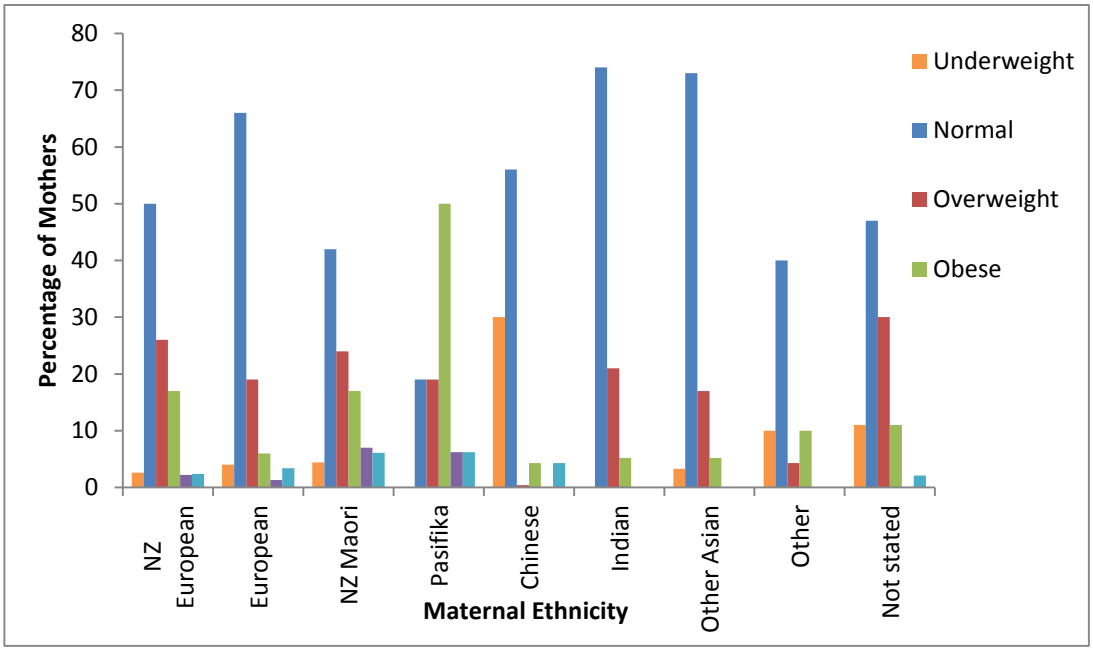

Figure 3. Percentage of mothers within each BMI category according to ethnicity.

4.3.1.4 Parity

Forty-two percent of mothers were first-time mothers and 40% were having their second baby. Parity and breastfeeding status are not independent when analysed by Chi-square test (p = 0.003). The pattern is as shown in Figure 4. The proportion of supplemented babies is highest in primiparous mothers (mothers having their first baby) compared to mothers having subsequent babies.

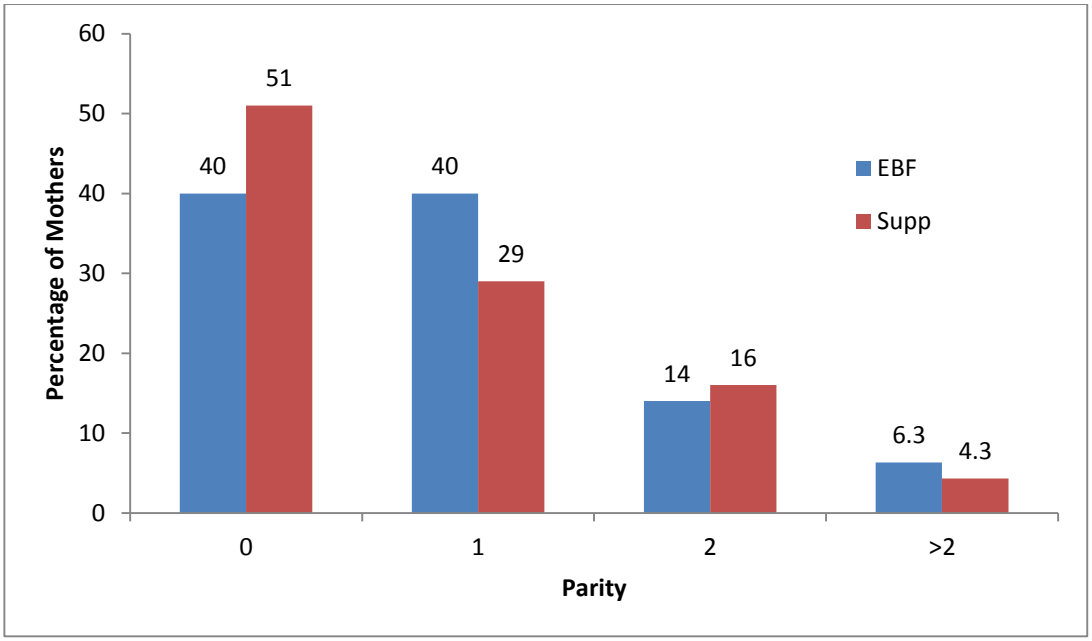

Figure 4. Percentage of mothers exclusively breastfeeding and supplementing by parity.

Note: Supp = supplemented, EBF = exclusive breastfeeding.

4.3.1.5 Smoking

Sixty-seven percent of mothers had never smoked and 13% were current smokers. There were a few mothers who had quit either recently, $\leq$ 4 months ago (1%), and the remaining had quit > 4 months ago. Breastfeeding status and smoking status show statistical independence by Chi-square test (p = 0.40) (Table 4.1) that is, there was no association between smoking and breastfeeding. Figure 5 shows the proportion of mothers supplementing and exclusively breastfeeding in each of the smoking categories to be approximately equal.

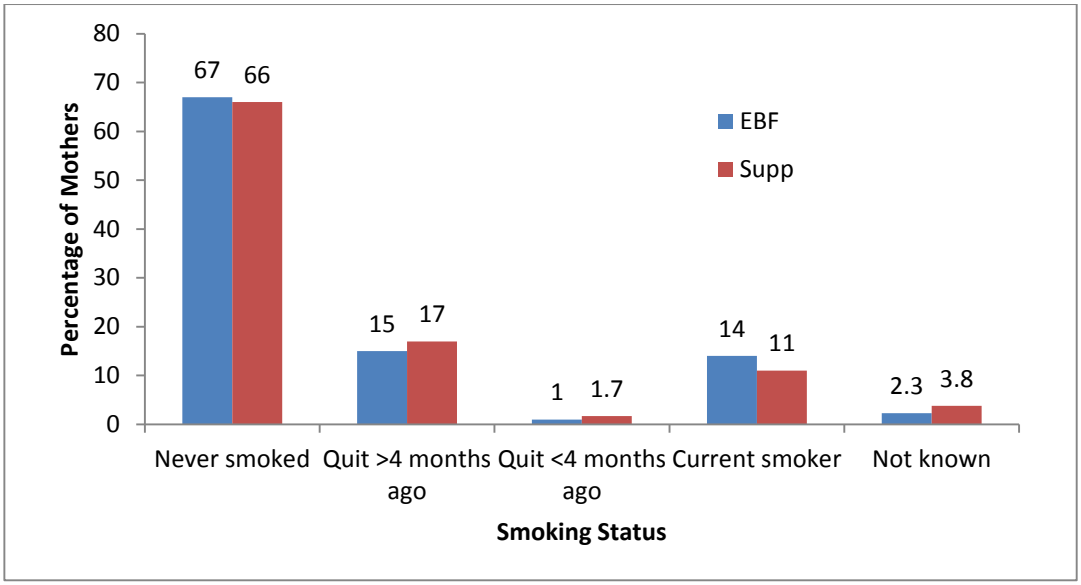

Figure 5. Percentage of mothers exclusively breastfeeding and supplementing according to smoking status.

Note: Supp = supplemented, EBF = exclusive breastfeeding.

Figure 6 shows the percentage of mothers for each ethnicity who were classed as current smokers at time of booking with their Lead Maternity Carer. The prevalence of smoking was highest for mothers of NZ Māori at 39%. This was significant by Chi-square ($Chi^2 = 140$, $p < 0.001$).

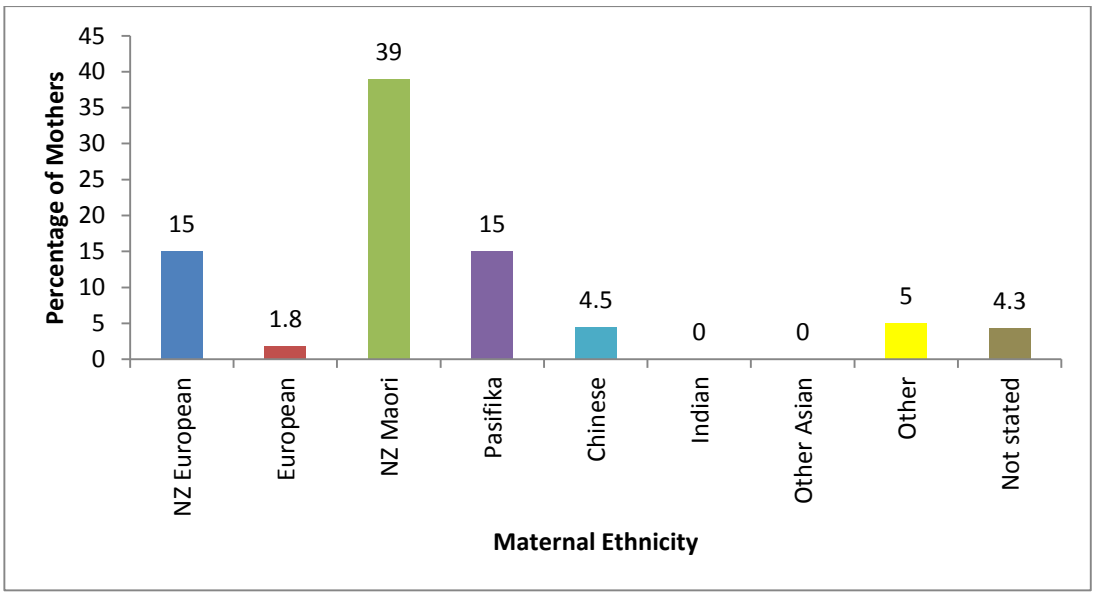

Figure 6. Percentage of mothers who were current smokers at time of booking with Lead Maternity Carer according to ethnicity.

Of the 42 mothers of NZ Māori ethnicity who were current smokers at time of booking, 37 were exclusively breastfeeding and 5 were supplementing (12%) at time of discharge.

4.3.2 Labour and Birth Characteristics

The labour and birth characteristics and feeding outcomes are presented in Table 4.2. The variables examined were birth method, use of Syntocinon in labour either to induce or augment labour, use of Syntocinon and use of analgesia in labour/birth. Chi-square test was used to identify any statistical difference between the means of the demographics of the exclusively breastfeeding and the supplemented groups. Significance was found for each variable. In each case, the percentage of babies exclusively breastfed or supplemented within a category was determined by using the total exclusive or total supplemented as the denominator in order that the columns each add up to 100%. In this way the similarities between the exclusive column and supplemented column can be compared for similarities and differences. The graphs present this information more visually.

4.3.2.1 Birth Method

Sixty percent of women had a normal vaginal birth, while 29% had a caesarean birth. Birth method was a significant predictor of supplementation as indicated by Chi-square test ($p = 0.005$). This is shown in Figure 7.

Table 4-2. Labour and birth characteristics and feeding outcome at discharge

Variable	n (%)	Exclusive	Supplemented	Chi^2 or F	p value
Feeding at Discharge n (%)	n =1530	1296 (84.7)	234 (15.3)		
Syntocinon in labour	n (%)	n (%)	n (%)	Chi^2 = 5.35	p= **0.021**
No	1223 (80)	1049 (81)	174 (74)		
Yes	307 (20)	247 (19)	60 (26)		
Postpartum[1] Treatment	n (%)	n (%)	n (%)	Chi^2 = 23.2	p= **0.002**
None	140 (9)	131 (10)	9 (3.8)		
IV or IM	838 (55)	720 (56)	118 (50)		
Both IV & IM	477 (31)	385 (30)	92 (39)		
Three meds	63 (4)	53 (4.1)	10 (4.3)		
Four or more meds	12 (1)	7 (0.05)	5 (2.1)		
Birth	n (%)	n (%)	n (%)	Chi^2 = 14.7	p = **0.005**
Normal Vaginal	912 (60)	797 (61.5)	115 (49)		
Ventouse	102 (6.7)	83 (6.4)	19 (8)		
Forceps	66 (4.3)	53 (4.1)	13 (5.5)		
Elective CS	220 (14)	183 (14)	37 (15.8)		
Emergency C/S	230 (15)	180 (14)	50 (21.4)		
Analgesia	n (%)	n (%)	n (%)	Chi^2 = 9.02	p = **0.003**
No Analgesia	779 (51)	681 (52.5)	98 (42)		
Analgesia	751 (49)	615 (47.5)	136 (58)		
Analgesia type[2]	n (%)				
Pethidine	97 (13)				
Labour Epidural	368 (49)				
Labour Spinal	263 (35)				
Birth Epidural	315 (42)				
Birth Spinal	360 (48)				

Notes:

[1] IV= intravenous; IM = intramuscular; 'Three meds' indicates the woman had 3 types of medication postpartum and 'Four or more meds' indicates she had four or more types of medication indicating a possible treatment for postpartum haemorrhage.

[2] Analgesia type, women may have had more than one type of analgesia category.

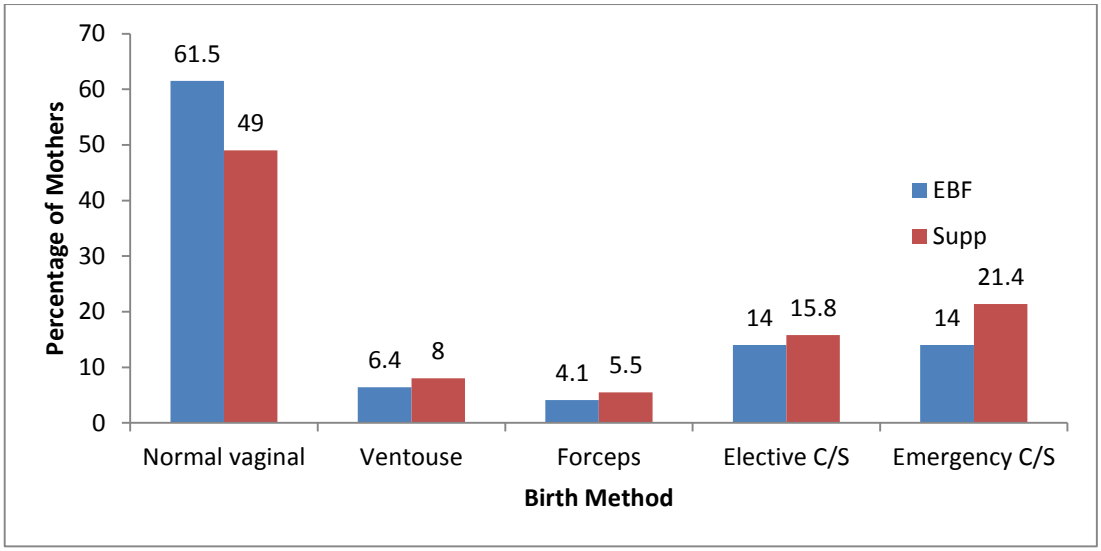

Figure 7. Percentage of mothers exclusively breastfeeding and supplementing by birth method.

Note: Supp = supplemented, EBF = exclusive breastfeeding.

4.3.2.2 Syntocinon in Labour

Twenty percent of women were given Syntocinon (synthetic oxytocin) during labour, either for induction or augmentation of labour. This was significantly associated with supplementation by Chi-square test (p = 0.021). The breastfeeding status and Syntocinon use during labour is shown graphically in Figure 8.

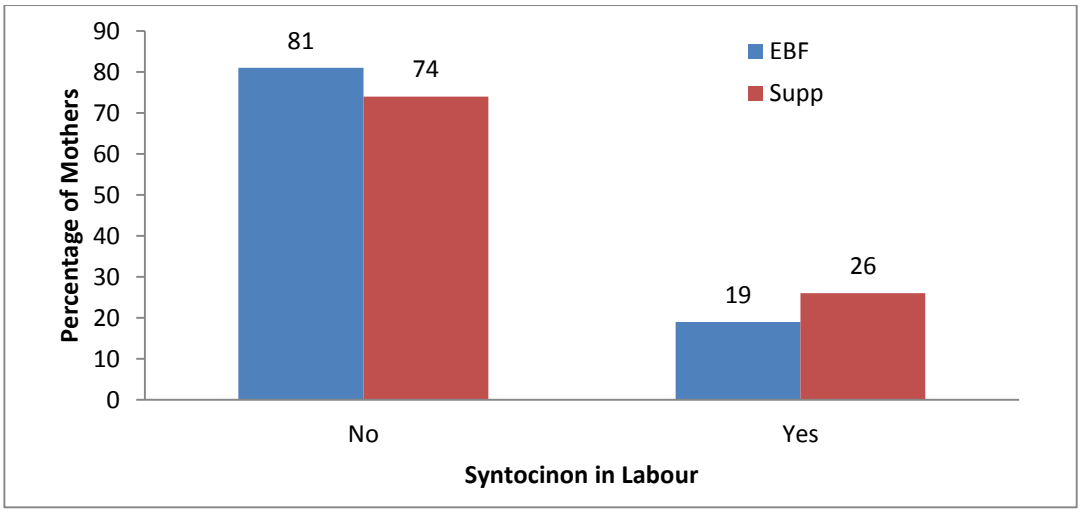

Figure 8. Percentage of mothers exclusively breastfeeding and supplementing by Syntocinon in labour category.

Note: Supp = supplemented, EBF = exclusive breastfeeding.

4.3.2.3 Postpartum Treatment

Postpartum treatment was analysed in five groups. There is evidence of non-independence of postpartum treatment with formula supplementation by Chi-square test ($p = 0.002$). Formula supplementation is lower than expected in the 'None' group and is higher than expected in the 'Both intravenous & intramuscular' group. (The sample sizes for 'Three treatments' and 'Four or more treatments' are too small for useful analysis.) The 'None' group is represented by the 9% of women who had physiological management of third stage with no prophylactic treatment. This was associated with the lowest rate of supplementation (3.8%). The majority of women were treated with either intravenous or intramuscular Syntocinon. Thirty-one percent of women were recorded as having both intravenous and intramuscular Syntocinon. Women having 'Three treatments' are given a third medication as treatment for postpartum bleeding deemed as heavier than normal or are having a postpartum haemorrhage. Women in the 'Four or more treatments' group were treated with more than three medications to control bleeding. The percentage of mothers who supplemented and exclusively breastfed their babies for each postpartum treatment category are shown in Figure 9.

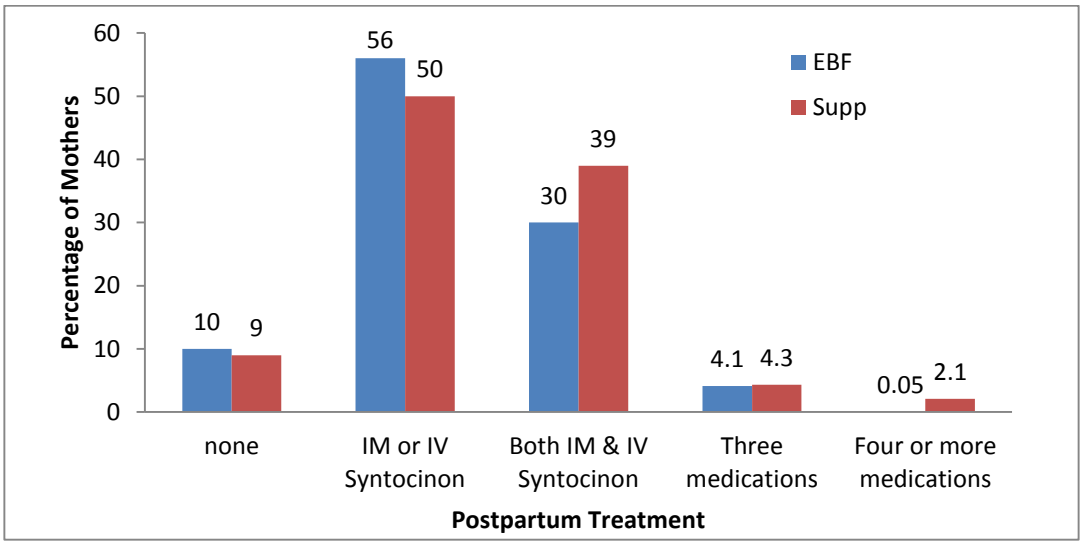

Figure 9. Percentage of mothers exclusively breastfeeding and supplemented by postpartum uterotonic treatment category.

Notes: Supp = supplemented, EBF = exclusive breastfeeding. 'Three medications' indicates the mothers had three types of treatment postpartum and 'Four or more medications' indicates she had four or more types of treatment postpartum.

4.3.2.4 Analgesia Use

Labour or birth analgesia was experienced by 49% of women. Any analgesia was associated with significantly increased rate of formula supplementation (p = 0.003) (Figure 10). Many women had more than one type of analgesia for either labour, birth or both. The frequency of the different types of analgesia used is shown in Figure 11.

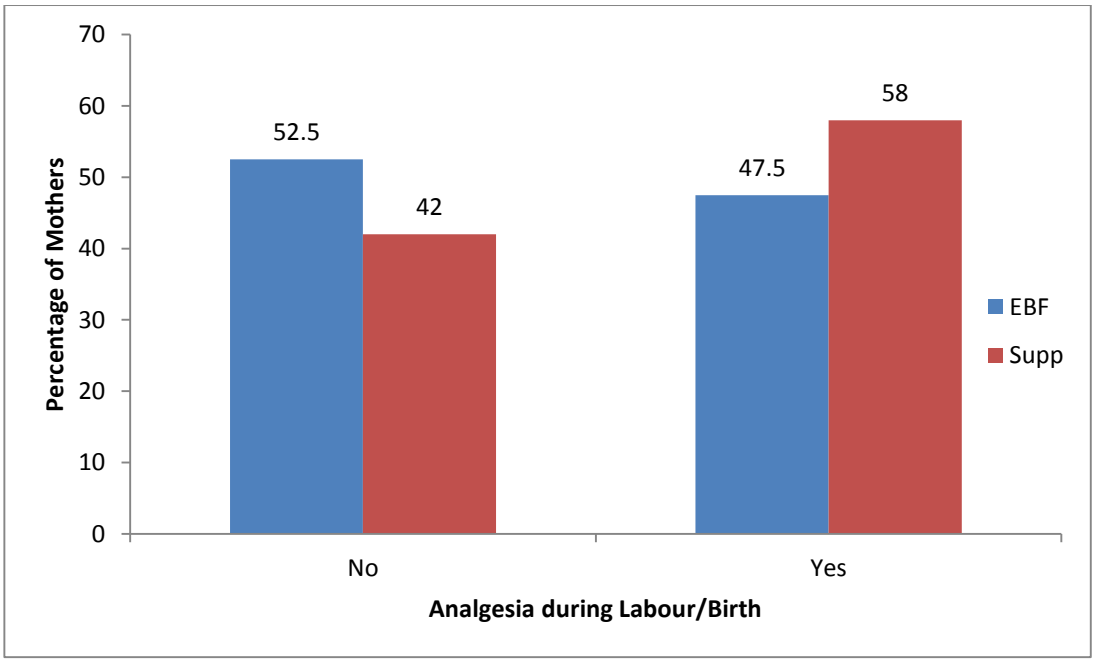

Figure 10. Percentage of mothers exclusively breastfeeding and supplementing according to analgesia use during labour or birth

Note: Supp = supplemented, EBF = exclusive breastfeeding.

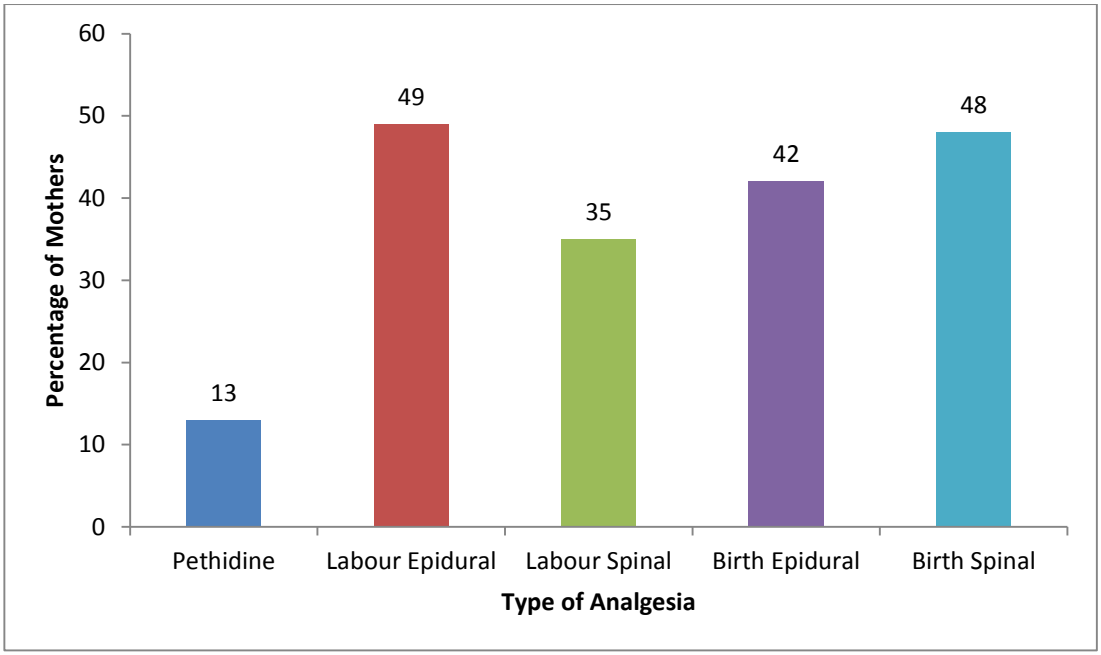

Figure 11. Percentage of analgesia type among mothers who used analgesia during labour or birth.

Note: Multiple types of analgesia may have been used in each case (49% of all cases had more than one type of analgesia).

4.3.3 Infant Characteristics

Table 4.3 presents the infant characteristics in relation to feeding outcome at discharge from hospital. The characteristics examined were gestational age, birth-weight, ethnicity, delay to initial skin-to-skin contact and the duration of skin-to-skin contact. All of these infant characteristics were found to be significant when exclusive breastfeeding and supplemented groups were compared by Chi-square or ANOVA. In each case, the percentage of babies exclusively breastfed or supplemented within a category was determined by using the total exclusive or total supplemented as the denominator in order that the columns each add up to 100%. In this way the similarities between the exclusive column and supplemented column can be compared for similarities and differences. The graphs present this information more visually.

4.3.3.1 Gestational Age

The mean gestational age at birth was 39.6 weeks. There was a small but significant difference between the average gestational ages of the babies exclusively breastfed and those who were supplemented. Mean gestational age for exclusively breastfed babies was 39.7 weeks; mean gestational age for supplemented babies was 39.0 weeks

($p < 0.001$). The frequency distribution of gestational age is shown in Figure 12. There were ten babies recorded > 43 weeks, these outliers are likely to be incorrectly recorded due to estimates of delivery date at time of booking.

4.3.3.2 Birth-weight

The mean infant birth-weight was 3530 grams. There was a significant difference between the mean birth-weights between exclusively breastfed and supplemented babies. Mean birth-weight for exclusively breastfed babies was 3550 grams; mean birth-weight for supplemented 3430 grams ($p = 0.001$).

4.3.3.3 Infant Ethnicity

The association between infant ethnicity and feeding outcome was significant ($Chi^2 = 15.9$, $p = 0.044$). As with the mother's ethnicity, the greatest number of babies was represented by New Zealand European at 72% followed by European (8.9%) and New Zealand Māori (8.4%) with the remaining ethnicities representing less than 2.5%. Feeding outcome by ethnicity is shown in Figure 12. Babies of NZ Maori, Pasifika, Chinese and Other Asian had higher percentages of supplementation compared to NZ European, European and 'not stated' which had higher percentages of exclusively breastfeeding. This was significant by Chi-square ($p = 0.044$) but is statistically unreliable as some of the cells had small numbers.

Table 4-3. Infant characteristics and feeding outcome at discharge

Variable		Exclusive	Supplemented	Chi^2 or F	p value
Feeding at Discharge n (%)	n =1530	1296 (84.7)	234 (15.3)		
Gestation weeks (Mean ± sd)	39.6 ± 1.3	39.7 ± 1.3	39.0 ± 1.5	F= 54.6	p < **0.001**
Birth-weight grams (Mean ± sd)	3530 ±480	3550 ± 460	3430 ± 560	F= 11.1	p = **0.001**
Infant Ethnicity	n (%)	n (%)	n (%)		
NZ European	1101 (72)	936 (72)	165 (71)	Chi^2 = 15.9	p = **0.044**
European	136 (8.9)	124 (9.6)	12 (5.1)		
NZ Māori	129 (8.4)	106 (8.2)	23 (9.8)		
Pasifika	35 (2.3)	26 (2.0)	9 (3.8)		
Chinese	24 (1.6)	18 (1.4)	6 (2.3)		
Indian	20 (1.3)	16 (1.2)	4 (1.7)		
Other Asian	31 (2.0)	22 (1.7)	9 (3.8)		
Other	20 (1.3)	17 (1.3)	3 (1.3)		
Not stated	35 (2.3)	32 (2.5)	3 (1.3)		
Delay to Initial SSC minutes (Mean ± sd)	15 ± 24	14.4 ± 23	18.4 ± 27	F= 5.75	p **= 0.017**
Delay to Initial SSC category	n (%)	n (%)	n (%)	Chi^2 = 4.5	p = 0.21
0 minutes	17 (1.1)	12 (0.93)	5 (2)		
1-5 minutes	950 (62)	820 (63)	130 (56)		
6-30 minutes	248 (16.2)	206 (16)	42 (18)		
31-60 minutes	255 (16.7)	210 (16)	45 (19)		
61+ minutes	60 (3.9)	48 (3.7)	12 (5)		
Duration of SSC in minutes (Mean ± sd)	65 ± 40	67 ± 41	56 ± 32	F= 14.6	p **< 0.001**
Duration of SSC	n (%	n (%	n (%	Chi^2 = 16.4	p = **0.001**
0 minutes	17 (1.1)	12 (0.93)	5 (2)		
1-15 minutes	100 (6.5)	79 (6.1)	21 (9)		
16-30 minutes	181 (12)	145 (11)	36 (15)		
31-60 minutes	755 (49)	631 (49)	124 (53)		
61+ minutes	477 (31)	429 (33)	48 (21)		

Notes: SSC= Skin-to-skin contact between mother and baby within the first 3 hours of birth. All SSC analyses exclude the 17 cases for which 0 minutes was recorded. Sd = standard deviation.

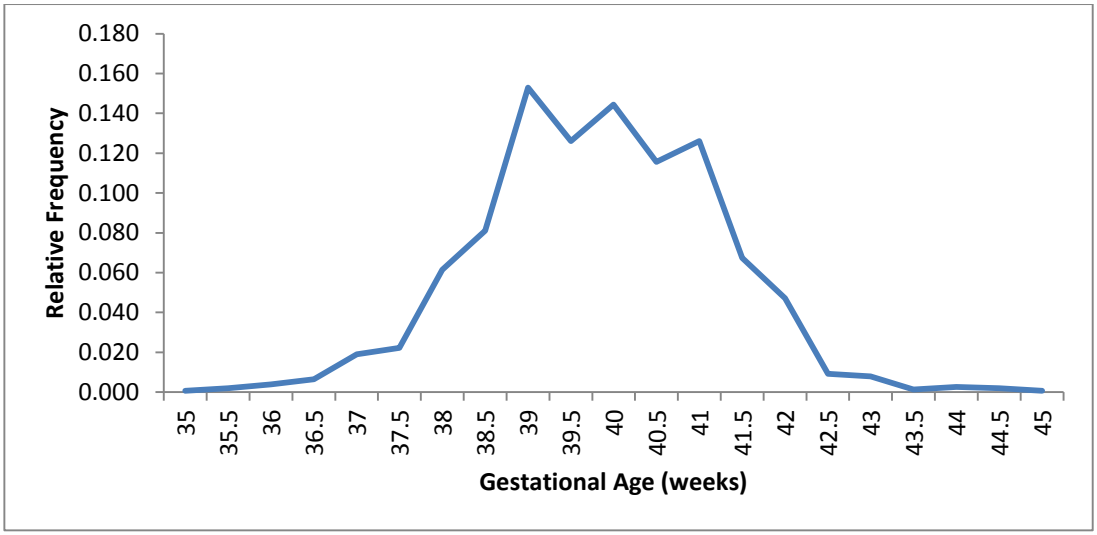

Figure 12. Frequency distribution of gestational age.

Note: Gestation of greater than 43 weeks (n = 10) is likely to be due to recording error.

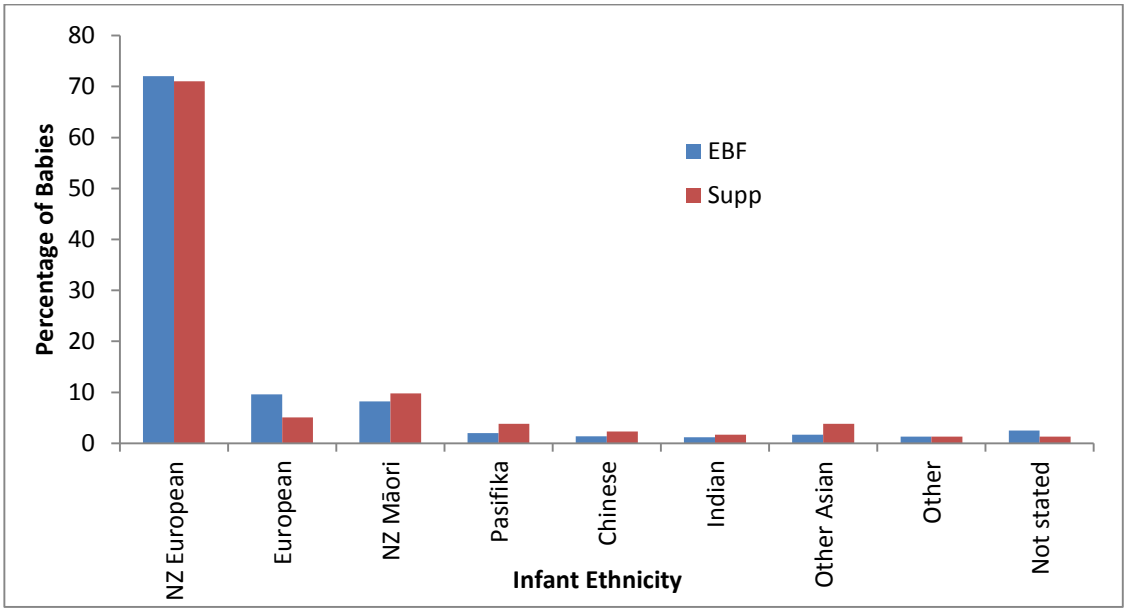

Figure 13. Percentage of babies exclusively breastfeeding and supplemented by infant ethnicity status.

Note: Supp = supplemented, EBF = exclusive breastfeeding.

4.3.3.4 Initiation of Skin-to-Skin Contact

The mean delay to initial skin-to-skin contact at birth was 15 minutes. Most babies (62%) went into skin-to skin contact with their mothers within 5 minutes of birth and 78% were having skin-to-skin contact within 30 minutes of birth. Time until the initial

skin-to-skin contact between mother and baby at birth for supplemented versus exclusively breastfed babies was significantly different (mean initiation time for supplemented was 18.4 minutes; mean initiation time for exclusively breastfed was 14.4 minutes (p = 0.017) (See Table 4.3). Thus babies who were exclusively breastfeeding on discharge had, on average, shorter delays to initial skin-to-skin contact than did babies who were supplemented during the hospital stay.

There were 17 cases where skin-to-skin initiation was recorded as 0. It is unknown whether these had no skin-to-skin at birth or it was not recorded. The number in this category is statistically too small to be used as a reference group and was not included in the analysis.

When skin-to-skin initiation was analysed in time-frame categories, there was no significant difference between the groups. However, there appears to be a simple linear trend, with the probability of exclusive breastfeeding decreasing with increasing delay in skin-to-skin initiation (Figure 14). The observed trend does not reach significance by logistic binary regression (pModel = 0.128; no pairwise comparisons significant). Thus, further analysis was carried out.

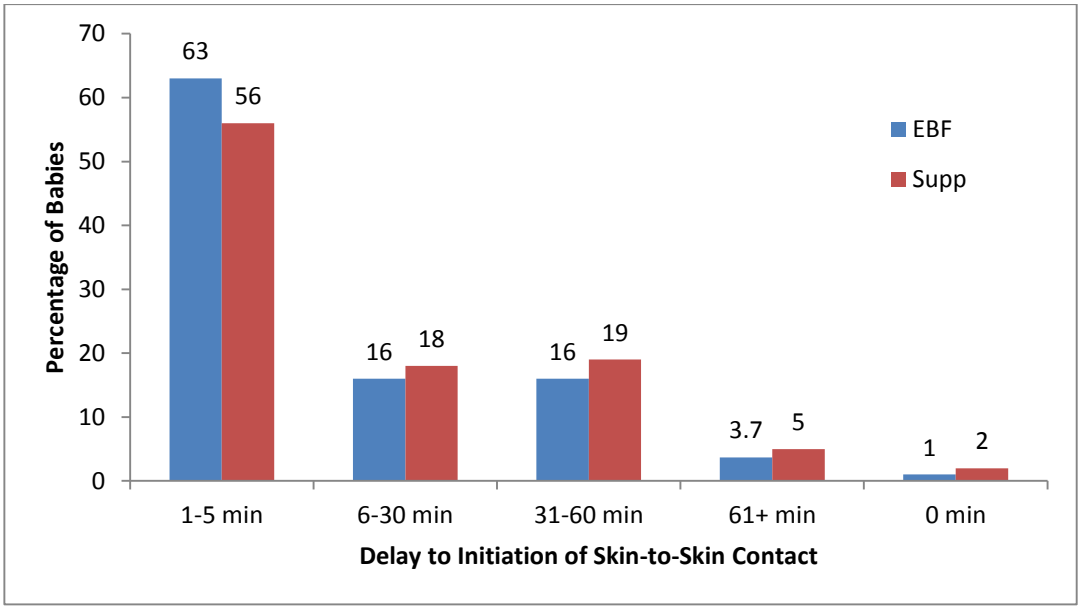

Figure 14. Percentage of infants exclusively breastfeeding by initial skin-to-skin contact delay categories.

Notes: 0 min indicates no values were recorded, Supp = supplemented, EBF = exclusive breastfeeding.

An alternative categorisation of skin-to-skin contact delay is by the peak values that can be seen in a frequency distribution of skin-to-skin data (Figure 15). It is clear that midwives tend to round to certain time values, as shown by the modes at 1, 5, 10 minutes, etc. With these recording peaks as category boundaries, the distribution of probability of exclusive breastfeeding by category is more complex (Figure 16).

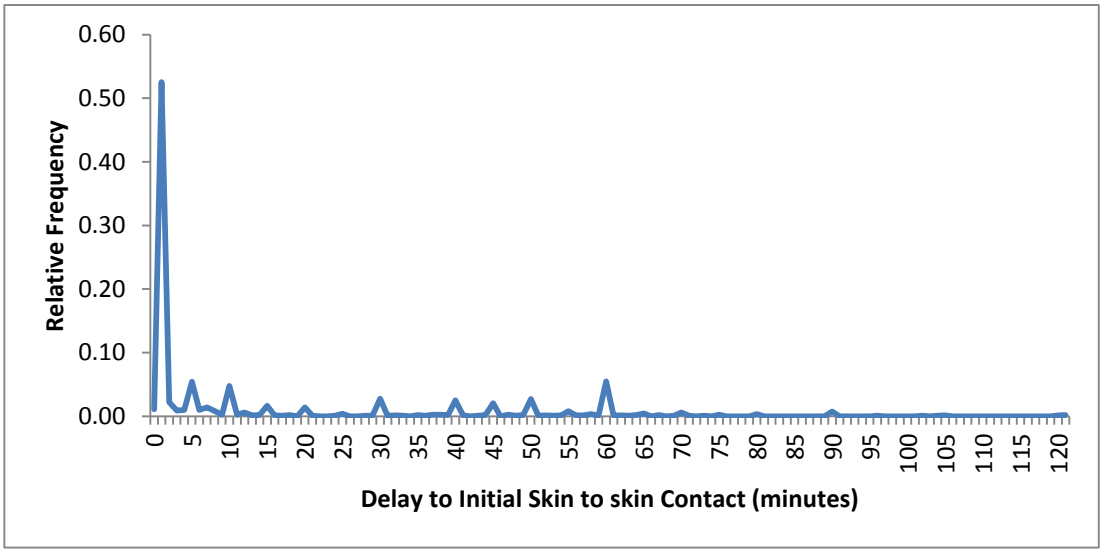

Figure 15. Frequency distribution of initial skin-to-skin contact delay in five minute intervals.

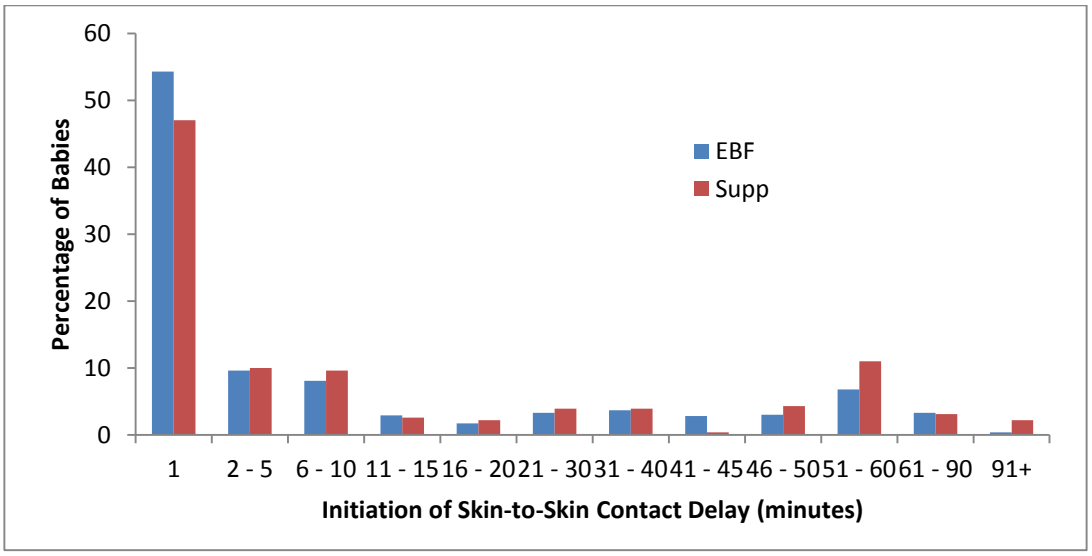

Figure 16. Percentage of babies exclusively breastfed and supplemented by recording peak of initial skin-to-skin contact delay.

Note: Supp = supplemented, EBF = exclusive breastfeeding.

With this categorization, the single predictor model is significant (p = 0.03), and three pairwise comparisons with the reference category of 1 minute are of interest:

- 41 - 45 minutes. OR = 0.18; p = 0.093 (1/37 supplemented)
- 51 - 60 minutes. OR = 1.87; p = 0.012 (25/112 supplemented)
- 91+ minutes. OR = 6.51; p = 0.003 (5/10 supplemented)

That is, delays of 51-60 and 91+ minutes are associated with a significant increase in the odds of supplementation, as expected. However, a delay of 41-45 minutes is associated with a very *large decrease* in the odds of supplementation (OR = 0.18) relative to the reference category of 1 minute. Of the 37 cases in the 41-45 minutes category, only 1 (3%) was recorded as having been supplemented. (Although the pairwise comparison does not reach significance (p = 0.093) the effect is so distinct that it would most likely be significant with a larger sample size.) This proportion is by far the smallest of any category and considerably smaller than the proportion of supplementation across the entire sample (15.3%). The women in this category had the following birth methods:

- Normal Vaginal 0
- Ventouse 1
- Forceps 3
- Elective C/S 14
- Emergency C/S 19

For these women, the delay in initial skin-to-skin contact was not associated with formula supplementation.

The delay to initial skin-to-skin contact was significantly different between birth methods ($p < 0.01$) (Figure 17). There is a considerable delay in the initiation of skin-to-skin contact at caesarean births compared to vaginal births.

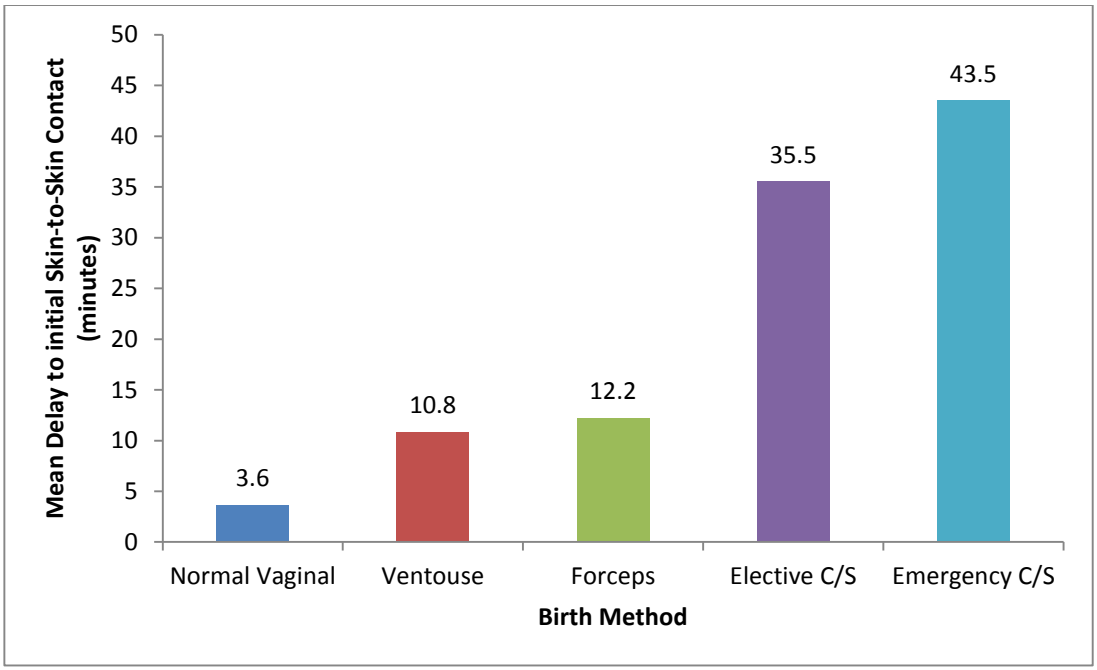

Figure 17. Mean delay to initial skin-to-skin contact between mother and baby by birth method.

There were significant differences between the maternal ethnicities when analysed by initial skin-to-skin contact delay category as presented in Figure 18 ($Chi^2 = 38.7$, $p = 0.03$). Mothers of Chinese ethnicity had a higher percentage of immediate (within 5 minutes) skin-to-skin contact compared to other ethnicities and mothers of Pasifika and Other Asian ethnicities had slightly longer delays to initial skin-to-skin contact. The 0 minutes category ($n = 17$) was excluded from the analysis.

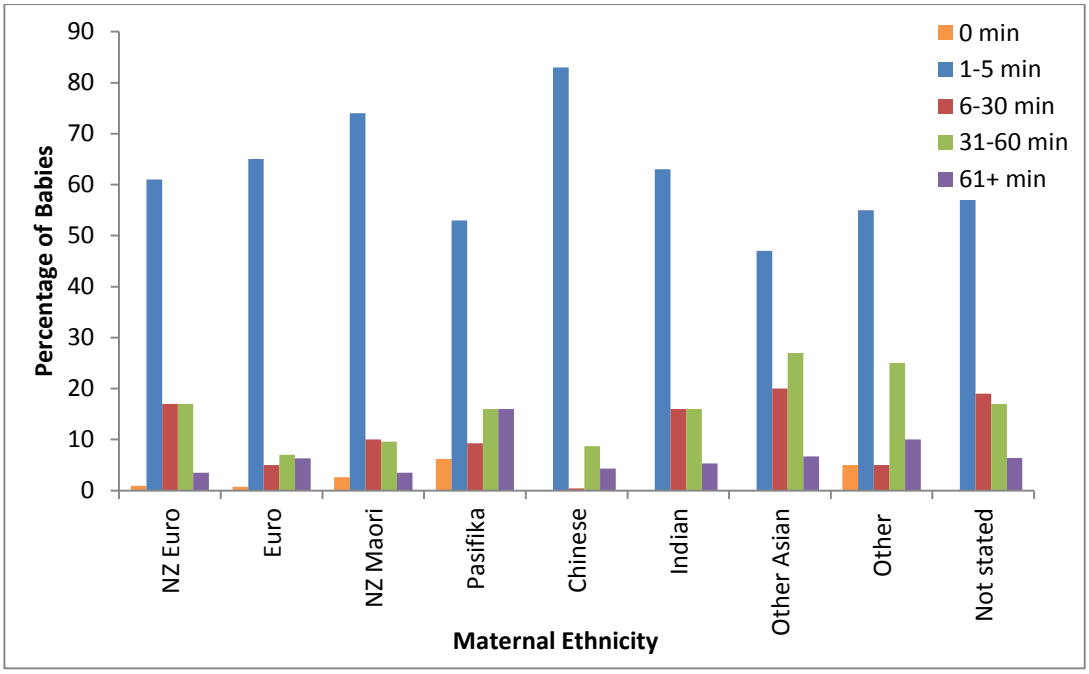

Figure 18. Percentage of babies within initial skin-to-skin contact delay categories by maternal ethnicity.

Notes: min = minutes delay to initial skin to skin contact between mother and baby at birth. 0 min indicates no values were recorded.

4.3.3.5 Duration of Skin-to-Skin Contact

The mean duration of skin-to-skin contact time between mother and baby at birth was 65 minutes. The mean duration for supplemented versus exclusively breastfed babies was significantly different (mean duration for supplemented babies was 56 minutes; mean duration for exclusively breastfed babies was 67 minutes ($p < 0.001$) (Table 4.3). Thus babies who were supplemented had, on average, shorter first skin-to-skin contact duration than did babies who were exclusively breastfed during the hospital stay.

Analysed in time-frame categories, breastfeeding status and duration of skin-to-skin contact at birth are not independent ($Chi^2 = 16.4$, $p = 0.001$) (Figure 19); thus a duration of skin-to-skin contact of at least an hour at birth was associated with lower rates of supplementation.

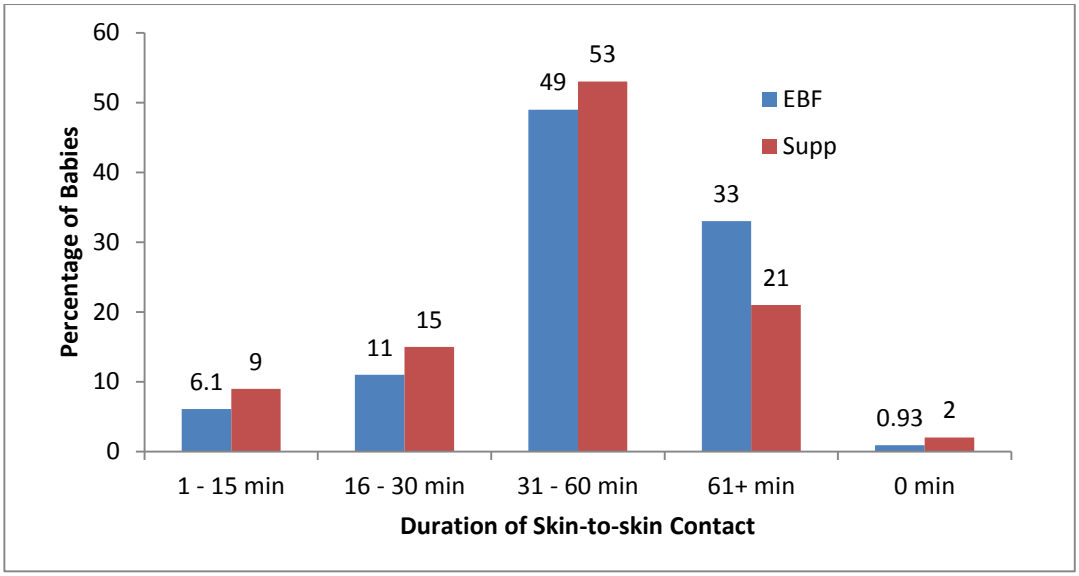

Figure 19. Percentage of babies exclusively breastfed and supplemented by duration of skin-to-skin time at birth in time-frame categories.

Note: 0 min indicates no values were recorded. Supp = supplemented, EBF = exclusive breastfeeding.

The mean duration of skin-to-skin contact by birth method is significantly different (F=2.58, p = 0.04). However, the significance is between the longest (ventouse) and the shortest (forceps) and this is probably not of clinical significance as it is a matter of only a few minutes between the various birth methods (Figure 20).

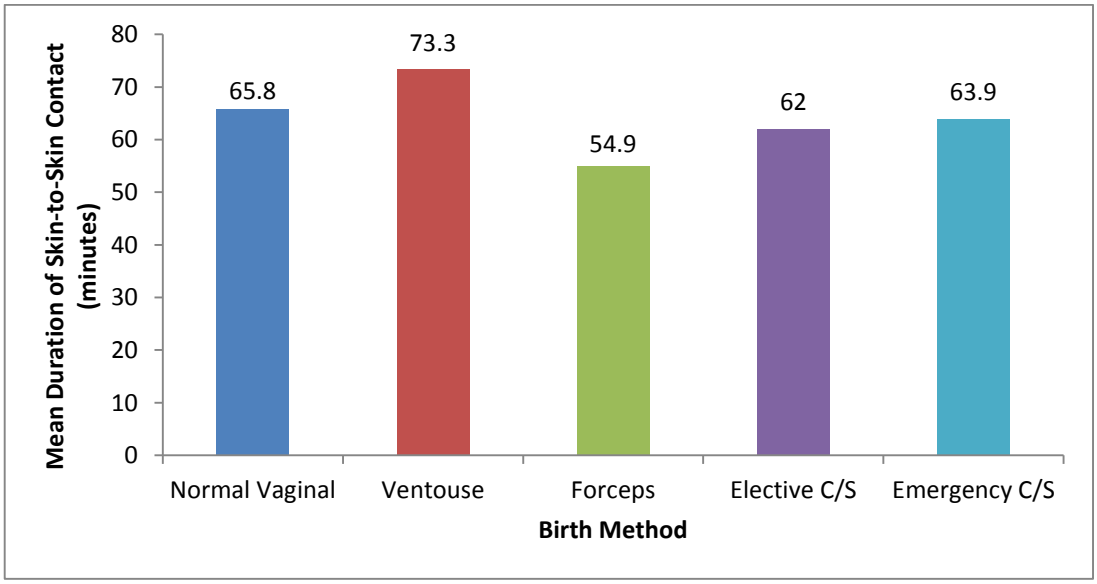

Figure 20. Mean duration of initial skin-to-skin contact by birth method.

There were no significant differences found between the maternal ethnicities with regard to the duration of skin-to-skin contact between mother and baby at birth ($Chi^2 = 28$, $p = 0.24$).

4.3.4 Summary of Initial Analysis

In summary, the data from 1530 mother-baby pairs were analysed. Fifteen percent of breastfed babies were supplemented with infant formula during the hospital stay. Supplementation was significantly associated with maternal BMI, parity, use of Syntocinon in labour, postpartum treatment with Syntocinon or other uterotonic, birth method, use of analgesia during labour and birth, infant gestation, infant ethnicity, birth-weight, initiation of skin-to-skin contact at birth and duration of skin-to-skin contact at birth. Maternal age, smoking status and maternal ethnicity were not significantly associated with supplementation.

4.4 LOGISTIC REGRESSION

The results of the logistic regression analysis are presented in Table 4.4. Unadjusted odds ratios (OR) are provided by the bivariate analysis where each variable is entered into the logistic regression analysis one at a time. Ethnicity was not included in the regression analysis because the ethnicities other than NZ European were represented by comparatively small numbers and were statistically unreliable.

4.4.1 Age

Maternal age was not a significant predictor of formula supplementation.

4.4.2 BMI

Treated as a continuous variable, BMI is a significant predictor of formula supplementation (OR = 2.19; p = 0.023). Thus each unit increase in BMI is associated with an increase in odds of supplementing by a factor of 2.19. When analysed in categories, being in the overweight or obese categories was associated with increased odds of formula supplementation. With normal as the reference category, the pairwise comparisons with the overweight (OR = 0.66; p = 0.014) and obese (OR = 0.65; p = 0.03) categories are significant (see Table 4.4).

There were some significant interactions between BMI and other variables. Ethnicity has already been mentioned, also BMI and initiation of skin-to-skin by category ($Chi^2 = 28$, $p = 0.006$) that is, there was increasing delay to initial skin-to-skin contact as the

BMI of the mothers increased. BMI and birth method also showed a positive interaction (Chi^2 = 30, p = 0.016). Mothers of high BMI (≥30) had higher rates of caesarean birth than mothers of normal BMI (<30) (34% compared to 25%).

4.4.3 Smoking

By bivariate logistic regression, pairwise comparisons with 'never smoked' as the reference category, there was no association between smoking and supplementation (pModel = 0.39) (see Table 4.4). That is, the odds of supplementing or exclusive breastfeeding at discharge seem to be approximately equal for all smoking status categories (Figure 4). The observed low proportion of exclusive breastfeeding for the "Gave up ≤ 4 months ago" group represents only 16 cases (of the 1530 total) and is not statistically reliable.

4.4.4 Parity

With parity 0 (mothers having their first child) as a reference category, the binary logistic regression model is significant (pModel = 0.002). Pairwise comparisons with parities 1 and 3 reached significance (see Table 4.4). Parity of 1 (women having their second baby) and parity of 3 (women having a fourth baby was associated with significantly decreased odds of supplementation (OR = 0.58; p = 0.001 and OR = 0.31; p = 0.028 respectively). Parity was regrouped into primiparous and multiparous and reanalysed. The results are shown in Table 4.5. Multiparity is associated with a significant reduction in formula supplementation (OR = 0.65; p = 0.003).

4.4.5 Birth Method

Birth method was a significant predictor of supplementation by logistic regression (pModel < 0.001). All birth methods other than normal vaginal were associated with increased odds of supplementation during the hospital stay (see Table 4.4). Pairwise comparison with normal as a reference reveals significance for emergency caesarean only (Table 4.4). Compared to normal vaginal delivery, other birth methods were associated with an increased odds of formula supplementation but only birth by emergency caesarean reaches significance (p = 0.001) with an odds ratio of 1.93.There were low numbers in the ventouse (6.7%) and forceps (4.3%) which may have contributed to the non-significance.

Table 4-4. Bivariate analysis: Unadjusted odds ratios for formula supplementation

Variable	Unadjusted OR	95% Confidence Interval	P
Age	0.99	0.97 -1.02	0.57
BMI (continuous)	2.19	1.12 – 4.28	**0.023**
Underweight	1.39	0.66 – 2.92	0.39
Normal (ref)	1.00		
Overweight	1.52	1.09 -2.13	**0.014**
Obese	1.54	1.04 – 2.29	**0.030**
High Risk Obese	1.39	0.56 – 3.41	0.48
Parity			
0 (ref)	1.00		
1	0.57	0.42 - 0.79	**0.001**
2	0.94	0.63 – 1.41	0.78
3	0.31	0.11 – 0.88	**0.028**
4+	1.01	0.41 – 2.52	0.98
Smoking status			
Never (ref)	1.00		
Quit >4mo	1.19	0.82 – 1.75	0.36
Quit ≤4mo	1.89	0.60 - 5.94[1]	0.28
Current	0.82	0.53 – 1.28	0.39
Birth Method			
Normal (ref)	1.00		
Ventouse	1.59	0.93 – 2.71	0.09
Forceps	1.70	0.89 – 3.22	0.10
Elective C/S	1.40	0.93 – 2.1	0.10
Emergency C/S	1.93	1.33 – 2.79	**0.001**
Analgesia			
No analgesia (ref)	1.00		
Analgesia	1.54	1.16 – 2.04	**0.003**
Syntocinon Augmentation No (ref)	1.00		
Yes	1.46	1.06 – 2.03	**0.024**
Postpartum Treatment none (ref)	1.00		
Syntocinon IV or IM	2.39	1.18 – 4.82	**0.015**
Syntocinon both & IM & IV	3.48	1.71 – 7.09	**0.001**

[1] n = 12 causing the wide CI

IV & IM + alternative meds	3.64	1.51 – 8.78	**0.004**
Gestation	0.67	0.60 – 0.75	**0.001**
Birth-weight (continuous)	0.99	0.99- 1.0001	**0.001**
Birth weight category			
<2500 g	19.5	6.29 – 60.79	**0.000**
2500-2999 g	1.4	0.90 – 2.17	0.14
3000-3499 g (ref)	1.00		
3500-3999 g	0.78	0.55 – 1.11	0.17
4000+ g	0.91	0.60 – 1.38	0.66
Delay to Initial SSC (continuous)[2]	1.01	1.001 – 1.01	**0.018**
Delay to Initial SSC categorical			
1-5 minutes (ref)	1.00		
6-30 minutes	1.29	0.88 – 1.88	0.19
31-60 minutes	1.35	0.93 – 1.96	0.11
61+ minutes	1.58	0.816 – 3.05	0.18
Duration of SSC continuous	0.99	0.986 – 0.99	**0.001**
Duration of SSC categorical			
1-15min (ref)	1.00		
16-30min	0.93	0.51 – 1.71	0.82
31-60min	0.74	0.44 – 1.24	0.25
61+min	0.42	0.24 – 0.74	**0.003**

Notes: SSC= Skin-to-skin contact between mother and baby within the first 3 hours of birth
[2] All SSC analyses exclude the 17 cases for which 0 minutes was recorded.

4.4.6 Analgesia

Mothers who received analgesia had greater odds of supplementation than did mothers who received no analgesia. This effect is significant by logistic regression (pModel = 0.003). With No Analgesia as reference category, the logistic regression gives an odds ratio for Analgesia of 1.57. That is, receiving analgesia is associated with an increase in odds of supplementation by a factor of 1.57. An interaction of analgesia and gestation was found (OR = 1.2, 95% CI = 1.004 - 1.45, p = 0.045) thus the earlier the gestation the less likely the use of analgesia.

4.4.7 Syntocinon

Use of Syntocinon in labour was a significant predictor of supplementation (OR 1.46; p = 0.024). Postpartum treatment with Syntocinon or other uterotonic was also a strong predictor of supplementation with increasing treatment modalities associated with increased odds of formula supplementation. Compared to having physiological third

stage (no treatment), treatment with intravenous or intramuscular Syntocinon was associated with 2.39 odds for formula supplementation (p = 0.015). Having both intravenous and intramuscular Syntocinon was associated with 3.48 odds for supplementation (p = 0.001) and having additional treatments was associated with an odds of 3.64 for supplementation (p = 0.004).

4.4.8 Gestation

Gestational age is a significant predictor of formula supplementation (OR = 0.67). Thus each unit increase in gestational age (1 week) is associated with a decrease in the odds of formula supplementation by a factor of 0.67.

4.4.9 Birth-weight

Birth-weight is a significant predictor of supplementation (OR = 0.99; p = 0.001). Thus each one gram increase in birth weight is associated with a decrease in the odds of supplementation by a factor of 0.99. When analysed in categories, only birth-weight of less than 2,500g was a significant predictor of supplementation.

4.4.10 Initiation of Skin-to-Skin Contact

Initiation of skin-to-skin contact as a continuous variable is a significant predictor of supplementation (OR = 1.01; p = 0.018) (see Table 4.4). Thus each minute increase in delay to initial skin-to-skin contact is associated with an increase in the odds of supplementation by a factor of 1.01. Analysis of categories has been shown previously. In order to further explore different time frame categories, analysis was performed on the data in fifteen minute intervals. Additional analysis in fifteen minute intervals is shown in Table 4.5.

Table 4-5. Odds ratios for formula supplementation and parity analysed in two groups and skin-to-skin initiation delay analysed by fifteen minute intervals.

Variable	Unadjusted OR	95% Confidence Interval	p
Parity 0/More			
0 (ref)	1.00		
1+	0.65	0.50 – 0.86	**0.003**
Delay to Initial SSC			
1-15 (ref)	1.00		
16-30	1.29	0.71 – 2.35	0.41
31-45	0.71	0.36 – 1.35	0.32
46-60	1.66	1.10 – 2.50	**0.016**
61-75	1.55	0.66 – 3.60	0.31
76-90[1]	---	---	---
91+	5.97	1.71 – 20.8	**0.005**

Notes: SSC= Skin-to-skin contact between mother and baby within the first 3 hours of birth. All SSC analyses exclude the 17 cases for which 0 minutes was recorded.

[1] All subjects in this interval (n=16) were in the same Formula Supplementation category (Formula Supp = 0), so the Odds Ratio is undefined.

When analysed in 15 minute intervals, there is a trend for increasing odds of formula supplementation except for the dip at 45 minutes as was found previously when analysed by frequency peak however now it is non-significant. Significance is seen at the 46-60 minute interval which is associated with an increased odds of formula supplementation (OR 1.66; p = 0.016). Having a delay of greater than 91 minutes was associated with a large increase in odds of supplementing (OR 5.97; p = 0.005).

4.4.11 Duration of Skin-to-Skin Contact

As a continuous covariate, duration of skin-to-skin is a significant predictor of supplementation (OR = 0.99; p < 0.001). Thus each increase in the duration of skin-to-skin contact is associated with a reduction in the odds of supplementation by a factor of 0.99.

The logistic regression (Table 4.4) shows a simple linear trend. The model overall is significant (pModel < 0.001). Pairwise comparisons with the reference category of 1-15 minutes are as expected, showing decreased odds of supplementation with increasing duration time; however only 61+ minutes is significantly different (OR = 0.42; p < 0.003) (see Table 4.4).

4.5 MULTIPLE REGRESSION MODELLING

4.5.1 Predictors of Formula Supplementation

Table 4.6 presents the multiple regression analysis using the variables which were significant ($p \leq 0.05$) in the prior bivariate regression analysis from Table 4.4. Adjusted odds ratios (aOR) are provided by the multivariate analysis where all the chosen variables are entered into the logistic regression analysis together at the same time. This 'adjusts' the odds ratios for the effects of potential interactions between the variables. This provides a model of the most significant predictors of formula supplementation. From Table 4.6, the most significant predictors are BMI category of overweight, parity of 0, younger gestation, shorter duration of skin-to-skin and having any form of postpartum treatment.

In this model, birth method, analgesia use, birth weight, initiation of skin-to-skin contact and Syntocinon use in labour are no longer significant.

Table 4-6. Multiple logistic regression model showing adjusted odds for formula supplementation (adjusted for all variables in table).

Variable		Adjusted OR	95% Confidence Interval	p-Value
BMI	Underweight	1.37	0.62 – 3.01	0.430
	Normal (ref)	1.00		
	Overweight	1.61	1.13 – 2.31	**0.009**
	Obese	1.47	0.97 – 2.23	0.071
	High Risk Obese	1.12	0.43 – 2.91	0.815
Parity	*0 (ref)*	1.00		
	1	0.59	0.41 – 0.86	**0.005**
	2	0.86	0.55 – 1.36	0.523
	3	0.22	0.07 – 0.75	**0.016**
	4+	1.15	0.42 – 3.15	0.787
Birth Method	*Normal*(ref)	1.00		
	Ventouse	1.19	0.64 – 2.22	0.580
	Forceps	1.06	0.51 – 2.19	0.883
	Elective C/S	0.79	0.41 – 1.50	0.465
	Emergency C/S	1.23	0.67 – 2.23	0.505
Analgesia	*No analgesia (ref)*	1.00		
	Analgesia	1.22	0.79 – 1.9	0.367
Syntocinon Augmentation	*No (ref)*	1.00		
	Yes	1.15	0.78 – 1.7	0.483
Postpartum treatment	*none (ref)*	1.00		
	Syntocinon IM or IV	2.83	1.19 – 6.73	**0.018**
	Syntocinon IM & IV	3.76	1.51 – 9.36	**0.004**
	Three or more meds	4.19	1.49 – 11.81	**0.007**
Gestation		0.66	0.59 – 0.75	**<0.001**
Birth Weight		1.00	1.00 – 1.00	0.517
Initiation of SSC		0.99	0.99 – 1.01	0.813
Duration of SSC		0.99	0.99 – 0.99	**<0.001**

Notes: SSC= Skin-to-skin contact between mother and baby within the first 3 hours of birth. All SSC analyses exclude the 17 cases for which 0 minutes was recorded.

4.5.2 Predictors of Formula Supplementation - Caesarean Births

Table 4.7 shows the adjusted odds ratios for formula supplementation for caesarean births only. Variables which were included for all birth types were included in the analysis. For caesarean births, the significant predictors of formula supplementation were decreasing parity (aOR = 0.61, 95% CI = 0.43 – 0.86, p = 0.005) decreasing gestation (aOR = 0.51, 95% CI = 0.39 – 0.66, p < 0.001) and decreasing duration of skin-to-skin contact (aOR = 0.99, 95% CI = 0.98 – 0.99, p = 0.004). The delay in initial skin-to-skin contact between mother and baby at birth was not a significant predictor of formula supplementation for these mother-baby pairs (p = 0.33)

Table 4-7. Multiple logistic regression model showing adjusted odds ratios for formula supplementation for caesarean births (adjusted for all variables in table).

Variable	Adjusted Odds ratio	95% Confidence Interval	p-Value
BMI continuous	0.97	0.93 – 1.02	0.28
Parity	0.61	0.43 – 0.86	**0.005**
Syntocinon Augmentation	1.35	0.65 – 2.78	0.42
Postpartum Treatment	1.3	0.82 – 2.06	0.27
Gestation	0.51	0.39 – 0.66	**<0.001**
Birth-weight	0.99	0.99 – 1.00	0.36
Initiation of SSC continuous	1.01	0.99 – 1.01	0.33
Duration of SSC continuous	0.98	0.98 – 0.99	**0.004**

Notes: SSC= Skin-to-skin contact between mother and baby within the first 3 hours of birth. All SSC analyses exclude the 17 cases for which 0 minutes was recorded.

4.5.3 Summary of Regression Analysis

Results of the bivariate logistic regression analysis revealed that the significant predictors for supplementation were BMI (overweight and obese categories), primiparity, birth method (emergency caesarean), analgesia during labour/birth, Syntocinon during labour, use of postpartum uterotonics, gestation, birth-weight of less than 2500 grams, delayed initiation of skin-to-skin contact, and a duration of skin-to-skin contact of less than one hour.

Results of the multiple logistic regression analysis indicated the strongest predictors of formula supplementation were BMI category of overweight, primiparity, use of Syntocinon and other uterotonics postpartum, gestation, and duration of skin-to-skin contact.

For caesarean births, the results indicate that parity, gestation and duration of skin-to-skin contact are important predictors of formula supplementation for these mothers and babies.

4.6 Reasons for Formula Supplementation

Out of the 234 breastfed babies who were supplemented during the hospital stay, there were 170 who had recorded reasons and there were 64 (27%) with no recorded reason, these were included in all the analyses as reason 'not recorded'. The prevalence of these reasons is shown in Figure 21. Multiple reasons could be chosen therefore the total percentage is greater than 100. The most common reason recorded was 'delayed lactation' (n = 66, 28%) followed by 'maternal request' (n = 54, 23%) and 'hypoglycaemia' (n = 48, 21%). Other categories were less common at 7.7% and less.

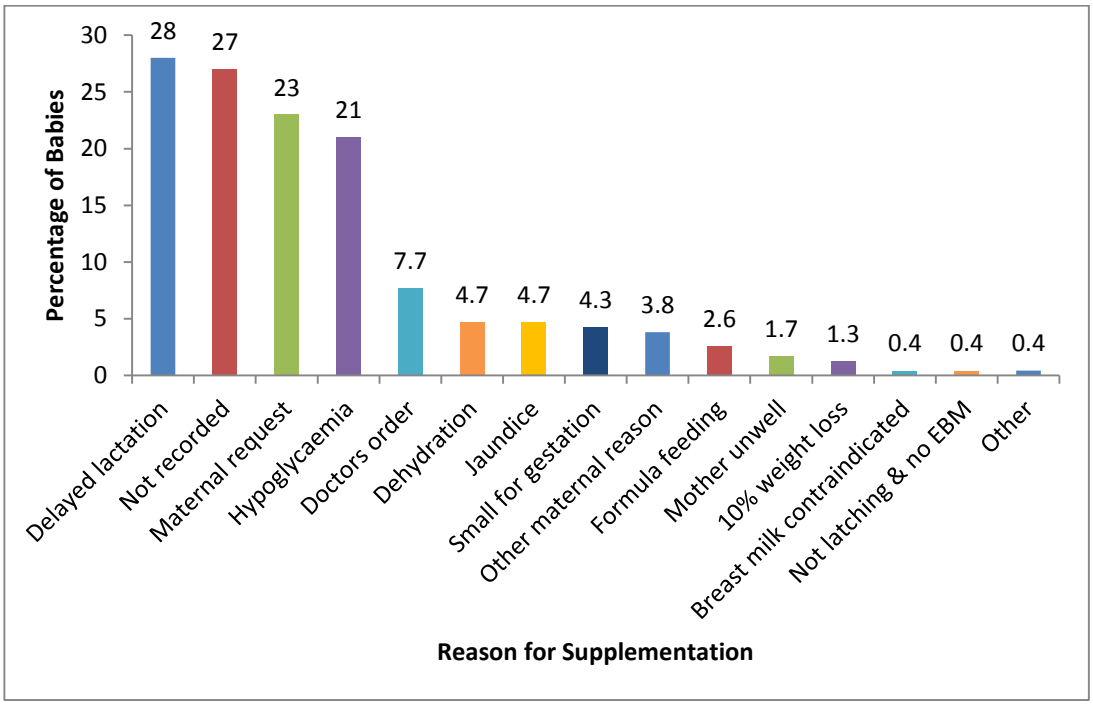

Figure 21. Percentage of babies supplemented according to reason for supplementation (n=234).

Note: No EMB= no lactation/no expressed breastmilk (EBM) available.

Most cases where the baby was supplemented and the reason was recorded, there was one reason recorded for supplementation while the remainder recorded two or more reasons (Figure 22).

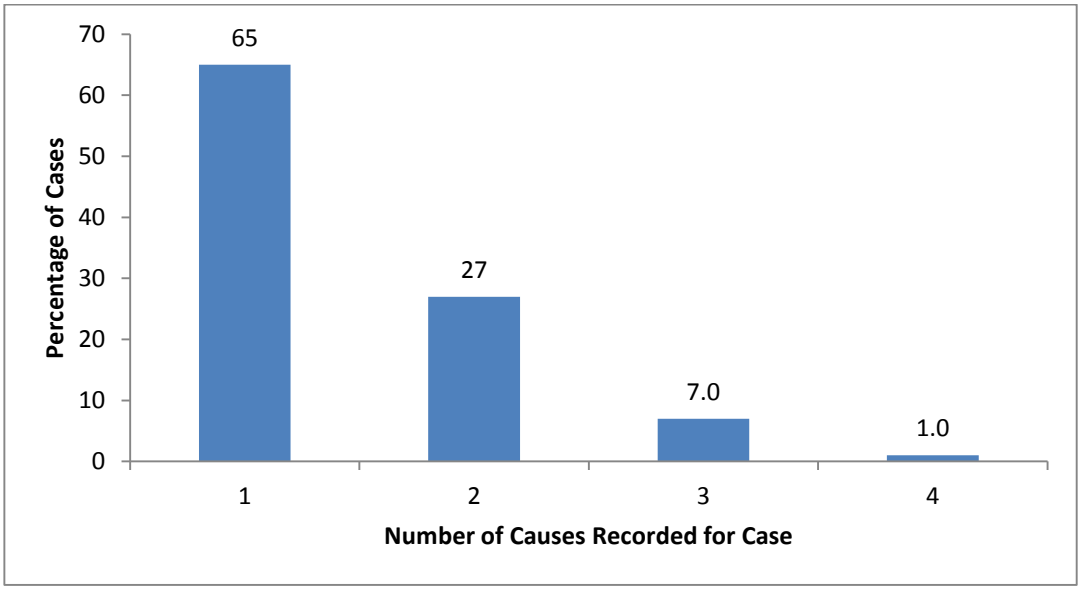

Figure 22. Number of causes recorded for each case of supplementation (n = 234).

The reasons for supplementation were analysed against the data from mother-baby pairs by Chi-square and bivariate logistic regression for all maternal, birth and infant variables. A summary of the analysis and the relationship with maternal, birth and infant variables is shown in Table 4.8. The significant ($p > 0.05$) results are in bold. Variables were analysed as continuous variables or in categories previously described. Birth-weight was divided into categories in 500 gram increments.

Table 4-8. Summary of statistics for the reasons for supplementation analysed by maternal, birth and infant variables.

Variable	Delayed Lactation n = 66	Maternal Request n = 54	Hypoglycaemia n = 48	Not recorded n = 64
Maternal age (continuous)	OR = 1.04 95% CI = 0.99-1.09 p = 0.14	**OR = 0.91** **95% CI = 0.86-0.97** **p = 0.002**	OR = 1.02 95% CI = 0.97-1.08 p = 0.44	OR = 0.97 95% CI = 0.92-1.02 p = 0.22
BMI (continuous)	OR = 0.99 95% CI = 0.95-1.05 p = 0.96	OR = 0.99 95% CI = 0.94-1.05 p = 0.79	OR = 1.04 95% CI = 0.99-1.09 p = 0.14	OR = 0.98 95% CI = 0.93-1.03 p = 0.38
BMI (category)	Chi^2 = 2.4 p = 0.67	Chi^2 = 2.7 p = 0.62	Chi^2 = 5.8 p = 0.21	Chi^2 = 5.4 p = 0.25
Parity (continuous)	**OR = 0.66** **95% CI = 0.46-0.96** **p = 0.028**	OR = 0.82 95% CI = 0.58-1.17 p = 0.28	OR = 1.14 95% CI = 0.83-1.56 p = 0.42	OR = 1.17 95% CI = 0.89-1.53 p = 0.26
Maternal ethnicity	Chi^2 = 5.8 p = 0.67	Chi^2 = 13 p = 0.13	Chi^2 = 12 p = 0.15	Chi^2 = 9.7 p = 0.29
Syntocinon in labour	Chi^2 = 0.38 p = 0.54	Chi^2 <0.01 p = 0.99	Chi^2 = 0.75 p = 0.39	Chi^2 = 1.3 p = 0.25
Postpartum treatment	Chi^2 = 4.9 p = 0.30	Chi^2 = 2.5 p = 0.65	Chi^2 = 4.8 p = 0.31	Chi^2 = 8.9 p = 0.064
Birth method	**Chi^2 10.1, p= 0.038**	Chi^2 = 3.6, p = 0.46	Chi^2 = 1.7, p = 0.78	Chi^2 = 6.1, p = 0.19
Analgesia use	**Chi^2 = 4.7, p = 0.03**	Chi^2 = 0.09,p = 0.76	**Chi^2 = 5.1, p= 0.024**	Chi^2 = 0.4, p = 0.51
Gestation (continuous)	OR = 0.97 95% CI = 0.79-1.2, p = 0.81	OR = 1.12 95% CI = 0.89-1.40 p = 0.32	**OR = 0.58** **95% CI = 0.44-0.76** **p <0.001**	OR = 1.06 95%CI = 0.87-1.3 p = 0.58
Birth-weight (continuous)	OR = 0.99 95% CI 0.99-1.00 p = 0.25	OR = 1.001 95%CI = 0.99-1.001 p = 0.078	OR = 0.99 95% CI = 0.99-1.00 p = 0.63	OR = 0.99 95% CI = 0.99-1.00 p = 0.26
Birth-weight (category)	ns	ns	**Chi^2 = 15, p = 0.011**	ns
Infant ethnicity	Chi^2 = 4.4, p = 0.82	Chi^2 = 11, p = 0.21	Chi^2 = 9.3, p = 0.32	Chi^2 = 8.6, p = 0.38
Initiation of skin-to-skin (continuous)	OR = 0.99 95% CI = 0.99- 1.01 p = 0.64	OR = 1.001 95% CI = 0.99-1.01 p = 0.29	OR = 0.99 95%CI = 0.97-1.001 p = 0.076	OR = 0.99 95%CI = 0.98-1.003 p = 0.13
Initiation of skin-to-skin (category)	**Chi^2 = 13**, **p = 0.005**	Chi^2 = 3.3 p = 0.35	Chi^2 = 4.2 p = 0.24	Chi^2 = 3.8 p = 0.29
Duration of skin-to-skin (continuous)	OR = 0.99 95% CI = 0.99 – 1.00 p = 0.30	**OR = 1.01** **95% CI = 1.001-1.02 p = 0.032**	OR = 1.00 95% CI = 0.99-1.01 p = 0.94	OR = 0.99 95% CI = 0.98-1.002 p = 0.17
Duration of skin-to-skin (category)	Chi^2 = 2.4 p = 0.49	Chi^2 = 4.2 p = 0.24	Chi^2 = 4.7 p = 0.19	Chi^2 = 6.8 p = 0.078

Notes: Variables were analysed as continuous variables (continuous) and or in categories (category). SSC= Skin-to-skin contact between mother and baby within the first 3 hours of birth. All SSC analyses exclude the 17 cases for which 0 minutes was recorded.

4.6.1 Delayed Lactation

There were 66 babies who were supplemented where one of the reasons recorded was 'delayed lactation'. There were four variables which were significantly associated with 'delayed lactation'. These were parity (OR = 0.66, 95% CI = 0.46-0.96, p = 0.28), birth method (Chi^2 = 10.1, p = 0.038), analgesia use (Chi^2 = 4.7, p = 0.03) and initiation of skin-to-skin contact by category (Chi^2 = 13, p = 0.005). Thus babies from mothers having their subsequent baby, those who had a birth other than elective caesarean (Figure 23) and those who were unexposed to analgesia (Figure 24) were less likely to be supplemented for the reason 'delayed lactation'.

The percentage of supplemented breastfed babies who were supplemented for 'delayed lactation' was 50% in those born by elective caesarean compared to 20% for those born by normal vaginal birth (Figure 23).

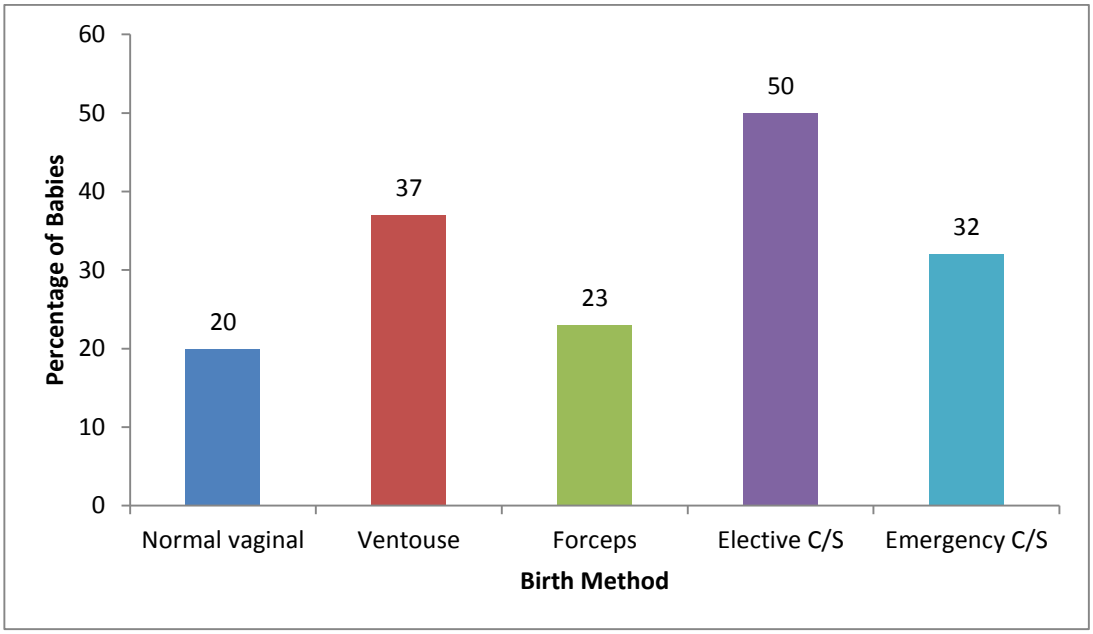

Figure 23. Percentage of supplemented babies (n = 234) where the reason for supplementation was 'delayed lactation' (n = 66) according to birth method.

The percentage of supplemented breastfed babies who were supplemented for 'delayed lactation' was 20% in those exposed to analgesia in labour compared to 34% for those not exposed to analgesia (Figure 24).

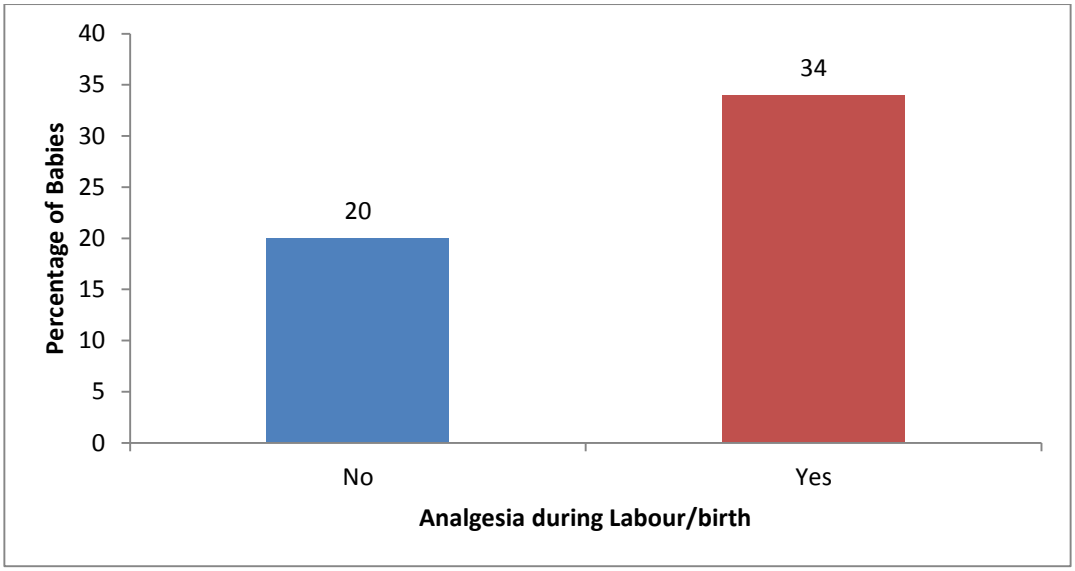

Figure 24. Percentage of supplemented babies (n = 234) where the reason for supplementation was 'delayed lactation' (n = 66) according to analgesia use in labour/birth.

Figure 25 shows the percentage of supplemented babies within each of the different maternal BMI categories who were supplemented for the reason 'delayed lactation' (n = 66). 'Delayed lactation' as the reason recorded was highest (56%) for mothers in the underweight category.

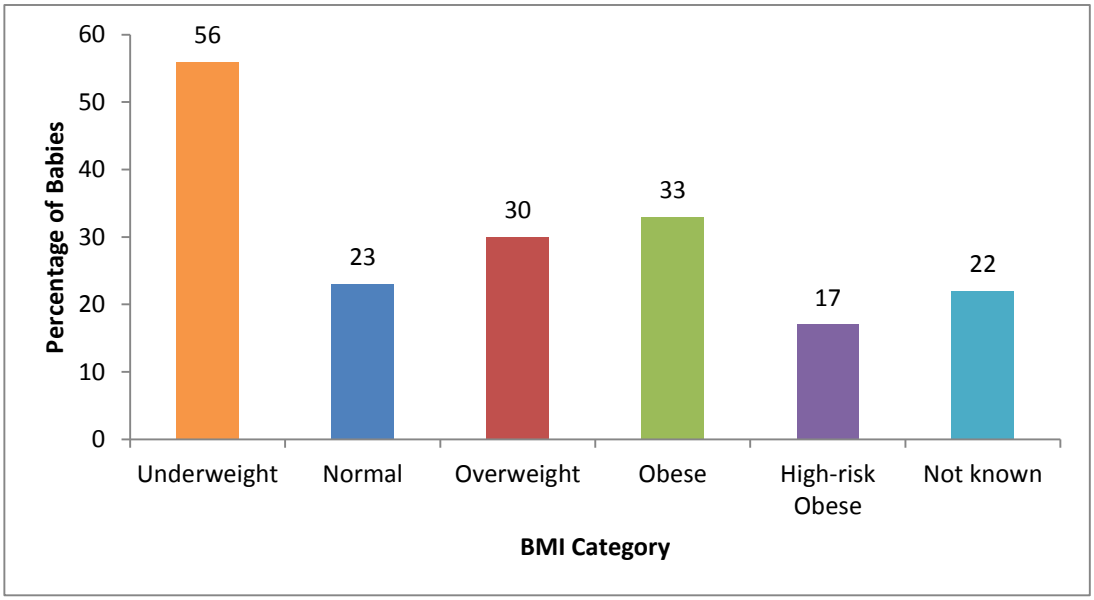

Figure 25. Percentage of supplemented babies (n = 234) where the reason for supplementation was 'delayed lactation' (n = 66) according to mother's BMI category.

The differences between the BMI categories with regard to 'delayed lactation' being recorded as the reason for supplementation was not significant by Chi square (Chi ^{2} = 2.4, p = 0.67). There were small numbers in some of the cells which makes the analysis unreliable (refer to Table 4.1).

Figure 26 shows the percentage of supplemented babies within each of the different maternal ethnicities who were supplemented for the reason 'delayed lactation'. The differences between the ethnicities with regard to 'delayed lactation' being recorded as the reason for supplementation were not significant by Chi-square (Chi ^{2} = 5.8, p = 0.67). There was a higher percentage of mothers of European and Pasifika ethnicity (44%) who's babies were supplemented for the reason 'delayed lactation' compared to mothers of the remaining ethnicities. There were small numbers in many of the cells which makes the analysis unreliable.

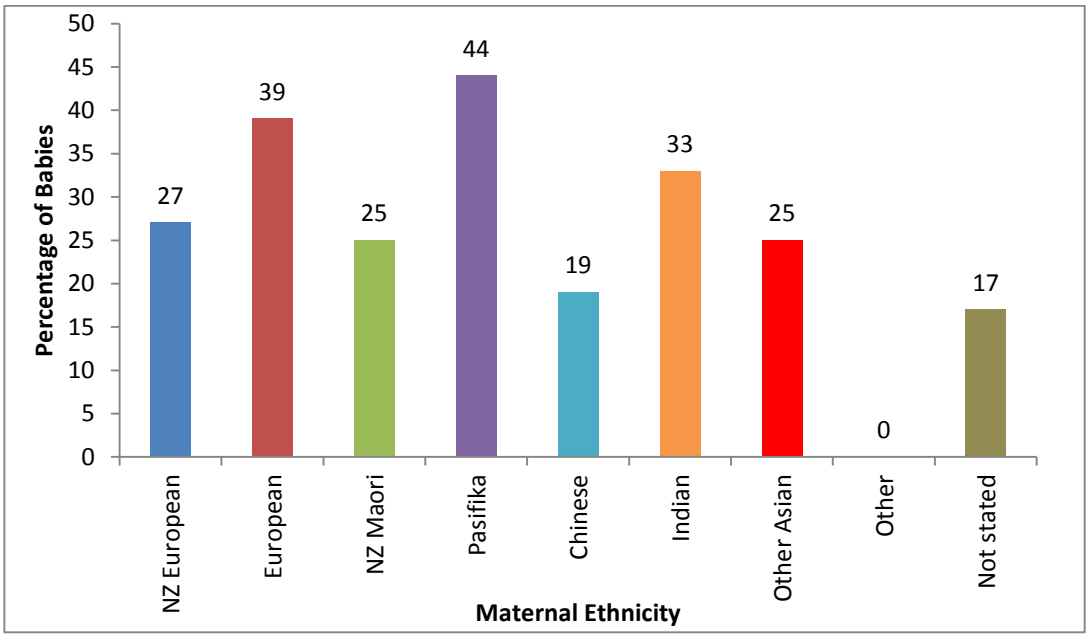

Figure 26. Percentage of supplemented babies (n = 234) where the reason for supplementation was 'delayed lactation' (n = 66) according to maternal ethnicity.

There was a significant relationship between delay to initial skin-to-skin contact and supplementation for the reason 'delayed lactation' (Figure 27). Although there are lower levels of 'delayed lactation' in cases where initial skin-to-skin contact was within 5 minutes compared to where there was a delay of up to 30 minutes and 60 minutes, however a delay of over an hour had the lowest level of 'delayed lactation'

cases where babies were supplemented ($Chi^2 = 13$, $p = 0.005$). The 0 minutes category was omitted from the analysis, however, it is worth noting these babies had a high level of supplementation for 'delayed lactation' at 40%.

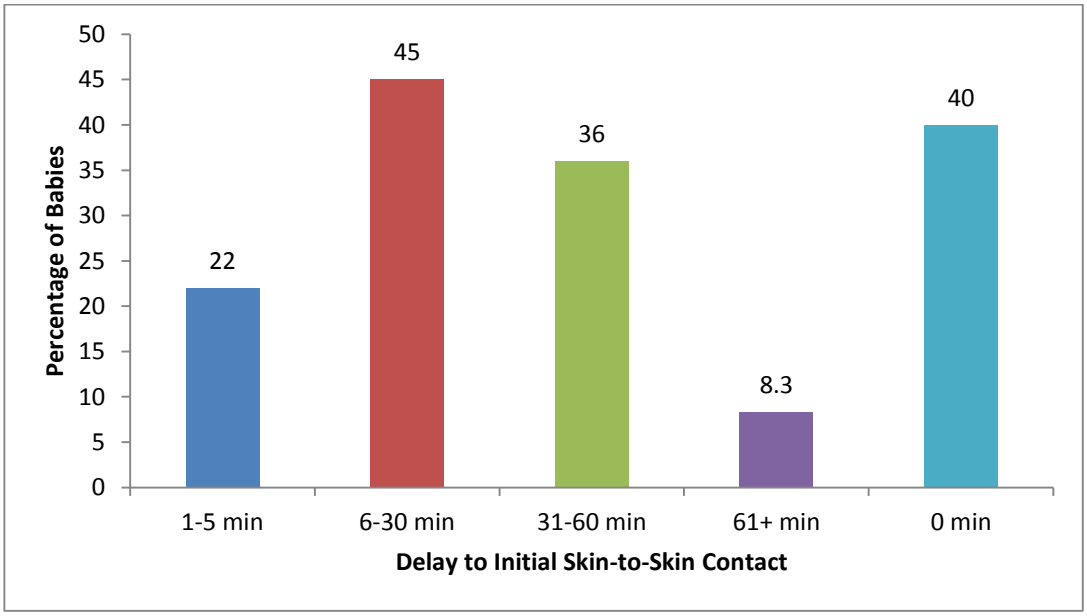

Figure 27. Percentage of supplemented babies (n = 234) where the reason for supplementation was 'delayed lactation' (n = 66) according to delay to initial skin-to-skin contact.

Note: 0 min indicates no values were recorded (n = 5).

4.6.2 Maternal Request

There were 54 babies who were supplemented where one of the reasons recorded was 'maternal request'; of these, 32 had no other reason recorded. There were only two variables significantly associated with 'maternal request', maternal age and duration of skin-to-skin contact both analysed as continuous variables (Table 4.7). As mother's age increased there was a decreasing likelihood the reason for supplementation was 'maternal request' (OR = 0.91 95% CI = 0.86 - 0.97, p = 0.002). Supplementation for 'maternal request' was associated with increasing duration of skin-to-skin contact (OR = 1.01, 95% CI = 1.001 - 1.02, p = 0.032).

For the 32 babies who were supplemented for 'maternal request' for which there was no additional reason documented, there were no significant associations with any of the variables investigated.

Figure 28 shows the percentage of babies who were supplemented for the reason 'maternal request' according to maternal BMI category. There was a slight trend for increasing maternal request with increasing BMI; however the largest percentage of cases where babies were supplemented for 'maternal request' was for mothers who were in the underweight BMI category. This trend was not significant by Chi-square ($Chi^2 = 2.7$ p = 0.62).

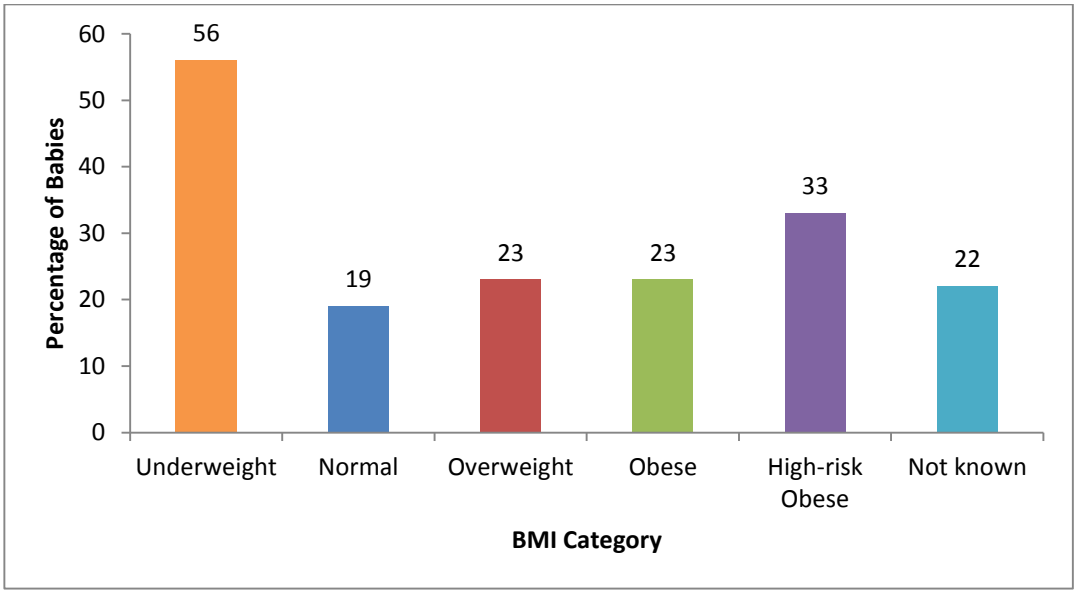

Figure 28. Percentage of supplemented babies (n = 234) where the reason for supplementation was 'maternal request' (n = 54) according to mother's BMI category.

Figure 29 shows the percentage of babies within each of the different maternal ethnicities who were supplemented for the reason 'maternal request'. There was a large percentage (67%) of mothers of Chinese ethnicity whose babies were supplemented for the reason 'maternal request' compared to mothers of NZ European or European, (19-20%) ethnicities. The differences between the ethnicities with regard to 'maternal request' being recorded as the reason for supplementation was not significant by Chi square ($Chi^2 = 13$, p = 0.13). There were small numbers in many of the cells which makes the analysis unreliable (refer to Table 4.1).

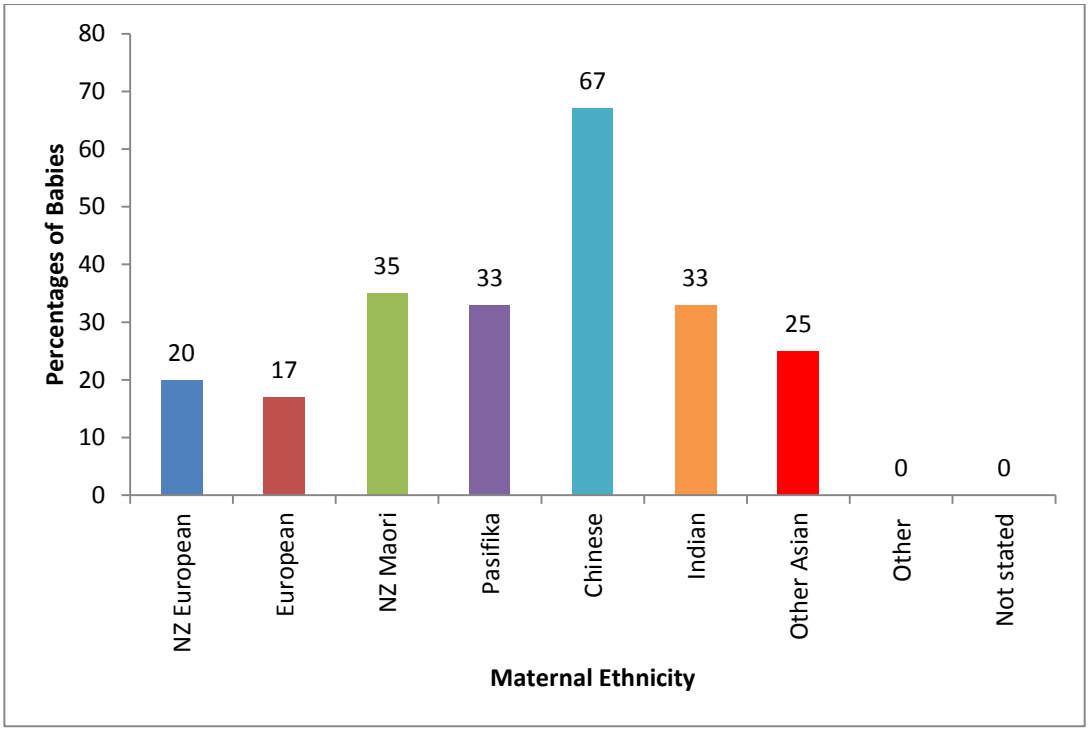

Figure 29. Percentage of supplemented babies (n = 234) where the reason for supplementation was 'maternal request' (n = 54) according to maternal ethnicity.

Figure 30 shows the percentage of babies supplemented for the reason 'maternal request' according to delay to initiation of skin-to-skin contact category. Although not significant, ($Chi^2 = 3.3$, $p = 0.35$) there appears to be a trend for increasing likelihood for 'maternal request' to be recorded as a reason with increasing delay to initiation of skin-to-skin contact with the greatest number (60%) recorded for the 0 minutes category where there was no skin-to-skin contact recorded.

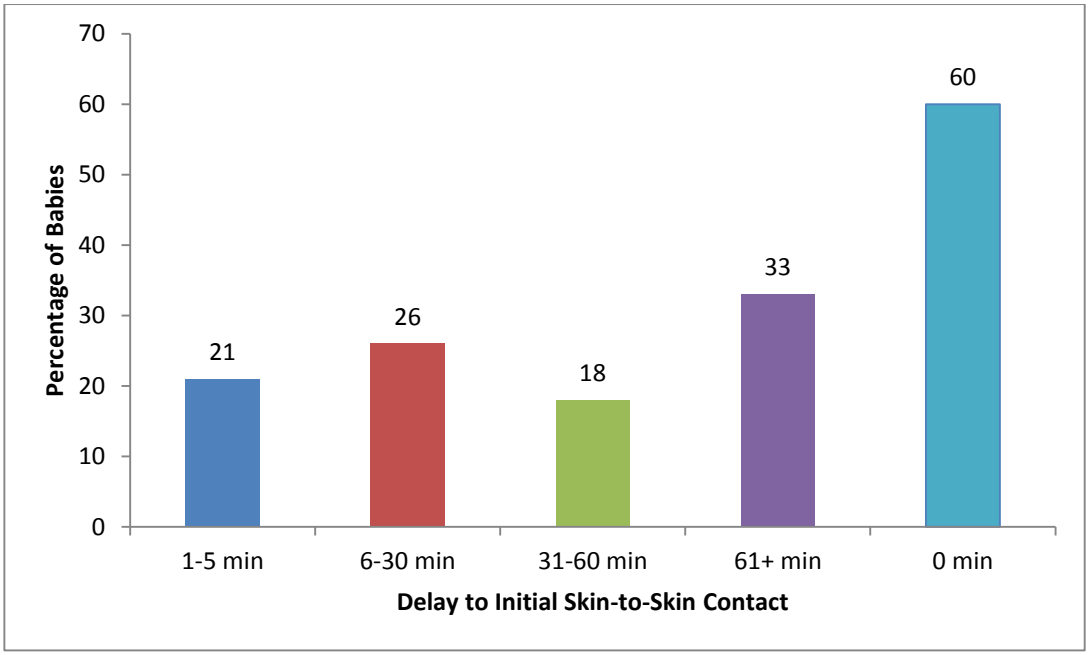

Figure 30. Percentage of supplemented babies (n = 234) where the reason for supplementation was 'maternal request' (n = 54) according to delay to initial skin-to-skin category.

Note: 0 min indicates no values were recorded (n = 5).

Figure 31 shows the percentage of supplemented babies who were supplemented for the reason 'maternal request' according to duration of skin-to-skin category. By logistic regression with duration of skin-to-skin as a continuous variable, there was trend for an increasing likelihood a baby would be supplemented for 'maternal request' for increasing duration of skin-to-skin contact. The greatest percentage of cases where babies were supplemented for 'maternal request' was in the 0 minutes category where there was no skin-to-skin recorded, this category was excluded from the analysis.

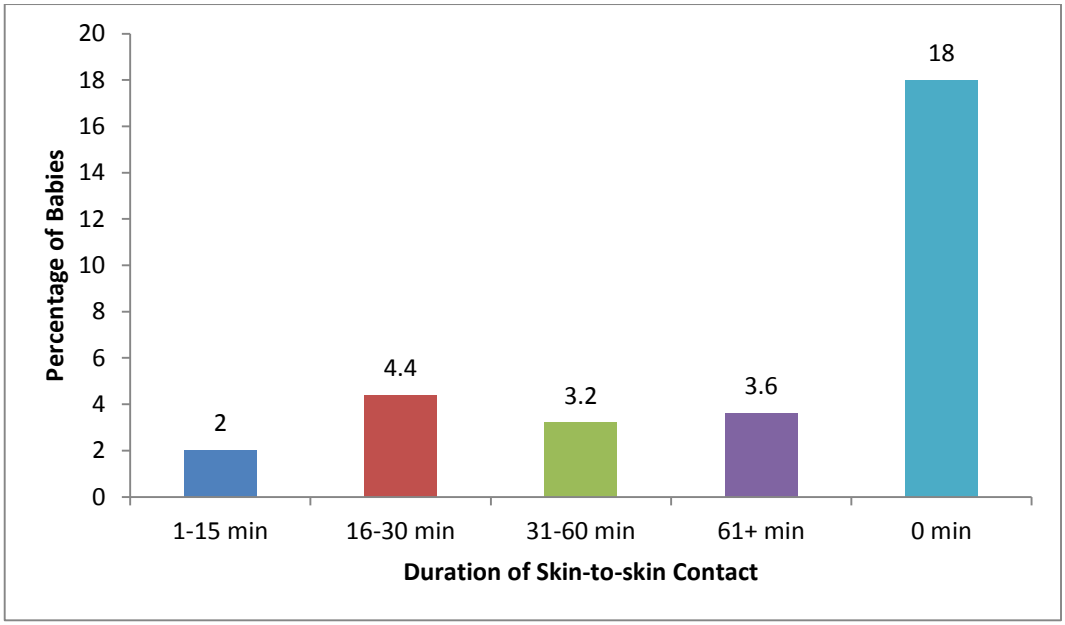

Figure 31. Percentage of supplemented babies (n = 234) where the reason for supplementation was for 'maternal request' (n = 54) according to duration of skin-to-skin category.

Note: 0 min indicates no values were recorded (n = 5).

4.6.3 Hypoglycaemia

There were 48 babies supplemented where one of the reasons recorded was 'hypoglycaemia'. There were three variables which were significantly associated with 'hypoglycaemia' (Table 4.7). These were non-exposure to analgesia (Chi^2 = 5.1, p = 0.024), birth-weight category (Chi^2 = 15, p = 0.011) and gestation (OR = 0.58, 95% CI = 0.89 - 0.76, p < 0.001). For birth-weight, supplementation for hypoglycaemia was more common in babies <2500 grams, 2500-3000 grams and in babies > 4500 grams. Initiation of skin-to-skin contact measured as a continuous variable approached significance (OR = 0.99, 95% CI = 0.97 - 1.001, p = 0.076, thus there was a trend for increasing likelihood of supplementation with increasing delay to initial skin-to-skin contact.

Figure 32 shows the percentage of babies who were supplemented for 'hypoglycaemia according to whether or not they were exposed to analgesia during labour. There were more cases of supplementation for 'hypoglycaemia' for babies who were not exposed to analgesia compared to those who were exposed to analgesia.

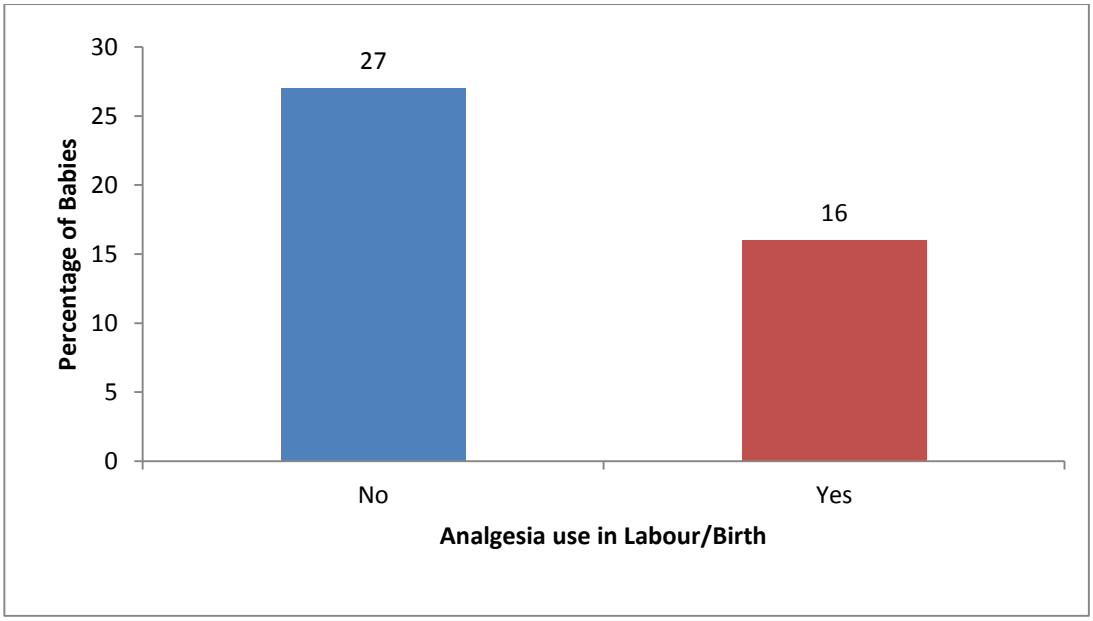

Figure 32. Percentage of supplemented babies (n = 234) where the reason for supplementation was 'hypoglycaemia' (n = 48) according to analgesia exposure during labour or birth.

Figure 33 shows the distribution of infant supplementation for 'hypoglycaemia' according to birth method. There were more babies born by the emergency caesarean who were supplemented for 'hypoglycaemia' (30%) compared to birth by other methods but this was not significant (Chi2 = 1.7, p = 0.72).

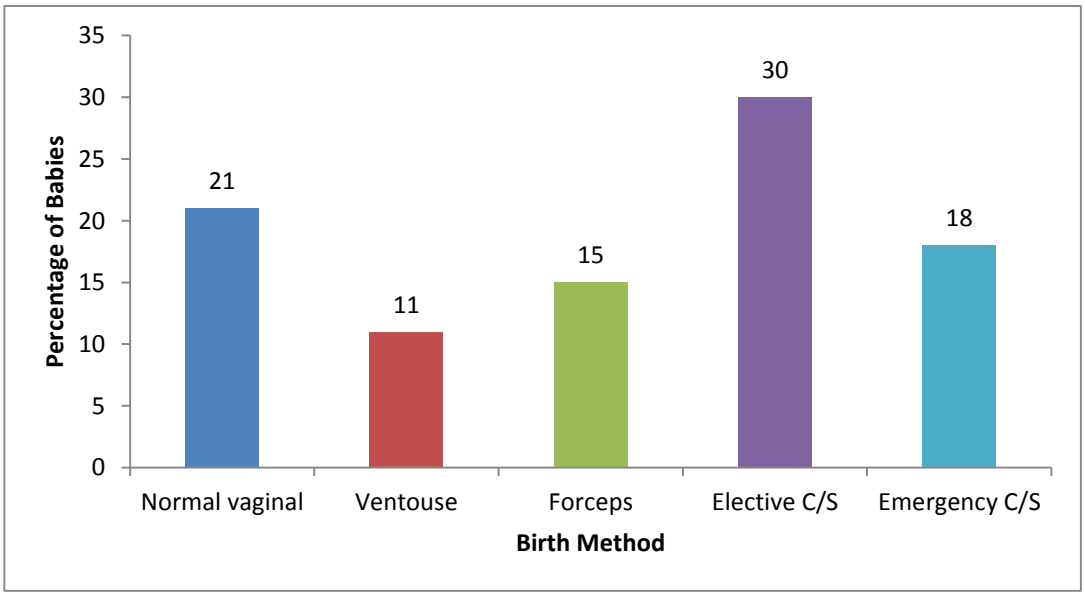

Figure 33. Percentage of supplemented babies (n = 234) where supplementation was for the reason 'hypoglycaemia' (n = 48) according to birth method.

Figure 34 shows the distribution of babies in each infant ethnicity category supplemented for 'hypoglycaemia'. Fifty percent of babies of Chinese and 44% of babies of Other Asian ethnicity were supplemented for 'hypoglycaemia'. This was not significant ($Chi^2 = 9.2$, $p = 0.32$); the numbers in many of the cells were small and statistically unreliable.

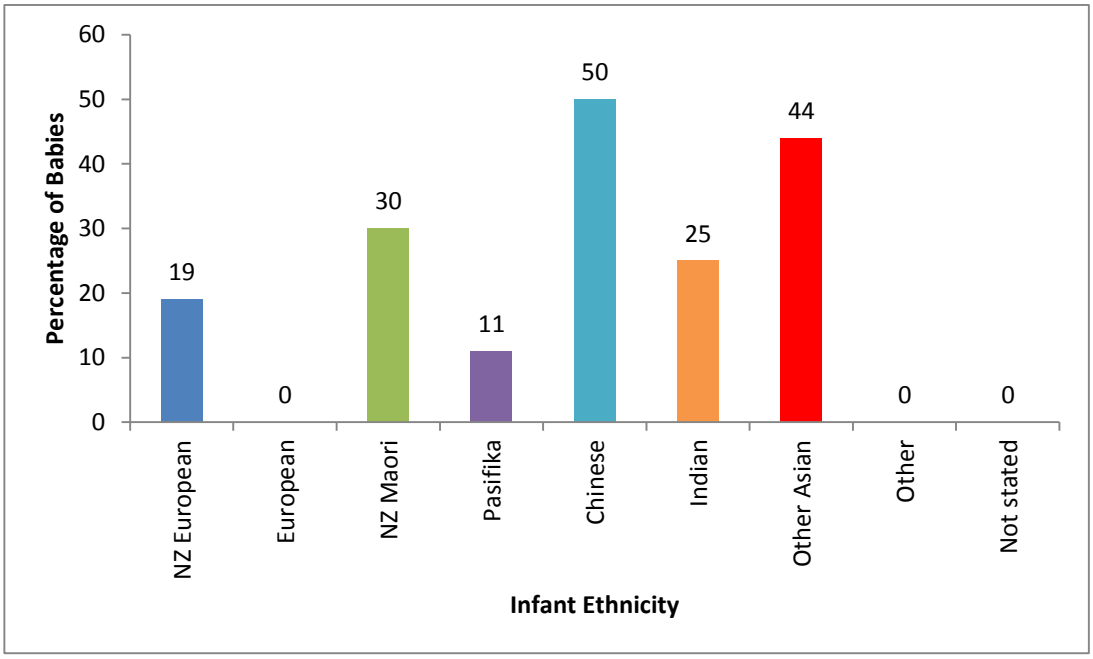

Figure 34. Percentage of supplemented babies (n = 234) where the reason for supplementation was 'hypoglycaemia' (n = 48) according to infant ethnicity.

Although not significant, (Chi 2 = 5.8, p = 0.21), Figure 35 shows the trend for more supplemented babies from mothers in the obese (n = 43) and high-risk obese category (n = 6) to be supplemented for hypoglycaemia.

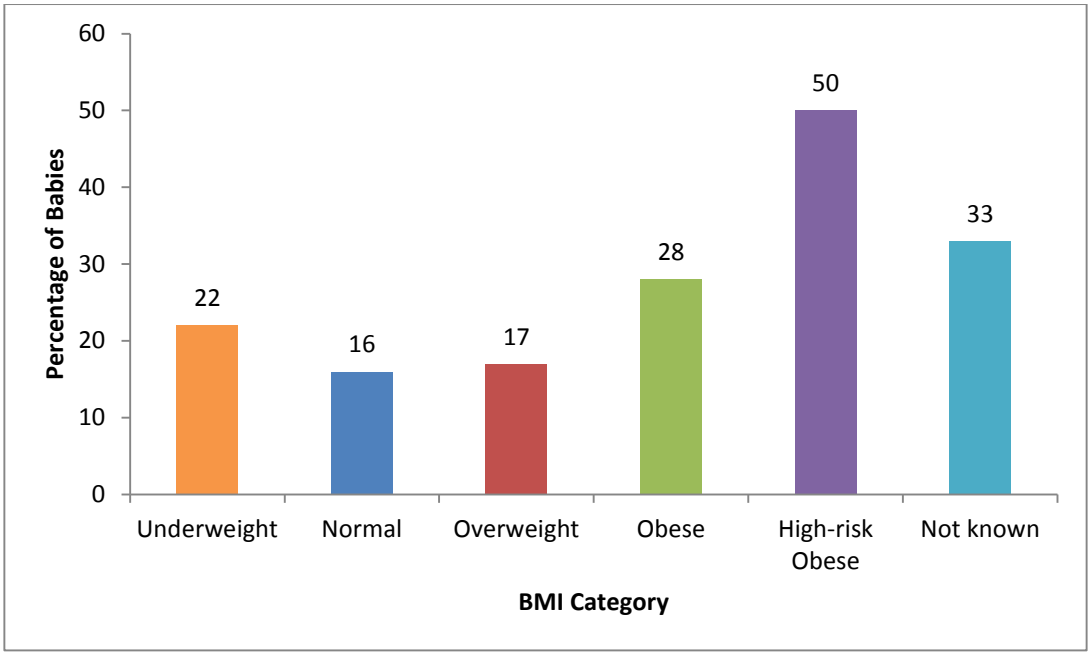

Figure 35. Percentage of supplemented babies (n = 234) where the reason for supplementation was 'hypoglycaemia' (n = 48) according to maternal BMI category.

4.6.4 Reason Not Recorded

There were 64 babies who were supplemented where there was no recorded reason. There were no variables significantly associated with reason 'not recorded'. Two variables approached significance, these were postpartum treatment ($Chi^2 = 8.9$, $p = 0.064$) and duration of skin-to-skin by category ($Chi^2 = 6.8$, $p = 0.078$).

Figure 36 shows the percentage of supplemented babies for whom there was no recorded reason according to postpartum treatment category. Although analysis with this variable did not reach significance, there were more cases of babies supplemented for no recorded reason in the 'none' and 'IV or IM' categories compared to the three or more medications categories. The small numbers of cases in these latter categories make it statistically unreliable.

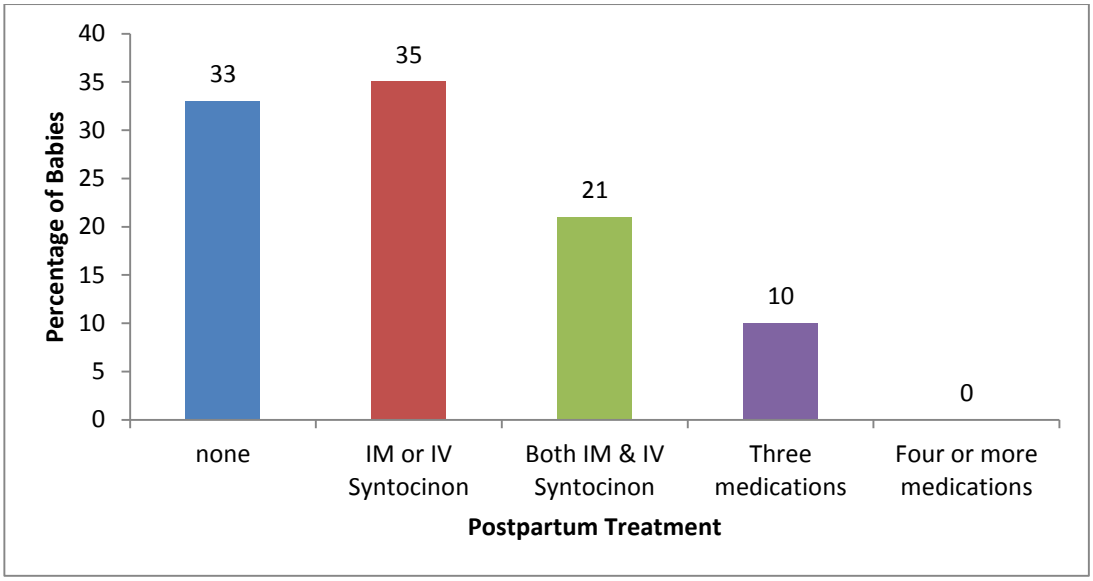

Figure 36. Percentage of supplemented babies (n = 234) where the reason for supplementation was 'not recorded' (n = 64) according to postpartum treatment.

Figure 37 shows the percentage of supplemented babies for whom there was no recorded reason for supplementation according to duration of skin-to-skin contact. Babies who had more than an hour of skin-to-skin contact had lowest percentage of babies supplemented for no reason (15%).

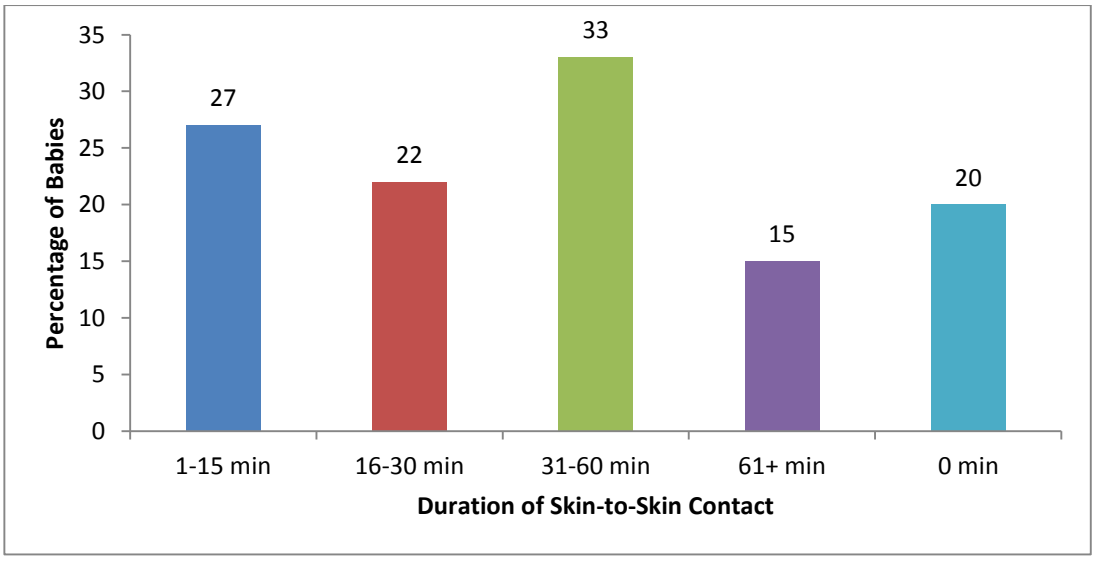

Figure 37. Percentage of supplemented babies (n = 234) where the reason for supplementation was 'not recorded' (n = 64) according to minutes duration of skin-to-skin contact at birth.

Note: 0 min indicates no values were recorded (n = 5).

Figure 38 shows the distribution of supplemented babies for which there was no recorded reason according to maternal ethnicity. There was a fairly similar percentage of numbers across many of the ethnicities. Babies of mothers from 'Other ethnicity' and 'not stated' are represented here where they were not represented in previous reasons for supplementation (see Figures 28 and 33).

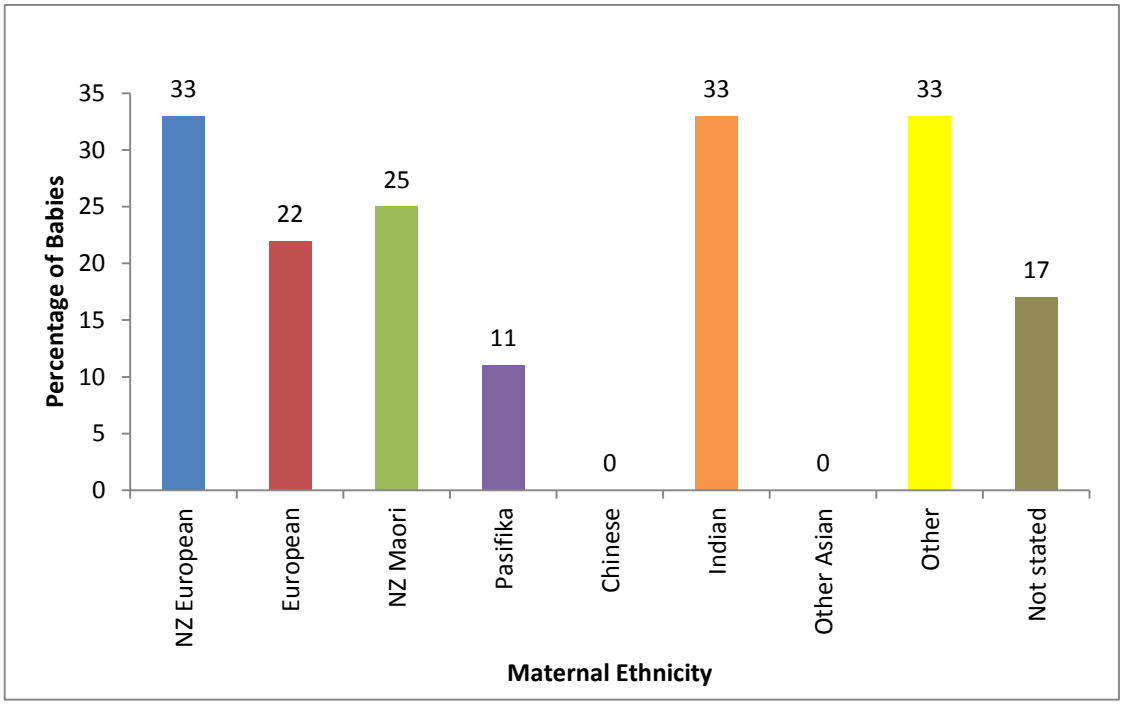

Figure 38. Percentage of supplemented babies (n = 234) where the reason for supplementation was 'not recorded' (n = 64) according to maternal ethnicity.

4.7 SUMMARY OF FINDINGS

In summary, the data from 1530 mother-baby was analysed. Fifteen percent of breastfed babies were supplemented with infant formula during the hospital stay. In the initial analysis, supplementation was significantly associated with maternal BMI, parity, use of Syntocinon in labour, postpartum treatment with Syntocinon or other uterotonic, birth method, use of analgesia during labour and birth, infant gestation, infant ethnicity, birth-weight, initiation of skin-to-skin contact at birth and duration of skin-to-skin contact at birth. Maternal age, smoking status and maternal ethnicity were not significantly associated with supplementation.

Results of the bivariate logistic regression analysis revealed the significant predictors of supplementation were BMI (overweight and obese categories), primiparity, birth method (emergency caesarean) analgesia during labour/birth, Syntocinon during labour, use of postpartum uterotonics, gestation, birth-weight of less than 2500 grams, delayed initiation of skin-to-skin contact, and a duration of skin-to-skin contact of less than one hour.

Results of the multiple logistic regression analysis indicated the strongest predictors of formula supplementation were BMI category of overweight, primiparity, use of Syntocinon and other uterotonics postpartum, gestation, and duration of skin-to-skin contact. For caesarean births, the results indicate that parity, gestation and duration of skin-to-skin contact are important predictors of formula supplementation for these mothers and babies.

The most common documented reasons for formula supplementation were ‘delayed lactation’, ‘maternal request’ for formula, and hypoglycaemia. There were a large number of babies (27%) for whom there was no recorded reason for supplementation. ‘Delayed lactation’ was associated with primiparity, birth other than normal vaginal, use of analgesia during labour/birth and a longer delay to initiation of skin-to-skin contact. ‘Maternal request’ for formula was associated with lower maternal age and a shorter duration of skin-to-skin contact. Hypoglycaemia was associated with non-use of analgesia in labour/birth, earlier gestation and birth-weight category. Reason ‘not recorded’ for formula supplementation was not associated with any particular variable to a significant level.

The following chapter will discuss the significance of the findings in relation to recent literature and current practice. The implications for health professionals working with breastfeeding mothers and babies and possibilities for future research will be discussed.

5 DISCUSSION

5.1 INTRODUCTION

This chapter provides a summary of results and discusses the key findings in relation to the relevant literature. The research questions and hypotheses will be addressed. Study strengths and limitations will be identified and implications for clinical practice and further research considered.

5.2 SUMMARY OF STUDY

In this study demographic, biomedical, intrapartum and postpartum data were collected from 1530 mother-infant pairs who birthed in Dunedin hospital, a tertiary level, Baby-Friendly hospital in the South Island of New Zealand (NZ). While the hospital is tertiary level, it is the only option available for women wanting a hospital birth in the Dunedin area and also provides services for women requiring or choosing tertiary birthing facilities in the greater Otago region. The population has a higher proportion of NZ European ethnicity compared to other areas of NZ. Data were analysed to find potential predictors of formula supplementation in breastfed babies during the hospital stay. Fifteen percent of breastfed babies were supplemented. The recorded reasons for giving infant formula to breastfed babies were also investigated. Data were analysed by Chi-square test and logistic regression. Analysis revealed several independent predictors for formula supplementation, some of which have previously been identified in the literature, however this is the first time these results have been reported from a Baby-Friendly hospital.

5.3 MAIN FINDINGS

The main findings are discussed under headings of maternal characteristics, labour and birth characteristics, infant characteristics and recorded reasons for formula supplementation.

5.3.1 Maternal Characteristics

The maternal characteristics which were found to predict formula supplementation were body mass index (BMI) and parity (number of births). The characteristics which were not significantly associated with formula supplementation were maternal age, smoking status and ethnicity. Body mass index was recorded at the woman's first

booking visit. This was analysed as a continuous variable and in categories. Half of all the mothers were of normal BMI (18.5 - 24.9 kg/m^2). Over 40 per cent were overweight (25 – 29.9 kg/m^2), and or obese (30 – 39.9 kg/m^2). These figures compare slightly better than the New Zealand Ministry of Health (MOH) figures for 2013 which found that one third of adults were overweight and another third obese. These statistics are concerning and the 'obesity epidemic' is a focus of many health initiatives. The New Zealand (NZ) government recently released the 'Guidance for Healthy Weight Gain in Pregnancy' document, a guideline for health professionals caring for pregnant women (MOH, 2014).

It is recognised that women who are overweight and obese, and women who gain more weight than recommended during pregnancy, are at higher risk of pregnancy and birth complications (MOH, 2014). If birth method complications are considered to progressively increase with normal, ventouse, forceps, elective caesarean, emergency caesarean birth, this study found an association of increasing BMI with increasing birth complications ($p = 0.016$). Reduced breastfeeding is also acknowledged as being associated with overweight and obesity (MOH, 2014). The present study found there was a significant association of formula supplementation with BMI when analysed as a continuous variable (OR 2.2, 95% CI 1.1 - 4.3, $p = 0.023$). By category, the overweight (OR = 1.5, 95%CI 1.1 - 2.1, $p = 0.014$) and obese (OR = 1.5, 95% CI 1.04 - 2.3, $p = 0.03$) categories had higher odds ratios for supplementation when compared to normal.

This finding is in agreement with other studies (Al-Sahab et al., 2011; Amir & Donath, 2007; Biro et al., 2011; Donath & Amir, 2008b; Gubler et al., 2013; Jevitt et al., 2007; Visram et al., 2013). For example, an Australian study (Biro et al., 2011), reported babies born to obese (BMI >30) mothers had an adjusted odds ratio of 2.3 (95% CI 1.76-2.95) for formula supplementation. Furthermore, a Canadian study found overweight and obese mothers, while having the same intention to breastfeed as normal weight mothers, were less likely to be exclusively breastfeeding on discharge from hospital (adjusted OR 0.68, 95% CI 0.61 - 0.76) (Visram et al., 2012). The reasons for this finding are not clear, some studies report that overweight and obese mothers may experience a delay in lactogenesis II associated with ineffective breastfeeding (Nommsen-Rivers et al., 2010), reduced response to prolactin, increased rate of caesarean delivery and issues with body image and breast anatomy (larger

breasts with flatter nipples making it more difficult for the mother to position baby at the breast and more difficult for the baby to grasp the nipple) (Jevitt et al., 2007). These concepts will be explored later in this chapter.

As well as the physiological reasons, obese mothers may also have psycho-social characteristics associated with poor breastfeeding outcomes. One study (Hauff, Leonard, & Rassmussen, 2014) investigated maternal obesity, psycho-social factors, (social beliefs, attitudes, knowledge and behavioural beliefs towards breastfeeding), with breastfeeding intention, initiation and duration among 2824 women. An association of psycho-social characteristics with obesity, independent of physiological characteristics was found which adversely affected initiation and duration of breastfeeding. The obese mothers in their study had equal intentions to breastfeed as mothers of normal BMI, but experienced reduced initiation, exclusivity and duration of breastfeeding compared to mothers of normal BMI. Other complications of obesity relating to pregnancy and birth include diabetes and hypertension which are also associated with reduced breastfeeding rates (Kozhimannil, Jou, Attansio, Joarnt, & McGovern, 2014).

Studies have shown first time mothers to be twice as likely to supplement as multiparous mothers (Al-Sahab et al., 2011; Biro et al., 2011; Declercq et al., 2009; DiGirolamo et al., 2005; Gubler et al., 2013; Hauck et al., 2011; Jordan et al., 2013). Similarly, the present study found parity was an independent predictor of formula supplementation in the multivariate analysis. However the results were not consistent across parity when analysed by individual parities, from parity zero (first baby) to parity four or more (five or more babies). Compared to first-time mothers, mothers of parity one (second baby) and parity three (fourth baby) were significantly less likely to supplement, while parity two was also less likely to supplement but this did not reach significance and parity four or more was actually more likely to supplement. This lack of clear trend may have been due to smaller numbers in the higher parity groups. Alternatively, mothers of higher parity may be at risk for formula supplementation.

A New Zealand study examining factors associated with not breastfeeding exclusively among Pasifika infants also found a similar trend (Butler et al., 2004). Mothers having their first baby and mothers of parity four or more had higher odds of formula

supplementation. Many studies considered parity in two categories (Al-Sahab et al., 2011; Biro et al., 2011; Declercq et al., 2009; DiGirolamo et al., 2005; Gubler et al., 2013). In the current study, when the categories were collapsed into two groups, parity zero and parity greater than or equal to one, multiparity was clearly significantly associated with reduced supplementation. One cannot assume all multiparous mothers will be able to successfully and confidently breastfeed in hospital without any resort to supplementation. For example, a mother who had the experience of supplementation in hospital as a first-time mother, may have reduced confidence that she can exclusively breastfeed her subsequent babies.

Baby-Friendly practices may reduce the disparity between primiparous and multiparous mothers. Declercq et al., (2009) found an interaction between Baby-Friendly practices (the Ten Steps, see Appendix A) and parity. When there were six to seven of the ten Baby-Friendly practices in place, there was no significant difference between primiparous and multiparous mothers fulfilling their intention to exclusively breastfeed, compared to when there were only zero to one or two to three Baby-Friendly practices in place. This suggests supportive hospital practices can help to overcome this difference in breastfeeding associated with increasing parity. Primiparas experiencing six to seven Baby-Friendly practices were six times more likely to fulfil their intention to exclusively breastfeed than those experiencing zero to one. The lack of a clear trend with increasing parity found in the present study may be influenced by the presence of Baby-Friendly practices.

The reasons for increased supplementation amongst first-time mothers has been reported to be associated with inexperience of normal newborn behaviour, and lack of knowledge about the process or physiology of breastfeeding (DaMota et al., 2012), increased anxiety (Britton, 2007; Gagnon et al., 2005), lack of confidence (Dennis, 2006; Koskinen et al., 2014; Seminic et al., 2008) and the mother's or health worker's belief that formula can be a solution if breastfeeding is perceived as not being successful or effective (DaMota et al., 2012). Studies to date have focused on reasons mothers give or reasons health workers give for supplementation.

Common reasons given by first-time mothers for supplementing their babies in the hospital are low breastmilk supply, signs of inadequate intake and poor infant breastfeeding behaviour (Chantry et al., 2014). Reasons reported by maternity nurses

in one study were breastfeeding problems, infant behaviour perceived as not being satisfied with breastfeeding alone and maternal fatigue (Gagnon et al., 2005). These reasons were not limited to first-time mothers and the hospitals were not designated Baby-Friendly.

In a Baby-Friendly hospital, staff are required to undergo extensive training and education to support breastfeeding mothers, and mothers are required to sign an informed consent form before their infant receives formula for both medical and non-medical reasons. These measures are designed to reduce formula supplementation due to lack of education about infant and breastfeeding physiology. The reasons given by midwives for supplementation in the present study are explored later in this chapter.

Increasing maternal age is frequently associated with decreased supplementation (Bramson et al., 2010; DiGirolamo et al., 2008; Jordan et al, 2013; Nommsen-Rivers et al., 2010; Perrine et al., 2012) and this logically follows a decreasing supplementation rate with increasing parity, as mothers having their second baby are often older than mothers having their first baby. However, when there is a high breastfeeding initiation rate as in the present study, this phenomenon may not occur. This is supported by an Australian study (Scott et al., 2006) where age was not a significant predictor of supplementation. The initiation rate was 94%, similar to the present study (95%). In the present study, age was analysed as a continuous variable rather than in categories. In other studies, age is often divided into categories for analysis (Hauck et al., 2011; Perrine et al., 2012; Scott et al., 2006). It is possible that if age was analysed in categories, a different result may have been obtained.

The mothers in the study predominantly identified as NZ European (84%). This varies from the national figures for women who birthed in 2011 (MOH, 2014) which were European 51.5%, Māori 25.5%, Pasifika 11.5%, Asian 11.5%, and Other 2.0%. Maternal ethnicity was not found to be a predictor of formula supplementation in this study, however, there were some significant differences found when infant ethnicity was analysed. Because of the disparity with national figures, these results should be considered as reflecting the local situation and caution should be exercised when generalising to all Māori in NZ.

Smoking is another variable associated with formula supplementation (Al-Sahab et al., 2011; Butler et al., 2004; Collins et al., 2011). The percentage of women currently

smoking at time of booking with their lead maternity carer (LMC) was 14%. This compares well with the national rate of 15.3% which is from data collected by LMCs and collated by the Ministry of Health for 2011 (MOH, 2014). However, the rate of smoking was not determined for mothers who were excluded from the study. Exclusions included mothers who decided to exclusively formula feed their babies and mothers of babies who were admitted to the neonatal unit. These groups may have had a higher prevalence of smoking.

The national database also describes higher levels of smoking among Māori mothers (37%) and lower levels among mothers of Asian ethnicities (0.9%) (MOH, 2014). This study also found a high rate of smoking among mothers of Māori ethnicity at 39%, and only 0 to 4.5% among mothers of Asian ethnicity. Smoking has been identified as a risk factor for poor initiation and maintenance of breastfeeding among Māori mothers (Glover et al., 2009) and Pasifika mothers (Butler et al., 2004). In the present study, for Māori mothers who were current smokers at time of booking with their LMC, only 12% were supplementing on discharge from hospital. It is not known how many did not initiate breastfeeding (i.e. decided to formula feed from the outset). A recent analysis of smoking among NZ mothers registered with LMCs between 2008 and 2010 found that smoking prevalence decreased from 19.5% in 2008 to 18.4% in 2010 (Andrews et al., 2014).

In summary, the maternal characteristics which were found to be associated with formula supplementation were BMI and parity. These factors remained significant throughout the different levels of analysis. These results show that even in a Baby-Friendly hospital, babies born to mothers of high BMI and first-time mothers are at a higher risk for formula supplementation. This answers part of my primary research question, *"What are the biomedical, socio-demographic, intrapartum and postpartum factors associated with supplementation of breastfed babies during the maternity hospitalisation in a Baby-Friendly hospital?"* The clinical implications of these results will be discussed later in this chapter.

5.3.2 Labour and Birth Characteristics

The labour and birth characteristics which were significant predictors for formula supplementation in the bivariate analysis were Syntocinon use in labour, postpartum treatment with Syntocinon or other uterotonic, birth method, and use of analgesia

during labour and birth. When analysed by multiple logistic regression, use of Syntocinon in labour, birth method and analgesia were no longer significant. These factors will be discussed in relation to the relevant literature.

Sixty percent of mothers had a normal vaginal birth, while 6.7% had ventouse and 4.3% had forceps assisstance. Twenty nine percent of mothers had a caesarean birth, 15% were emergency. The caesarean section rate is higher than the national average of 24.3% while the proportion of those which were emergency was the same at just over half (MOH, 2014). Dunedin is a tertiary hospital serving the wider area of Otago. One of the reasons for the high caesarean rate may be that women are transferred in from rural primary units when there is an emergency which requires a caesarean birth and they pre-book for an elective caesarean when medically indicated. Birth method was a predictor of formula supplementation in the bivariate analysis ($p = 0.007$). Mothers who gave birth by means other than normal vaginal had increased odds of formula supplementation and mothers having an emergency caesarean were significantly likely to have babies who were supplemented at some time during the hospital stay (OR 1.9, 95% CI 1.3 - 2.8, $p = 0.001$).

Many studies have found that birth method can influence breastfeeding initiation and exclusivity (Al-Sahab et al., 2011; Biro et al., 2011; Bramson et al., 2010; Butler et al., 2004; Parry et al., 2013; Prior et al., 2012; Rowe-Murray & Fisher, 2002). Except for three studies (Biro et al., 2011; Bramson et al., 2010; Rowe-Murray & Fisher, 2002), Baby-Friendly practices were not considered. In all these studies, however, it was not hospital practice for immediate skin-to-skin contact between mother and baby to commence as soon as possible after birth (within 5-15 minutes) and breastfeeding initiation was delayed after a caesarean birth for at least an hour. This would not meet NZ Baby-Friendly standards. The standard for Step Four states,

> *"Place babies in skin-to-skin contact with their mothers immediately following birth for at least an hour. Encourage mothers to recognise when their babies are ready to breastfeed, offering help if needed."* NZBA (2011) Part 2, page 14.

This same standard applies for both vaginal and caesarean births. There will be more discussion on skin-to-skin practices later in this chapter.

Caesarean birth was no longer a significant predictor of formula supplementation once analysed by multivariate logistic regression when controlled for BMI, parity, birth

method, analgesia, Syntocinon (synthetic oxytocin) in labour, postpartum uterotonic treatment, gestation, birth-weight, initiation of skin-to-skin contact and duration of skin-to-skin contact. It is almost impossible to separate out the effects of caesarean birth on breastfeeding from the effects of analgesia on breastfeeding as they are not mutually exclusive and it would not be ethical to design an experiment conducting caesarean births with and without analgesia. However, we can compare the effect of birth with and without analgesia on breastfeeding outcomes.

Analgesia was recorded in five categories: pethidine, labour epidural, labour spinal, birth epidural and birth spinal. Forty-nine percent of mothers experienced epidural analgesia and 48% experienced spinal analgesia during labour or birth (although there was considerable overlap in these categories as described below). The current practice for caesarean analgesia at this institution is a combined spinal epidural; the spinal is fast acting and the epidural gives longer pain relief. This may explain the high result in both spinal and epidural categories as more than one option can be chosen. The national average rate for epidurals excluding caesarean section in 2011 was 24.7% (MOH, 2014). To simplify the analysis, analgesia was divided into two groups: analgesia no or yes. Fifity-one percent of mothers did not use analgesia for labour or birth.

Thirteen percent of mothers had pethidine during labour or early labour or latent phase of labour. The time-frame for administration was not part of the data collected. This is above the rate quoted by Goodson and Martis (2014) of 9.7% reported for 2011 among women registered with an LMC in New Zealand. The appropriateness of midwives prescribing pethidine for labour analgesia in the NZ setting has been the subject of a recent article (Goodson & Martis, 2014). The use of pethidine as a pain-relief in labour has not been evaluated by a randomised controlled clinical trial and its effectiveness has been the subject of recent debate as its main effect is that of sedation (Anderson, 2011). Pethidine is well known to have detrimental effects on the newborn including respiratory depression, and acidosis (Reynolds, 2011), and can affect newborn breastfeeding behaviour (Nissen et al., 1995; Ransjo-Arvidson et al., 2001) when administered within three to five hours of birth. Pethidine is metabolised into norpethidine which is biologically active and has a very long half-life in the neonate of 63 hours (Anderson, 2011) and can potentially affect the breastfeeding behaviour for several days. Pethidine on its own as a predictor for formula supplementation did

not reach significance in the present study. Many of the women receiving pethidine, however, would also have had other forms of pain relief.

Analgesia was a predictor of supplementation in the bivariate regression (OR 1.2, 95% CI 1.16 – 2.04 , p = 0.003). This is in agreement with other studies (Baumgarder et al., 2003; Beilin et al., 2005; Dozier et al., 2013; Jordan et al., 2009; Ransjo-Arvidson et al., 2001; Riordan et al., 2000; Wiklund et al., 2009) which found analgesia was associated with poor breastfeeding outcomes. However, in the multiple regression analysis which controlled for BMI, parity, birth method, analgesia, Syntocinon in labour, postpartum uterotonic treatment, gestation, birth-weight, initiation of skin-to-skin contact and duration of skin-to-skin contact, analgesia use failed to reach significance.

No significant effect of epidural analgesia on breastfeeding outcomes has been reported in a number of studies (Chang & Heaman, 2005; Gizzo et al., 2012; Radzyminski, 2003; Wilson et al., 2010). Many studies, however, have not adjusted for confounding variables which make it difficult to differentiate whether or not breastfeeding outcome was affected (Szabo, 2013). For example, some do not account for use of synthetic oxytocin (Baumgarder et al., 2003; Chang & Heaman, 2005; Gizzo et al., 2012; Ransjo-Arvidson et al., 2001), different combinations of analgesics (Chang & Heaman, 2005; Dozier et al., 2013; Gizzo et al., 2012; Wiklund et al., 2009), Baby-Friendly practices (Chang & Heaman, 2005; Gizzo et al., 2012; Jordan et al., 2013; Wilson et al., 2010), maternal BMI (Chang & Heaman, 2005; Dozier et al., 2013; Gizzo et al., 2013; Jordan et al., 2013), and have varying time-frames for breastfeeding assessment from only the immediate first couple of hours up to six months of age.

The possible mechanisms for the reported poorer breastfeeding outcomes in mothers and babies exposed to epidural analgesia has been under discussion in the literature. Epidural analgesia has been associated with poorer infant feeding behaviours (Baumgarder et al., 2003; Belin et al., 2005; Chang & Heaman, 2005; Gizzo et al 2012; Ransjo-Arvidson et al., 2001; Riordan et al., 2000). Epidural analgesia has also been shown to affect maternal hormone systems involved in milk release and production. Epidurals can cause a decrease in the endogenous release of oxytocin during labour (Jonas et al., 2009; Rahm et al., 2002) which can lead to a decrease in

the amount of colostrum/milk available for the infant (Nissen et al., 1996). Furthermore, Syntocinon with or without epidural can cause a reduction in maternal oxytocin pulses on day two (Jonas et al., 2009) considered essential for milk release and altered prolactin release (Jonas et al., 2009) essential for milk production.

The present study included use of Syntocinon as a variable. Twenty percent of women had their labour induced or augmented with Syntocinon. This compares to the rate reported nationally of 22% for induction of labour and 27% for augmentation in 2011 (MOH, 2014), but this did not specify Syntocinon augmentation only. In the present study, use of Syntocinon in labour and postpartum were found to be significantly associated with use of formula in the bivariate analyses, and in the multiple regression, postpartum treatment was found to be an independent predictor for formula supplementation. Syntocinon use in labour was associated with an unadjusted odds ratio of 1.5 (95% CI 1.06 - 2.03, p = 0.024) for formula supplementation. This finding is in agreement with other studies which found an association of synthetic oxytocin with poor breastfeeding outcomes (Dozier et al., 2013; Jordan et al., 2009; Wiklund et al., 2009).

Use of Syntocinon as a uterotonic to contract the uterus and hasten the expulsion of the placenta immediately postpartum, also known as 'active management' of third stage, is common practice. While 60% of mothers in the study had a normal vaginal birth, only 9% (n = 140) of mothers had no postpartum treatment, also called 'physiological management' of third stage. Physiological management is only an option for normal, physiological birth. Caesarean protocols dictate Syntocinon infusion postpartum. Over half (55%, n = 838) the mothers had one treatment of either intramuscular (IM) Syntocinon or intravenous (IV) Syntocinon, but some mothers were given additional treatment. These treatments included Syntocinon IM plus IV (two medications, 31%, n = 477), plus combined oxytocin ergometrine (Syntometrine) (three medications, 4%, n = 63), plus prostaglandin (Misoprostol or Carboprost) (four medications, 1%, n = 12). These mothers would likely have been treated for bleeding which was considered heavier than normal (> 500 mLs). The national rates of active versus physiological management vary between the different levels of healthcare facility. For example, Dixon et al., (2013) reported a cohort of low-risk mothers birthing at a tertiary facility were 2.8 times more likely to have an actively managed

third stage compared to mothers birthing at a primary facility and suggest this is likely to do with institutional protocols.

In the multiple regression analysis, compared to receiving no postpartum treatment, the odds for formula supplementation increased significantly with each increase in level of treatment. Mothers receiving the standard active management, one treatment of either IM or IV Syntocinon, had an odds ratio of 2.8 (95% CI 1.19 - 6.73, p = 0.018) for formula supplementation. Mothers receiving two treatments had an odds ratio of 3.8 (95% CI 1.51 - 9.36, p = 0.004) for supplementation. Many of these mothers would likely have been receiving an IV infusion of Syntocinon for augmentation of labour and been given additional IM Syntocinon as a uterotonic as is standard practice for delivery of the placenta in this maternity unit (Julie Robinson, Midwifery Educator, 2014, personal communication). These mothers were unlikely to have been bleeding excessively but may have been at greater risk for increased postpartum blood loss due to potential reduced responsiveness to Syntocinon (Robinson, Schumann, Zhang, & Young, 2003).

Finally, mothers who experienced heavier than normal blood loss would have been given additional treatments for postpartum haemorrhage as per protocol (Southern District Health Board Obstetric Haemorrhage Protocol). The 'three treatment' and 'four or more treatment' categories were collapsed into one category for the multiple regression analysis. This category of three or more treatments was associated with an odds ratio of 4.2 (95% CI 1.49 - 11.82, p = 0.007) for formula supplementation. Mothers in this group, which represented 5% (n = 73) of the sample, may have been compromised by a large blood loss and not been able to tend to their babies immediately nor have been well enough to breastfeed effectively for the first 24 hours or so. Data on blood loss was not collected in the present study. For 2012, the postpartum haemorrhage rate for vaginal births (defined as >600 mL) was 9% and for caesarean births (defined as >750 mL) was 20% in this maternity facility (Pauline Dawson, Research Midwife, 2014, personal communication).

Postpartum haemorrhage is understandably a risk factor for formula supplementation in hospital, however very little on this subject has been presented in the literature. Breastfeeding initiation was described in a NZ/Australian study of 206 mothers' experiences after a significant primary postpartum haemorrhage (Thompson, Heal,

Roberts, & Ellwood, 2010). Only one-quarter of mothers reported being able to hold their babies immediately after birth and only half reported being able to suckle their babies within an hour of the birth. For one-fifth of the babies, there was a delay of four to five hours before the first breastfeed. Furthermore, the likelihood of formula supplementation increased with the increasing volume of blood lost. Insufficient milk syndrome has been reported for mothers who experience a significant postpartum haemorrhage (Willis & Livingstone, 1995); this phenomenon will be discussed later in the chapter.

There is some evidence for an association with synthetic oxytocin and formula supplementation (Chantry et al., 2014; Dozier et al., 2013; García-Fortea et al., 2014; Jordan et al 2009), and impaired breastfeeding behaviour in newborns (Bell et al., 2013; Fernandez et al., 2012). Dozier et al., (2013) found that synthetic oxytocin administered during labour but not postpartum was associated with cessation of any breastfeeding at 30 days postpartum in mothers who initiated breastfeeding, but the study did not report on rates of in-hospital supplementation. García-Fortea et al., (2014) also found an association of labour oxytocin administration with formula feeding in hospital (RR 1.5, 95% CI 1.3-1.6) and reduced breastfeeding duration (RR 2.3, 95% CI 1.4-3.7). All the mothers in their study were given postpartum oxytocin. An association of synthetic oxytocin given during both labour and postpartum with breastfeeding cessation at 48 hours was reported for a large cohort of mothers (n = 48,366) (Jordan et al., 2009). Mothers who had a postpartum haemorrhage (blood loss > 1,000 mL) were excluded.

The administration of synthetic oxytocin may have an effect on the mother's own endogenous oxytocin status either by reducing production (Jonas et al., 2009) or by reducing the proliferation of or the sensitivity of oxytocin receptors in the uterus (Robinson et al., 2003) and or breast (Leng, Caquineau, & Sabatier, 2005), causing lack of response to her own or exogenously administered oxytocin (Odent, 2013). Furthermore, ergometrine, a component of Syntometrine, often used as an adjunct to Syntocinon when blood loss is above normal, is a dopamine agonist and has been shown to reduce prolactin secretion (De Groot, van Dongen, Vree, Hekster, & van Roosman, 1998), and was associated with cessation of breastfeeding by four weeks in one study (Begley, 1990).

The effect of synthetic oxytocin administered to the labouring mother on subsequent infant behaviour may also contribute to the increased likelihood of formula supplementation. It has been shown that while synthetic oxytocin administered peripherally to the mother does not cross her blood-brain barrier (Leng et al., 2005) it does appear to cross the placenta and the foetus's immature blood-brain barrier (Malek et al., 1996). Fernandez et al., (2012) found that babies exposed to intrapartum oxytocin had reduced breastfeeding reflexes in a dose-dependent relationship, and at three months, breastfeeding exclusivity was significantly related to amount received in labour. Dose-responsivity is one of the cornerstone criteria for attributing causality when associations are observed (Mundt, 2006). All mothers in the study had received epidural analgesia, as well as an actively managed third stage, which may also have contributed to newborn behaviour. Furthermore, controls receiving no treatment with intrapartum oxytocin were absent.

Exposure to intrapartum oxytocin was associated with poor pre-feeding cues in the newborn in another study (Bell et al., 2013). Immediate skin-to-skin contact between mother and baby were not part of hospital practice in their study; infants were observed in a warmer for the first 20 minutes post birth, swaddled and given to their mothers, then observed supine in a cot at 45 minutes of age. This study protocol is contrary to Baby-Friendly practices, nevertheless, it found that infants exposed to intrapartum oxytocin were 11.5 times (95% CI 1.8 - 73.3) more likely to demonstrate low/medium prefeeding cues compared to unexposed infants who demonstrated high levels of prefeeding organisation. No effect of epidural exposure was detected, however the study was limited by a small sample size (n = 47), wide confidence intervals, and furthermore, there was no mention of third stage management.

In summary, the results of this study show that labour and birth characteristics such as operative birth method, use of analgesia and oxytocin treatment are predictors for formula supplementation. The association of these labour and birth interventions with formula supplementation answers my primary research question and supports my first hypothesis *"Labour and birth interventions will be associated with increased formula supplementation of breastfed babies during the hospital stay"*. This result is supported by evidence from the literature which demonstrates labour and birth interventions can decrease breastfeeding exclusivity (e.g., Ahluwalia et al., 2012; Li Bai et al., 2013). Even in a Baby-Friendly hospital, mothers and babies experiencing these interventions

are at greater risk for formula supplementation. In addition, the consequences of birth interventions may influence breastfeeding behaviours in the newborn which may in turn influence mothers' interpretation of poor feeding cues as disinterest in breastfeeding (Chantry et al., 2014; Keemer, 2013), and the subsequent lack of breast stimulation in turn may lead to poor milk supply or delayed onset of lactation (Lind et al., 2014). These aspects will be discussed later in the chapter.

5.3.3 Infant Characteristics

While infant characteristics such as gestation and birth-weight are standard demographics usually included in analyses of breastfeeding outcomes, skin-to-skin contact is less commonly included. In the present study, infant characteristics found to be significantly associated with formula supplementation in the bivariate analysis were ethnicity, gestation, birth-weight, initiation of skin-to-skin contact and duration of skin-to-skin contact. In the multiple logistic regression, gestation and duration of skin-to-skin contact remained significant, independent predictors of formula supplementation.

These results are in line with other studies which have investigated the impact of gestation and birth-weight on breastfeeding outcomes (Biro et al., 2011; Donath & Amir, 2008). Gestation of the baby is well-known to be a risk factor for receiving breastmilk substitutes when the baby is late-preterm (35 - 37 weeks) (Walker, 2008). These babies are routinely tested for low blood glucose levels and often require some medically-indicated supplementary feeding if they develop hypoglycaemia, hyperbilirubinaemia or low weight gain. The effect of gestational age on initiation of breastfeeding in a country with a high rate of breastfeeding initiation has been studied by Donath and Amir (2008). Their study included late-preterm babies of 35 to 37 weeks and did not exclude babies who were admitted to a neonatal unit. Importantly, they found that babies considered term, at 37 to 39 weeks had lower rates of breastfeeding than babies born at greater than or equal to 40 weeks. The present study did not analyse gestation by category but found for each week of increase in gestation, the odds of formula supplementation decreased by a factor of 0.67. This is of clinical significance when women are booked in for induction of labour or an elective caesarean before 40 weeks.

For birth-weight, each increase in gram was associated with a decrease in the odds of formula supplementation by a factor of 0.99. When analysed by category, birth-weight of less than 2500 grams was significant in the bivariate model. In accordance with hospital protocols (Southern District Health Board) and in common with many other hospital protocols internationally (Wight & Marinelli, 2012), babies of less than 2500 grams, greater than or equal to 4500 grams and/or less than or equal to 36 weeks gestation are tested for blood glucose levels soon after birth. If the blood glucose level is less than 2.5 mmol/mL then the baby is placed in skin-to-skin contact with its mother (if not already), assisted to breastfeed in the first instance and given a supplement of mother's colostrum. If unable to feed or unable to express any colostrum, formula is given. Blood glucose is tested again in an hour's time and the process is repeated if the blood glucose is low. For these vulnerable babies, an increased rate of formula supplementation is not unexpected. The number of babies supplemented with formula for hypoglycaemia is discussed later in the chapter.

Significant differences for supplementation between infant ethnicities were found. This is different from the results for maternal ethnicity which did not reach statistical significance. Infant ethnicity is chosen by the parents at birth and it is this ethnicity which is monitored by the Ministry of Health and the New Zealand Breastfeeding Authority with regard to breastfeeding and other outcomes. Nationally, average rates of exclusive breastfeeding on discharge from hospital in 2012-3013 by infant ethnicity were: Māori 83%, Pasifika 82%, Asian 73% and Other 85% (NZBA data, Julie Stufkens, personal communication, 2014) (where 'Other' is represented by NZ European, European and Other ethnicities). In the current study, when infant ethnicities are grouped to match the NZBA categories, the rates of exclusive breastfeeding on discharge were Māori 82%, Pasifika 74%, Asian 75% and Other 86%. These rates compare favourably except for Pasifika infants which are 8% lower. Within the Asian grouping, the 'Other Asian' had the lowest rate at 71% and Chinese had the highest at 80%. There may be some benefit of separating Asian ethnicities out into individual groups, as in the present study, in order that these differences are detected and individualised interventions can be targeted at the different ethnicities according to individual cultural needs.

The delay in time to first skin-to-skin contact between mother and baby was a significant predictor of formula supplementation in the bivariate model but did not

hold for the multivariate analysis. A linear trend was found for delay of skin-to skin contact and formula supplementation. The majority of babies (62%) commenced skin-to skin contact within five minutes of birth, and by 30 minutes, 76% of babies were were having skin-to-skin contact with their mothers. Within one hour, 95% of babies were having skin-to-skin contact. Birth method impacted significantly ($p < 0.01$) on the delay until skin-to-skin contact. The average delay for a normal birth was 3.6 minutes, ventouse birth 11 minutes, forceps birth 12 minutes, while an elective caesarean was 36 minutes and an emergency caesarean was 44 minutes.

The practice of skin-to-skin immediately after a caesarean birth has been the focus of several recent articles where a 'natural' or 'family centered' caesarean is promoted (de Alba-Romero et al., 2014; Smith, Plaat, & Fisk, 2008; Zauderer, & Goldman, 2012). These articles discuss how immediate skin-to-skin and delayed cord clamping are facilitated and the current evidence behind these practices, together with the positive effects reported by parents. The evidence to support immediate skin-to-skin at caesarean birth may reasonably be extrapolated from the benefits of skin-to-skin at a normal vaginal birth but actual evidence at caesaraen birth is still lacking (Stevens, Schmied, Burns, & Dahlen, 2014). The present study did not find a significant association of delay to initial skin-to-skin contact and supplementation for caesarean births. Further research is required in this area in the form of a randomised controlled trial.

When the delay to initial skin-to-skin contact was analysed by recording peak frequency, it was found that in the group of 37 babies in the 41 to 45 minutes category, only one was recorded as supplemented on discharge, the remainder (97%) were exclusivley breastfed. This proportion is by far the largest of any category, and considerably larger than the proportion of exclusive breastfeeding across the entire sample (84.7%). Of the babies in this group, 29 birthed by caesarean section. Thus, the large delay (nearly 45 minutes) in itself was not detrimental to successful breastfeeding in these cases. By extension, one might question if such a delay is detrimental in any case. The general trend of increased foumula supplementation with longer delay in skin-to-skin initiation may be a consequence of the condition(s) causing the delay, rather than the delay itself. As previously mentioned, further research is needed in this area especially in relation to caesarean births.

Many studies published to date have not defined 'immediate' or 'early' skin-to-skin contact (Agdas et al., 2014; Bramson et al., 2010; Chantry et al., 2014; Mahmood, Jamal, & Khan, 2011) while some include 'within an hour' as a time-frame (McAllister et al., 2009). Some studies use the criteria 'breastfeeding initiation within one hour of birth' rather than actual 'skin-to-skin contact' (Carberry et al., 2013; Dabritz, Hinton & Babb, 2010; DiGirolamo et al., 2008; Nickel et al., 2013; Perrine et al., 2012; Pincombe et al., 2008) and none have compared the effect of different delays in skin-to-skin contact. In their Cochrane review, Moore et al., (2012) address this by defining three categories. *Immediate skin-to-skin*: within the first minute of birth; *very early skin-to-skin*: beginning at 30-40 minutes and *early skin-to-skin*: beginning at one to 24 hours. These categories are not mutually exclusive and due to lack of studies the authors were unable to make comparisons.

In the present study, while a linear (dose-response) trend was found for increasing formula supplementation with increasing delay of skin-to-skin initiation, this did not reach significance (pModel = 0.13). The majority (95%) of babies had skin-to-skin contact within one hour so one cannot compare them to other studies where there were large groups of babies who did not commence skin-to-skin until after one hour or more. As it is hospital practice under the BFHI to initiate skin-to-skin immediately, it is possible the 5% of mother-baby pairs who did not have skin-to-skin within one hour may have had other medical problems which precluded immediate skin-to-skin contact, and these problems may have contributed to poor breastfeeding. Initiation of skin-to-skin within one hour was therefore, a common denominator among mother-baby pairs in this study and thereby it is perhaps not surprising while immediate skin-to-skin contact is protective of exclusive breastfeeding, this variable was not a significant predictor of formula supplementation in the multiple regression analysis. Due to a lack of cases where there was delayed initiation of skin-to-skin contact and the possibility that these mother baby-pairs were separated for medically indicated reasons, it was not possible to clearly answer my first secondary research question, *"Is there an association between a delay in the initial initiation of skin-to-skin contact between mother and baby at birth and supplementation of breastfed babies?"*

Duration of skin-to-skin contact is another component of the skin-to-skin equation. The second secondary research question was, *"Is there an association between duration of skin-to skin contact between mother and baby during the first 2-3 hours*

after birth and supplementation of breastfed babies?" The majority of babies in the present study had over 30 minutes of skin-to-skin contact (80%) and the mean duration of skin-to-skin contact was over 60 minutes. Although the duration varied significantly between birth methods, the matter of a few minutes is unlikely to be of clinical significance. There was a significant linear trend (pModel < 0.001) of decreased odds of supplementation with increasing duration of skin-to-skin contact at birth. Skin-to-skin duration was also found to be a significant independent predictor in the multiple regression model ($p < 0.001$). This is in agreement with the study Bramson et al., (2010) conducted where differing skin-to-skin duration times during the 3 hours post birth were examined in a large cohort of babies (n = 21,842) and a linear, dose-response relationship was found. They also found mothers that exclusively breastfed were more likely to have birthed vaginally and had no analgesia, also in agreement with the present study. The study by Bramson et al., (2010) had a group of mother-baby pairs who did not have any skin-to skin contact during the first few hours post birth, thus were able to use this group for comparison.

Research on newborn behaviour and physiology, suggests the infant needs at least an hour of skin-to-skin contact at birth to go through the recently described, nine phases of instinctive reflexive behaviour to locate and crawl towards the breast and self-latch (Widstrom et al., 2011). Furthermore, infants placed in skin-to-skin contact are more likely to achieve an effective latch (Mikiel-Kostyra et al, 2002; Moore & Anderson, 2007; Rigard & Alade, 1990; Widström & Thingström-Paulsson, 1993). In addition, skin-to-skin contact supports the newborn physiologically by regulating the heart-rate, respirations, blood glucose levels and thermo-stability (Moore et al., 2012), and would seem to alleviate the 'stress of being born' (Bystrova et al., 2003; Ferber & Makhoul, 2004). It would seem to make physiological sense therefore, that infants should remain in skin-to-skin contact for at least an hour post birth. Maternal physiology also favours a duration of skin-to-skin contact with her newborn for at least an hour, as it is associated with reduced levels of the stress hormone cortisol, (Handlin et al., 2009), elevated levels of oxytocin (Matthieson, Ransjö-Arvidson, Nissen, & Uvnäs-Moberg, 2001), and prolactin production on day two (Jonas et al., 2009), all of which support maternal-infant bonding and also lactogenesis. Studies also show that mothers who had immediate (Koskinen et al., 2014) and prolonged (Aghdas et al., 2014), skin-to-skin contact with their infants had higher breastfeeding self-efficacy scores which is

correlated with increased initiation and duration of breastfeeding (Dennis, 2006). Finally, skin-to-skin contact may help counteract any negative effects epidural analgesia may have on the newborn (Gizzo et al., 2012).

One of the main aims of skin-to-skin contact after birth is to initiate the first breastfeed. Breastfeeding within the first hour is associated with a lower risk for poor feeding (Carberry et al., 2013), higher breastfeeding self-efficacy (Koskinen et al., 2014), breastfeeding exclusivity (Parry et al., 2013), and longer breastfeeding duration (DiGirolamo et al., 2008; Nickel et al., 2013). Many newborns will be assisted by the midwife to latch onto the breast for the first feed during this time. Step Four of the Ten steps of the BFHI says, "…*offering help if needed*". The nature of this help has not been well researched. Midwives may feel they need to intervene by using 'hands-on' help to assist the infant to latch onto the breast in order to speed up the first feed because of time constraints, or because they want to prevent hypoglycaemia or dehydration (Keemer, 2013). In a Baby-Friendly hospital, early interventions may include assistance with latching, extended skin-to-skin contact with mother, unrestricted access to the breast and hand expressing breastmilk to give to the baby. Johns et al., (2013) found that for 18% of first time Australian mothers in their study, the first feed for their babies consisted of expressed milk.

There is some controversy over whether or not offering help, rather than allowing time for the baby to self-latch, can hinder breastfeeding success in the longer term. Widstrom (1993, 2011) argues that the baby needs time and patience to self-regulate and to bring the tongue into the optimal position to latch onto the breast correctly. This may take over an hour. As previously discussed, breastfeeding within an hour is associated with better breastfeeding outcomes. This may also reflect an infant in better condition and a mother with favourable nipple protractility (Moore & Anderson, 2007).

In a recent Australian study (Cantrill, Creedy, Cooke, & Dykes, 2014) the behaviours of the infant, the mother and the midwife were observed in the birthing room during the first hour to determine which practices were positively or negatively associated with effective suckling. The hospital was working towards Baby-Friendly accreditation and the recommended practice was for immediate skin-to-skin contact for at least an hour. While over half of the babies initially went into skin-to-skin

contact with their mothers for at least 30 minutes, only 33% had continuous contact. They documented many interruptions for procedures such as weighing, vitamin administration, resuscitation, positional shift of the mother, passing the baby to a family member then back to the mother. They found 68% of babies began suckling within 60 minutes and the remaining 32% did not achieve an effective suckle by 60 minutes of age. They did not find it possible to make a correlation between duration of skin-to-skin contact and effective suckling due to the inconsistency of this practice. The best predictors of effective suckling were no suctioning of baby and when the baby was positioned at the breast by either the mother or the midwife with the chin pressed into the breast when approaching the nipple. This positioning of the newborn for effective latching is consistent with the findings of Widstrom (1993), who stressed the importance of infant tongue position, and Colson, Meek and Hawdon (2008), who have described maternal and infant positioning to optimise instinctive breastfeeding behaviours. Clearly, there are many more variables to consider during the first couple of hours relating to delivery room practices postpartum in addition to initiation and duration of skin-to-skin contact. This is an area which would benefit from more research.

In summary, this study found the infant and postpartum characteristics which strongly predicted formula supplementation were gestation and the duration of skin-to-skin contact and, to lesser extent, birth weight and the initiation of skin-to-skin contact. This concludes the answering of my primary research question, *"What are the biomedical, socio-demographic, intrapartum and postpartum factors associated with supplementation of breastfed babies during the maternity hospitalisation in a Baby-Friendly hospital?"* To address the second hypothesis: *"Delayed (more than one hour) initiation of skin-to-skin contact between mother and baby will be associated with formula supplementation during the hospital stay"* it cannot be accepted nor rejected because there were too few babies who did not experience skin-to-skin contact within an hour of birth. To address my third hypothesis: *"Duration of skin-to-skin contact between mother and baby for at least an hour in the first two to three hours of birth will be associated with exclusive breastfeeding during the hospital stay"* the results support acceptance of this hypothesis.

While no causal relationships can be inferred, significant associations between mother and infant characteristics, birthing practices and formula supplementation can inform

future prospective studies and highlight mothers and babies at risk for formula supplementation.

5.3.4 Reasons for Formula Supplementation

The key documented reasons for formula supplementation in this study were 'delayed lactation' (n = 66, 28%), 'maternal request' (n = 54, 23%) and 'hypoglycaemia' (n = 48, 21%). These were not mutually exclusive as more than one reason could be chosen. The other reasons documented contained smaller numbers of cases and were too infrequent to be usefully analysed. In addition, there were a large number of babies for whom there was no reason recorded (n = 64, 27%). Reasons were individually analysed against all maternal, birth and infant variables.

Supplementation for the reason 'delayed lactation' was significantly associated with primiparity, birth by elective caesarean, analgesia use and delay to initiation of skin-to-skin contact. Although not reaching significance, 'delayed lactation' was more prevalent in mothers of underweight BMI category compared to normal, and in mothers of Pasifika and European (other than NZ European) ethnicity. Supplementation for 'maternal request' was significantly associated with younger maternal age and increasing duration of skin-to-skin contact. Although not significant, 'maternal request' for supplementation was greater in mothers of underweight BMI category and greater in certain maternal ethnicities particularly in mothers of Chinese ethnicity, and in cases where there was no recording of initial skin-to-skin contact or duration of skin-to-skin contact. Supplementation for 'hypoglycaemia' was found to be significantly associated with no analgesia use in labour and or birth, early gestation and birth-weight. Although not significant, supplementation for 'hypoglycaemia' was also more common for babies of mothers in obese and high-risk BMI categories, and in babies from mothers of Chinese and Other Asian ethnicities. Reason 'not recorded' for supplementation was not significantly associated with any of the variables investigated.

The literature defines the term 'delayed onset of lactation' as delayed lactogenesis II, or "milk coming in" after 72 hours postpartum (Perez-Escamilla & Chapman, 2001). In the present study, the average postnatal hospital stay was only 56 hours; the reason 'delayed lactation' was not a diagnosis but was recorded as a reason for any case where there was insufficient colostrum/breastmilk available for the infant's needs. In

this situation, hospital guidelines (SDHB) recommend expressing by hand or by pump to obtain breastmilk, and where the infant‘s needs are not met, a supplement is recommended if medically indicated. The literature reports the prevalence of delayed onset of lactation, ‘insufficient milk’ or ‘perceived insufficient milk supply’ in the first 72 hours postpartum to range from 10% in rural Guatemala (Hruschka, Sellen, Stein, & Martorell, 2003), 11% in Western Australia (Scott, Binns, & Oddy, 2007), 17% in a study of primiparous mothers in Peru (Matias, Nommsen-Rivers, Creed-Kanashiro, & Dewey, 2010), 23% in California (Dewey, Nommsen-Rivers, Heinig, & Cohen, 2003), 27% in urban Guatemala (Grajeda & Pérez-Escamilla, 2002), 35% in Connecticut (Chapman, & Perez-Escamilla, 1999a) and 44% in a large cohort of primiparous mothers in California (Nommsen-Rivers et al., 2010). The present study did not seek to determine the prevalence of delayed onset of lactation. There may have been some women who experienced delayed onset of lactation whose babies were not supplemented. Among babies who were supplemented, the prevalence of ‘delayed lactation’ or more correctly termed, ‘insufficient breastmilk’ (n = 66), was 28%. As a percentage of all the breastfeeding mothers this was only 4.3%, but this is likely to be an underestimate as the average postnatal stay is only 56 hours. Insufficient breastmilk in the first two days may precede a clinical diagnosis of delayed lactation (Nommsen-Rivers et al., 2009). Delayed lactation is not one of the recognised medical indications for formula supplementation (NZBA, 2011) however, the consequences of delayed lactation are excess weight-loss and dehydration (Dewey et al., 2003) which are clinical indications for supplementation. Weight loss, a common reason for supplementation in some studies (Chantry et al., 2014; Keemer, 2013), was not a common reason in the present study as babies are not routinely weighed before discharge.

Delayed onset of lactation has been reported to be significantly associated with primiparity (Dewey et al., 2003; Grajeda & Pérez-Escamilla, 2002; Scott et al., 2007), maternal age greater than or equal to 30 (Nommsen-Rivers et al., 2010), high BMI (Matias, Dewey, Quesenberry, & Gunderson, 2014; Nommsen-Rivers et al., 2010; Nommsen-Rivers et al., 2012), diabetes (Nommsen-Rivers et al., 2012), caesarean birth (Dewey et al., 2003; Grajeda, & Pérez-Escamilla, 2002; Nommsen-Rivers, Mastergeorge, Hansen, Cullum, & Dewey, 2009; Nommsen-Rivers et al., 2010; Scott et al., 2007), labour and or birth analgesia (Lind et al., 2014), postpartum haemorrhage

(Willis & Livingstone, 1995), supplementation before the onset of lactation (Chapman & Perez-Escamilla, 1999; Hruschka et al., 2003; Nommsen-Rivers et al., 2010), infant birth-weight greater than 3600g (Nommsen-Rivers et al., 2010), infant Apgar score of less than eight (Matias et al., 2010), and ineffective breastfeeding and postpartum oedema (Nommsen-Rivers et al., 2010).

In the present study, primiparity, elective caesarean birth, analgesia and initiation of skin-to-skin contact were significantly associated with babies receiving formula for 'delayed lactation'. There was no significant association with high BMI and delayed lactation in the present study; instead, the highest level of delayed lactation was seen in the underweight category. Similarly, an Australian study found no association of delayed lactation with high BMI (Scott et al., 2007). However, the present study showed a trend for 'delayed lactation' to be recorded more for mothers in the overweight and obese BMI categories compared to mothers in the normal BMI category. The lack of a clear trend may be due to insufficient power due to smaller numbers in some of the categories.

There was no significance between maternal ethnicity and 'delayed lactation' but the analysis was hindered by the small numbers in many of the ethnicity categories. In particular, mothers of Pasifika ethnicity were significantly more likely to be in the obese category and this ethnicity had the greatest percentage of babies supplemented for 'delayed lactation'. With a greater sample number, this may have reached statistical significance.

Use of labour analgesia has been reported recently as a risk factor for delayed lactation regardless of birth method (Lind et al., 2014). Several categories of birth method and different types of analgesia were included in their study. Overall, in the sample of 2366 mothers, the incidence of delayed lactogenesis was 23%. Mothers who received pain medications reported a two to three times higher odds of experiencing delayed lactogenesis compared to mothers who did not use pain medications. As in other studies of birth and analgesia, it is not possible to separate birth method from analgesia when it comes to caesarean birth, as association does not imply causation.

No studies were found which reported on incidence of delayed lactation and initiation or duration of skin-to-skin contact. One may hypothesise that the favourable effects of skin-to-skin by release and activation of endogenous oxytocin and prolactin (Jonas

et al., 2009; Matthieson et al., 2001), the increase in breastfeeding self-efficacy (Ahgdas et al., 2014) and the higher incidence of breastfeeding exclusivity (Bramson et al., 2010; Moore et al., 2012), would mean a decrease in the incidence of delayed lactation with early initiation of skin-to-skin and increasing duration of skin-to-skin contact. While there was a significant relationship between 'delayed lactation' and delay to initiation of skin-to-skin contact there was not an expected linear trend. While there were a lower percentage of babies supplemented for 'delayed lactation' in the immediate (within 5 minutes of birth) skin-to-skin category compared to babies for whom skin-to-skin was delayed for up to an hour, the lowest percentage of cases was in the greater than one hour category. One may assume these babies were supplemented for a reason other than 'delayed lactation'. The category which had the highest percentage of cases of supplementation for 'delayed lactation' was for babies for whom the delay to initial skin-to-skin was either zero or not recorded, therefore it was not possible to draw any insight from this analysis.

Evidence has been published recently on the effect of altered glucose metabolism and the incidence of delayed lactation (Lemay et al, 2013; Nommsen-Rivers et al., 2012). Higher infant birth-weight, higher maternal BMI, and older maternal age are correlates for altered glucose metabolism and all have been shown to be associated with delayed lactation (Nommsen-Rivers et al., 2010). In a study of 883 mothers with gestational diabetes, authors report the incidence of delayed lactogenesis to be 33% (Matias et al., 2014). The authors also found that insulin treatment was a strong predictor of delayed lactogenesis in these mothers. In another study, non-diabetic mothers with normal insulin response to a glucose challenge were more likely to have earlier onset of lactogenesis than mothers who showed signs of impaired glucose metabolism when several different metabolic hormones and biomarkers were measured (e.g. insulin, adiponectin, leptin, resistin) (Nommsen-Rivers et al., 2012).

Hospital protocols recommend blood glucose testing within the first one to two hours of birth on all babies whose mothers have been diagnosed with type I or II diabetes or gestational diabetes. Babies of gestation less than 37 weeks gestation and all babies who weigh less than 2500 grams or more than 4500 grams are also tested as these are risk factors for hypoglycaemia (Wight & Marinelli, 2014). In the present study, of the 48 babies who were supplemented for hypoglycaemia, 12 (25%) were also supplemented for 'delayed lactation' (results not shown). In accordance with SDHB

protocols, a blood glucose level (BGL) of less than 2.5mmol/L requires supplementation with mother's breastmilk in the first instance. If this is not sufficient to bring the BGL up over 2.5mmol/L, then supplementation with infant formula is medically indicated. In the present study, it is not known how many babies were tested for hypoglycaemia which did not require supplementation with infant formula.

The practice of collecting colostrum antenatally, to enable supplementation with mother's own milk in cases where baby is at risk of supplementation, has become common since the SDHB guidelines first became available in 2009. These guidelines suggest that mothers express their own colostrum starting from 34 to 36 weeks gestation and freeze it for use in the immediate postpartum period. Any mother whose baby may be at risk of supplementation including babies of mothers with diabetes, babies who are small for gestational age, inevitable preterm birth and mothers who have had previous breastfeeding difficulties, are encouraged to commence expressing antenatally. Thus some of the babies with hypoglycaemia may have been treated with expressed colostrum without resort to formula.

Supplementation for hypoglycaemia was significantly associated with early gestation and non-use of analgesia. The association with non-use of analgesia may be due to the direct association of analgesia with gestation (OR = 1.2, 95% CI = 1.004 - 1.45, p = 0.045) thus the earlier the gestation the less likely the use of analgesia during labour and birth. While the association of hypoglycaemia with BMI was not significant at p = 0.14, 50% of supplemented babies born to mothers in the high-risk obese BMI category and 28% of babies in the obese BMI category were supplemented for hypoglycaemia compared to 16% of supplemented babies in the normal BMI category. It is not known what percentage of mothers was diagnosed with diabetes in each of these categories. The number of referrals to the diabetic clinic for 2012 calendar year was 121 (Cate Wilson, diabetes specialist, personal communication). This represents a rate of total referrals for pre-existing diabetes, type I and II and also gestational diabetes of 6.4%. This is the overall rate of diabetes for the whole cohort of mothers before exclusions. This rate is similar to the 6% reported in the literature (Martin et al., 2011 as cited in Kozhimannil et al., 2014).

The associations of hypoglycaemia with birth-weight category and gestation are consistent with the literature (Wight & Marinelli, 2014). A trend for increased

percentages of babies in certain ethnicities to have higher supplementation rates for hypoglycaemia, particularly those born to mothers of Chinese and Other Asian ethnicity was observed, but the numbers were too small for any significant associations to be found with any of the variables. Babies of these ethnicities are, on average, smaller than babies of NZ European ethnicity according to a longitudinal study of infants born in NZ (Morton et al., 2012).

Supplementation for 'maternal request' was the second highest recorded reason among babies who were supplemented (n = 54). 'Delayed lactation' and 'hypoglycaemia' were conditions which may also have been present in the exclusively breastfed group of babies. However, 'maternal request' was a reason unique to supplemented babies. Midwives may record the reason 'maternal request' for many reasons. Prior to dispensing formula for any reason, midwives must ensure mothers are fully informed of the risks of formula supplementation and an informed consent form is signed. When there is no medically justifiable reason for supplementation, mothers are first encouraged and supported to settle their babies in other ways. Some mothers may request formula if they have sore or damaged nipples or are suffering from extreme postpartum discomfort or tiredness (Chantry et al., 2014; DaMota et al., 2012; Keemer, 2013). These are not recognised as acceptable reasons under the BFHI (see Acceptable reasons for Formula Supplementation, Appendix B) and were not specified in the data collection tool.

The factors significantly associated with 'maternal request' for formula were younger maternal age ($p = 0.002$) and increasing duration of skin-to-skin contact ($p = 0.032$). An increased likelihood for maternal request for formula by younger mothers may be related to lack of experience and education about how breastfeeding works, and expectations of newborn behaviour (DaMota et al., 2012).

The association of maternal request for formula with longer skin-to-skin duration at birth may be explained by a number of possibilities, none of which can be substantiated by the available results. For this small number of babies, they may have been 'born hungry' a term used to describe babies who show signs of having lost weight in utero and seem to want to make up for it once born. These babies often want to feed continuously from birth and may have spent a long time in skin-to-skin contact from birth, breastfeeding, and not have been satisfied. Their mothers may then have

perceived they did not have enough milk and requested supplementation. The association of 'maternal request' for formula with increasing birth-weight approached significance ($p = 0.078$). The general trend for supplementation overall, was for decreasing supplementation for increasing birth-weight by a factor of 0.99. For the particular babies who were supplemented for 'maternal request' there was an opposite trend. These babies may have been large babies who displayed signs of being extra-hungry and their mothers did not feel able to satisfy them. In addition, they may also have been more vulnerable in some other way, for example, large for gestational age, and or born to mothers with diabetes. These mothers may have been encouraged to hold their babies in skin-to-skin contact for an extended time to help stabilise blood glucose levels (Moore et al., 2012). Babies of diabetic mothers, or babies of high birth weight (<4500g), may have been supplemented initially for another reason such as hypoglycaemia. This may have undermined the mother's confidence in her own capability to breastfeed or supply sufficient nutrition. Another explanation for keeping these babies in longer skin-to-skin contact may be that these babies were unable to latch due to maternal factors such as flat or inverted nipples, or infant factors such as an oral anomaly like ankyloglossia, dysfunctional suck or sleepy behaviour. Unfortunately these reasons were not included in the data collection tool.

An Australian study found a rate of 37% for 'baby could not latch' in the initial postpartum period which led to the use of strategies such as extended skin-to-skin contact and use of expressed milk (Keemer, 2013). An American study of 447 postpartum mothers found a rate of 44% for 'infant feeding difficulty' at day zero (Wagner, Chantry, Dewey, & Nommsen-Rivers, 2013). These studies indicate a need for further exploration of these phenomena in order that these reasons are better defined and characterised.

When analysed by ethnicity, there were some non-significant ($p = 0.13$) differences which may be of interest. Supplemented babies from mothers of Chinese ethnicity had a high rate (67%) of supplementation for maternal request compared to those of NZ European mothers (20%). Although numbers of mothers in many ethnicities were too small to be statistically useful, the significant differences between feeding outcomes according to infant ethnicity may indicate cultural differences and may expose areas where targeted interventions can be made to address different cultural practices and beliefs. For the Chinese in particular, the influence of NZ infant formula marketing in

China is of concern. New Zealand is a leading milk powder exporter and since the 2008 NZ-China Free Trade Agreement which stipulated a phase-out of infant formula tariffs, infant formula export to China has increased dramatically (Galtry, 2013). Infant formula from NZ is perceived as high quality and safe, particularly after the melamine incident in 2008, where thousands of babies fed a Chinese brand of formula became sick and some died of melamine poisoning (Xiaojing, 2011). Hospitals in China have a high supplementation rate, reported to be 62% (Qiu, Zhao, Binns, Lee, & Xie, 2008). Chinese tradition has the mother resting for the first month and the infant attended to by family members, who may prefer infant formula, as it is seen to help the baby sleep longer and grow into a 'prized chubby baby' (Harney, 2013). Chinese mothers do not believe their milk is sufficient to feed their babies in the first few days and relatives often bring gifts of infant formula (Qiu, Zhao, Binns, Lee, & Xie, 2009). Relatively recent migrants from China to NZ may therefore be more likely to request infant formula. This is an area for tailored education.

There were some non-significant trends for infants of NZ Māori mothers which are worth mentioning. These infants were more likely to be supplemented for hypoglycaemia and maternal request than NZ European babies. National rates of exclusive breastfeeding for Māori and Pasifika infants are on average 10% lower than for NZ European infants at six weeks and beyond (NZBA data, Julie Stufkens, personal communication, 2014). Infants of Pasifika mothers may also be at greater risk of supplementation during the hospital stay. As discussed earlier, this ethnic group have a lower exclusive breastfeeding rate, high rates of obesity, high rates of formula supplementation for 'delayed lactation' and high rates of these mothers requesting formula. Studies indicate that mothers of Māori and Pasifika descent quote 'insufficient milk' as a reason for supplementing their babies (Heath, Tuttle, Cleghorn, & Parnell, 2000; Nand, 2010, as cited in "Un-Doctored", 2010),

Both women of Māori and Pasifika and also of Asian descent have increasing rates of obesity and diabetes in NZ, with estimates of diabetes being three times that of NZ Europeans (Joshy et al., 2008; Simmons, Harry, & Gatland, 1999). Although numbers are small, the results from the present study lend evidence to support these findings and raise concerns about the health for people of these ethnicities. Specific interventions involving assessment of well-being according to measures defined by Māori and Pasifika themselves, and models of care developed by members of these

ethnicities have been suggested as the best way forward to address these disparities (Glover et al., 2009; Henare, Puckey, Nicholson, & Szaszy, 2011).

Maternal request for formula is reportedly associated with birth occurring at night (Gagnon, et al., 2005; Grassley et al., 2014), lack of preparedness for newborn behaviour (Chantry et al., 2014; DaMota et al., 2012), and lack of knowledge of lactation physiology (Chantry et al., 2014; DaMota et al., 2012). However, studies cited were not conducted in Baby-Friendly hospitals. In the present study, the timing of formula dispense was not investigated and the reasons recorded were categorised by the midwives rather than the by the mothers themselves as was the case in the aforementioned studies. In the present study, the babies of many of the mothers who requested formula (n = 22/54) had been supplemented for another reason, for example, hypoglycaemia or 'delayed lactation'. In these cases, the request for formula may come from the mother who has experienced or perceived her milk supply being insufficient for her baby's needs, or concerned that her baby may be in danger of hypoglycaemia if she does not request formula.

Once formula has been dispensed for one reason, it may be dispensed again for another reason and the mother may begin to doubt her capability to produce enough milk. This may be a real or perceived insufficient milk supply. Even when a supplement is given in the hospital for a medically accepted reason such as hypoglycaemia, there is evidence that this affects a mother's confidence in herself that she will be able to feed her baby as it can lower her breastfeeding self-efficacy (Koskinen et al., 2014).

Many mothers will cite insufficient milk supply (IMS) as their explanation for supplementing breastfeeding or expressed milk feeding (Chantry et al., 2014; Harris, 2011; Heath et al., 2000; Morton et al., 2012; Tender et al., 2009). This is often called perceived IMS as mothers often will doubt their supply due to feelings of breast 'emptiness' or infant behaviour such as wanting to feed frequently, or being unsettled and having sleep 'problems'. This issue may also arise if the infant fails to gain weight according to the average trajectory and health professionals question the mother's milk supply. In a study of 114 Dunedin mothers (Harris, 2011), 61% of mothers thought that they had insufficient milk at some time during the study period of birth to 4 months. Perceived IMS was the most frequent (68%) reason mothers were supplementing at between two to nineteen weeks. Harris (2011) found predictors of

perceived IMS to be, mother's worry about adequate infant weight gain in the first three weeks, supplementation before seven weeks, infants feeding frequently, and infant sleep rated as a problem at seven weeks. Not all mothers who felt they may have IMS supplemented their babies. Some responded by breastfeeding more frequently or expressing their milk to increase their supply (Harris, 2011).

It is often quoted that only 5% of mothers cannot successfully breastfeed with sufficient supply of breastmilk (Neifert, 2001). This figure seems to have originally come from an opinion of Spence (1938), but this has not been verified scientifically. Some studies report this figure may be more like 10 to 15% (Neifert et al., 1990) or 12.5% (Stuebe et al., 2014). Prospective, longitudinal studies involving clinical assessment of each mother and baby would need to be conducted to confirm these figures.

There were a significant number of babies who were supplemented for no recorded reason. It is not possible to determine why the reason for supplementation for so many babies was not recorded. These were babies who appeared in the electronic data base as being supplemented but for whom there was no record on the chart for recording 'Reasons for Formula Use'. It is plausible, that since the delivery suite where babies are cared for in the immediate postnatal period is located some physical distance from the rooms where the formula is stored and where the chart are kept, that, in the rush of an emergency, this was a barrier to the recording. It is also possible that midwives did not record supplementation if they felt guilty for supplementing as it is not considered best practice.

There was no particular factor associated with having no recorded reason; cases appeared to be distributed fairly evenly across the variables investigated. There were some non-significant differences noted for ethnicity, postpartum treatment and skin-to-skin duration. When analysed by ethnicity, supplemented babies of mothers from the Other Ethnicity group represented 33% of those supplemented for no recorded reason. This group was not represented by the other reasons previously discussed, which may have indicated a possible language barrier with some of these mothers. However, the same percentage of NZ European babies were also supplemented for no recorded reason. Although not meeting significance, there were lower percentages of supplemented babies from mothers who received three to four postpartum uterotonic

treatments (Chi^2 = 8.9 p = 0.064) supplemented for no recorded reason. One may assume the supplementation for these babies was documented more diligently if the mother was having a higher level of monitoring and treatment for postpartum blood loss.

Approaching significance, duration of skin-to-skin contact of more than one hour was associated with less recording of supplementation for no reason (Chi^2 = 6.8 p = 0.078). For these babies, the optimal duration of skin-to-skin was practiced which may have indicated they were vulnerable babies and were supplemented for medically indicated reasons.

In summary, analysis of the reasons recorded for supplementation has given some insight into this practice. The key reasons for supplementation were due to insufficient breastmilk, maternal request for formula and hypoglycaemia. The answer to my third secondary research question, *"What are the most prevalent documented reasons for formula supplementation during the hospital stay?"* has been answered in part, however, the high incidence of the reason not being recorded indicates more could be learned if recording was more diligent. The associations between the individual reasons and the maternal/infant characteristics and birthing practices were determined, answering my fourth secondary research question, *"What are the associations of maternal/infant socio-demographic biomedical or intrapartum variables with the most prevalent reasons documented for formula supplementation?"* In particular, insufficient milk was associated with primiparity, elective caesarean birth, use of analgesia in labour and birth, and a delay in the initial skin-to-skin contact. These factors are in agreement with the predictors for formula supplementation and support my hypotheses. The results are also consistent with evidence from the literature. There is much scope for further research in this area.

5.4 STRENGTHS AND LIMITATIONS

Utilizing the complete sample of mother-baby pairs from an entire calendar year was a strength of this study as it ensured generalizability of the findings to the general population of the Otago area, and possibly to other Baby-Friendly tertiary facilities in New Zealand. The results may not be generalizable to other Baby-Friendly facilities in other parts of the world where the Baby-Friendly criteria vary from those of New Zealand. The use of clinically recorded data was a strength as it did not rely on the

recall of either midwifery or clerical staff or the mother. The large sample size was a strength of this study as it allowed predictors of formula supplementation to be identified. However, the small percentage of mother-baby pairs in the supplemented group proved to be a limitation when some of the variables were broken down into numerous categories, where some of the numbers became too small to be statistically useful, as they lacked power. This was especially the case when analysing ethnicity and postpartum treatment data.

Another limitation was apparent in the skin-to-skin data. For the babies for whom the early skin-to-skin data was recoded as zero, it was unclear whether it was actually zero or simply not recorded. It would have been useful to have determined this for the analysis. Furthermore, the high prevalence of skin-to-skin contact within one hour of birth (95%) did not allow comparisons with skin-to-skin contact delayed beyond one hour of birth.

There were some limitations of the data collection tool, 'Reasons for Formula Use'. Firstly, there were no reasons depicting infant factors, for example, 'sleepy baby', 'baby unable to latch', 'suboptimal breastfeeding behaviour' and 'signs of inadequate infant intake'. Addition of these factors into a data collection tool may allow more complete information on why babies are supplemented. Secondly, the term 'delayed lactation' was not a good descriptor, as it was used to describe circumstances where there was insufficient milk for baby's needs, rather than a clinical diagnosis where the onset of lactation is delayed for more than 72 hours. This may have impacted on data collection. Thirdly the reason 'maternal request' did not acknowledge the possible challenges a mother may be facing in breastfeeding her baby in the immediate postpartum period such as postpartum pain and exhaustion. There is currently no readily available, nationally or internationally agreed upon data collection tool which takes into account both these infant and maternal factors. The development of such a tool would be helpful for data collection and audit of practices for Baby-Friendly hospitals, and hospitals working towards Baby-Friendly accreditation.

Finally, the numbers of babies with no recorded reason for supplementation (27%) hindered the determination of reasons for formula use. There is also the possibility that the mismatch between data sets occurred as a result of some of these babies

miscoded as fully or partially breastfed when they were actually exclusively breastfed (See Definitions and Abbreviations, page vi).

5.5 Implications for Clinical Practice

The present study has identified predictors of formula supplementation for breastfed babies. These were found to include BMI (overweight and obese categories), primiparity, birth method (emergency caesarean) analgesia during labour/birth, Syntocinon during labour, use of postpartum uterotonics, early gestation, birth-weight of less than 2500 grams, delayed initiation of skin-to-skin contact, and a duration of skin-to-skin contact of less than one hour. While some of these factors are not modifiable, health professionals aware of these risk factors can inform mothers of the possible impact of birthing practices, screen mothers at risk, detect any potential problems early and ensure expert assistance and support is available if required. In order to optimise outcomes, practitioners can be aware of infants who are potentially affected by labour and birth medications such as Syntocinon and analgesia, birth method, and birth practices which can impact on suckling skills or breastfeeding behaviours.

Mothers can be educated antenatally about factors that may increase the risk of supplementation, for example, the potential effects of labour medications on their baby and breastfeeding, about normal infant behaviours after birth, and the importance of early skin-to-skin contact. Expectations about newborn crying, feeding and sleeping patterns and maternal tiredness can be addressed to better prepare mothers for the mental and physical demands of a new baby. Mothers can also use this information to make an informed consent when it comes to induction of labour, use of analgesia and trial of labour rather than elective caesarean, if these are options. Mothers can be more prepared for breastfeeding and practitioners can offer anticipatory guidance to optimise breastfeeding success.

Concern about milk supply is the most common problem breastfeeding mothers report (Chantry et al., 2014; Morton et al., 2012; Stuebe et al., 2014). Concerns over milk supply need to be taken seriously in order to help mothers meet their breastfeeding intentions. Mothers who experience delayed lactation are at risk of earlier cessation of exclusive breastfeeding compared to mothers who have a timely onset of lactation (Chapman & Perez-Escamilla, 1999b). These mothers potentially need more

breastfeeding support during the hospital stay and this should be recognised when staffing levels are allocated. Strong emotions may be evoked when mothers with milk supply concerns interact with health providers. These mothers may already be feeling guilty, pressured and fearful (Flaherman, Hicks, Cabana, & Lee, 2012), therefore, the healthcare practitioner needs to give evidence-based advice in a non-biased manner so an informed decision can be made. Medical practitioners can affirm a mother's experience and offer encouragement and consistent advice based on evidence. Even a few words of encouragement and praise can make a difference to the exclusivity and duration of breastfeeding (Ramakrishnan, Oberg, & Kirby, 2013; Taveras et al., 2003).

Mothers whose babies who have an increased risk of supplementation can be encouraged to begin antenatal colostrum collection from around 34 weeks gestation in order that their babies are supplemented with their own milk if needed, during the initial postpartum period to avoid supplementation with formula (Cox, 2006; Forster et al., 2011). While the literature suggests this practice has not yet been shown to have any proven benefit and may have risks (Chapman, Pincombe, & Harris, 2013; Cox, 2010; Forster et al., 2011), it has become common practice in the region of this study. The anecdotal experience personally observed at our facility of mothers who have practiced antenatal expressing, is that they successfully avoided infant formula, they would do it again, and many have used this practice for second and subsequent pregnancies. The postulated risks are that it may cause preterm labour due to stimulation of uterine contractions and may result in more preterm admissions to the neonatal unit. To date no randomised controlled trials assessing the risks and benefits of antenatal expression of colostrum have been published, and it has been suggested there is inconsistency in the techniques used for expression (Chapman, Pincombe, Harris, & Fereday, 2013).

Increasing rates of caesarean births, managed births, increasing rates of obesity and medically complex pregnancies will see increasing rates of formula supplementation, unless strategies are developed to address these problems. Increased support to mothers antenatally, and in the early postpartum period, may help avoid the use of formula. Alternatives to supplementation with formula include use of mother's own colostrum collected antenatally, the provision of another mother's milk via milk banking, use of donor milk or peer-to-peer milk sharing. These alternatives have become more common recently as mothers seek to exclusively breastmilk feed

(Gribble, 2014). Alternatively, the use of dextrose gel has been shown to improve infant blood glucose levels post birth in babies at risk for hypoglycaemia (e.g. from pregnancies complicated by maternal diabetes, preterm birth, and low birth-weight). Infants randomised to receive dextrose gel had reduced formula use, reduced admission to neonatal intensive care, and increased breastfeeding rates at two weeks of age (Harris, Weston, Signal, Chase, & Harding, 2013).

5.6 RECOMMENDATIONS FOR PRACTICE

Midwives and other health professionals working with mothers and babies may be involved in different aspects of care at different points of their journey through the health care system. The following recommendations can be summarised from the research findings. These have been divided into the three areas where segmentation often occurs.

1. Antenatally: Identify mothers with risk factors for formula supplementation such as primiparas, and being overweight or obese BMI ($\geq$30 kg/m^2). Prenatal education can be given about the increased risks for supplementation with planned elective caesarean, planned induction of labour, analgesia use and planned active management of third stage. Plan for a normal, physiological labour and birth.

2. During labour and birth: Support mothers to use non-pharmacological methods of pain relief, avoid use of Syntocinon to augment labour and facilitate physiological management of third stage. Facilitate immediate (within 5 minutes of birth) skin-to-skin contact between mother and baby for at least an hour in duration.

3. Postnatally: Identify mothers who have a high BMI, are of a younger age, primiparous, were induced with Syntocinon, used analgesia in labour or birth, had a caesarean birth, and those who were treated with postpartum uterotonics. In addition, identify babies of late preterm gestation, smaller or larger birth-weight, of Māori, Pasifika or Asian descent, those who experienced a delay in having skin-to-skin contact with their mothers and those who had a short duration of skin-to-skin contact (less than one hour). These mothers and babies will need extra support to exclusively breastfeed during the hospital stay.

5.7 IMPLICATIONS FOR FURTHER RESEARCH

The repeated reporting of lactation insufficiency as a reason for supplementation indicates a need for more research of a more rigorous and systematic nature to determine what percentage of mothers cannot actually supply enough breastmilk to sustain their babies. It seems astounding to think that so little is actually known about possible lactation malfunction in the human breast, the underlying causes and possible prevention and treatment strategies.

Advocate for research to help stem the rise of obesity and research into best strategies on how to target interventions to support mothers who present with a high BMI in order to help reduce the poor outcomes associated with this condition.

The possible link between analgesia birthing medications and lactation is disputed in the literature; more research is needed to understand the impact of each of these factors on breastfeeding, especially how they impact on lactation physiology.

Incidence, efficacy and safety of antenatal colostrum expressing is also controversial. Randomised controlled trials are needed to determine the efficacy of this practice. If effective, this practice has the potential to significantly reduce formula supplementation in the early postpartum period.

The impact of skin-to-skin contact at caesarean birth needs randomised controlled trials to confirm the efficacy of the impact of immediate versus a short delay to initial skin-to-skin contact on breastfeeding exclusivity.

The findings showed some significant differences between ethnicities indicating an area for future research to determine effective breastfeeding support particular to different ethnicities.

Routinely collected hospital data can be a rich source of information which can be analysed to improve clinical outcomes. In-hospital supplementation levels were found to be lower than rates reported internationally. Careful documentation and record-keeping can yield valuable data to audit breastfeeding outcomes. More research is needed to place this research in the context of performance from other Baby-Friendly hospitals, both within NZ and internationally. In the United States, one of the 2020 Healthy People goals is for breastfed newborns to receive less formula supplementation in the first two days of life, with a reduction from the current level

of supplementation of 25 percent in 2008, to 14.3 percent in 2020 (United States Department of Health and Human Services 2010). The results suggest we are currently close to this rate at 15.3% for Dunedin Hospital.

Compared to breastfeeding initiation internationally, NZ mothers initiate breastfeeding at a high rate, but levels drop off in a similar manner to rates reported internationally. The BFHI has improved breastfeeding initiation, exclusivity and continuance, but more research is needed to determine why breastfeeding rates decline and what measures could be put in place to support exclusive breastfeeding for six months and beyond.

5.8 CONCLUSION

Despite global recommendations for exclusive breastfeeding from birth, there are a number of breastfeeding mothers and babies for whom supplementation with infant formula is an outcome of their hospital experience. Although the supplementation rate of 15 percent may seem acceptable for the Baby-Friendly hospital standards, the results of this study show there is potential for improvement. By analysing routinely collected hospital data, several independent predictors of formula supplementation were found. These included high maternal BMI, primiparity, postpartum treatment with uterotonics, early gestation and duration of skin-to-skin contact. While not independent, other risk factors identified were labour induction or augmentation with Syntocinon, analgesia use in labour or birth, emergency caesarean birth, infant ethnicity and delay to initiation of skin-to-skin contact. The key documented reasons for formula supplementation were insufficient breastmilk, maternal request and hypoglycaemia. The associations of these particular recorded reasons with maternal/infant and birth practice characteristics were consistent with the predictors of supplementation. Some important risk factors for insufficient breastmilk were determined. These were primiparity, elective caesarean and delay to initial skin-to-skin contact. Many of these mothers at risk can be identified in the antenatal period and be given additional education and support both antenatally and in the early postnatal period. The association of maternal age and maternal request for formula, suggests extra support and education could particularly benefit younger mothers. Supplementation for hypoglycaemia was associated with early gestation and certain birth-weight categories. These are often predictable and not unexpected characteristics

in particular circumstances, and there may be the opportunity for mothers to collect colostrum antenatally to give to their babies in the newborn period. In addition, there were a large number of babies where the reason for supplementation was not recorded suggesting the potential for improved outcomes with more diligent documentation.

This is the first study to report on the breastfeeding outcomes as well as the rates and reasons for formula supplementation from a Baby-Friendly hospital environment in NZ. While Baby-Friendly practices are in place, the environment of a tertiary hospital may mean many mothers have complex medical needs and birth intervention rates may be higher. Therefore, health practitioners will need to be skilled at recognising risk factors for supplementation if they are to protect, promote and support mothers and babies achieve breastfeeding exclusivity.

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APPENDIX A: TEN STEPS TO SUCCESSFUL BREASTFEEDING

Every facility providing maternity services and care for newborn infants should:

1. Have a written breastfeeding policy that is routinely communicated to all health care staff.
2. Train all health care staff in skills necessary to implement this policy.
3. Inform all pregnant women about the benefits and management of breastfeeding.
4. Help mothers initiate breastfeeding within half an hour of birth.
5. Show mothers how to breastfeed, and how to maintain lactation even if they should be separated from their infants.
6. Give newborn infants no food or drink other than breast milk, unless medically indicated.
7. Practise rooming-in - that is, allow mothers and infants to remain together - 24 hours a day.
8. Encourage breastfeeding on demand.
9. Give no artificial teats or pacifiers (also called dummies or soothers) to breastfeeding infants.
10. Foster the establishment of breastfeeding support groups and refer mothers to them on discharge from the hospital or clinic.

(Source: *Protecting, Promoting and Supporting Breastfeeding: The Special Role of Maternity Services,* a joint WHO/UNICEF statement published by the World Health Organisation.)

APPENDIX B: ACCEPTABLE REASONS FOR FORMULA SUPPLEMENTATION

(**Source** NZBA, 2011: part 2; pp 27-29.
http://www.babyfriendly.org.nz/fileadmin/documents/going-babyfriendly/DownloadBFHIdocumentspage/Part%202.pdf)

INFANT CONDITIONS

Infants who should not receive breastmilk or any other milk except specialised formula include:

- Infants with classic galactosemia: a special galactose-free formula is needed.
- Infants with maple syrup urine disease: a special formula free of leucine, isoleucine and valine is needed
- Infants with phenylketonuria: a special phenylalanine-free formula is needed (some breastfeeding is possible, under careful monitoring)

Infants for whom breastmilk remains the best feeding option but who may need other food in addition to breastmilk for a limited period include:

- Infants born weighing less than 1500 g (very low birth weight)
- Infants born at less than 32 weeks of gestation (very preterm)
- Newborn infants who are at risk of hypoglycaemia by virtue of impaired metabolic adaptation or increased glucose demand (such as those who are preterm, small for gestational age or who have experienced significant intrapartum hypoxic/ischaemic stress, those who are ill and those whose mothers are diabetic[1] if their blood sugar fails to respond to optimal breastfeeding or breastmilk feeding
- Infants who show symptoms of clinical dehydration, and for whom breastfeeding and maternal lactation has been fully assessed, confirming a delay in lactogenesis II.

('Breastfeeding Answers Made Simple' pgs.203, 414, 619 N Mohrbacher 2010)

MATERNAL CONDITIONS

Mothers who are affected by any of the conditions mentioned below should receive treatment according to standard guidelines.

Maternal conditions that may justify permanent avoidance of breastfeeding

- HIV infection (New Zealand Ministry of Health Guidelines)[2]

Maternal conditions that may justify temporary avoidance of breastfeeding

- Severe illness that prevents a mother from caring for her infant, for example sepsis.
- Herpes simplex virus type 1 (HSV-1): direct contact between lesions on the mother's breasts and the infant's mouth should be avoided until all active lesions have resolved
- Maternal medication:
    - sedating psychotherapeutic drugs, anti-epileptic drugs and opioids and their combinations may cause side effects such as drowsiness and respiratory depression and are better avoided if a safer alternative is available[3]
    - radioactive iodine-131 is better avoided given that safer alternatives are available – a mother can resume breastfeeding about two months after receiving this substance
    - excessive use of topical iodine or iodophors (e.g., povidone-iodine), especially on open wounds or mucous membranes, can result in thyroid suppression or electrolyte abnormalities in the breastfed infant and should be avoided
    - cytotoxic chemotherapy requires that a mother stops breastfeeding during therapy

Maternal conditions during which breastfeeding can still continue, although health problems may be of concern:

- Breast abscess: breastfeeding should continue on the unaffected breast; feeding from the affected breast can continue if the situation of the abscess/drainage area permits[4]
- Mastitis: if breastfeeding is very painful, milk must be removed by expressing to prevent progression of the condition[4]
- Hepatitis B: infants should be given hepatitis B vaccine, within the first 48 hours or as soon as possible thereafter[5].
- Hepatitis C

- Tuberculosis: mother and baby should be managed according to national tuberculosis guidelines[6,7]
- Substance use:
    - maternal use of nicotine, alcohol, ecstasy, amphetamines, cocaine and related stimulants has been demonstrated to have harmful effects on breastfed babies
    - alcohol, opioids, benzodiazepines and cannabis can cause sedation in both the mother and the baby

[1] *Hypoglycaemia of the newborn: review of the literature.* Geneva, World Health Organization, 1997 (WHO/CHD/97.1; http://whqlibdoc.who.int/hq/1997/WHO_CHD_97.1.pdf, accessed 24 June 2008)

[2] http://www.moh.govt.nz/moh.nsf/indexmh/breastfeeding-questions-hiv

[3]*Breastfeeding and maternal medication: recommendations for drugs in the Eleventh WHO Model List of Essential Drugs.* Geneva, World Health Organization, 2003.

[4] *Mastitis: causes and management.* Geneva, World Health Organization, 2000 (WHO/FCH/CAH/00.13; http://whqlibdoc.who.int/hq/2000/WHO_FCH_CAH_00.13.pdf accessed 24 June 2008).

[5] *Hepatitis B and breastfeeding*. Geneva, World Health Organization, 1996. (Update No. 22).

[6] *Breastfeeding and Maternal tuberculosis*. Geneva, World Health Organization, 1998 (Update No. 23).

[7] Guidelines for Tuberculosis Control in New Zealand (2010) Management of the Neonate exposed to Maternal Tuberculosis (page 95) http://www.moh.govt.nz/moh.nsf/Files/guidelines-tuberculosis-2010/$file/guidelines-tuberculosis-control-new-zealand.pdf

APPENDIX C: HEALTH RESEARCH SOUTH APPROVAL

Health Research South

COPY

8/10/2012

Project ID 00847

Dr. Andre Smith
Womens & Childrens Health, DPH

Dear Andre

REF: Predictors of exclusion breast feeding in a New Zealand "baby friendly" hospital.

I am writing on behalf of Health Research South to confirm that the project mentioned above has been granted approval to proceed.

According to our records:

This project is due to commence on:	08/10/2012
It is due to be completed by:	20/08/2015

If you have any questions with regards to this process, please contact me quoting the project ID shown above.

Yours sincerely

R Sharpe

Ruth Sharpe
CLINICAL RESEARCH ADVISOR

cc.: PIP STEWART, SOUTHERN DHB
STEPHANIE KALMAKOFF, LACTATION CONSULTATION , QUEEN MARY MATRNITY, DPH

Health Research South,
University of Otago, Dunedin School of Medicine and Southern District Health Board,
PO Box 913, Dunedin 9054
Ruth Sharpe, Clinical Research Advisor, Ph: 03 470 3843 (Hosp 7979); Ruth.Sharpe@otago.ac.nz

APPENDIX D: PROPOSAL ACCEPTANCE

From: Sally Baddock <Sally.Baddock@op.ac.nz>
To: "Stefanie.Kalmakoff@southerndhb.govt.nz" <Stefanie.Kalmakoff@southerndhb.govt.nz>; "stefanie kalmakoff (woodkal@xtra.co.nz) (woodkal@xtra.co.nz)" <woodkal@xtra.co.nz>
Sent: Friday, 17 May 2013 4:40 PM
Subject: Proposal SUBMISSION 0905 doc_PG commts.doc

Hi Stefanie, I am pleased to say the Post graduate committee has approved your proposal. There are some minor corrections added in track changes.

Following a seminar with Health Research South I believe I am now clear on the ethics process for this project. It will be necessary to follow the HRS protocol and gain ethical approval from the University of Otago (Health) ethics committee. I suggest you still consult with the Kaitohutohu office here at OP as you can use this to indicate your consultation to the OU committee. Once you have this approval you will be able to forward a copy of the letter to the Otago Polytechnic ethics committee. It will not be necessary to complete 2 ethics processes. I believe you are already in contact with Ruth Sharpe – this is excellent. She will identify a DHB sponsor for the project – at no cost to you.. This is a requirement of the DHB.

I suggest the next move is to download the UO ethics form and begin to complete this. You should also contact the Otago Polytechnic Kaitohutohu office to enquire about sending your proposal for consultation, and continue your discussions with Ruth.

I hope that gets you on track.

Well done. Let me know when you have some progress on the consultation and ethics – and if I can be of any help with this.

Regards,
Sally B

Dr Sally Baddock
Co-Head of School
School of Midwifery, Te Kura Atawhai ka Kaiakapono te Hakuitaka
Otago Polytechnic, Te Kura Matatini ki Otago

Mobile 021705782
Freephone 0800762786
www.otagopolytechnic.ac.nz

APPENDIX E: UNIVERSITY OF OTAGO ETHICS APPROVALS

12/210

Academic Services
Manager, Academic Committees, Mr Gary Witte

20 August 2012

Dr A Smith
Department of Women's and Children's Health
Dunedin School of Medicine

Dear Dr Smith,

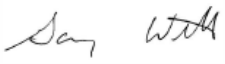
I am writing to let you know that, at its recent meeting, the Ethics Committee considered your proposal entitled "**Predictors of exclusive breastfeeding in a New Zealand 'baby friendly' hospital**".

As a result of that consideration, the current status of your proposal is:- **Approved**

For your future reference, the Ethics Committee's reference code for this project is:- **12/210**.

Approval is for up to three years from the date of this letter. If this project has not been completed within three years from the date of this letter, re-approval must be requested. If the nature, consent, location, procedures or personnel of your approved application change, please advise me in writing.

Yours sincerely,



Mr Gary Witte
Manager, Academic Committees
Tel: 479 8256
Email: gary.witte@otago.ac.nz

c.c. Professor B J Taylor Head Department of Women's and Children's Health

Academic Services
Manager, Academic Committees, Mr Gary Witte

29 May 2013

Dr A Smith
Department of Women's and Children's Health
Dunedin School of Medicine

Dear Dr Smith,

I am again writing to you concerning your proposal entitled "**Predictors of exclusive breastfeeding in a New Zealand 'baby friendly' hospital and reasons given for formula supplementation**", Ethics Committee reference number **12/210**.

Thank you for your request for an amendment, initially received in April. We note that this research is being undertaken for Stefanie Kalmakoff's Master of Midwifery via Otago Polytehnic.

You have requested the title of the project be amended as above, and for data collection to be extended to cover January to December 2012. Additional variables will be examined including ethnicity, smoking status, analgesia during labour, and timing of skin to skin contact. We confirm these amendments are approved.

Your proposal continues to be fully approved by the Human Ethics Committee. If the nature, consent, location, procedures or personnel of your approved application change, please advise me in writing. I hope all goes well for you with your upcoming research.

Yours sincerely,

Mr Gary Witte
Manager, Academic Committees
Tel: 479 8256
Email: gary.witte@otago.ac.nz

c.c. Professor W Gillett HOD Department of Women's and Children's Health

12/210

Academic Services
Manager, Academic Committees, Mr Gary Witte

15 January 2014

Dr A Smith
Department of Women's and Children's Health
Dunedin School of Medicine

Dear Dr Smith,

I am again writing to you concerning your proposal entitled "**Predictors of exclusive breastfeeding in a New Zealand 'baby friendly' hospital and reasons given for formula supplementation**", Ethics Committee reference number **12/210**.

Thank you for the letter from Stefanie Kalmakoff dated 15 January 2014 requesting an amendment to this proposal. You would like to collect an additional variable from the retrospective data - the use of labour augmentation with Syntocinon. This amendment is approved.

Your proposal continues to be fully approved by the Human Ethics Committee. If the nature, consent, location, procedures or personnel of your approved application change, please advise me in writing. I hope all goes well for you with your upcoming research.

Yours sincerely,

Mr Gary Witte
Manager, Academic Committees
Tel: 479 8256
Email: gary.witte@otago.ac.nz

c.c. Professor W Gillett HOD Department of Women's and Children's Health

APPENDIX F CONSULTATION WITH NGĀI TAHU CONSULTATION COMMITTEE

APPENDIX G: CONSULTATION WITH OTAGO POLYTECHNIC KAITOHUTOHU OFFICE

On 2/07/2013, at 8:58 AM, "stefanie kalmakoff" wrote:

Dear all, many thanks for considering my research proposal. As Sally has outlined, I am a Midwife and Lactation Consultant at the SDHB and have been granted permission from the DHB, Otago University Ethics Committee and the Ngai Tahu Research Consultation Committee to access hospital data. My project involves looking retrospectively at socio-demographic and birth data to assess factors associated with formula supplementation of breastfeeding babies. The implications are that modifiable factors will be found which can lead to targeted interventions to facilitate exclusive breastfeeding.

I understand as a student of Otago Polytechnic I am also able consult with Otago Polytechnic Kaitohutohu Office.

Māori have the right to enjoy a health status that is at least the same as that enjoyed by non-Māori.

Plunket data have identified mothers and babies of Māori ethnicity as having lower exclusive breastfeeding rates. This research will be looking at breastfeeding rates by ethnicity and the results may help identify barriers to exclusive breastfeeding for Māori and non-Māori. Improved breastfeeding rates may make a significant contribution to the reduction of inequalities between the health status of Māori and non-Māori.

I look forward to any suggestions or comments you might have.

Many thanks,

Stefanie Kalmakoff

From Gina Huakau, 2nd July, 2013:

Kia ora koutou
Thank you Stefanie, this reads very well and your points were clear. You have been through a few hoops, and as Khyla mentioned below your intended research seems well thought out. All the best!

Ka mihi Gina

And from Prof Khyla Russell, 2nd July:

Kia ora koutou,
Thank you for the emails. I am in Osaka on leave after a conference in the Netherlands. I will be back in my office (or at least toDunedin) on July 11th.

After that. I will respond to these enquiries.
There seems little that you have not done in regard to ethics & Ngai Tahu consultation committee, so there is nothing to hold up your research that i can see.

Na te wiki nunui ko ta te reo rakatira,

Na khyla

Dr Khyla Russell's further response 14th August, 2013:

Tēnā koe Stefanie,
I have indeed given this further consideration but until the research be.
My one query is how you might be able to address the Treaty of Waitangi section in regard to a specific article? If you have considered this, might that be the part of the research platform upon which you have based your response to the Treaty section.

It reads and seems ethically sound to me as stated in the earlier response and though what I am asking in not essential to the research or the right to proceed, I would like to know how you feel Māori mothers are advantaged or not; and, whether you consider what might be a contributor along with the age at which they become mothers has an effect?

Again I stress this is not essential, I am merely interested in how you see this as significant of whether you do so.

Hope the research is underway and that you are still enthusiastic in it. My apologies for the late response and you having to remind me Stefanie.

So much can come into the office and the deadlines planned for / may become altered as a consequence ofsuch interruptions.

Kia mau te kaupapa Rakahau, (keep old of your research topic).
Nā Khyla

30th August 2013:

Dear Khyla, thank-you for your response and your thoughts.

I am interested in your interpretation of the Treaty in how it relates to breastfeeding mothers. I do believe there is a lot more we can do to help Māori mothers; while their breastfeeding initiation rates are comparable in the hospital setting they fall off slightly more once discharged from hospital.

I will endeavour to look at age, smoking status and all aspects of birthing practices in relation to ethnicity to see if there is any associations which can help elucidate risk factors for formula supplementation for breastfeeding babies.

Kind Regards,
Stefanie Kalmakoff

APPENDIX H: OTAGO POLYTECHNIC ETHICS APPROVAL

Stefanie Kalmakoff
8 Beaconsfield Road
Portobello
Dunedin, 9014
14th August, 2013

Bridie Lonie
Chair of Ethics
Otago Polytechnic

Dear Bridie,

I am writing this for the information of the Otago Polytechnic Ethics Committee.

I am undertaking a Masters of Midwifery at Otago Polytechnic. My project involves accessing data from hospital records at the Southern DHB. I have followed the process required by Health Research South and have obtained ethical approval from Otago University Ethics Committee and undergone consultation with Ngai Tahu Research Consultation Committee as per hospital protocol. Further to this I have engaged in consultation with the Kaitohutohu Office. They have approved my research proposal with further comments as per below.

Email communication as per below:

From Gina Huakau, 2nd July, 2013:

Kia ora koutou

Thank you Stefanie, this reads very well and your points were clear. You have been through a few hoops, and as Khyla mentioned below your intended research seems well thought out. All the best!

Ka mihi Gina

And Dr Khyla Russell's response 14th August, 2013:

Tēnā koe Stefanie,

I have indeed given this further consideration but until the research be.

My one query is how you might be able to address the Treaty of Waitangi section in regard to a specific article? If you have considered this, might that be the part of the research platform upon which you have based your response to the Treaty section.

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Hope the research is underway and that you are still enthusiastic in it.

My apologies for the late response and you having to remind me Stefanie.

So much can come into the office and the deadlines planned for / may become altered as a consequence of such interruptions.

Kia mau te kaupapa Rakahau, (keep old of your research topic).

Nā Khyla

Bridie Lonie replied on 15th August 2013:

Dear Stefanie

Many thanks. I have forwarded this to our administrator and we shall get back to you shortly.

With best wishes

Bridie