Feeding Practices and Growth of Preterm Infants Discharged from the Neonatal Intensive Care Unit at Auckland City Hospital until Twelve Months Corrected Age

A thesis presented in partial fulfilment of the requirements for the degree of

Masters of Science

In

Nutrition and Dietetics

at Massey University, Albany, New Zealand.

Jennifer Angela-Jane Vitali

2014

Abstract

Background: Preterm infants are unique in their physiological, developmental and nutritional needs. Previous research regarding the preterm infant has focused on interventions within the hospital setting. Recently the lack of research in the post discharge period has been highlighted. The period after discharge poses a vulnerable period as previous intensive care, growth and nutritional monitoring of the infant are no longer readily available. The aim of this study was to identify current breastfeeding, complementary feeding, feeding practices and growth of preterm infants after hospital discharge from the Neonatal Intensive Care Unit (NICU) at Auckland City Hospital until twelve months corrected age.

Method: Infants who were born preterm (<37 weeks' gestation) were recruited from Auckland City Hospital NICU, a tertiary care level hospital. Homes visits were undertaken at four months after discharge and at twelve months corrected age to collect anthropometric measurements. Online surveys were administered at four months post discharge and at six, nine and twelve months corrected age. Data collected included demographic information at birth, mode of feeding, age of introduction of complementary foods and types of foods introduced to infants. Data were analysed using descriptive statistics. Group comparisons were made using Pearson's chi-square (χ^2), Fishers Exact test and paired T- tests. Differences were considered significant at $P< 0.05$.

Results: Sixty-eight preterm infants were recruited from the NICU at Auckland City Hospital of whom the majority (76%) were born moderate to late preterm. The median (range) age of babies was 34 weeks (24^{+2} - 36^{+6} weeks) and their mean (± SD) birth weight was 2.03 ± 0.65 kg. At hospital discharge 73% of the infants were exclusively breastfed. By four months after discharge this had decreased to 46%, and by 12 months corrected age, only 21% of babies continued to be breastfed. The mean chronological age of complementary food introduction was 23 ± 4.4 weeks (range 12 - 34 weeks). The majority of the babies (84%) started complementary feeding within the recommended age range. The most common first food was baby rice (45%) and infants showed increasing variation in their diet from six until twelve months corrected age. Z-scores for weight, length and head circumference were calculated using UK-WHO data. There was a significant decrease in mean Z-scores for

weight, length and head circumference between birth and hospital discharge. The majority of infants regained this deficit by four months and twelve months corrected age. Although, there were a few infants found to be at risk of growth faltering.

Conclusion: This study shows that the majority of preterm infants discharged from the NICU are breastfed at discharge, although, breastfeeding declines significantly by four months after discharge and thereafter. The majority of infants are introduced to complementary feeding appropriately although the choices of early complementary foods need to be addressed to include high energy nutrient dense foods. Lastly, growth in the post discharge period of these infants was adequate to support and maintain growth for the majority of infants, more research is needed to determine the feeding practices over this time which impacted on growth.

Acknowledgements

I would like to acknowledge numerous people for their help and support in completing this research. Firstly, I would like to thank the families and preterm infants involved in the study for their time and continued involvement in this study which without it would not have been possible.

I would also like to thank my academic supervisor, Dr Cath Conlon, your encouragement, support, advice and understanding have be invaluable during this thesis. You have truly been amazing! A further acknowledgement to Cheryl Gammon, thank you for all of your support and guidance in the completion of this thesis. I would also like to thank my professional supervisor, Barbara Cormack, for your clinical insight into the feeding of preterm infants and providing advice for the completion of this thesis.

A big thank you to Owen Mugridge as research coordinator. Your co-ordination of this study and assistance with recruitment and data collection have been very much appreciated. In addition, Charlotte Moor and Briar Emmett, for your hard work recruiting participants and in data collection in the initial phases of this trial.

Of course, my Darling Lars Buxton, your love and support has made all of this possible, sorry that you were the one on the firing line! I am forever grateful for your support and encouragement over the last few years. My Mum you have been a pillar of support for me, you are the best! And of course all my family and friends for all of your support and encouragement throughout. Last but not least my class mates, how could I have done this without your everyday support, coffee breaks, advice and of course your hugs when I really needed them!

Dedication

I would like to dedicate this thesis to my Dad, Devan Vitali. Sadly you didn't get to see me complete this although your unconditional love and support surely motivated me to get this done! I love you more than words can say Pops!.

I would also like to dedicate this to my darling girl, Mia Cornes, not a day goes by that I don't miss your beautiful smile!

Table of Contents

Abstract ii

Acknowledgements iv

Dedication v

Table of Contents vi

List of Tables xi

List of Figures xii

Appendices xiii

Abbreviations List xiv

Contributions Table xvi

Chapter 1.0 Introduction 1

1.1 Introduction 1

1.2 Purpose of the Study 6

1.2.1 Aim 7

1.2.2 Objectives 7

1.2.3 Hypothesis 7

1.3 Structure of the Thesis 8

Chapter 2.0 Literature Review 9

2.1 Preterm Birth 9

2.1.1 Definition of Preterm Birth 9

2.1.2 Classification of Preterm Birth by Birth Weight 9

2.1.3 Classification of Preterm Infants by Age Terminology 9

2.1.4 Causes of Preterm Birth 9

2.1.5 Rates of Preterm Birth 10

2.1.6 Complications Associated with Preterm Birth 11

2.1.7 Feeding the Preterm Infant 12

2.1.8 Importance of Post-Discharge Nutrition in Preterm Infants 13

2.2 Breast and Formula Feeding Practices in Preterm Infants 14

2.2.1 Exclusive Breastfeeding 15

2.2.2 Mixed Feeding 15

2.2.3 Benefits of Breastmilk 15

2.2.4 Composition of Breastmilk 15

2.2.5 Exclusive Breastfeeding in Preterm Infants 16
2.2.6 Fortification of Breastmilk 17
2.2.7 Preterm Infant Formulas 17
2.2.8 Breastfeeding Recommendations 18
2.2.9 Duration of Breastfeeding in Preterm Infants 18
2.2.10 Breastfeeding Initiation in Hospital 19
2.2.12 Breastfeeding after Hospital Discharge 22
2.2.13 Factors Affecting Duration of Breastfeeding 25
2.3 Preterm Infants and Complementary Feeding 26
2.3.1 Definition of Complementary Feeding 26
2.3.2 Introduction to Complementary Feeding Preterm Infants 26
2.3.3 Early Introduction of Complementary Feeding 27
2.3.4 Late Introduction of Complementary Feeding 28
2.3.5 Recommendations for Complementary Feeding 29
2.3.6 Current Complementary Feeding Practices 34
2.3.7 Age of Introduction of Complementary Feeding 34
2.3.8 Factors Affecting Introduction of Complementary Feeding 36
2.3.9 First Food Introduced for Complementary Feeding 36
2.3.10 Complementary Foods Eaten Over First Year of Life 37
2.3.11 Sources of Feeding Information in New Zealand 38
2.3.12 Introduction of Other Fluids in Preterm Population 38
2.4 Vitamin and Mineral Supplement Practices in Preterm Infants 40
2.4.1 Supplementation Guidelines 40
2.4.2 Supplement Use in Preterm Infants 41
2.4.3 Supplementation and Mode of Feeding 41
2.5 Growth in Preterm Infants 41
2.5.1 Definitions of Growth in Infants 42
2.5.2 Growth Assessment Tools 42
2.5.3 Growth in Preterm Infants 43
2.5.4 Factors Affecting Growth in Preterm Infants 44
2.5.5 Consequences of Poor Growth 45
2.5.6 Preterm Infant Growth at Hospital Discharge 46
2.5.7 Preterm Infant Growth Post Hospital Discharge 47
2.5.8 Feeding Practices Affecting Growth after Hospital Discharge 47

2.6 Summary 50
Chapter 3.0 Methods 51
3.1 Study Design 51
3.2 Ethics 51
3.3 Study population 51
3.3.1 Setting 51
3.3.2 Eligibility Criteria 52
3.3.3 Exclusion Criteria 53
3.3.4 Sample Size 53
3.3.5 Consultation for the Study 54
3.4 Recruitment of Participants 54
3.5 Baseline Birth and Demographic Data Collection 55
3.5.1 Birth Data Collection from Medical Notes 55
3.5.2 Demographics Questionnaire 55
3.6 Tools to Assess Infant Feeding Practices 55
3.6.1 The Infant Feeding Practices Questionnaire 55
3.6.2. Anthropometric Measurements 58
3.7 Procedure 59
3.7.1 Survey administration 59
3.7.2 Home visits 60
3.8 Data analysis: 60
Chapter 4.0 Results 62
4.1 Description of Participants 62
4.2 Milk Feeding Practices in Preterm Infants 65
4.2.1 Main Type of Milk Feeding used for Preterm Infants 65
4.2.2 Mode of Feeding 67
4.2.3 Singleton and Twin Births and Association with Milk Feeding 67
4.2.4 Ethnicity 67
4.3 Complementary Feeding in Preterm Infants 68
4.3.1 Age of Complementary Food Introduction 68
4.3.2 Infants Meeting Preterm Feeding Guidelines 69
4.3.3 First Foods Introduced to Preterm Infants 69
4.3.4 Food Frequency Questionnaire Data 70
4.4 Feeding Practices in Preterm Infants 72

4.4.1 Number of Meals and Snacks per day 72
4.4.2 Feeding Practices of Preterm Infants at Nine and Twelve Months Corrected Age 72
4.4.3 Breast or Formula Milk fed Before Solids 73
4.4.3 Reasons for Starting Solids 73
4.4.5 Parent Reported Advice and Support for Introducing Complementary Feeding 74
4.4.6 Fluids Intake in Preterm Infants 74
4.5 Vitamin and Mineral Supplementation Practices 75
4.6 Growth in Preterm Infants 76
4.6.1 Z-score analysis for Weight, Length and Head Circumference 76
4.6.3 Z-Score Change as an Indicator of Faltering Growth 77
4.6.5 Growth and Timing of Complementary Feeding 78
Chapter 5.0 Discussion 80
5.1 Study Characteristics 81
5.2 Breastfeeding and Other Milk Feeding in Preterm Infants from Discharge until Twelve Months Corrected age 81
5.2.1 Breastfeeding at Hospital Discharge 81
5.2.2 Breastfeeding and Milk Feeding at Four Months Post Discharge 82
5.2.3 Breastfeeding and Milk Feeding until Twelve Months Corrected Age 82
5.2.4 Singleton and Twin Birth and Breastfeeding 83
5.2.5 Ethnicity 84
5.2.6 Type of Formula used by Preterm Infants at Six and Twelve Months Corrected Age 85
5.3 Complementary Feeding in Preterm Infants 85
5.3. Age of Introduction of Complementary Feeding 85
5.3 Infants Meeting Preterm Complementary Feeding Guidelines 86
5.3. Supports for Introducing Complementary Feeding to Preterm Infants 87
5.3. First Foods Introduced to Preterm Infants 88
5.3 Commonly Eaten Foods at Six, Nine and Twelve Months Corrected age 89
5.4 Feeding Practices in Preterm Infants 91
5.3 Sequence of Infant Feeding 91
5.3 Texture of Complementary Foods 91
5.4. Introduction of Other Fluids to the Preterm Infant Over Until Twelve Months Corrected Age 92
5.5 Supplementation Practices from Hospital Discharge until Twelve Months Corrected Age 92
5.6 Preterm Infant Growth 93

5.6.1 Mean Growth of Preterm Infants from Birth until Twelve Months Corrected Age 93
5.6.2 Preterm Infant Growth According to Meeting Preterm Feeding Guidelines 96
Chapter 6.0 Conclusion 98
6.1 Summary of the Study 98
6.2 Conclusion 99
6.3 Strengths 100
6.4 Limitations 101
6.5 Recommendations for Future Research 103
Reference List 104
Appendices 116

List of Tables

Table 2.1 Preterm Infants Breastfeeding at Hospital Discharge Worldwide……21

Table 2.2 Worldwide Studies Showing the Percentage of Preterm Infants being Breastfed after Discharge from the Hospital……24

Table 2.3 Term and Preterm Infant Complementary Feeding Recommendations from around the World……32

Table 2.4 Age of Introduction of Complementary Food to Preterm Infants from Observational Studies Worldwide……35

Table 2.5 Changes in Weight, Length and Head Circumference Z-scores in Preterm Infants at Hospital Discharge……47

Table 4.1. Baseline Characteristics of Preterm Infants……64

Table 4.2 Mother's Demographic Characteristics at Birth……65

Table 4.3 Type of Formula Used at Six and Twelve Months Corrected Age……66

Table 4.4 Corrected Age of Solids Introduction in Preterm Infants……69

Table 4.5 First Foods Introduced to Preterm Infants……70

Table 4.6 Introduction of Foods to Infants at Six, Nine and Twelve Months Corrected Age..71

Table 4.7 Meals and Snacks per Day at Six, Nine and Twelve Months Corrected Age……72

Table 4.8 Feeding Practices at Nine and Twelve Months Corrected Age……73

Table 4.9 Number and Percentage of Infants fed Milk before Solids……73

Table 4.10 Reasons for Introducing Solids for the First Time……74

Table 4.11 Introduction of Fluids at Six, Nine and Twelve Months Corrected Age……75

Table 4.12 Infants Taking Supplements at Six, Nine and Twelve Months Corrected Age……75

Table 4.13 Preterm Infants with a Negative Change in Z-Score by One or More Standard Deviations……78

Table 4.14 Preterm Infants with a Positive Change in Z-Score by One or More Standard Deviations ……78

List of Figures

Figure 2.1 Timeline of Changes in Complementary Feeding Recommendations……29

Figure 3.1 Study Design of Post Discharge Feeding Practices of Preterm Infants Study……52

Figure 4.1 Flow Diagram of Recruitment and Final Number of Participants……..62

Figure 4.2 Main Type of Milk Feeding at Hospital Discharge and thereafter until Twelve Months Corrected Age……..66

Figure 4.3 Ethnicity and Main Type of Milk Feeding at Discharge, Four Months Post Discharge and Twelve Months Corrected Age……68

Figure 4.4 Mean (±SD) Weight Z-scores for Preterm Infants at Birth, Discharge, Four months Post Discharge (PD) and Twelve Month Corrected Age (CA)……76

Figure 4.5 Mean (±SD) Length Z-scores for Preterm Infants at Birth, Discharge, Four months Post Discharge (PD) and Twelve Month Corrected Age (CA)……..76

Figure 4.6 Mean Head Circumference Z-scores for Preterm Infants at Birth, Discharge, Four months Post Discharge (PD) and Twelve Month Corrected Age (CA)……76

Figure 4.7 Growth at Twelve Months Corrected Age in Relation to Introduction of Complementary Feeding According to and not According to Guidelines……79

Appendices

Appendix A Study Information Sheet

Appendix B Contact Letter

Appendix C Infant Informed Consent Form

Appendix D Maternal Informed Consent Form

Appendix E Data Collection from Medical Notes

Appendix F Demographic Questionnaire

Appendix G Infant Feeding Practices Questionnaire Four Month Post Discharge

Appendix H Infant Feeding Practices Questionnaire Six Months

Appendix I Infant Feeding Practices Questionnaire Nine Months

Appendix J Infant Feeding Practices Questionnaire Twelve Months

Appendix K Standard Operating Procedure Weight

Appendix L Standard Operating Procedure Length

Appendix M Standard Operating Procedure Head Circumference

Appendix N Infant Feeding Practices Questionnaire email

Appendix O Infant Feeding Practices Questionnaire email Reminder

Appendix P Data Collection Sheet 2

Abbreviations List

ACH	Auckland City Hospital
AGA	Appropriate for Gestational Age
ANZNN	Australian and New Zealand Neonatal Network
ADHB	Auckland District Health Board
BDA	British Dietetics Association
CA	Corrected Age
EBF	Exclusively Breast Fed
EBM	Expressed Breast Milk
ELBW	Extremely Low Birth Weight
ESPGHAN	European Society of Paediatric Gastroenterology, Hepatology and Nutrition
EUGR	Extra-uterine Growth Restriction
FFQ	Food Frequency Questionnaire
GP	General Practitioner
GUINZ	Growing up in New Zealand
IUGR	Intra-uterine Growth Restriction
LBW	Low Birth Weight
MOH	Ministry of Health (New Zealand)
NEC	Necrotising Enterocolitis
NICU	Neonatal Intensive Care Unit
RCT	Randomised Control Trial
RDI	Recommended Daily Intake
SD	Standard Deviation
SGA	Small for Gestational Age
UK	United Kingdom
US	United States

VLBW Very Low Birth Weight

WHO World Health Organisation

Contributions Table

Contributors	Role in Research
Jenny Vitali	Student researcher, research design including six, nine and twelve month questionnaire development, contacting and following up participants, assisting with follow up, statistical analysis, results interpretation, main author of thesis
Dr. Cath Conlon	Massey University academic supervisor, applied for ethics, research design, assisted with questionnaire development, assisted in interpretation of results, revised and approved the thesis.
Barbara Cormack	Professional Supervisor, advised on research design, assisted with recruitment of participants and revised thesis.
Owen Mugridge	Participant recruitment, anthropometric measures of infants, development of standard operating procedures assisted with questionnaire development and administration.
Prof. Frank Bloomfield	Advised on research design
Cheryl Gammon	Assisted with statistical analysis, revised thesis.
Briar Emmett	Research design, baseline questionnaire and demographic data collection, applied for ethics, participant recruitment, MSc student who presented Vitamin D results at four months post discharge.
Charlotte Moor	Research design, baseline questionnaire and demographic data collection, applied for ethics, participant recruitment, MSc student who presented iron status results at four months post discharge.

Chapter 1.0 Introduction

1.1 Introduction

A Preterm infant is defined as an infant born less than 37 weeks gestation (World Health Organisation, 2009b). The number of preterm births has been increasing in almost all countries, with more than one in ten infants now being born preterm worldwide (World Health Organisation, 2012). In New Zealand (NZ), the percentage of births that are preterm, has steadily increased from 4.3% in 1980 (Craig, Thompson, & Mitchell, 2002) to 7.4% in 2011 (Ministry of Health, 2013). Being born early is a major determinant of neonatal morbidity and mortality and associated with long term adverse health consequences (World Health Organisation, 2009b).

Preterm infants can be classified according to their degree of prematurity. Extremely preterm infants are born at less than 28 weeks, very preterm are born between 28 and <32 weeks, and moderate to late preterm are born between 32 to <37 weeks (World Health Organisation, 2012). The majority of preterm infants are categorised as moderate to late. In 2012, 10.4% of births in Auckland were preterm, of which 7.5% were moderate to late (Pot *et al.*, 2012).

There is a large survival gap of preterm infants between low and high income countries. In high income countries 90% of infants born before 28 weeks survive compared to only 10% surviving in low income countries (Blencowe *et al.*, 2012). Debate arises over the acceptable age of viability for preterm infants, currently the most accepted age is between 22 and 24 weeks gestation (Auckland District Healthboard, 2007; Callen & Pinelli, 2004).

Subcategories based on gestational age are a useful indicator as lower gestational age at birth is associated with increased mortality, disability, intensity of neonatal care and cost (Blencowe *et al.*, 2012). Moderate to late preterm infants fare better than infants of earlier gestational age although are likely to experience more complications than term infants (Behrman & Butler, 2007). The advancement of neonatal medicine has resulted in increased survival rates of preterm infants (Conrad, 2013). In Auckland, 96% of preterm infants survived in 2006. Survival rates increased with increasing gestational age at birth (Auckland

District Healthboard, 2007). This creates a possible dilemma as infants who survive may face a lifetime of developmental, health, growth and feeding issues (Behrman & Butler, 2007).

Preterm infants can be categorised according to either their chronological or corrected age. Chronological age is the infant's actual age from birth, whilst corrected age is calculated by subtracting the number of weeks born before 40 weeks gestation from their chronological age (American Academy of Pediatrics, 2004).

When compared to term-born infant's preterm infants begin life nutritionally disadvantaged for a number of reasons (McGuire, Henderson, & Fowlie, 2004). Firstly, the last trimester of pregnancy is when the majority of nutrients are accreted by the fetus, and preterm infants miss out on this *in-utero* accretion (Conrad, 2013). In addition, they have increased energy and nutrient requirements, due to very rapid growth and immature organs systems (Conrad, 2013). The immaturity of the preterm infant's digestive systems impacts on digestion, absorption and metabolism of food which decreases nutrient assimilation (Conrad, 2013; Foote & Marriott, 2003; McGuire *et al*., 2004). Furthermore, medical complications and neonatal morbidities can increase nutritional requirements. Establishing feeding in a small, sick infant takes longer, and feeds can be interrupted by medical interventions, limiting the amount of nutrition the preterm infant receives (Cooke, 2011). In addition, some infants have on-going complications with chewing and swallowing which decreases oral intake (Foote & Marriott, 2003).

As a result of these factors many preterm infants accumulate a nutritional deficit which is not regained before hospital discharge (Embleton, Pang, & Cooke, 2001; McGuire *et al.*, 2004; Shah & Shah, 2009). Consequently, many preterm infants are at a high risk of malnutrition (Conrad, 2013; Schanler, 2005) and leave hospital with faltering growth (Cooke, 2011). Ideally, growth for the preterm infant should match *in utero* accretion rates (Hay, 2008). However, difficulties arise in meeting nutrient requirements due to delays in reaching full feed rates in hospital (Hay, 2008; Kurl, Heinonen, & Länsimies, 2003). Inadequate energy and nutrient intake can lead to growth restriction during a critical period of development. Resulting in long term short stature, organ growth failure and neuronal deficits which affect long term behavioural and cognitive outcomes (Hay, 2008). This highlights the importance of optimal nutrition in avoiding faltering growth and its consequences in preterm infants.

The majority of nutrition interventions and support in preterm infants occurs between birth and hospital discharge. Despite this, many preterm infants leave hospital with less than optimal nutritional status (Hay, 2008). Very little is known about how preterm infants are fed after hospital discharge (Shah & Shah, 2009). The period after discharge is a vulnerable period as preterm infants leave the controlled clinical environment with feeding supports and growth monitoring to a home environment without these supports. The World Health Organisation (WHO) (2009a) states that adequate nutrition during infancy and early childhood is essential to ensure growth and development of children to their full potential.

The New Zealand Ministry of Health (MOH) recommends exclusive breastfeeding from birth to six months (Ministry of Health, 2008) for healthy term infants. Breastmilk or human milk is also the best form of milk feeding for preterm infants and provides the infant with several non-nutritive advantages. Breastmilk contains immune properties, and factors which promote gut maturation, improve tolerance and provide a protective effect against necrotizing enterocolitis. Necrotizing enterocolitis is one of the most life threatening gastrointestinal emergencies in neonatal care, and preterm infants are highly susceptible (Hunter *et al.*, 2008). Despite these benefits, breastmilk may not contain enough of the nutrients a preterm infant requires and fortification of breastmilk is often necessary to meet the infant's nutrient needs (McGuire *et al.*, 2004; Shah & Shah, 2009; Tudehope, 2013).

Initiation of breastfeeding is more difficult in preterm infants, due to their physiological immaturity. Preterm infants can have difficulties achieving the essential skills for oral feeding, for example, the ability to coordinate a suck-swallow-breath pattern (Crapnell *et al.*, 2013). Current evidence shows that initiation of breastfeeding is lower in preterm infants and the duration is shorter when compared to their full term counterparts (Espy & Senn, 2003; Taylor, Lim, & Neville, 2010). Donath and Amir (2008) in an Australian cohort, found only 41% of preterm infants were breastfed at six months post term, compared to 60.5% of term infants.

Furthermore, very little is known about the introduction of complementary feeding in preterm infants (Marriott *et al.*, 2003). Complementary feeding is the process of introducing foods and other liquids into the infant's diet in addition to breastmilk (World Health Organisation, 2009a). By six months of age, human milk alone can no longer meet a term-

born infant's nutritional requirements for nutrients such as iron and zinc. Complementary feeding becomes necessary to avoid their nutrient store becoming depleted (Agostoni *et al.*, 2008; World Health Organisation, 2009b). Preterm infants have limited accretion of these nutrients *in utero*, and therefore they are more likely to become depleted sooner. The introduction of solids into an infant's diet marks a change in overall intake. The infant is required to transition from a diet of only milk to different foods and textures, whilst also meeting high nutrient requirements to maintain their growth (Young & Krebs, 2013).

In New Zealand, the MOH recommend complementary feeding should begin at around six months of age (Ministry of Health, 2008). The appropriateness of these guidelines for a preterm population has been questioned (Palmer & Makrides, 2012). The need for separate feeding guidelines for preterm infants to account for their prematurity and increased nutrient requirements has been proposed (Foote & Marriott, 2003; King, 2009).

The Neonatal and Infant Nutrition Handbook was developed to provide feeding guidelines for infants in New Zealand (Cormack, 2013). Advice for complementary feeding of preterm infants is included within these guidelines, based on evidence from Palmer and Makrides (2012). A corrected age of three months (13 weeks) has been recommended as an appropriate age to consider starting solids. It also highlights that starting solids before 16 weeks chronological age is too early, whilst after seven months is too late. The guidelines also recommend the introduction of high energy, iron rich foods (Cormack, 2013). Preterm infants have high energy demands, therefore it is important they are eating high energy foods so that their growth is not compromised (Fewtrell, 2003). Traditionally infants are introduced to cereals, vegetables and fruit as first foods. The energy and iron content of these foods are not adequate to meet the needs of preterm infants especially those who have been exclusively breastfed until this time (Krebs & Hambidge, 2007; Young & Krebs, 2013).

Concerns arise from starting solids too soon in preterm infants (King, 2009). As infants change from a milk diet to including solids, milk may be displaced by nutrient poor first foods which can impact on growth. This is especially problematic in preterm infants as it increases the chance of growth restriction in a critical period of development when growth deficits in preterm infants have already likely accrued (King, 2009). In addition,

developmental immaturity of organ systems needs to be considered in regards to the kidneys and gastrointestinal tract (Foote & Marriott, 2003; Palmer & Makrides, 2012). Furthermore, the increased risk of allergy becomes a concern. An observational study of preterm infants found those who had any solids introduced before ten weeks corrected age were at an increased risk of eczema (Morgan *et al.*, 2004). A final consideration is the delay in gross motor development and head control. Good head control is essential for safe eating and in many preterm infants the development of head control is delayed to around three months corrected age (Palmer & Makrides, 2012).

Issues can also arise if the introduction of solids is left too late. Similarly, to concerns of early introduction introducing solids too late can increase the likelihood of nutrient deficiencies and impact growth (McLeod, Sherriff, & Patole, 2013). Key nutrients of concern are energy, protein and micronutrients such as iron, vitamin D, zinc, calcium and phosphorus which the infant is at risk of developing a deficiency if complementary feeding is started too late (King, 2009). Furthermore, solid foods provide infants with the opportunity to develop age appropriate feeding skills, minimising their risk of developing feeding issues later (McLeod *et al.*, 2013). The introduction of solids after seven months chronological age increases the likelihood of the infant developing aversions to anything in their mouth other than milk (Palmer & Makrides, 2012).

Internationally, a few observational studies have reported the age of introduction of solids in preterm infants. This includes an Italian study where the mean age of solid introduction was 22 weeks chronological age, with 60.9% of infants starting complementary feeding before four months corrected age (Fanaro, Borsari, & Vigi, 2007). In another study, of a cohort of preterm infants from Surrey, England the mean chronological age for solids introduction was 17 weeks (Norris *et al.*, 2002).

Preterm infants, especially those who are exclusively breastfed are at risk of micronutrient deficiencies at discharge due to breastmilk not supplying adequate nutrients for growth (Greer, 2007; Shah & Shah, 2009). Auckland City Hospital NICU aim to overcome this with their current supplementation protocol for iron and Vitamin D. Supplementation is based on the infant's birth weight and gestational age. The guideline recommends that infants continue with supplements until established onto a balanced diet of solids (Auckland District

Healthboard, 2014a). There is very little research on compliance with supplementations and duration of supplementation in a preterm population.

Many preterm infants are subject to poor growth, the WHO recognises that early nutritional deficits are linked to long term impairments in growth and health (World Health Organisation, 2009a). Many preterm infants, especially those born very preterm are growth restricted at the time of hospital discharge (Morgan *et al.*, 2012). Ehrenkranz *et al.* (1999) reports around 90% of preterm infants are less than the tenth percentile for corrected age, when discharged from hospital. For many infants growth restriction continues into childhood. This is of concern as it includes delayed head growth which increases the risk of poor cognitive and education outcomes in childhood (Fewtrell, 2003; Morgan *et al.*, 2012). Furthermore early growth restriction has been associated with increased mortality and heart disease in later life (Barker, 1997).

The post discharge nutrition of preterm infants is an understudied area (Shah & Shah, 2009). A lack of evidence in this area has meant current recommendations for feeding preterm infants are based on the paucity of evidence available. This study aims to provide current feeding practices of preterm infants after hospital discharge in the Auckland setting. There is also a lack of evidence on the effects of nutrition during early hospitalisation on long term growth outcomes (Fewtrell, 2003). This study aims to determine if the feeding practices of preterm infants in the post discharge period are adequate to support growth until twelve months corrected age.

1.2 Purpose of the Study

This study was part of a larger longitudinal observational study, which initially assessed the iron and vitamin D status of preterm infants from birth until four months post-discharge. This thesis will present the post discharge feeding practices and growth outcomes of preterm infants after hospital discharge from the NICU at Auckland City Hospital until twelve months corrected age.

The findings from this study will provide a snap shot of current feeding practices in preterm infants after hospital discharge. This situation analysis will provide data on whether these

infants are meeting current recommendations for breastfeeding and complementary feeding, which may guide future nutrition and feeding recommendations to ensure optimal growth and development. The study will also describe iron and Vitamin D supplementation use in preterm infants, determining how long preterm infants continue with supplementation. Furthermore, this study will provide information on where parents currently receive advice for introducing solids to their preterm infant. Finally, growth of preterm infants will be investigated in relation to feeding practices.

1.2.1 Aim

To identify current breastfeeding, feeding practices and to compare the growth of preterm infants from hospital discharge from NICU at Auckland City Hospital to twelve months corrected age using WHO growth standards.

1.2.2 Objectives

1. To determine whether preterm infants after hospital discharge are being breastfed, formula fed or mixed fed and the duration until one year corrected age.

2. To determine the age of introduction of complementary foods, types of foods introduced and the progression of introduction of foods until one year corrected age.

3. To identify what resources and level of support caregivers of preterm infants have for introducing solid food to their infant.

4. To identify which supplements preterm infants are using following hospital discharge until one year corrected age.

5. To explore relationships between feeding practices and growth using WHO growth standards

1.2.3 Hypothesis

1. Preterm infants in Auckland, New Zealand are not meeting current recommendations for breastfeeding.

2. Preterm infants in Auckland, New Zealand are not meeting current recommendations for the introduction of complementary feeding.

3. Preterm infants in Auckland, New Zealand are not meeting growth outcomes from birth to hospital discharge and to 12 months corrected age.

1.3 Structure of the Thesis

This thesis is presented in six chapters. The first chapter introduces the topic and highlights the importance of the research. The literature regarding preterm infant's current milk and complementary feeding practices along with growth will be discussed in Chapter 2. Following this, Chapter 3 will provide a detailed description and justification of the methods used in the study. Chapter 4 reports the results found in this study which are then interpreted and discussed in chapter 5. Chapter 6 draws the research to a conclusion and reflects on the strengths and limitations as well as making future recommendations.

Chapter 2.0 Literature Review

2.1 Preterm Birth

2.1.1 Definition of Preterm Birth

A preterm infant is defined as an infant born at less than 37 weeks gestation (World Health Organisation, 2009b). Preterm infants can be further categorised based on their gestational age. Extremely preterm infants are born less than 28 weeks, very preterm are born between 28 to <32 week's gestation, and moderate to late preterm are born between 32 and <37 weeks (World Health Organisation, 2012). Globally the majority of preterm births (84%) occur between 32 and 36 weeks gestation (Behrman & Butler, 2007; Blencowe *et al.*, 2012).

2.1.2 Classification of Preterm Birth by Birth Weight

Around two thirds of preterm infants are low birth weight thus can be classified according to their weight (Tucker & McGuire, 2004). Low birth weight (LBW) infants are those born weighing less than 2.5kg, very low birth weight (VLBW) infants are born less than 1.5kg, and extremely low birth weight (ELBW) infants are born less than 1.0kg (World Health Organisation, 2011). Due to a number of preterm infants being LBW, studies on LBW infants which included preterm infants will be included in the literature review.

2.1.3 Classification of Preterm Infants by Age Terminology

Preterm infants may also be classified according to chronological or corrected age. Chronological age is the infants actual age from birth whilst corrected age otherwise known as adjusted age, is a calculated age. This is calculated by subtracting the number of weeks born before 40 weeks from their chronological age (American Academy of Pediatrics, 2004). The use of corrected age is important when assessing growth in research and for the ability to identify genuine delays versus delays related to the child's gestational age at birth (D'Agostino, 2010).

2.1.4 Causes of Preterm Birth

Preterm birth can occur for a variety of reasons, which are separated into two subtypes, spontaneous and provider initiated induced preterm delivery (World Health Organisation,

2012). Firstly, spontaneous preterm birth is the most common. The mechanism remains unclear, although, infection, inflammation, uteroplacental ischaemia or haemorrhage and stress have been proposed (Goldenberg *et al.*, 2008; World Health Organisation, 2012). Known risk factors include multiple gestation (Behrman & Butler, 2007; Goldenberg *et al.*, 2008; Steer, 2005), women with shorter intervals between pregnancies and previous preterm delivery (Goldenberg *et al.*, 2008).

Secondly, provider initiated or medically indicated preterm birth is an early induction of labour or caesarean. This results in early cessation of pregnancy for the health of the mother or her foetus (Ananth & Vintzileos, 2006; World Health Organisation, 2012). The most common causes include preeclampsia, foetal distress, placental abruption and small for gestational age infants (Ananth & Vintzileos, 2006). Despite significant advances in reducing preterm birth worldwide the complex aetiology of preterm birth means that it is unlikely to be resolved fully (Flood & Malone, 2012).

2.1.5 Rates of Preterm Birth

The rate of preterm birth is increasing in New Zealand and worldwide (Beck *et al.*, 2010; Ministry of Health, 2013). Increases are due to increases in multiple gestations, assisted reproductive therapies, increasing mothers age and increased reliance on ultrasound dating of pregnancy as opposed to last menstrual period which may increase the number of infants classed as preterm (Craig, Thompson & Mitchell, 2002; Behrman & Butler, 2007; Beck et al., 2010). Behrman and Butler (2007) report that preterm births have increased or remained stable in all but three of 65 countries with consistent data (Behrman & Butler, 2007; Blencowe *et al.*, 2012; South Island Alliance, n.d). Beck *et al.* (2010) estimated that in 2005, 12.9 million births (9.6%) worldwide were preterm with majority occurring in Africa and Asia (85%). There are ethnic and socioeconomic disparities in the rates of preterm birth around the world. A large equity and survival gap exists between high and low income countries, with low income countries faring far worse (Behrman & Butler, 2007; Blencowe *et al.*, 2012; World Health Organisation, 2012).

The percentage of infants born preterm in New Zealand has steadily increased from 4.3% in 1980 (Craig *et al.*, 2002) to 7.4% in 2011 (Ministry of Health, 2013). In 2011, six infants per 100 live births were born preterm at Auckland District Health Board, (National Maternity

Monitoring Group, 2013). Disparities in preterm birth exist in New Zealand, with higher rates seen in Māori infants (8.1%), male infants, infants born into higher deprivation (7.0%) and infants born to younger (less than 25 years) or older (35+ years) mothers (Ministry of Health, 2012; South Island Alliance, n.d).

With increasing incidence of preterm birth, advances in medical technology, perinatal and neonatal care, survival of preterm infants is also increasing. Although, preterm infants may face a life of developmental, health, growth and feeding issues (Behrman & Butler, 2007). As infants being being born preterm is likely to continue, this highlights that understanding the optimal way to nourish these infants is essential to ensure optimal short and long term outcomes for these infants.

2.1.6 Complications Associated with Preterm Birth

Compared with infants born at term (37 to 41 weeks gestation), preterm infants have an increased risk of death and disability (Behrman & Butler, 2007). Over one million children die each year due to complications from preterm birth. In addition, many of the surviving infants face a lifetime of long term adverse health outcomes and disability incurring physical, psychological and economic cost (Beck *et al.*, 2010; World Health Organisation, 2012). The effects of preterm birth are far reaching, affecting the individual, their families and the communities they live within (World Health Organisation, 2012). Furthermore, preterm infants face a variety of nutrition related complications through infancy.

Many complications arise from their immature organ systmems which are under-developed to support life in the extra-uterine environment (Behrman & Butler, 2007; World Health Organisation, 2012). The suck-swallow reflex, which enables the infant to be fed at the breast or via a bottle, develops at around 34 weeks gestation. Although, oral feeds can begin as early as 28 weeks, early introdution can reinforce abnormal feeding habits (DeMauro *et al.*, 2011). For majority of preterm infants of earlier gestational age oral feeds are not considered safe due to neurological immaturity and respiratory compromise. This makes enteral feeding via a nasogastric or orogastric tube essential for nutrient delivery and growth. Long term exposure to enteral tube feeding can increase oral sensitivity and poor feeding skills (DeMauro *et al.*, 2011; Mason, Harris, & Blissett, 2005; McGuire *et al.*, 2004) including difficulties chewing and swallowing as they transfer to oral feeds.This can decrease

oral intake and impact on nutritional status and growth (Fewtrell, Lucas, & Morgan, 2003; Foote & Marriott, 2003; Lapillonne *et al.*, 2013; Mason *et al.*, 2005).

Furthermore, in comparison with term infants, preterm infants have much higher rates of faltering growth and poor health. They often have oromotor hypotonia, fatigue easily, lack strength and have increased risk of respiratory distress syndrome, asthma, feed intolerance, necrotising enterocolitis (NEC), infection and hypothermia (Beck *et al.*, 2010; Behrman & Butler, 2007; Maastrup, 2014). These factors impact on the preterm infant's ability to feed and further increase nutrient requirements which are already difficult to meet. In addition, neurodevelopmental disabilities are common. This includes cerebral palsy, mental retardation, impaired learning and language, visual and sensory disorders and behavioural and social-emotional difficulties (Beck *et al.*, 2010; Behrman & Butler, 2007; Blencowe *et al.*, 2012). A prospective study (n=35) investigating feeding issues in preterm infants found that nine of 14 infants with a disorganised or dysfunctional feeding pattern were those with a neurological disorder. Additionally those infant with identified feeding issues were more likely to have faltering growth (Hawdon *et al.*, 2000). Being born preterm can have various consequences and many of these affect nutritional status and growth.

2.1.7 Feeding the Preterm Infant

The recommended nutrient requirements of preterm infants are based on providing nutrients similar to *in utero* accretion rates of a reference fetus (Aggett *et al.*, 2006; Hay, 2008; O'Connor *et al.*, 2003). These recommendations are based on consensus from groups of experts (Aggett *et al.*, 2006). Although, nutrient recommendations based on *in utero* accretion rates do not account for additional requirements which may be required for growth or medical complications in preterm infants.

Poor placental transfer of nutrients and poor maternal nutrition status while the fetus is *in utero* in addition to low tissues stores at preterm birth due to missing inadequate nutrient accretion increases nutritional requirements from the outset (Conrad, 2013). Furthermore, nutrient requirements increase after birth because establishing feeding in a small, sick infant takes longer. In addition, the interruption of feeds due to clinical concerns may further delay time to reach full feeding rates also reducing the amount of nutrition the infant receives (Cooke, 2011; Hay, 2008; Kurl *et al.*, 2003). This can be exacerbated as intravenous and

enteral nutrition probably do not achieve the same nutrient delivery as the placenta consequently, protein and energy deficits can accrue (Marriott & Foote, 2003; Shah & Shah, 2009; Su, 2014). Immature digestive systems further compound the deficit because of immature digestion, absorption and metabolism decreasing nutrient assimilation. Immature digestion also increase physiological and metabolic demands in addition with on-going medical issues which all further increase nutritional requirements for the preterm infant (Conrad, 2013; Marriott & Foote, 2003; McGuire *et al.*, 2004). As a result, many preterm infants accumulate a nutritional deficit which is not regained before hospital discharge (Embleton *et al.*, 2001; McGuire *et al.*, 2004; Shah & Shah, 2009).

All of these factors increase the likelihood of a preterm infant being discharged from the hospital with malnutrition. Consequently, growth restriction may occur at a critical period of development and lead to short stature, organ growth failure and neuronal deficits which incur long term behavioural and cognitive outcomes (Hay, 2008). Thus, prevention of these deficiencies by optimising nutrition will benefit preterm infants both in the short and long term.

2.1.8 Importance of Post-Discharge Nutrition in Preterm Infants

There is extensive literature regarding the optimal way to feed term infants over the first year of life, although limited literature in preterm infants (O'Connor & Unger, 2013). The post discharge period is a critical period of development and preterm infants are particularly vulnerable initially after hospital discharge and around the time of introduction of complementary feeding. Failing to meet nutrient requirements can lead to poor long term functional outcomes, including growth deficits, neurodevelopment abnormalities and behavioural issues (Aggett *et al.*, 2006). There is a lack of evidence in the long term effects of nutrition during early hospitalisation on later growth. This emphasises the importance of more research into the post discharge nutrition of preterm infants to determine if feeding during this time better predicts growth (Fewtrell, 2003).

Directly after birth is a critical period in preterm infant nutrition (Fewtrell, 2003). Establishing feeds after birth can be difficult and delays in reaching full feeds can compromise the amount of nutrition the preterm infant receives. According to ADHB enteral feeding guidelines a full feed rate is defined 180 ml/kg/day or 200ml/kg/day for

infants not growing well (Cormack, 2012). Delays in reaching full feed rates leads to insufficient nutrition being provided to produce reference fetus growth rates (Hay, 2008; Kurl *et al.*, 2003). Furthermore, establishing breastfeeding in preterm infants can be problematic due to limited neurological competence, slower brain maturation, infant fatigue, limited alertness, lack of muscle strength and limited feeding skills such as latching (Davanzo *et al.*, 2013; Lapillonne *et al.*, 2013; Maastrup, 2014).

Many infants display faltering growth at the time of discharge and also encounter a vulnerable period after they are discharged home (Hay, 2008; Kurl *et al.*, 2003). Infants are vulnerable at this time as they leave a clinically controlled environment in which monitoring of growth is a priority. Prior to discharge feeding regimes are often changed and breastmilk fortifiers are often stopped or infants are changed to a less energy dense infant formula (Fewtrell, 2003). Parents become responsible for feeding an infant who has likely encountered a number of feeding issues in the past. After discharge parents of preterm infants need to overcome these issues without the previous supports also increasing the likelihood of issues going unrecognised, further compromising the infant's growth. Nutritional monitoring of preterm infants may be needed longer than a few weeks post term although nutrition after discharge is a relatively neglected topic (Fewtrell, 2003).

The timing of introduction of complementary feeding is a critical time. Already limited nutrient stores from birth begin to become depleted, especially iron. The introduction of complementary feeding becomes essential as milk alone can no longer meet the nutrient requirements of the infant (Agostoni *et al.*, 2008). Thus, iron deficiency can become a concern particularly if iron rich foods are introduced late and due to the introduction of foods which decrease the efficiency of iron absorption (Marriott & Foote, 2003; Shah & Shah, 2009). Infants are often introduced to nutrient poor first foods (for example pureed apple) which can lead to inadequate energy intake (Lapillonne *et al.*, 2013).

2.2 Breast and Formula Feeding Practices in Preterm Infants

Breastmilk is optimal for the preterm infant as it provides highly bioavailable nutrients and a range of active factors which promote immunity, gut development and aid digestion. A concern for the preterm infant is that breastmilk may not meet the nutritional recommendations. Although fortification of breastmilk is common it can be problematic if

the infant is breastfeeding. For preterm infants who are not receving breastmilk specialised infant formulas are available based on the nutrient requirements of the preterm infant. The use of preterm infant formulas will be dependent on protocols of the clinical unit.

2.2.1 Exclusive Breastfeeding

The World Health Organisation (2009a) defines exclusive breastfeeding (EBF) as an infant recieving only breastmilk. This can be from his or her mother, a wet nurse or expressed breastmilk (EBM) with no other solids or liquids. There is an exception of oral rehydration solutions and vitamin, mineral supplements or medicines.

2.2.2 Mixed Feeding

Mixed feeding also known as partial breastfeeding is when an infant is breastfed whilst also receiving water-based drinks, food-based fluid, semi-solid food or solid food (World Health Organisation, 2014). For infants in countries such as New Zealand mixed feeding is often described as receiving breastmilk in addition with formula milk.

2.2.3 Benefits of Breastmilk

Breastmilk is regarded as the optimal choice of feeding for preterm infants (O'Connor & Unger, 2013)**.** Breastmilk is beneficial for the gastrointestinal system with improved digestion, absorption and better feed tolerance. Furthermore breastmilk contains immune properties for host defence which are especially important in such a vulnerable population. Notable benefits for breastfed infants include increased protection from NEC, reduction in early infection, late onset sepsis and retinopathy (de Oliveira *et al.*, 2007; Hay, 2008; Maastrup, 2014; O'Connor & Unger, 2013; Pineda, 2011; Su, 2014; Tudehope, 2013; Zachariassen *et al.*, 2010). The minerals and trace elements in breastmilk are also highly bioavailable (Fransson & Lönnerdal, 1982). Human milk also confers developmental and psychological benefits to the infant which impact long term growth and development (Tudehope, 2013; Zachariassen *et al.*, 2010). Furthermore, advantages of breastmilk extend to include health benefits to the mother including maternal wellbeing (Maastrup, 2014; Zachariassen *et al.*, 2010).

2.2.4 Composition of Breastmilk

The nutrition of human milk can differ widely and vary depending on time after delivery, length of gestation, length of lactation and method of collection or expression (Tudehope, 2013). Initially, colostrum is produced and contains high concentrations of immune and growth factors, even higher than a term mother's colostrum (de Oliveira *et al.*, 2007; Tudehope, 2013). Transitional milk is produced around the 3^{rd} – 14^{th} day post-partum, this is high in fat, lactose and vitamins (Tudehope, 2013). After this mature milk is produced. The protein composition of breastmilk contains a mix of bioavailable peptides which enhances digestion compared to infant formulas (Maastrup, 2014). The predominant whey protein α-lactalbumin, which digests easily and promotes gastric emptying and contains beneficial host defence properties (Tudehope, 2013). The composition of breastmilk differs between mothers of infants born preterm and term-born infants. Preterm milk is higher in carbohydrates, fat and energy, whilst protein content decreases with increasing gestational age (Bauer & Gerss, 2011).

2.2.5 Exclusive Breastfeeding in Preterm Infants

Despite the benefits of breastfeeding the literature clearly identifies that breastmilk alone is not sufficient for preterm infants as it does not meet nutrient requirements (Morgan *et al.*, 2012; Shah & Shah, 2009; Tudehope, 2013). Thus, growth and nutritional deficits occur in preterm infants who are fed with unfortified breastmilk (Schanler, Shulman, & Lau, 1999; Tudehope, 2013). In their review article Su (2014) found preterm infants who were exclusively breastfed were sent home with a lower body weight. Unfortified breastmilk contains inadequate quantities of protein to support growth and lean body mass accretion. Su (2014) proposes for infants weighing less than 1500g at birth, breastmilk is not nutritionally adequate to support growth and human milk fortifiers are necessary. The Canadian Academy of Paediatrics (1995) states that unfortified breastmilk for the preterm infant is an inadequate sole source of nutrients. Thus the goal for feeding preterm infants is to have them receiving breastmilk, although, breastmilk alone cannot meet the infants nutrient requirements.

Establishing breastfeeding can be difficult and infants are often not able to be exclusively breastfed at the start of their life, thus mothers are required to express their breastmilk (Maastrup *et al.*, 2014). Mothers require support in hospital and after hospital discharge to

sustain breastfeeding (Tudehope, Page, & Gilroy, 2012). However, lactation support is not always available (O'Connor & Unger, 2013). Which can lead to growth faltering which may go undetected if growth is not frequently monitored after discharge (O'Connor & Unger, 2013).

2.2.6 Fortification of Breastmilk

Breastmilk is the recommended feeding choice but as breastmilk alone does not meet nutritional requirements, fortification of breastmilk is necessary (Su, 2014). Fortification of breastmilk optimises rates of growth in the preterm infant whilst also providing the benefits of breastmilk (Canadian Academy of Paediatrics, 1995; Schanler *et al.*, 1999). Nutrition deficits of preterm infants can be improved by the addition of extra nutrients such as energy, protein, vitamins (vitamins A, D, B and C) and minerals (iron, zinc calcium and phosphate) (Anderson, 2013; Tudehope, 2013). Fortification of breastmilk has been shown to increase weight gain and head growth in infancy (Morgan *et al.*, 2012). In a study by Schanler *et al.* (1999) preterm infants (n= 108) were fed either fortified breastmilk or preterm formula. Infants fed fortified breastmilk had less NEC and sepsis than the formula group highlighting the additional benefits of the breastmilk. A Cochrane review investigating growth of preterm infants consuming multi-nutrient fortifiers found increases in weight, length and head circumference (Kuschel & Harding, 2004).

2.2.7 Preterm Infant Formulas

When breastmilk is not available a preterm infant formula can be used for feeding (Su, 2014). Formula provides an alternative for mothers who cannot or choose not to provide breastmilk. Formula does not contain the same advantages of breastmilk such as bioactive factors and protection from NEC. Formula is also associated with an increased risk of infection due to handling increasing the likelihood of cross contamination when compared to breastfeeding (Hay, 2008; Tudehope *et al.*, 2012; World Health Organisation, 2007).

Preterm infant formula is useful if a mother cannot produce sufficient amounts of milk or an infant is not growing appropriately on standard formula (Tudehope, 2013). A standard term formula is designed for term infants, thus preterm formulas have been formulated to meet the nutritional needs of preterm infants. Preterm formulas are energy and protein enriched

and contain minerals, vitamins and trace elements designed to match intra-uterine accretion rates of these nutrients (Su, 2014; Tudehope, 2013). In their review article Hay (2008) found in clinical follow up studies of infants fed formula, the nutrient content of the formula was directly and positively associated with mental and motor outcomes in later life. Infants generally transition from a preterm to term formula after 37 weeks corrected gestational age (Tudehope *et al.*, 2012).

2.2.8 Breastfeeding Recommendations

Breastfeeding recommendations exist for infants in New Zealand and worldwide but, the majority of recommendations are for term infants. The WHO recommends EBF for six months, with continued breastfeeding up to two years of age and beyond. These recommendations are made for a term and preterm population. The WHO feeding guidelines recognise that for preterm infant's breastfeeding is the best option although they may require other supplementation in addition to breastmilk for a period of time (World Health Organisation, 2009a). In New Zealand, the Ministry of Health also recommends EBF for six months (Ministry of Health, 2008). Locally in New Zealand, the Neonatal and Infant Nutrition Handbook recommends human milk as the best nutrition for preterm infants (Cormack, 2013) although, highlights that breastmilk may not contain sufficient nutrients for the preterm infant and hence breastmilk fortifiers may be necessary.

Auckland District Health Board Neonatal Feeding Clinical Guidelines

There are marked differences between feeding guidelines in different neonatal units (Tudehope *et al.*, 2012). At Auckland City Hospital (ACH) Neonatal Intensive Care Unit (NICU) the feeding guidelines, for infants born before 37 weeks, recommend breastfeeding expressed breastmilk, and if breastmilk is not available infant formula should be started. In addition, infants born less than 32 weeks or less than 1800grams are fed fortified expressed breastmilk or preterm formula (Auckland District Healthboard, 2014a).

2.2.9 Duration of Breastfeeding in Preterm Infants

Initiation of breastfeeding in hospital and continuation at discharge and until one year was reviewed in the literature. Although, it was difficult to compare between studies due to differences in the way breastfeeding is defined. Differences include breastfeeding reported

as EBF alone or fed any breastmilk (includes mixed feeding/combination) or being fed solely from the breast.

2.2.10 Breastfeeding Initiation in Hospital

Difficulties may arise when mothers try to initiate breastfeeding in preterm infants. In comparison to full term infants, preterm infants have more medical risks and are in hospital longer which affects the likelihood of breastfeeding (Espy & Senn, 2003). Worldwide, breastfeeding initiation was lower in preterm infants than full term infants. Donath and Amir (2008) found initiation of breastfeeding in preterm infants to be 88.2% (n= 105) in contrast to 92% in term infants (n= 1419). An Australian study by Taylor *et al.* (2010) found 70.1% of preterm infants initiated breastfeeding in contrast to 81% of term infants. This study also found initiation decreased with decreasing gestational age.

Interestingly, preterm infants admitted to a NICU (n= 29940), were more likely to initiate breastfeeding and maintain it for four weeks than preterm infants not admitted into the NICU (n= 108419) ($P< 0.01$) (Colaizy & Morriss, 2008). Furthermore, early initiation of breastmilk pumping, within 12 hours post-partum, is associated with higher rates of breastfeeding. Conversely, the use of nipple shields and pacifiers were associated with decreased rates breastfeeding initiation (de Oliveira *et al.*, 2007; Maastrup *et al.*, 2014).

In New Zealand, in the Growing up in New Zealand (GUINZ) study, 96.3% (n= 5795) of infants were being EBF on their first day of life, although within one week this declined to 92.8%. Some of the infants in this cohort 6.2% (n= 424) were born preterm, however, differences between preterm and term infants are not reported (Morton *et al.*, 2012).

2.2.11 Breastfeeding at Hospital Discharge

2.2.11.1 Worldwide

Preterm infants are likely to stay in hospital for longer after birth than term infants and during this time it is likely they will encounter a variety of factors that decrease the likelihood of breastfeeding at hospital discharge. Various studies worldwide have reported breastfeeding in preterm infants at hospital discharge **Table 2.1**. The percentage of preterm infants being EBF at discharge ranged from 6% in Portugal (Bonet *et al.*, 2011) to 84% in Sweden (Funkquist *et al.*, 2010). These rates are lower than full term populations. A review

of breastfeeding in full term infants at discharge from Australia, Europe and Canada ranged from 74% to 95% (Callen & Pinelli, 2004). Åkerström, Asplund, and Norman (2007) compared rates of breastfeeding between preterm infants and sick full term infants, despite term infants being sick they were more likely to be be EBF at discharge (65%) than preterm infants (53%), ($P< 0.05$).

Maastrup (2014) found infants who were EBF at discharge were significantly more likely to have any milk feeding by six months. Thus, discharge rates of EBF are a useful indicator of breastfeeding success after discharge. The review of the literature showed 20% - 68% of preterm infants around the world were EBF at discharge (Table 2.1).

Table 2.1 *Preterm Infants Breastfeeding at Hospital Discharge Worldwide*

Author (Date)	Country	Study Population	Rates of Breastfeeding at Hospital Discharge
Espy and Senn (2003)	USA	Preterm (n= 151)	73.3%†
Åkerström *et al.* (2007)	Sweden	Preterm (n= 785)	53%, 35% ‡
Lee and Gould (2009)	California, USA	VLBW (n= 6790)	61.1%†
Zachariassen *et al.* (2010)	Denmark	Very preterm (n= 478)	60%, 5% ‡
Funkquist *et al.* (2010)	Sweden	Preterm (n= 177)	84%, 13% ‡
Bonet *et al.* (2011)	Eight European regions	Very preterm (n= 3006)	6%, 44% ‡ (Portugal) 7%, 19% ‡ (France, Ile de France) 14%, 3% ‡ (France, Burgundy) 29% (Trent) 17%, 28% ‡ (Belgium) 18%, 52% ‡ (Italy, Lazio) 22%, 33% ‡ (Netherlands) 24%, 13% ‡ (Poland) 29%, 8% ‡ (United Kingdom)
Pineda (2011)	Country not identified	VLBW (n= 135)	34%, 14% ‡
Davanzo *et al.* (2013)	Italy (Multicentre)	High-risk new-borns (n= 2948, preterm n= 1950)	20%
Sassá *et al.* (2013)	Brazil	Preterm infants (n= 53)	50%, 40% ‡
Barois *et al.* (2013)	France	Very preterm (n= 77)	38%
Mamemoto *et al.* (2013)	Japan	LBW (n= 115)	22.6%
Maastrup (2014)	Denmark	Preterm (n= 1488)	68%*

Classification of Breastfeeding by study:
Exclusive: Exclusive Breastmilk Alone
*Exclusive: Exclusive Breastmilk Delivered from the Breast
†: Represents Percentage of Exclusive and Mixed Feeding Combined.
‡: Represents Percentage of Exclusive Breast Feeding Percentage, Percentage of Mixed Feeding

2.2.11.2 New Zealand

In the last decade New Zealand has seen an improvement in the rate of breastfeeding at hospital discharge. This has been partly due to the introduction of the WHO's Baby Friendly Hospital Initiative in 2002. Since then a dramatic increase in the rate of breastfeeding at

discharge has been seen, with an increase from 55.6% in 2001 to 84.4% in 2011 (Martis & Stufkens, 2013). This data was collected from 30 maternity services throughout New Zealand and represents 90% of the New Zealand population. The Australian and New Zealand Neonatal Network conducted a prospective audit on level 2 and level 3 NICUs in Australia and New Zealand. This audit determines breastfeeding rates for preterm infants, although data for both countries is combined. Of all infants (n= 7440) 74.8% were breastfeeding at discharge (Chow, 2013).

2.2.12 Breastfeeding after Hospital Discharge

2.2.12.1 Worldwide

Determining breastfeeding after discharge provides evidence of how breastfeeding is maintained in a preterm population. It is important to note that different studies report breastfeeding at different time points. Thus for the purpose of this literature review studies reported breastfeeding at 4, 6, 9 and 12 months are discussed. In addition, the literature also report findings differently in relation to infant age, with studies reporting either the infant's chronological or corrected age or both.

Preterm infants are likely to face challenges and experience difficulties with maintaining breastfeeding (Donath & Amir, 2008). Much of the breastfeeding data in preterm infants is from Sweden **Table 2.2**. Sweden has a very high breastfeeding rate, which is also seen in their preterm infants. In their review, Ross and Browne (2013) report that Sweden is regarded as the most successful country at discharging infants breastfeeding and maintaining breastfeeding in preterm infants. Flacking *et al*., (2010) found 42% of infants at six months of age were still EBF and 11% still breastfeeding. Another study by Flacking, Nyqvist, and Ewald (2007) found 60% of infants continued to breastfed at six months which included both exclusive and partially breastfed. In contrast, preterm infants from Brazil had much lower rates with only 6.8% - 16% continuing to be EBF at six months (de Oliveira *et al.*, 2007; Sassá *et al.*, 2013). Åkerström *et al.* (2007) highlights that Sweden's higher breastfeeding rates are attributable to their culture in which breastfeeding is promoted in public and private healthcare along with social supports for parents to facilitate breastfeeding.

A common finding in the literature is that duration of breastfeeding in preterm infants is shorter than in term infants. Furthermore, mothers of preterm infants are more likely to wean from the breast earlier than mothers of term infants (Åkerström *et al.*, 2007; Donath & Amir, 2008; Flacking, Nyqvist*, et al.*, 2007). Donath and Amir (2008) compared duration of breastfeeding between term and preterm infants and found preterm infants were less likely to be breastfeeding at six months of age (41%) compared to term infants (60.5%).

Only three studies, all from Sweden, report breastfeeding at nine months of age in preterm infants. All three studies report both breastfeeding and mixed feeding combined. At nine months 14% - 28% of preterm infants were being fed in this way (Flacking, Nyqvist, *et* al. 2007; Ostlund, Nordstrom, Dykes & Flacking, 2010). Furthermore, the same three studies report breastfeeding in preterm infant's at twelve months age. Breastfeeding at twelve months ranged from 6% - 12% **Table 2.2**. This shows a trend for breastfeeding to steadily decrease by twelve months corrected age.

Table 2.2 *Worldwide Studies Showing the Preterm Infants being Breastfed after Discharge from Hospital*

Author (Date)	Study Design	Study Population	Four Months age	Six Months age	Nine Months Age	Twelve Months Age
Åkerström *et al.* (2007)	Sweden	Preterm (n= 785)	51%,* 28%*	17%,* 48%*	-	-
de Oliveira *et al.* (2007)	Brazil	Preterm (n= 278)	17.7%, 42.9%	6.8%, 47.9%‡	-	-
Flacking, Nyqvist, *et al.* (2007)	Sweden	Preterm (n= 2093)	72%†	60%†	28%†	9%†
Flacking, Wallin, and Ewald (2007)	Sweden	Very preterm (n= 225)	62%†	45%†	22%†	12%†
Donath and Amir (2008)	Australia	(n= 3600) (Preterm n= 177)	-	41.2%†	-	-
Ostlund *et al.* (2010)	Sweden	Preterm (n= 695)	58%†	39%†	14%†	6%†
Funkquist *et al.* (2010)	Sweden	Preterm (n= 177)	57%, 16%	42%, 11%	-	-
Flacking, Ewald, and Wallin (2011)	Sweden	Late Preterm (n= 197), very preterm (n= 103)	Late preterm 71%†, Very preterm 58%†	Late preterm 55%†, Very preterm 43%†	-	-
Sassá *et al.* (2013)	Brazil	Preterm infants (n= 53)	-	16%, 7% ‡	-	-
Maastrup (2014)	Denmark	Preterm (n= 1488)	-	45%,* 23%*‡	-	-

*Represents Corrected Age Used

†: Represents Percentage of Exclusive and partially breastfed Combined.

‡: Represents Percentage of Exclusive Breastfeeding Percentage, Percentage Mixed Feeding

2.2.12.2 New Zealand

There is a lack of preterm breastfeeding data in New Zealand after hospital discharge, thus term infant data is included in the literature review. Plunket New Zealand has the most recent data for breastfeeding after discharge. Plunket reports they see 90% of New Zealand infants, thus providing nationwide data, which is inclusive of preterm infants. Plunket report exclusive, full and partial breastfeeding. Exclusive refers to breastmilk only, with no other

liquids or solid foods. Full refers to full breastfeeding with minimal amounts of water but no other liquid or solid foods. Partial refers to a mixture of breastmilk and formula. In 2013, at three months of age 42% of infants were EBF, 13% were fully breastfed and 20% were partially breastfed, with the remaining infants fed formula. By six months of age EBF had decreased to 17%, and full and partial increased to 18% and 40% respectively (Royal New Zealand Plunket Society, 2014).

Furthermore, Plunket released a report regarding breastfeeding in New Zealand between 2004 and 2009. This was useful for identifying the differences in breastfeeding amongst different ethnic groups within New Zealand (Royal New Zealand Plunket Society, 2010). The report conluded that the ethnic group identified as "other" had the highest rates of breastfeeding, This includes all ethnicities except Asian, Māori and Pacific Island. The Asian ethnic group showed the greatest increase in breastfeeding between 2004 and 2009. When exclusive and full breastfeeding were combined breastfeeeding increased from 23% - 30%. Plunket identifed that from these findings further reseach is needed to investigate the reasons for the current high rates of breastfeeding within the Asian population (Royal New Zealand Plunket Society, 2010).

The GUINZ study also provides data on EBF. By four months of age, 47.3% of infants continued to be EBF, this decreased to 28.1% by five months and 6% by six months. At nine months of age Asian infants were the most likely to be breastfeeding (50.6%) compared to Pacific Island (47%), New Zealand European (46.7%) and Māori (40.5%) infants (Morton *et al.*, 2012). To conclude, there is no preterm specific breastfeeding data after hospital discharge in New Zealand.

2.2.13 Factors Affecting Duration of Breastfeeding

Breastfeeding duration can be influenced by various factors. This includes length of hospital stay (de Oliveira *et al.*, 2007; Pineda, 2011), birth weight (Lee & Gould, 2009), gestational age (Lee & Gould, 2009; Maastrup, 2014; Maastrup *et al.*, 2014; Pineda, 2011; Sassá *et al.*, 2013), and multiple birth. Studies have found mixed results for breastfeeding rates and multiple births (twin and triplet births). Lower breastfeeding has been found in infants born in multiple births (Maastrup *et al.*, 2014; Taylor *et al.*, 2010; Zachariassen *et al.*, 2010). Twin infants are less likely to be EBF at three and six months compared to singleton infants

(Åkerström *et al.*, 2007). In contrast, other studies found the opposite with multiple birth being associated with more breastfeeding (Lee & Gould, 2009). Pineda (2011) (n= 135) found mothers of multiples were 4.4 times more likely to have initiated breastmilk feeding than singleton pregnancies ($P< 0.01$). The effect of multiple birth as a factor in breastfeeding preterm remains contradictory. Understanding the influence of these factors in the post discharge period highlights infants at a higher risk of early breastfeeding cessation. Interventions to support these at risk infants could be an area of future research.

Furthermore, mother related factors associated with the duration of breastfeeding include mother's age (Espy & Senn, 2003; Lee & Gould, 2009; Zachariassen *et al.*, 2010), cigarette smoking status (Espy & Senn, 2003; Lee & Gould, 2009; Maastrup *et al.*, 2014; Zachariassen *et al.*, 2010), and socioeconomic status (Flacking, Wallin*, et al.*, 2007; Lee & Gould, 2009; Zachariassen *et al.*, 2010). Breastfeeding the preterm infant can be very emotional and stressful for the mother. Many are required to learn to express breastmilk to establish and maintain their milk production which may be required for extended periods of time (Maastrup, 2014; Tudehope, 2013).

2.3 Preterm Infants and Complementary Feeding

2.3.1 Definition of Complementary Feeding

The WHO defines complementary feeding as a process when breastmilk is no longer sufficient to meet the nutritional requirements of infants (World Health Organisation, 2009a). The introduction of other foods and liquids is necessary along with breastmilk to meet nutrient requirements. The WHO recommends the transition to complementary feeding should occur from six months and onwards (World Health Organisation, 2009a).

2.3.2 Introduction to Complementary Feeding Preterm Infants

The introduction of complementary feeding marks a major change in the infant's diet, with major alterations in the macronutrient and micronutrient content (Fewtrell *et al.*, 2003). The energy and iron content previously supplied from a diet of breastmilk alone is no longer sufficient. Thus, complementary feeding becomes necessary to meet the energy and nutrient gaps (Agostoni *et al.*, 2008; World Health Organisation, 2009a). If complementary

foods are not introduced at the appropriate time an infants growth may falter and nutrient deficiencies can occur (Fewtrell *et al.*, 2003; World Health Organisation, 2009a).

There are various considerations to take into account with the introduction of solid foods to an infant's diet which is further complicated in a preterm population. Further research is needed to develop evidence-based feeding guidelines in preterm infants (Palmer & Makrides, 2012). Additional considerations include the growing body of evidence that preterm infants discharged from the hospital have accrued nutrient deficits (Embleton *et al.*, 2001; McGuire *et al.*, 2004; Shah & Shah, 2009). This highlights the importance of nutrition in the post discharge period as preterm infants have special nutrient requirements that may need to be met in order to promote growth and development after hospital discharge (Marriott & Foote, 2003; Shah & Shah, 2009).

Recommendations for complementary feeding have not traditionally considered differences between breastfed and formula fed infants or that certain groups of infants, including preterm, could benefit from different recommendations for the introduction of complementary foods (Young & Krebs, 2013). The risk of developing a micronutrient deficiency is much higher in breastfed infants than formula fed infants. Infant formulas have higher concentrations of some nutrients thus decreasing the likelihood of a formula fed infant developing a micronutrient deficiency. In contrast, breastfed infants are at increased risk of iron deficiency especially if complementary feeding is delayed or if first foods are a poor source of haem iron.

Preterm infants are a heterogeneous population they differ in gestational age at birth, early nutritional intake, current nutrition status, nutritional requirements, organ immaturity and developmental progress and readiness (Palmer & Makrides, 2012). All of these factors need to be considered when introducing preterm infants to complementary feeding.

2.3.3 Early Introduction of Complementary Feeding

Difficulties can arise if preterm infants start solids too soon. These include issues with immature organ systems, displacement of nutrients, increased allergy risk and developmental readiness (King, 2009). Developmental immaturity of organ systems, namely the digestive tract and kidneys, needs to be considered before adding solids to the infant's

diet. This is due to the high permeability of this digestive tract and whether the under developed kidneys can manage the increased solute load from the food (Marriott & Foote, 2003; Palmer & Makrides, 2012). However, King (2009) proposes that digestive and renal function mature after birth despite the infants prematurity. In a study by Wauben *et al.* (1998) (n= 37) infants who were fed early (postnatal day 3-5) compared to those fed late (postnatal day 10-14) were able to tolerate oral nutrition sooner, had less feed intolerance and had shorter hospital stay. Another concern is the change from a diet of purely breastmilk or formula to one which includes solid foods. This transition means that milk begins to become displaced by the addition of nutrient poor first foods because a reduction in nutrient density can impact the preterm infant's growth (King, 2009).

An increased risk of allergy has been suggested. In an observational study of preterm infants, those who had any solids introduced before 10 weeks corrected age or four or more solids introduced prior to 17 weeks corrected age were at an increased risk of eczema at twelve months post term (Morgan *et al.*, 2004). However, other studies have found that preterm infants have a lower risk of allergy than term born infants (Siltanen *et al.*, 2011; Zachariassen *et al.*, 2011).

A final consideration is the delay in gross motor development and head control. Good head control is essential for safety when eating. In many preterm infants the development of head control is delayed to around 3 months corrected age (Palmer & Makrides, 2012). If solids are introduced before this time head control may not be sufficiently developed for safe eating.

2.3.4 Late Introduction of Complementary Feeding

Issues can also arise if the introduction of solids is left too late. This includes nutrient deficiency and development of feeding issues. Introducing solids too late can increase the likelihood of nutrient deficiencies in the infant which can impact growth (McLeod *et al.*, 2013). Nutrient deficiencies could include energy and protein in addition to micronutrients such as iron, vitamin D, zinc, calcium and phosphorus if complementary feeding is started too late (King, 2009). As the introduction of solid foods begins and solids food replaces breastmilk, the energy density of complementary food may be lower than the energy

density of breastmilk. However delaying solids introduction for longer will also lead to further nutrient deficiencies (Marriott & Foote, 2003).

Furthermore, solids provide infants with the opportunity to practice age appropriate feeding skills. This exposure minimises the risk of developing feeding issues later (Agostoni *et al.*, 2008; McLeod *et al.*, 2013). The introduction of solids after seven months chronological age increases the likelihood of the infant developing aversions to anything in their mouth other than milk (Palmer & Makrides, 2012). Hence, the timely solid food introduction is essential for both nutritional and developmental reasons (Agostoni *et al.*, 2008).

The acceptance of novel flavours is critical in younger infants. The earlier introduction of fruit and vegetables during complementary feeding is associated with greater acceptance of these foods (Caton *et al.*, 2014). There is some evidence of a critical period for flavour acceptance between four and seven months (Cooke *et al.*, 2013). At this time infants are particularly receptive to new tastes. It is important to capitalise on this window of opportunity by introducing a wide variety of fruit and vegetables early during the period of complementary feeding (Cooke, McCrann, & Higgins, 2013).

2.3.5 Recommendations for Complementary Feeding

The introduction of solid foods into an infant's diet has remained a controversial topic for decades, with guidelines about the optimal time changing over the past 40 years. Palmer & Makrides (2012) outline a timeline of changes to feeding recommendations (**Figure 2.1**).

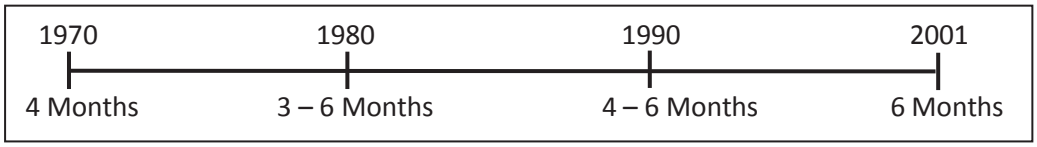


Figure 2.1. *Timeline of Changes in Complementary Feeding Recommendations*

To date, groups who have developed feeding recommendations have failed to consider preterm infants as a separate infant population who require their own specific guidelines. Hence, there are few complementary feeding guidelines for the preterm population (Palmer & Makrides, 2012). Current recommendations do not recognise potential differences in nutritional requirements between preterm infants and term infants. Failure to do so could

be in part responsible for the poor growth seen in this group of infants (Marriott *et al.*, 2003).

2.3.5.1 Worldwide Recommendations for Complementary Feeding in Preterm Infants

Globally there are few recommendations for complementary feeding preterm infants (**Table 2.3**). The age at which complementary solid foods should be introduced is controversial with conflicting advice from advisory bodies (Agostoni *et al.* (2008). The WHO recommends introducing complementary foods at six months of age which aims to protect EBF for the first six months of life (World Health Organisation, 2009a). This recommendation is made for all infants with no differentiation between term and preterm infants. The WHO recommendations are predominantly based on evidence from developing countries (Lanigan *et al.*, 2001). Agostoni *et al.* (2008) question the WHO recommendations as they believe they are far removed from the current feeding practices occurring in developed countries. Thus, the European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPHAGAN), released a position paper regarding the introduction of solids to infants. Of note is that these guidelines are made for healthy infants in Europe, with no differentiation for preterm infants (Agostoni *et al.*, 2008). ESPHAGAN recommend that introducing of solid foods should not occur before 17 weeks after birth and no later than 26 weeks after birth (Agostoni *et al.*, 2008). The British Dietetics association (BDA) adopted the same guidelines. In regards to preterm specific guidelines the BDA refers to BLISS for preterm specific infant feeding guidelines. BLISS is a charity in the United Kingdom working to provide the care for premature infants and their families (BLISS, 2011), they recommend that preterm infants to be introduced to solids by five months and no later than eight months chronological age. They also recommended delaying solids until at least three months corrected age to ensure the infant is developmentally ready (King & Aloysius, 2011). These recommendations are aligned with an evidence based guideline for preterm infants by King (2009) and Palmer and Makrides (2012).

Previously, in the UK, the Committee on Medical Aspects of Food and Nutrition Policy (COMA) now known as the Scientific Advisory Committee on Nutrition (SACN) had a preterm specific recommendation for complementary feeding. This guideline from 1994 suggested that introduction of complementary feeding should begin once the infant had reached at

least 5kg, when no tongue thrust reflex existed and the infant was able to eat from a spoon. These guidelines are now outdated and no longer available in the literature but are cited in King (2009) and Palmer and Makrides (2012). King (2009) highlights the lack of evidence in the formation of these guidelines and how use of these guidelines could be detrimental. If complementary feeding was left until an infant weighed 5kg, extremely preterm infants could be ten months corrected age before they reach this weight. Furthermore, the tongue protrusion reflex is not as useful as an indicator in preterm infants and the ability to eat from a spoon is dependent on lip seal, thus delaying until this is evident and the infant could miss the critical window of taste acceptance (King, 2009).

The majority of recommendations identify that infants should be assessed individually as it is important that signs of developmental readiness for introducing solids foods are considered (British Dietetics Association, 2013; More *et al.*, 2010). The timing and pace of introducing solids is dependent on caregiver awareness of infant's cues around feeding and responding to those. Evidence shows that preterm infants may have feeding opportunities delayed as parents consider them too immature to carry out new skills (Cooke *et al.*, 2013; King & Aloysius, 2011).

Table 2.3. Term and Preterm *Infant Complementary Feeding Recommendations from around the World*

Group or Organisation	Complementary Feeding Recommendation	Intended Population	Country of Origin
Department of Health, 1994	When 5kg is achieved, no tongue thrust present and able to eat from a spoon	Preterm infants	England
ESPHAGAN, Aggett *et al.* (2006)	Not before 17 weeks and no later than 26 weeks	Healthy infants in Europe	Europe
(World Health Organisation, 2009a)	Six months (20 weeks)	All infants	Worldwide
King (2009)	Between five – eight months chronological age provided the infant is at least three months corrected age	Preterm infants	Evidence – Based Guideline
BLISS (2011)	Five to eight months chronological age and at least three months corrected age	Preterm infants	England
Joint consensus statement from UK and Irish paediatric dietitians and speech language therapists, King and Aloysius (2011)	Five to eight months chronological age with appropriate readiness cues from infant	Preterm infants	United Kingdom and Ireland
Palmer and Makrides (2012)	Three months corrected age (13weeks) nutrient dense solids	Preterm infants	Evidence – Based Guideline
British Dietetics Association (2013)	Not before 17 weeks and no later than 26 weeks	All infants, preterm infants referred to Bliss	England

There are few studies on complementary feeding in preterm infants. This leads to difficulties when developing feeding protocols for this population (Marriott *et al.*, 2003; Norris *et al.*, 2002). Complementary feeding is regarded as a sensitive topic. Parents and health professionals alike have strong beliefs which are not evidenced based and likely to bring about debate (Cooke *et al.*, 2013). The literature shows the most common recommendation for preterm infants is after three months corrected age (King, 2009; Palmer & Makrides, 2012).

2.3.5.2 New Zealand Recommendations for Complementary Feeding in Preterm Infants

The New Zealand MOH recommends the introduction of complementary feeding at around six month's age for healthy term infants. This recommendation is based on the WHO recommendation and aims to protect exclusive breastfeeding until six months of age. The guidelines recommend that advice should be adapted for infant groups with special nutrient requirements such as preterm infants. In addition, the MOH recommends that first foods should include iron-fortified infant cereal and cooked and puréed meats (Ministry of Health, 2008). Specific guidelines for a preterm population are outlined in the Neonatal and Infant Nutrition Handbook. The guideline states that it may not be safe to recommend exclusive breastfeeding until six months corrected age in preterm infants. A corrected age of three months (13 weeks) is the earliest time to consider starting solids, provided the infant is developmentally ready e.g. can hold head up. They suggest there is a small window of opportunity after 16 weeks chronological age and before seven months chronological age to successfully start solids (Cormack, 2013). This guideline goes further to recommend that infants be introduced to energy and iron rich foods e.g. baby rice or pureed meats, banana, kumara, avocado.

2.3.5.3 Age Appropriate Feeding Recommendations

The MOH identify age appropriate recommendations for infant feeding. At six months of age this includes the introduction of other fluids such as water, ensuring the baby is held or in a highchair at meal times, ensuring the baby is offered milk before solids and offered pureed textured foods (Ministry of Health, 2008). In a guideline from Auckland City Hospital for preterm infants it outlines the consideration of developmental cues in preterm infants which include the infant is able to sit up, eat from a spoon and leans toward the spoon when food is offered. It also recommends similar recommendations as the MOH with offering pureed foods first (Cormack, 2011). At around seven months the MOH encourage increasing the variety of textures to include mashed foods. By eight months the infant should change to solids being offered before milk feeds and increasing textures to lumpy. This progression is also recommended for preterm infants although two months after starting solids is the age guide (Cormack, 2011). By twelve months, finger foods and family meals are recommended along with snacks between meals (Ministry of Health, 2008)

2.3.6 Current Complementary Feeding Practices

There is very limited evidence in New Zealand and around the world regarding current infant feeding practices in preterm infants.

2.3.7 Age of Introduction of Complementary Feeding

2.3.7.1 New Zealand

Currently, in New Zealand the Growing Up in New Zealand (GUINZ) study identifies the age of introduction by food type. Five months was the mean age that infants were introduced to baby rice and fruit (Morton *et al.*, 2012). Another New Zealand study by Heath *et al.* (2002), in healthy term infants, found 45% of infants were given non-milk foods before four months of age. The mean age of introduction was 17 weeks, with only 4% of infants introduced to meat before four months. One New Zealand study investigating differences in feeding practices among different ethnicities in New Zealand found differences in opinion regarding the appropriate age to introduce solids. Despite age recommendations for the introduction of solids from health professionals, Māori, Pacific and young European women introduced solids at around three months. Furthermore, Pacific caregivers were the most likely to introduce solids earliest with some introducing solids as early as six to eight weeks (Abel *et al.*, 2001).

There is a lack of research in New Zealand on the timing of the introduction of complementary feeding in preterm infants. This research on what age preterm infants from ACH NICU are introduced to first foods and whether these infants are meeting current recommendations is therefore an important contribution to the literature.

2.3.7.2 Worldwide

There is also a lack of research regarding complementary feeding in preterm infants around the world. A literature search ono the introduction of solid foods to preterm infants identified mainly observational studies **Table 2.4**.

Table 2.4. *Age of Introduction of Complementary Foods Preterm Infants from Observational Studies Worldwide*

Title	Location	Study design	Mean (±SD) Age - Chronological	Mean (±SD)Age - Corrected
Norris *et al.* (2002)	England	Structured interviews, preterm infants (n= 253)	17.1 ± 0.23 weeks	11.5 ± 0.21 weeks
Fanaro and Vigi (2007)	Italy	Observational study, preterm infants (n=230)	22.2 ± 0.4 weeks	15.1 ±0.39 weeks

One review article investigated the factors associated with complementary feeding in preterm and full term infants of which two studies were on preterm infants (Fewtrell *et al.*, 2003). This review found preterm infants had a mean age of solids introduction of 17 weeks with a range of 10 - 36 weeks chronological age (Fewtrell *et al.*, 2003). Another study investigated the age of introduction of solids in preterm infants reported data from the United Kingdom (UK) (n= 51), Chile (n= 49), and United States (US) (n= 275). Although, results of this study should be interpreted with caution as results are not published instead are only available as a poster. Despite this, the findings will be reported due to the sparse research available on this topic. Results are reported "the number of infants that had been introduced to solids by four months chronological age". In this study, 39% in the UK, 19% in the US and no infants in Chile had received solids by four months chronological age (Yee *et al*., 2001). When "the number of infants that had been introduced to solids by four months corrected age" was reported 98% of UK infants, 67% of US infants and 41% of Chile infants had been introduced to solids. Overall this study concluded that infants from UK were introduced to solids earlier than UK recommendations with multiple foods being introduced at one time. Similarly, US infants were more likely to be following guidelines for chronological age rather the corrected age. Whilst, infants from Chile were more likely to follow the guidelines recommended for term infants (Yee *et al.*, 2001).

There has been one randomised controlled trial (n= 68) in the United Kingdom in 1998 investigating the time and quality of solid foods introduced to preterm infants. The intervention group (n= 37) was advised to introduce solid foods at 13 weeks chronological age provided the infant weighed at least 3.5kg (Marriott *et al., 2003)*. Whilst the control

group (n= 31) was advised to introduce solids by 17 weeks chronological age, provided the infant weighed at least 5.0kg. Both groups received advice regarding introducing high protein, energy dense food. The mean chronological age solids were introduced was earlier in the intervention group (14.9 weeks vs 17.8 weeks). The mean corrected age was 6.3 weeks in the intervention group and 9.9 weeks in control group. At six months age, infants in the intervention group consumed more energy than the control group although, by twelve months age this was no longer present. The infants in the intervention group had significantly greater rate of length growth (Marriott *et al.*, 2003).

2.3.8 Factors Affecting Introduction of Complementary Feeding

Very few studies have looked at the factors affecting the introduction of solids in preterm infants. Gestational age is associated with the age of introduction with preterm infants of earlier gestational age introduced to solids earlier (Fanaro & Vigi, 2007; Norris *et al.*, 2002). Infant birth weight was associated with earlier introduction of solids in heavier born infants (Fanaro & Vigi, 2007; Fewtrell *et al.*, 2003; Norris *et al.*, 2002). The infant's mode of milk feeding also showed a strong association between formula feeding and being introduced to solid foods earlier (Fanaro & Vigi, 2007; Fewtrell *et al.*, 2003; Norris *et al.*, 2002). Furthermore, mothers age was also associated with older mothers more likely to introduce solids later (Fanaro & Vigi, 2007; Norris *et al.*, 2002).

2.3.9 First Food Introduced for Complementary Feeding

The first foods introduced first are important in a preterm population. Recommendations are to introduce energy dense iron rich foods. Although, many infants are introduced to first foods which are a poor source of both energy and iron. In the GUINZ study the most frequently introduced food was baby rice, followed by fruit and vegetables, of which the latter are poor energy and iron sources (Morton *et al.*, 2012). One New Zealand study investigated differences in feeding practices among different ethnic groups in New Zealand. This found that among all ethnic groups' pureed fruit, vegetables and soft cereals were a common first food (Abel *et al.*, 2001). This study was conducted in a term population although findings relating to cultural beliefs surrounding feeding practices are likely to translate to a preterm population.

Data for preterm infants alone is not available in New Zealand although, a few studies worldwide report first foods in a preterm population. Similar to New Zealand, a study by Norris *et al.* (2002) from Surrey found predominantly baby rice (84.6%), followed by baby cereal and rusks were introduced as first foods. Only 3.2% of infants were offered pureed vegetables and 2.8% pureed fruit. Fanaro and Vigi (2007) investigated a cohort of Italian infants of which majority (46.8%) were offered mashed fruit or rice in vegetable soup (29.1%), meat as a first food was offered to 9.5% of infants. The introduction of baby rice as a first food is of importance due to its iron content. In New Zealand and England no infants were introduced to meats as first foods, thus fortified infant cereals or baby rice are a beneficial alternative without being detrimental on the iron status of the infant.

2.3.10 Complementary Foods Eaten Over First Year of Life

The literature highlighted gaps regarding complementary foods eaten over the first year of life in the New Zealand setting and in a preterm population. The following studies GUINZ and the Infant Feeding Practices II study both included samples which include preterm infants but consist of majority term infants (Fein *et al.*, 2008). The GUINZ study investigated which foods were introduced by nine months of age. By nine months infants had consumed a wide range of food and were most likely to eat vegetables, fruit, meat and bread on a daily basis. Meat, eggs and bread were introduced at a mean age of seven months, and by nine months 58.9% of infants were having meat daily. Furthermore, by this age 53% had been introduced to at least one of sweets, chocolate, hot chips or potato chips. The least likely foods to be introduced by nine months were shellfish and soy-based foods (Morton *et al.*, 2012).

In the US, Infant Feeding Practices II study, 18% of infants were consuming infant cereal by three months age, which increased to 40% by four months this continued to increase and declined to 46% by one year of age. The median age for meat introduction was eight months and by one year 97% of infants were consuming meat or meat substitutes. Also, by one year around half of infants were consuming fries, candy, cookies or cake daily (Grummer-Strawn, Scanlon, & Fein, 2008).

2.3.11 Sources of Feeding Information in New Zealand

An understanding of where parents receive information is important to understand influential sources of infant nutrition and identify possibilities for future interventions. In the GUINZ study, by the time the infant was nine months old information about infant diet and nutrition was received from Plunket (93%), family or friends (77%) and GP (24%) (Morton *et al.*, 2012).

The New Zealand feeding practices study by Abel *et al.* (2001) highlighted that Pacific Island families were less likely to rely on health professionals for help, instead more likely to rely on extended family and partners. Traditional Māori were similar with women relying more on older women within the family. Although, less traditional Māori living in nuclear families were more likely to rely on health professionals, partners and peers for support. Similarly, to the latter group of Māori, New Zealand European women receive less advice from extended family and rely on partners for support followed by health professionals and friends.

2.3.12 Introduction of Other Fluids in Preterm Population

The Ministry of Health (2008) infant feeding guidelines recommend that breastmilk alone is sufficient for fluid requirements from 0-6 months, although formula fed infants may require additional boiled and cooled water. From six to twelve months infants may require additional water furthermore after one year the introduction of whole cow's milk becomes appropriate (Ministry of Health, 2008). The introduction of additional fluids such as juice, teas and soft drinks is not encouraged in young infants. There is no research on preterm infants in New Zealand on which additional fluids preterm infants are consuming.

2.3.12.1 Cow's Milk

Cow's milk refers to unmodified whole cow's milk. Cow's milk can be introduced to infants around 7-8 months into cooked foods (Ministry of Health, 2008). Although recommendations discourage the introduction of cow's milk as a milk drink before twelve months age. Furthermore, the preterm infant guidelines from the Auckland City Hospital also recommend that preterm infants wait until twelve months corrected age (Cormack, 2011). Unmodified cow's milk is not suitable as a sole source of nutrition for infants. This is because cow's milk contains excess concentrations of protein, sodium, phosphate,

potassium and calcium whilst having inadequate quantities of iron, vitamin C and linoleic acid (Wijndaele *et al.*, 2009). In addition, early consumption of cow's milk has been associated with adverse health effects in infants. This includes an association with iron deficiency anaemia as it is a poor source of iron. This is especially of concern in already vulnerable infants such as those born preterm (Lombard & Labuschagne, 2012; Michaelsen *et al.*, 2007; Woldu, Mezgebe, & Lekisa, 2014). Early introduction of cow's milk in term infants can lead to an increase in renal solute load, gastrointestinal bleeding, constipation and increased risk of developing type 1 and type 2 diabetes (Wijndaele *et al.*, 2009). In a New Zealand study in Dunedin by Heath *et al.* (2002) in term infants, 69% were given cow's milk as a beverage before twelve months age. Yee *et al.* (2001) compared feeding practices in preterm infants between countries and found that 39% of infants from the UK, 19% in the US and 8% in Chile had received cow's milk by twelve months corrected age.

2.3.12.2 Other Fluids

In addition to early introduction of whole cow's milk, infants are often introduced to other fluids such as soft drinks, tea and juices before one year. The consumption of other fluids displaces nutritious foods and beverages in the diet (Skinner, Ziegler, & Ponza, 2004). Furthermore, consumption of these drinks can lead to micronutrient deficiencies, for example, high consumption of fruit juices may lead to calcium deficiency (P. Emmett, North, & Noble, 2000). The consumption of tea in infancy may lead to iron deficiency due to its impact iron absorption (P. Emmett *et al.*, 2000; Merhav *et al.*, 1985). In the long term the introduction of high sugar beverages has been associated with childhood obesity (Skinner *et al.*, 2004). Of further concern is that what infants are exposed to during infancy become preferences in later childhood (Skinner *et al.*, 2004).

In the GUINZ study one third of infants had tried fruit juice by nine months of age and a few had consumed soft drinks (5.4%), tea (3.1%) and herbal drinks (2.2%) (Morton *et al.*, 2012). Data from the Infant Feeding Practices II Study showed that by one year 15% of infants were consuming sweetened beverages. Few studies have investigated the introduction of other fluids in a preterm population. de Oliveira *et al.* (2007) followed a cohort of Brazilian infants of which 95.7% had been introduced to tea and water by 6 months.

There is a large gap in the literature regarding introduction of complementary feeding and feeding practices in preterm infants.

2.4 Vitamin and Mineral Supplement Practices in Preterm Infants

Preterm infants are at risk of nutrition deficiencies at hospital discharge (Shah & Shah, 2009). To prevent deficiencies, supplementation of both vitamins and minerals are essential and it is important they are supplied in appropriate amounts to avoid shortcomings and excess (Dall'Agnola & Beghini, 2009). Iron is necessary for brain development and vitamin D is an important nutrient in the prevention of metabolic bone disease (Bhatia *et al.*, 2013). Furthermore, growth and neurodevelopment are dependent on the supply of essential nutrients (Dall'Agnola & Beghini, 2009).

2.4.1 Supplementation Guidelines

The WHO recommends LBW infants are supplemented with vitamin D, calcium, phosphorus, iron and vitamin K (World Health Organisation, 2011, 2012). Supplemental vitamin and mineral recommendations from ADHB are based on infant birth weight and gestational age. All preterm infants born at <32 weeks and/or <1800g are given 3-6mg/kg/day of ferrous sulphate from four weeks of age. In addition, Vitadol C is started at 0.2ml, twice daily for infants consuming more than 150ml/kg/day, this is reduced once weight reaches 1500g. Vitadol C contains vitamins A, C and D. A typical dose of 0.3ml provides and infant with 667µg of vitamin A, 33mg of vitamin C and 400IU of vitamin D (PHARMAC; Pharmaceutical Management Agency New Zealand, 2013). Upon discharge the infants mentioned above are prescribed iron and Vitadol C and advised to continue supplementation until the infants is eating a good mixed diet of solids (Auckland District Healthboard, 2014a). Vitadol C is a supplement available in New Zealand which contains Vitamin D, C and A (Ministry of Health, 2013b).

Debate exists in the literature regarding how long infants should be supplemented for. Schanler (2005) recommends that supplementation should continue for at least six months post discharge. In contrast the American Academy of Pediatrics and ESPGHAN recommend that iron supplementation should continue over the first year of life (Agostoni *et al.*, 2012; American Academy of Pediatrics, 1997).

2.4.2 Supplement Use in Preterm Infants

The use of supplements in preterm infants is a relatively understudied area. One study investigating supplement use in preterm infants found that only 18% of infants were given vitamins as recommended, and 49% were not taking their supplement despite recommendations (Milton & King, 2012). Late preterm infants who were being breast or mixed fed in the Infant Feeding Practices II study received no oral iron supplements at one to two months age, although, by 10.5 months this increased to 13% (Dee *et al.*, 2008).

2.4.3 Supplementation and Mode of Feeding

The literature reports differences in supplementation practices between infants who are EBF and those who are formula fed. Breastfed infants are at greater risk of nutrient deficiencies after hospital discharge due to breastmilk often not meeting nutrient requirements for growth in preterm infants (Greer, 2007). Exclusively breastfed preterm infants are at risk of iron deficiency due to poor stores (American Academy of Pediatrics, 1997). Thus, it is recommended that preterm infants who are EBF are supplemented with supplemental vitamins, iron and vitamin D to ensure adequate nutrient delivery for growth (Dall'Agnola & Beghini, 2009; Greer, 2007; Schanler, 2005). Furthermore, when a preterm infant is weaned from breastfeeding it is advised that infants begin an iron fortified formula (Dall'Agnola & Beghini, 2009). In contrast, unless medically advised the exclusively formula fed infant requires no supplements provided the formula used is iron-fortified (Schanler, 2005).

2.5 Growth in Preterm Infants

Human growth and development is characterised by changes in size, shape and maturity over time (Cameron & Bogin, 2012). Infants undergo rapid growth in their first year of life. Weight is expected to double within the first 4 – 6 months and height is expected to increase by 50% (Holdsworth, Madden, & Webster, 2006). Growth involves rapid development of body tissues and organ development which increases energy and nutrient demand of the infant (Holdsworth *et al.*, 2006).

For all infants, term and preterm, growth is a useful clinical marker of health and nutrition status in infancy. Abnormal patterns or delays in growth can indicate medical nutritional or

developmental delays (Bernardi, Goulart, & Amancio, 2003; Cameron & Bogin, 2012; Parsons, George, & Innis, 2011). Preterm infants are at a high risk of growth faltering, thus ensuring adequate nutrition during the early years is critical to optimise long term health, growth and development in preterm infants (Embleton *et al.*, 2001).

2.5.1 Definitions of Growth in Infants

Small for gestational age (SGA) is defined as an infant weighing less than the 10th percentile for weight for gestational age (Dusick *et al.*, 2003; Watson *et al.*, 2013). Appropriate for gestational age (AGA) is a weight between the 10^{th} and 90^{th} percentile (Watson *et al.*, 2013).

Intra-uterine growth restriction (IUGR), is when growth becomes restricted whilst the infant is in utero (Levene, Tudehope, & Thearle, 2000). Extra-uterine growth restriction (EUGR) describes faltering growth in the extra-uterine environment as a result of nutrition deficits in the first weeks of life (Clark, Thomas, & Peabody, 2003). Extra-uterine growth restriction is common in preterm infants due to nutritional deficits once they are born.

Faltering growth also known as postnatal growth failure, growth retardation and failure to thrive, is defined by weight that tracks downward and crosses more than two centile lines (Holdsworth *et al.*, 2006; Shields, Wacogne, & Wright, 2012).

2.5.2 Growth Assessment Tools

Growth can be assessed in a variety of ways. The most important anthropometric measures in paediatrics are weight, length and head circumference (Aggett *et al.*, 2006; Cameron & Bogin, 2012). These measurements assess different body compartments therefore have different levels of clinical significance (Cameron & Bogin, 2012). Weight represents the infant's total mass, which includes lean tissue, fat, extracellular and intracellular fluid. Thus, changes to an infant's weight represent changes to the infant's body composition (Moyer-Mileur, 2007). Length is a linear measurement of the infant's supine length, this better reflects lean tissue mass and is not influenced by fluid status (Moyer-Mileur, 2007). Length better reflects long term growth, surveillance of changes reflect a longer time period than weight as it can take more than three months for significant changes in length to be detected (Cameron & Bogin, 2012). Head circumference measures the width around the infants head and indicates brain growth (Cameron & Bogin, 2012). Infants usually present

with growth faltering in weight and length, with head circumference affected last (Levene *et al.*, 2000). Head circumference in infancy and childhood correlates with later developmental achievements in VLBW infants (Moyer-Mileur, 2007). A subnormal head circumference is associated with poor cognitive function at school age (Dusick *et al.*, 2003).

Growth charts are used to plot an infant's weight, length and head circumference to determine their growth rate by comparing against reference data of infants of the same age and gender (Shields *et al.*, 2012). Growth charts are useful to identify inadequate or excessive growth by determining if growth is proportionate or disproportionate, determined by the crossing of percentiles (Aggett *et al.*, 2006; Parsons *et al.*, 2011). The use of serial measurements of anthropometric data helps to determine if nutrition is adequate in VLBW infants (Moyer-Mileur, 2007). In New Zealand the UK-WHO growth charts are used for preterm infants (Holdsworth *et al.*, 2006; Ministry of Health, 2010). Controversy exists with the use of different growth charts, Tudehope *et al.*, (2012) identifies that using growth charts in preterm infants can be problematic as infants born early are smaller than those that remain *in utero.*

Z-scores can be used to evaluate growth, a Z-score is an individual's deviation from the median value of a reference population divided by the standard deviation of the reference population (WHO Multicentre Growth Reference Study Group, 2009). Z-scores indicate how far a child is from the mean or median of the reference group, indicating how an infant is growing in comparison to growth of infants of the same age and gender. Z-scores are frequently used to describe growth in population studies and publications (Parsons *et al.*, 2011).

2.5.3 Growth in Preterm Infants

Preterm infants are a heterogeneous population; born at varying gestational ages, birth weights and have varying levels in the complexity of care required. Hence nutritional requirements are dependent on the infant who require differing nutrient requirements in order to sustain growth (Embleton *et al.*, 2001). Growth can be used to assess the nutritional adequacy of the diet and is a useful indicator of postnatal and health outcomes of the infant (Bhatia, 2013; Moyer-Mileur, 2007; Schanler, 2005).

Nutrition has an essential role in the growth of preterm infants because inadequate nutrition may be responsible for preterm infants not achieving their growth potential (Moyer-Mileur, 2007). The main nutrition goal is to achieve growth rates of the reference fetus of the same gestational age who remained in *utero* (Hay, 2008).

Despite this, the growth of many preterm infants falters after birth and at hospital discharge (Kurl *et al.*, 2003). Embleton *et al.* (2001) proposes that current feeding guidelines and recommended daily intakes (RDI) are not adequate to maintain the growth of preterm infants as it does not account for their additional need thus making growth faltering inevitable. As nutrient intakes are hard to achieve and maintain in early life nutrient deficits quickly accrue. In their study of preterm infants (n= 105), RDIs were rarely achieved and preterm infants were discharged before early nutritional deficits were regained. Current feeding practices lead to preterm infants being discharged from the hospital growth restricted due to the energy and protein deficits (Su, 2014). This growth faltering leads to preterm infants being discharged home with smaller weight, length and head circumference than their term-born counterparts (Clark *et al.*, 2003).

2.5.4 Factors Affecting Growth in Preterm Infants

As outlined in the introduction of this literature review there are various factors impacting nutritional intake and thus growth in preterm infants. This includes missing out on the fetal weight gain and nutrient accretion which occurs in the last trimester of pregnancy (Bernardi *et al.*, 2003). Delays in reaching full feed rate (Hay, 2008; Kurl *et al.*, 2003), feed intolerance (Lapillonne & Griffin, 2013), feeding recommendations only meeting growth and not additional factors such as acute illness and morbidities such as anaemia, chronic pulmonary disease and neurological and developmental disorders (Bernardi *et al.*, 2003; Kurl *et al.*, 2003; Lapillonne & Griffin, 2013). Furthermore, inadequate nutrient provision is a significant factor in growth faltering, as many preterm infants are unable to meet their energy and protein needs in NICU (Dusick *et al.*, 2003; Hay, 2008). An audit of energy and protein intakes of preterm infants in New Zealand found daily weight gain was associated with both energy and protein intakes ($P< 0.001$). However despite meeting recommended nutrient intakes infants displayed faltering growth suggesting recommended intakes may not be adequate to achieve fetal rates of growth (Cormack & Bloomfield, 2006).

Furthermore, gestational age is associated with faltering growth and is more prevalent in infants of lower gestational age (Clark *et al.*, 2003; Cooke, Ainsworth, & Fenton, 2004; Tudehope *et al.*, 2012). A factor contributing to this, is the initial weight loss experienced after birth, which is more pronounced and occurs for a greater length of time in infants of lower gestational age, reaching an average weight loss of 15% (Bernardi *et al.*, 2003).

Birth weight is also associated with growth. Very Low Birth Weight infants take a longer time to reach growth potential than LBW infants, hence EUGR is more common in infants of lower birth weight (Blackburn, 1995; Clark *et al.*, 2003; Dusick *et al.*, 2003; Tudehope *et al.*, 2012). Dusick *et al.* (2003) found that the incidence of growth faltering was inversely associated with birth weight.

2.5.5 Consequences of Poor Growth

Poor growth is common in preterm infants. This is of concern due to the association between poor growth and poor neurodevelopmental outcomes (Belfort *et al.*, 2011; Ehrenkranz *et al.*, 2006; Latal-H *et al.*, 2003). Neurodevelopmental impairments can include neurologic impairments, sensory delays, impaired learning and language and later lead to poor school performance (Blackburn, 1995; Clark *et al.*, 2003).

Belfort *et al.* (2011) found that an increase in weight and head growth before term led to better neurodevelopment outcome in infants. This continued after term, although weight increases out of proportions of length conferred no additional benefits, thus highlighting that overcompensation of nutrients will promote excess weight gain and of note fat mass gain (Aimone *et al.*, 2009). Furthermore, a study by Latal-H *et al.* (2003) found that birth Z-scores were not significantly associated with neurodevelopmental outcomes at two years, although increases in weight and length Z-scores at two years age was associated with improved neurodevelopmental outcomes at two years. This indicates that post natal growth in the post discharge period is important for neurodevelopmental outcomes.

The neonatal period is a crucial period of fetal programming and early nutritional deficits can have long term consequences (Schanler, 2005). Infants born low birth weight due to poor growth in *utero* are at an increased risk of cardiovascular disease, hypertension and diabetes as adults (Barker *et al.*, 1993; Lapillonne & Griffin, 2013).

2.5.6 Preterm Infant Growth at Hospital Discharge

For preterm infants a variety of factors during their hospital stay can lead to poor growth by discharge. Fewtrell (2003) reports that data from their own and other cohorts have shown a high proportion of preterm infants are below the 10th centile for weight, length and head circumference at discharge. In a large audit of 24 NICUs, which comprised a total of 24, 371 preterm infants between 23- 34 weeks, 28% were growth restricted (less than the tenth percentile) for weight, 34% for length and 16% for head circumference by discharge. Furthermore, EUGR was significantly associated with infants who were LBW and of decreasing gestational age (Clark *et al.*, 2003). In a systematic review by Ross and Browne (2013) growth outcomes for preterm infants at hospital discharge were determined. This highlighted that majority of preterm infants are discharged from hospital with a negative change in Z-score (**Table 2.5**). In a study of very preterm infants by Kurl *et al.* (2003) all preterm infants had malnutrition and growth faltering during their initial hospital stay. Early preterm infants had a mean decrease in weight Z-scores of -1.6, whilst late preterm infants had less of a decrease although decreased by -0.5. In addition, length Z-scores also decreased for both groups at discharge -2.0 and -0.5 respectively. Head circumference was not measured as a part of this study. Funkquist *et al.* (2010) also found that all preterm infants showed a negative change in Z-scores and growth by hospital discharge. They concluded that preterm infants with a higher Z-score for weight, length and head circumference at birth were at higher risk of poor growth during hospitalisation. Cooke *et al.* (2004) investigated difference in discharge weights between infants in level I-II care and level III care hospitals. The level I-II unit's care for infants who are more mature and less critically ill compared to level III units which are an intensive care for the smallest, most critically sick infants. There was a significant difference in the change in Z-score seen at discharge between the two units. Infants discharged from level I-II units having larger decreases in Z-scores, this could be due to less monitoring than the level III units. The evidence shows that preterm infants are particularly vulnerable to growth deficits by the time they are discharged from the hospital. Poor growth between birth and discharge has been associated with long term development, improvements in early neonatal growth may improve long term outcomes in extremely preterm infants although the effect of improvements in growth may be small (Franz *et al.*, 2009).

Table 2.5 *Changes in Weight, Length and Head Circumference Z-Scores in Preterm Infants at Hospital Discharge*

Study Author	Study Design	Change in Weight Z-score Mean ±SD	Change in Length Z-score Mean ±SD	Change in Head Circumference Z-score
Kurl *et al.* (2003)	Prospective study, Finland, (n= 64 preterm infants)	≤28 weeks: -1.6 ±1.1 >28 weeks: -0.5 ±1.1	≤28 weeks: -2.0 ±2.9 >28 weeks: -0.5 ±1.5	Data not collected
Cooke *et al.* (2004)	Prospective study, UK (n= 659 preterm infants)	Level I-II care -0.86 ± 0.85 Level III care -0.72 ± 0.86	Data not collected	Data not collected
Cormack *et al.* (2006)	Prospective study, New Zealand (n= 34)	-1 [1, -2.5]*	Data not collected	Data not collected
Funkquist *et al.* (2010)	Retrospective, comparative design, Sweden, (n= 127 AGA preterm infants)	-0.9 [2.9, -0.8]*	-0.3 [2.6, -3.0]*	0.5 [2.5, -1.5]*

* Median and interquartile range. AGA: Appropriate for Gestational Age.

2.5.7 Preterm Infant Growth Post Hospital Discharge

After hospital discharge represents a critical time for infant growth. During this time the supports for feeding and monitoring of growth that existed within the hospital environment are less frequent. Many preterm infants are discharged with growth faltering and it is important to understand what happens to growth in the post discharge period. Growth of preterm infants lags behind their full term counterparts in the early post discharge months (Ross & Browne, 2013; Schanler, 2005). Dodrill *et al.* (2008) found preterm infants had significantly lower mean weight and length Z-scores than term infants at term, 4, 8 and 12 months corrected age. In a small study of 19 infants by Bernardi *et al.* (2003) it was found that by 12 months corrected age 26.3% of preterm infants had a weight deficit and 21% had a severe length deficit. In contrast to other studies that have identified poor growth after discharge Funkquist *et al.* (2010) found that despite preterm infants exhibiting a negative change in Z scores from birth to discharge by 2 months corrected age there was a positive change in all growth parameters. Furthermore infants born with the lowest birth weight showed the greatest increase in growth by 18 months corrected age (Funkquist *et al.*, 2010).

2.5.8 Feeding Practices Affecting Growth after Hospital Discharge

2.5.8.1 Mode of Milk Feeding

Mode of milk feeding in preterm infants is often associated with growth after hospital discharge. By the time of hospital discharge exclusively breastfed preterm infants have accrued the greatest nutritional deficits (Aimone *et al.*, 2009). A study by Funkquist *et al.* (2010) investigated growth between infants receiving breastmilk alone or fortified breastmilk. Months of breastfeeding was correlated negatively with length Z-scores at both 6 and 18 months, no other growth parameters were affected during the first 18 months of life (Funkquist *et al.*, 2010). In contrast another study found no significant differences in weight, length or head circumference between infants receiving unfortified (n= 102) or fortified (n= 105) mother's milk until 4 months' corrected age. Although, infants receiving a preterm formula had a greater increases in weight Z scores until term and in length Z scores until 6 months corrected age (Zachariassen *et al.*, 2010).

Research has also investigated the growth of preterm infants by comparing breastfed infants to infants receiving infant formula. Morgan, Lucas, and Fewtrell (2004) found breastfed infants were significantly lighter and shorter than formula fed infants at both 12 weeks and 9 months corrected age (Morgan, Lucas, Fewtrell, 2004). Furthermore, body composition and growth after hospital discharge was investigated and formula fed infants had significantly higher bone mineral content and lower total body fat than the human milk fed infants, despite this the growth of the human milk fed infants was still within a healthy range (Wauben *et al*., 1998). A study by O'Connor *et* al. (2003) compared growth in four different feeding groups of infants, which included those who were fed predominantly human milk, predominantly formula, infants who received more than 50% of energy from human milk and infants that received less than 50% of energy from human milk. This study found that the predominantly formula fed infants had greater increases in weight, length and head circumference than infants fed predominantly human milk fed, or those who received more than 50% of their energy from human milk. This study also investigated neurodevelopmental outcomes and interestingly by 12 months corrected age a positive association was found between human milk feeding and developmental scores using the Bayley Mental Index (O'Connor *et al.*, 2003). This suggests that despite human milk fed infants having slower early growth rates their developmental scores were not affected.

Morley, Cole and Gore (1994) also found that infants receiving preterm formula gained weight and head circumference faster than infants fed a donor breastmilk. However, infants fed donor breastmilk had higher developmental scores than formula fed infants supplying further evidence of breastmilk conferring developmental benefits.

In a longitudinal study of preterm infants differences in growth were found in the neonatal unit between infants receiving preterm formula than infants receiving a term formula or banked donor breastmilk. Although, by nine months corrected age no differences were evident in weight, length, head circumference or skinfold thickness which was also seen again by the time the infants reached 7.5 – 8 years of age. The authors conclude that clinically this is significant as poor neonatal growth occuring in the neonatal period can resolve by infancy and childhood (Morley & Lucas, 2000).

Differences in growth have also been investigated between infants receiving different types of formula milks. One study investigated differences between standard term formulas and energy and protein enriched formula milks found that feeding preterm infants with energy and protein enriched formulas led to statistically significant difference in weight and length at 18 months corrected age. Although, Henderson, Fahey, and McGuire (2005), highlights that the clinical significance of these findings is not yet clear and it is unknown whether these differences would persist into later adulthood.

2.5.8.2 Complementary Feeding and Growth

There is less evidence regarding the growth of preterm infants and the timing of complementary feeding. One study found differences in weight and length between infants introduced to solids earlier and later. Infants introduced to complementary feeding before 12 weeks were heavier (P= 0.001) and longer (P= 0.03) than those introduced after 12 weeks. By 18 months no differences in weight or length was seen between the two groups (Morgan *et al.*, 2004) this suggests that catch up growth occurred in the infants introduced to solids later.

2.6 Summary

Preterm infants are a unique group of infants with different physiological, medical and nutritional needs. The number of preterm births is increasing and more infants are surviving highlighting a need to determine the best way to care for these infants while ensuring optimal growth and development. There is a vast amount of literature regarding nutrition for preterm infants during the hospital period but very little evidence on how preterm infants are or should be fed following hospital discharge, especially in New Zealand. The aim of this research is to determine the current feeding practices and growth of preterm infants after hospital discharge from NICU at Auckland City Hospital until 12 months corrected age.

Chapter 3.0 Methods

3.1 Study Design

The "Post Discharge Nutrition of Preterm Infants: micronutrient status and feeding practices of preterm infants after hospital discharge", was a longitudinal, observational study. The aim of the larger trial was to determine the micronutrient status, feeding practices and growth of preterm infants from a tertiary Neonatal Intensive Care Unit at Auckland City Hospital from discharge until twelve months corrected age. This thesis will report the feeding practices and growth of these preterm infants from four months after discharge until twelve months corrected age. **Figure 3.1** shows the study flow of the participants recruited to the study until 12 months corrected age.

3.2 Ethics

Ethical approval for the study was obtained from Massey University Human Ethics Committee: Southern A application 13/06. In addition, in February 2013 the research committee at Auckland District Health Board (ADHB) granted permission for infants to be recruited through ADHB, reference A+5810. All parent(s) or legal guardian(s) gave informed written consent for themselves and their infant/s to participate in the study. Confidentiality of all participants was maintained by providing all infants and their mothers with a unique identification code.

3.3 Study population

3.3.1 Setting

Participants in the study were recruited from Auckland City Hospital (ACH) Neonatal Intensive Care Unit (NICU). This hospital cares for families located in North, West and Central Auckland. Infants from Northland requiring intensive care are also transferred to ACH. Auckland City hospital is one of two hospitals in the Auckland region that offers tertiary level care services for infants, thus caring for infants born less than 30 weeks gestation (Auckland District Healthboard, 2014b). Thus, recruiting infants from Auckland City Hospital NICU allowed infants of varying degrees of prematurity to be recruited in the study. Participants were recruited to the study if their families lived in the Auckland region, defined as living as far North as Whangaparoa to as far South as the Bombay Hills. All infants

who were admitted to NICU at ACH between 1 October 2012 and 30 April 2013 were assessed for eligibility to participate in the study.

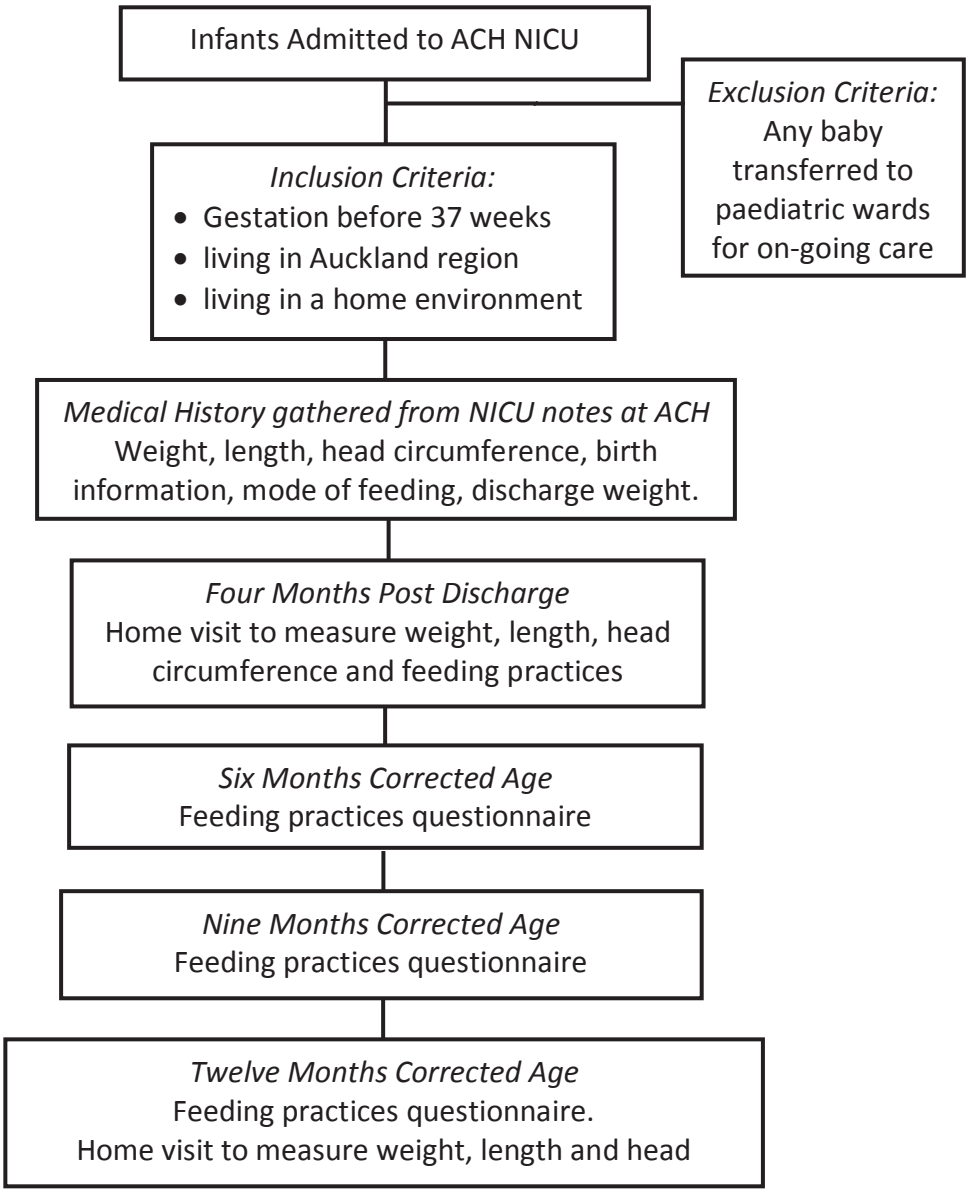


Figure 3.1 *Study Design of Post Discharge Feeding Practices of Preterm Infants Study*

3.3.2 Eligibility Criteria

The eligibility criteria of this observational study was broad in order to capture as many infants as possible. This was intended to provide a comprehensive picture of feeding practices of preterm infants after discharge from the NICU. Criteria included infants born at less than 37 weeks gestation who were admitted to the NICU at Auckland City Hospital

between 1 October 2012 and 30 April 2013. This included preterm infants born in other hospitals and transferred to Auckland City Hospital NICU, as well as infants born in ACH and transferred to other hospitals provided the infants spent time in Auckland NICU during the above dates. Participants were required to be living at home and in the Auckland region of New Zealand until 12 months corrected age.

3.3.3 Exclusion Criteria

The exclusion criteria included any preterm infants who were transferred to paediatric wards for ongoing specialist hospital care. This was due to complications of their condition possibly impacting feeding practices and to ensure researchers were sensitive to the parent's situation.

3.3.3.1 Procedure for Families who moved out of Auckland Region

For families who moved from the Auckland region during the study, participants were offered to continue to take part although, due to access were excluded from home visits and gathering of anthropometric data.

3.3.4 Sample Size

As this study was part of a larger trial initially participant recruitment was required to determine both iron and Vitamin D status of preterm infants. The number of infants required to determine significance of vitamin D status was 44 (Emmett, 2013), whilst 78 infants were required to determine significance of iron status (Moor, 2013). Initial recruitment aimed for 100 infants to allow for a 30% attrition rate.

This study followed these infants and was therefore a convenience sample. Although post hoc analysis was conducted to determine the clinical significance of differences for weight Z-scores. The sample size of n= 56, retrospectively provided 99% power to detect a mean difference of 1 Z-score in weight Z-score, at an alpha level of 0.05. From a clinical point of view this difference would indicate an infant should be monitored for growth faltering (Mehta *et al.*, 2013).

3.3.5 Consultation for the Study

Researchers consulted with both Massey University and Auckland District Health Board Māori advisors prior to commencement of recruitment. Although Māori were not the focus of the study care was taken to ensure that the cultural needs of Māori participants would be met.

3.4 Recruitment of Participants

Prior to recruitment nurses, dietitians and medical staff at Auckland City Hospital NICU were informed about the study via a voice over presentation. This presentation highlighted the importance of the research to NICU staff as parents may wish to discuss the study and NICU staff had the opportunity to promote the study to eligible families.

Recruitment was by convenience sampling, between 1 October 2012 and 30 April 2013. The NICU log book which documents all infant admissions to ACH NICU unit provided researchers with patient national health index (NHI) numbers and the gestational age of the infant at birth. The log book was used by researchers to find all infants who met the eligibility criteria. Researchers then approached the ward clerk for contact details. Screening infants in this way and using the ward clerk, who had a relationship with the families from the NICU, ensured that families of non-surviving infants were not contacted by researchers. Contact details of all surviving preterm infants were then provided to the lead researchers at Massey University. All mothers and/or caregivers of infants identified in the recruitment process were sent a study information sheet (Appendix A). This outlined the importance of the research and what participation would involve. A contact letter (Appendix B) requesting participation and contact details request was sent to parents with a free return post envelope. Parents who expressed interest were asked to return the above to researchers at Massey.

Massey researchers then followed up all mothers who expressed interest with a phone call. Parents who did not return the contact details form were followed up with a phone call after one week of the above letters being sent. Parents were given the opportunity to ask questions regarding the study. Verbal consent was obtained from all mothers for their infants and themselves to be enrolled in the study. A home visit four months post hospital

discharge was arranged by phone. Written consent, for infant and mother to participate in the study, was then obtained at the home visit (Appendix C; Appendix D).

3.5 Baseline Birth and Demographic Data Collection

3.5.1 Birth Data Collection from Medical Notes

Medical and birth data were obtained from the medical notes. Data collected included length of hospital stay after birth, gestational age at birth, type of delivery, singleton or multiple birth, birth weight, birth length, birth head circumference and mode of infant feeding at hospital discharge (Appendix E). Discharge weights were collected in retrospect via discharge letters at ACH.

3.5.2 Demographics Questionnaire

The demographics questionnaire (Appendix F) consisted of nine questions to determine the characteristics of the mother and infant population. Questions included the mother's date of birth, ethnicity and number of previous births. Infant related questions included gender, ethnicity and date of discharge. This questionnaire was interviewer administered at the time of recruitment.

3.6 Tools to Assess Infant Feeding Practices

3.6.1 The Infant Feeding Practices Questionnaire

A total of four infant feeding practices questionnaires were used to assess feeding practices, these were conducted at four months post hospital discharge and at six, nine and twelve months corrected age. Due to this study being a part of a larger trial feeding practices data was collected at four months after hospital discharge to determine the effect of feeding practices on infant iron status after discharge. As feeding data were collected at this stage this data was included into this study.

Assessing feeding practices throughout the first year meant mothers were more likely to be accurate in recollecting information. The questionnaires were continually developed from the initial infant feeding practices questionnaire to account for the difference in developmental stages that occur in feeding over the first year of life. These included

changes such as the transition from breastmilk or formula feeding as their main source of nutrition, to the introduction of solids and then to consuming "table foods" (Birch & Doub, 2014; van Dijk, Hunnius, & van Geert, 2012). Administering the questionnaire at the infant's corrected gestational age ensured standardisation between the preterm infants' ages. The questionnaires were based on previous infant feeding questionnaires, including the Infant Feeding Study ll, developed by the Centre for Disease Control and Prevention (Centres for Disease Control and Prevention, 2009), and one from the Growing up in New Zealand study, developed by University of Auckland (Growing up in New Zealand, 2010) which provided questions relevant for a New Zealand population.

Pilot testing of questionnaires was carried out to assess acceptability and ensure questions were clear for mothers. Mothers expressed a preference for being able to do the questionnaire online at their own convenience. Therefore, it was decided to provide all questionnaires on Survey Monkey, except for the initial four month post discharge questionnaire. Survey monkey is an online questionnaire tool; which allows questionnaires to be reformatted into an online format. A link to the questionnaire can then be emailed to parents for them to complete at their convenience. The questionnaire developed for this study offered various features including prompts and skip logic to ensure participants answer all relevant questions. All questionnaires contained standardised prompts to ensure parents understood the way to answer the questions. Researchers analysed questionnaire responses to ensure all relevant data had been collected and if necessary emailed parents for further clarification. There was also the opportunity to check and clarify any answers from the 12 month corrected age feeding practices questionnaire with the parent at the home visit.

3.6.1.1 Four Months Post Hospital Discharge: Infant Feeding Practices Questionnaire

The Four Months Post Hospital Discharge: Infant Feeding Practices Questionnaire consisted of 22 questions (Appendix G). Mothers were asked questions relating to milk feeding to determine whether infants were breastfed, formula fed or mixed feeding and the duration of each. Further questions were asked regarding whether solids and/or other liquids had been introduced. This questionnaire was based on the Health and Social Care Information

Centre “Infant Feeding Survey” (Health and Social Care Information Centre, 2010) and the questionnaire developed by Golding (Golding, 1991).

3.6.1.2 Six Month Corrected Age Questionnaire: Infant Feeding Practices Questionnaire

The six month corrected age questionnaire included a total of 63 questions (Appendix H) to determine feeding practices at this age. The questionnaire included questions regarding the infant’s type and mode of milk feeding. Mothers of infants who were formula fed or mixed feeding were also asked about types of formula used. Secondly, the introduction of solids was assessed, including age of introduction, first food to be introduced and a food frequency questionnaire to determine what foods were being introduced to preterm infants at six months corrected age. The foods in the food frequency questionnaire were based on foods commonly eaten in New Zealand, taken from the MOH’s National Children’s Nutrition Survey (Ministry of Health, 2008), the Growing up in New Zealand study (Morton *et al.*, 2012) and ‘first foods’ currently recommended for preterm infants (Cormack, 2011). Further questions investigated fluid intake and infant vitamin and mineral supplementation.

3.6.1.3 Nine month corrected age questionnaire: Infant Feeding Practices Questionnaire

The nine month corrected age questionnaire comprised 74 questions which expanded on the six month questionnaire and included questions to determine if the infant was eating age appropriate foods and other food related developmental changes (Appendix I). This questionnaire included all previous questions regarding milk, solids, fluid intake and supplement use. Additional topics related to the developmental stage of the infants were added such as where infants sit to eat, textures used and self-feeding were investigated.

This questionnaire also asked where parents obtained information or advice regarding the introduction of solids, support regarding solids and resources they are using in the community. This was asked within the nine month questionnaire to ensure all infants had been introduced to solids by this point.

3.6.1.4 Twelve month corrected age questionnaire: Infant Feeding Practices Questionnaire

The twelve month corrected age questionnaire included 94 questions and expanded on the nine month questionnaire to include cow's milk and 'other' milk (Appendix J). All previous questions were left the same to include milk feeding, solids, fluids, supplementation and developmental feeding stages.

3.6.2. Anthropometric Measurements

The following standard operating procedures for anthropometric measurements were developed to ensure the consistency and accuracy of measurements (Appendix K; Appendix L; Appendix M).

3.6.2.1 Weight

Infant weights were taken using Atronics SSB digital baby Scales. Scales were cleaned before each home visit. At the home scales were placed on a hard surface and tarred. Infants were then undressed by the parent and weighed naked or in a clean nappy as per parent's preference. If an infant was weighed in their nappy a clean nappy was weighed to be subtracted from the infant's weight. To ensure accuracy the infants were weighed two times and measurements were recorded on the data collection sheet. If weights differed by more than 50g a third weight was taken and the mean of all weight used.

3.6.2.2 Length

Infant length was measured using a Seca 416 infantometer length board. Infants remained nude from the weight measurement which improves the accuracy of the measurement. The length board was placed on a large flat surface. The infant was laid flat on their back on the length board. The infants head was positioned against the board at the top of the length board, with parent or other researcher holding it in place. The researcher applied slight pressure on the infant's legs to ensure full extension; the foot piece was then moved towards the infant's heel. The infant's feet were positioned flat against the bottom board to ensure an accurate reading. The measurement was recorded to the nearest mm. A second measurement was then taken, if the measurement varied by 1cm a third measurement was to be taken. The average of the three measurements was then recorded.

3.6.3.3 Head Circumference

Head circumference was taken using a flexible plastic measuring tape with the infant sitting on the floor or on their parent's knee. The researcher then wrapped the tape measure around the infants head as per standard operating procedure. The initial measurement was taken and recorded to the nearest mm on the data collection sheet; a second measurement was then taken. If the measurement was not within 5mm of the first a third measurement was taken and the average of the three measurements recorded.

3.7 Procedure

Baseline data was collected in the primary phase of the "Post Discharge Nutrition of Preterm Infants: micronutrient status and feeding practices of preterm infants after hospital discharge "trial (B. Emmett, 2013; Moor, 2013). The mother and infant demographic questionnaire was completed over the phone with all mothers of infants eligible for the study. Infant's anthropometric measurements from their time in the NICU at Auckland City Hospital and at four months post discharge were collected. Feeding practices were investigated with the four month post discharge infant feeding practices questionnaire, this was interviewer administered at the four months post discharge home visit between April 2013 and September 2013.

3.7.1 Survey administration

Infants six, nine and twelve month corrected age was calculated using birth date and gestational age, this was then entered into in an excel data sheet. On the week the infants were due to reach six, nine and twelve months corrected age, the parents were sent an email to introduce the format of the questionnaires and instructions for completion (Appendix N). The infant feeding questionnaires were administered to parents via email within one week of the infant turning six, nine or twelve months corrected age. Emailing the parents occurred between June 2013 and June 2014. The email included instructions on how to access and fill out the questionnaire and their infant's individual identification code. Contact details were given to parents so they could contact the researcher if they experienced any issues. Parents and caregivers without access to a computer or internet were given the option of a phone administered questionnaire or to have a questionnaire mailed to their home address with a free return envelope. Parents who did not complete

the questionnaire within two weeks of the first email were sent a reminder by email to encourage them to fill in the questionnaire (Appendix O). The reminder email reminded parents to fill the questionnaire in retrospect for the week that their infant turned six, nine or twelve months corrected age. Upon completion of the questionnaires the researcher checked them online to ensure all appropriate sections were filled in and all answers were completed.

3.7.2 Home visits

Researchers scheduled a home visit as close to twelve months corrected age as possible, based on the parent's availability. Home visits aimed to decreased subject burden and reduce disruptions to the infant's normal routine thus decreasing stress for the infant as they were in a familiar environment. One week before the visit, parents were emailed information regarding what would happen during the 12 month visit. Two trained researchers went to the participant's family home or day care to conduct anthropometric measurements on the infant/s. The same researcher took the measurements at the four month post discharge and twelve month corrected age visits to reduce variability in anthropometric measurements (Appendix P).

3.8 Data analysis:

Responses from the infant feeding practices questionnaires were downloaded from Survey Monkey straight into excel, where they were coded. The demographic questionnaire responses were coded and entered into excel. Statistical analyses were performed using SPSS statistics (IBM SPSS Statistics Version 21). The variables were tested for normality using the Kolmogorov-Smirnov, Shapiro-Wilk tests, and normality plots. Non-normally distributed data was transformed into approximately normal distributions, if possible, by logarithmic transformation. Data is reported as mean (standard deviation (SD)) if normally distributed, geometric mean (95% confidence interval (CI)) if log-transformed, medians [25, 75 percentiles] if non-normally distributed data, or frequencies.

Descriptive statistics were used to describe infant and mother characteristics. Pearson's chi-square ($\chi 2$) was used was used to examine differences between groups. Where the group sizes were too small, and the assumptions for $\chi 2$ were not met, Fisher's exact test was used. Milk feeding groups were categorised into those receiving breastmilk only compared to

those receiving either a combination (mixed) or formula, due to small subject numbers. Infants were categorised into their ethnicity, if two ethnicities were chosen then the mothers identified ethnicity was used. A significance level of $P< 0.05$ was taken as statistically significant. A confidence interval (95^{th}) was determined for proportions of breastfeeding and formula feeding, age of introduction of complementary feeding and percentage meeting preterm feeding guidelines using the Newcombe method.

Repeated measures ANOVA was used initially to examine significant differences in weight, length and head circumference Z-scores for the preterm Infants at birth, discharge, four months post discharge and twelve months corrected age. However, since the assumptions of sphercity were not satisfied, the number of subjects missing at the different time points (n= 49) and that it was the differences at sequential time points that were of interest, the data was further analysed using dependent-t tests.

Z-scores for growth were calculated using completed weeks of gestation or the infants corrected age. Z-scores were then tested for normality based on the Kolmogorov-Smirnov, Shapiro-Wilk tests, and normality plots. Paired T tests were used to determine the significance of Z-scores between different time points. A change in Z-score was calculated by subtracting the Z-score at birth from Z-score at discharge and thereafter.

Chapter 4.0 Results

4.1 Description of Participants

Figure 4.1 shows the number of participants recruited to the study at baseline and who completed the study at four months post discharge and at six, nine and twelve months corrected age.

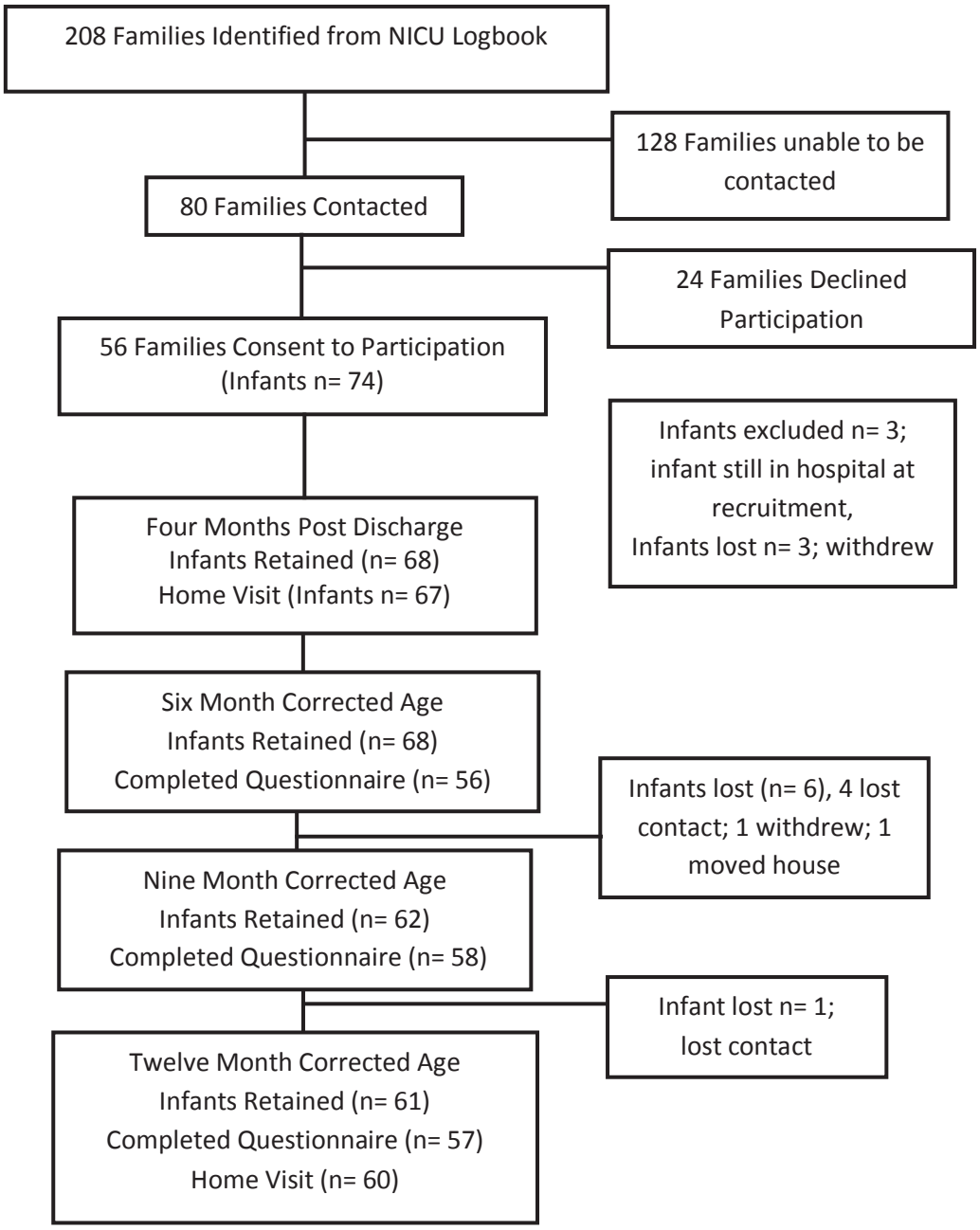


Figure 4.1 *Flow Diagram of Recruitment and Final Number of Participants*

Of the 208 families identified from the NICU logbook, 56 families were recruited into the "Post Discharge Nutrition of Preterm Infants: micronutrient status and feeding practices of preterm infants after hospital discharge" study.

At the home visit at four months post discharge, data was collected for 68 infants. These families were invited to complete the questionnaires and a final home visit at twelve months corrected age regardless of response history. Over the duration of the study a total of 13 infants dropped out (n= 11 families). The number of infants retained in the study at each time point and the number for whom questionnaires and home visits were completed is shown in **Figure 4.1**. One family (n= 1 infant) was not living in the Auckland region at twelve months corrected age therefore the home visit was not completed and anthropometric data was not collected. Forty eight infants had complete data at six, nine and twelve months corrected age.

The baseline characteristics of participants are shown in **Table 4.1**. At birth the median gestational age of infants was 34 weeks +3 days, with a range of 24 weeks +2 days to 36 weeks +6 days. The majority of infants (76%) were classified as moderate to late preterm infants (born between 32^{+1} to 36^{+6} weeks). There were 32 infants from singleton births and 36 infants (18 sets) from twin births. The participants had a birth weight (mean ± SD) of 1.98 ± 0.65 kg and the majority of infants were classed as LBW (<2.5 kg) infants.

Table 4.1 *Baseline Characteristics of Preterm Infants*

Participant Characteristics	Characteristics (n= 68)
Gender, n, (%)	
Male	37, (54)
Female	31, (46)
Singleton, n, (%)	32, (47)
Twins, n, (%)	36, (53) (18 sets)
Ethnicity, n, (%)	
New Zealand European	39, (57.3)
New Zealand Māori	5, (7.3)
Pacific Island	8, (11.7)
Asian	8, (11.7)
Indian	7, (10.2)
African	1, (1.8)
Gestational Age (weeks +days) median, [25th, 75th percentile]	
Whole group	34 +3, [32 +5, 35 +6]
< 32 weeks, (n, %= 16, 24)	29 +5, [26 +3, 31 +1]
≥32 weeks, (n, %= 52, 76)	34 +6, [34 +1, 36 +2]
Birth Weight (kg), mean ± SD	1.98 ± 0.65
ELBW (<1.0kg), (n, %)	3, (4.4)
VLBW (<1.5kg), (n, %)	15, (22.4)
LBW (<2.5kg), (n, %)	30, (44.8)
≥2500g (n, %)	19, (28.4)
Birth Length (cm), mean ± SD	44.1 ± 4.6
Birth Head Circumference (cm), mean ± SD	30.9 ± 3.1
Discharge Weight (kg), mean ± SD	2.3 ± 0.6
Length of Hospital Stay (days), geometric mean [95% CI]	19 [15-24]
Age at Four Months Post Discharge (weeks +days), median, [25th, 75th percentile]*	
Chronological	19 +3, [18 +4 - 22 +5]
Corrected age	14 +3, [13 +1 – 16 +4]

*missing data (n= 67)

The mother's characteristics are detailed in **Table 4.2**. Mothers had a mean (± SD) age of 34.7 (± 5.0) years. The majority of mothers identified with the New Zealand European ethnic group (64%), followed by Asian (14%), and all were non-smokers.

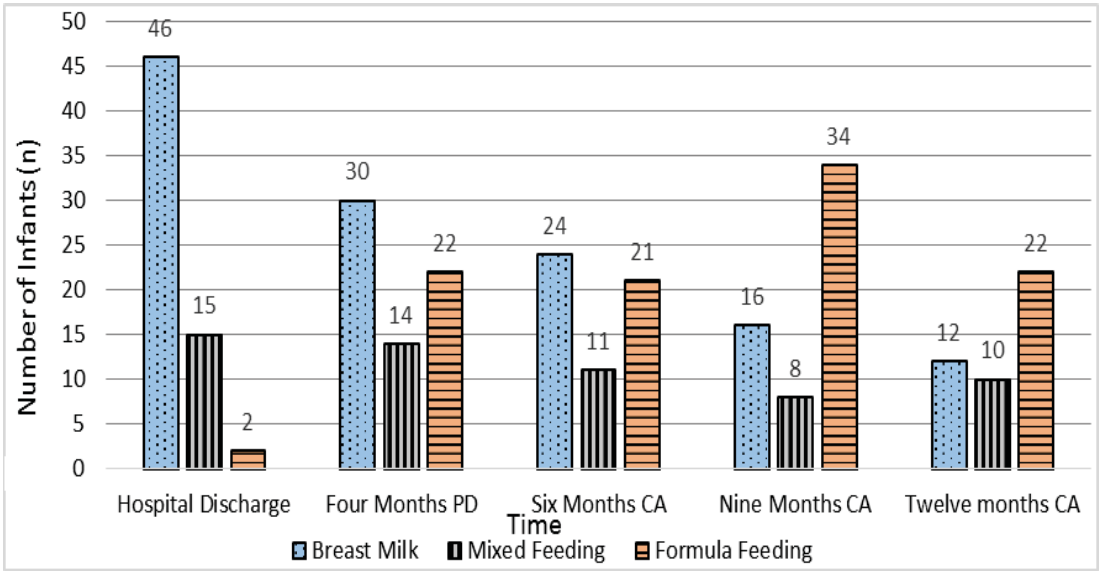
Table 4.2 *Mother's Demographic Characteristics at Birth*

Mother Characteristics	Baseline Demographics (n= 50)
Age at Delivery (years), mean ± SD, (range)	34.7 ± 5.0, (21 – 44)
Ethnicity, n, (%)	
New Zealand European	32, (64)
New Zealand Māori	2, (4)
Pacific Island	3, (6)
Asian	7, (14)
Indian	5, (10)
African	1, (2)
Number of Previous Births, n, (%)	
None	27, (54)
One	19, (38)
Two	2, (4)
Four or More	2, (4)
Smoking Status, n, (%)	
Non-smoker	50, (100)

4.2 Milk Feeding Practices in Preterm Infants

4.2.1 Main Type of Milk Feeding used for Preterm Infants

At hospital discharge, 46 (73%, CI [62%, 84%]) infants were receiving breastmilk, 15 (24%) received a combination of formula and breastmilk (mixed feeding), and 2 (3%, CI [-1%, 7%]) received formula (**Figure 4.2**). The number of infants receiving breastmilk as their main type of milk decreased significantly between hospital discharge and four months post hospital discharge, 73% versus 46% ($P< 0.01$).



PD= Post Discharge, CA= Corrected Age. Missing data (n= 2) at four months PD

Figure 4.2 *Main Type of Milk Feeding at Hospital Discharge and thereafter until Twelve Months Corrected Age*

The number of infants receiving formula increased from discharge to twelve months corrected age. The greatest increase occurred between hospital discharge (3%) and four months post discharge (22%) (*P*<0.01). Formula feeding continued to increase through the first year and the number peaked at nine months corrected age with 34 (59%) infants being formula fed. There were significant differences in type of milk feeding between each time point (*P*< 0.01). By twelve months corrected age only 12 infants continued to be breastfed (21%, CI [11%, 32%]), the number having formula also decreased to 22 infants (39%, CI [26%, 52%]), the number consuming cow's milk had increased see section 4.4.6.

4.2.1.1 Type of Formula Used at Six and Twelve Months Corrected Age

The type of formula used for both formula and mixed feeding was investigated. One infant was using a preterm formula at six months corrected age whilst majority were fed a Gold labelled formula at six (56.3%) and twelve (60.0%) months corrected age **Table 4.3**.

Table 4.3 *Type of Formula Used at Six and Twelve Months Corrected Age*

Formula Type, n, (%)	Six Months Corrected Age (n= 32)	Twelve Months Corrected Age (n= 30)†
Preterm Formula	1, (3.1)	0, (0)
Stage Two Formula	13, (40.6)	12, (40.0)
Gold Formula	18, (56.3)	18, (60.0)

† Two infants missing as mixed fed with cow and soy milk.

4.2.2 Mode of Feeding

Categories for mode of feeding included: breastfeeding, bottle feeding, a combination of breast and bottle feeding or nasogastric feeding.

At hospital discharge, of the 46 infants receiving breastmilk, 29 were being breastfed, 13 were receiving breast and bottle feeding, 3 were fed via nasogastric tube and only one baby was receiving breastmilk exclusively from a bottle. By six months corrected age all infants who were receiving breastmilk were being breastfed except for one.

At discharge, of the 15 infants receiving mixed feeding, 14 received this via a combination of breast and bottle, with only one exclusively bottle fed. Of the 11 infants at six months corrected age receiving mixed feeding, two were predominantly breastfed, five were breast and bottle fed and four fed via a bottle.

4.2.3 Singleton and Twin Births and Association with Milk Feeding

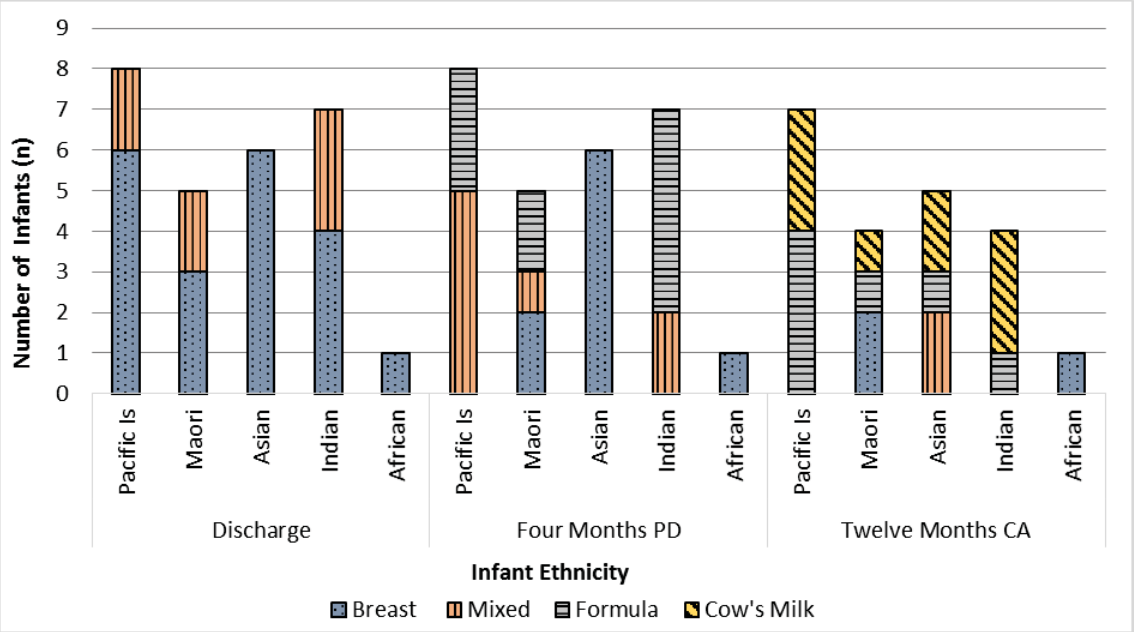
At discharge 26 (93%) singleton preterm infants received breastmilk whilst only 2 (7%) received formula or were mixed fed. In contrast, 20 (57%) twin infants received breastmilk and 15 (43%) received formula or were mixed fed (P= 0.002). Twin versus singleton birth continued to be significantly associated with type of milk feeding at four months post discharge (P= 0.008), with singleton infants more likely to receive breastmilk than twin infants, 19 infants (63%) and 11 infants (31%) respectively. By six months the effect was no longer statistically significant (P= 0.105).

4.2.4 Ethnicity

The largest ethnic group was New Zealand European. Almost three quarters (73%) of New Zealand European infants were breastfed at hospital discharge (n= 27). This declined to 18 (51%) by six months corrected age and 9 (25%) by twelve months corrected age.

For the majority of other ethnic groups subject numbers were too small for statistical analysis, hence descriptive statistics are reported. **Figure 4.3** reports the number of infants in the other ethnic groups and their main type of milk feed. All Asian infants (n= 8) received breastmilk at hospital discharge and continued at four months post discharge. The majority of Indian (n= 4) and Pacific Island (n= 6) infants received breastmilk at discharge, with others

receiving some breastmilk although, by four months post discharge none of these infants continued to receive solely breastmilk.



PD= Post Discharge, CA= Corrected Age, Pacific Is= Pacific Island

Figure 4.3 *Ethnicity and Main Type of Milk Feeding at Discharge, Four Months Post Discharge and Twelve Months Corrected Age*

4.3 Complementary Feeding in Preterm Infants

4.3.1 Age of Complementary Food Introduction

The mean (± SD) chronological age of introduction to solids was 23 ± 4.3 weeks. The age range was 12 weeks (three months) to 34 weeks (eight and a half months). Over half (53.2%, CI [41%, 66%]) of infants were introduced to solids between 22 and 24 weeks (five ½ months to six months) chronological age.

Furthermore, in terms of corrected age the mean (± SD) age of solids introduction was 16 ± 4.0 weeks (four months) **Table 4.4**. Almost two thirds of (65%) preterm infants were introduced to solids between 16 and 20 weeks (four to five months) corrected age.

Table 4.4. *Corrected Age of Solids Introduction in Preterm Infants*

Age of solid introduction (n= 63)	**Corrected age n, (%)**
<9 weeks*	4, (6.0)
10 -12 weeks*	6, (10.0)
13 - 15 weeks	8, (13.0)
16 - 18 weeks	31, (49.0)
19 – 21 weeks	10, (16.0)
>22 weeks	4, (6.0)

*Not fed according to preterm feeding guidelines

4.3.2 Infants Meeting Preterm Feeding Guidelines

Palmer and Makrides (2012) recommend that healthy preterm infants are introduced to solids at 13 weeks corrected age. It also states that introducing solids before four months chronological age would be too soon and after seven months chronological age too late.

According to this guideline 53 (84%, CI [75%, 93%]) preterm infants were following recommended guidelines. A small group of infants were not meeting guidelines because they started solids before 13 weeks corrected age (n= 10).

In relation to the chronological age recommendations, one infant was introduced to solids too early (at 12 weeks), while 5 (7.9%) infants were introduced to solids too late (after seven months chronological age).

4.3.3 First Foods Introduced to Preterm Infants

The most common first food was baby rice (**Table 4.5**) followed by fruit or vegetable puree. No infants were introduced to meat as a first food.

Table 4.5 *First Foods Introduced to Preterm Infants*

First Food Introduced (n= 53)	n, (%)
Infant Baby Rice	24, (45.3)
Fruit	15, (28.3)
Pear	7, (13.2)
Apple	7, (13.2)
Banana	1, (1.8)
Vegetable	14, (26.4)
Pumpkin	8, (15.2)
Kumara	2, (3.8)
Carrot	2, (3.8)
Potato	1, (1.8)
Courgette	1, (1.8)

Missing data: one infant was not introduced to solids, two mothers chose not to answer.

4.3.4 Food Frequency Questionnaire Data

Food frequency questionnaire data was collected at six, nine and twelve months corrected age. **Table 4.6** reports the number and percentage of infants who had been introduced to a range of foods over this time. By six months corrected age the majority of infants had been introduced to a variety of foods. This includes infant cereal (85.4%), apples and pears (96.3%), tropical fruits including banana (87.2%), starchy vegetables including potato and kumara (96.3%), and red and orange vegetables including pumpkin and carrots (98.1%). By nine months corrected age more infants had been introduced to protein foods with 93.1% of infants introduced to chicken. There was an increase in introduction of breads and cereals groups and the dairy group of foods. The intake of snack foods, including those high in sugar and/or fat, such as potato chips and potato fries, increased by twelve months corrected age. Table 4.6 shows that by twelve months corrected age a wide variety of foods had been introduced to the infants.

Table 4.6 *Introduction of Foods to Infants at Six, Nine and Twelve Months Corrected Age*

Food, n, (%)	Six Months Corrected Age (n= 55)	Nine Months Corrected Age (n= 58)	Twelve Months Corrected Age (n= 57)
Protein Foods			
Beef	41, (74.5)	52, (89.6)	53, (92.9)
Lamb	24, (43.6)	50, (86.2)	50, (87.8)
Chicken	39, (70.9)	54, (93.1)	56, (98.2)
Pork	8, (14.5)	25, (43.1)	42, (73.7)
Egg	13, (23.6)	42, (72.4)	52, (91.2)
Breads/ Cereals/ Pasta			
Bread	17, (30.9)	54, (93.1)	57, (100)
Infant Cereal	47, (85.4)	54, (93.1)	51, (89.5)
Pasta	17, (31.0)	52, (89.6)	53, (92.9)
Rice	27, (49.0)	54, (93.1)	57, (100)
Crackers	8, (14.5)	42, (72.0)	52, (91.2)
Rusk	29, (52.7)	50, (86.0)	48, (84.2)
Dairy			
Cheese	7, (12.7)	46, (79.3)	51, (89.4)
Yoghurt	22, (40.0)	47, (81.0)	54, (94.7)
Custard	14, (25.4)	38, (65.5)	42, (73.7)
Ice Cream	4, (7.2)	15, (25.8)	26, (45.6)
Fruit			
Apple, Pear	53, (96.3)	57, (98.2)	57, (100)
Stone Fruit	24, (43.6)	38, (65.5)	50, (87.7)
Tropical	48, (87.2)	57, (98.2)	56, (98.2)
Berries	26, (47.2)	49, (84.5)	50, (87.7)
Vegetable			
Starchy	53, (96.3)	57, (98.3)	57, (100)
Cruciferous	34, (61.8)	55, (94.8)	56, (98.2)
Leafy Green	30, (54.5)	54, (93.1)	52, (91.2)
Red & Orange	54, (98.1)	57, (98.3)	57, (100)
Beans & Peas	28, (50.9)	52, (89.6)	55, (96.4)
Snack Foods			
Raisins	3, (5.5)	21, (36.2)	36, (63.1)
Muesli Bar	1, (1.8)	4, (6.9)	12, (21.0)
Potato Chips	1, (1.8)	9, (15.5)	15, (26.3)
Potato Fries	2, (3.2)	2, (3.4)	22, (38.5)
Chocolate	1, (1.8)	3, (5.2)	13, (22.8)
Biscuits	2, (3.2)	23, (39.7)	40, (70.0)

4.4 Feeding Practices in Preterm Infants

4.4.1 Number of Meals and Snacks per day

The number of meals and snacks infants were offered per day was investigated and reported in **Table 4.7**.

Table 4.7 *Meals and Snacks per Day at Six, Nine and Twelve Months Corrected Age*

Infant Age	Median, [25th, 75th percentile]
At Six Months Corrected age	
Number of Meals per Day	3 meals, [2.54, 2.85]
Number of Snacks per Day	<1 snack, [0.18, 0.62]
At Nine Months Corrected age	
Number of Meals per Day	3 meals, [2.97, 3.10]
Number of Snacks per Day	1 snack, [1.05, 1.50]
At Twelve Months Corrected age	
Number of Meals per Day	3 meals, [2.93, 3.21]
Number of Snacks per Day	2 snacks, [1.70, 2.06]

Non parametric data reported as median, [25th, 75th percentile]

4.4.2 Feeding Practices of Preterm Infants at Nine and Twelve Months Corrected Age

New Zealand guidelines recommend a developmental approach to introducing textures and encouragement of self-feeding. Data on food texture, feeding skills and seating position was collected at nine and twelve months corrected age (**Table 4.8**). By nine months corrected age the majority of infants were receiving mashed foods (72.5%) and by twelve months corrected age the majority were receiving finger food (56.1%). By nine months corrected age majority (94.8%) of infants were self-feeding with finger foods. The use of spoons for self-feeding increased from 41.4% of infants at nine months corrected age to 71.9% at twelve months corrected age.

Table 4.8 *Feeding Practices at Nine and Twelve Months Corrected Age*

Feeding Practices, n, (%)	Nine Months Corrected age (n= 58)	Twelve Months Corrected age (n= 57)
Texture of Solid Food		
Pureed	13, (22.4)*	0, (0)
Thick Smooth	28, (48.3) *	6, (10.5)
Mashed	42, (72.4) *	19, (33.3)
Finger Food	36, (62.0) *	32, (56.1)
Introduced to Self-Feeding		
Finger Foods	55, (94.8)	56, (98.2)
Spoon	24, (41.4)	41, (71.9)
Fork	4, (7.0)	10, (17.9)
Type of Seating		
High Chair	50, (86.2)	49, (82.5)
Held by Caregiver	2, (3.4)	3, (5.3)
Bumbo Seat	1, (1.7)	1, (1.7)
Seated on Floor	1, (1.7)	1, (1.7)
Seated on Furniture	3, (5.2)	3, (5.2)

* More than one option could be chosen

4.4.3 Breast or Formula Milk fed Before Solids

The MOH recommends infants are fed breast or formula milk before solid foods before nine months of age, after nine months this recommendation changes to solid foods being offered before milk. The number of preterm infants being fed breast or formula milk before being offered solid foods is shown in **Table 4.9**.

Table 4.9 *Number and Percentage of Infants fed Milk before Solids*

Infant Age	Fed Milk Before Solids, n, (%)
Six Months Corrected Age (n= 55)	45, (82)
Nine Months Corrected Age (n= 58)	19, (33)
Twelve Months Corrected Age (n= 57)	5, (9)

4.4.3 Reasons for Starting Solids

Mothers were able to choose from a selection of answers to identify the main reasons for introducing solids to their preterm infant; multiple responses could be chosen (**Table 4.10**). The most commonly identified reason was the baby showing interest in the foods the mother was eating (73%).

Table 4.10 *Reasons for Introducing Solids for the First Time*

Reason	%
Baby Interested in the Foods the Mother was Eating	73.0
Baby Showing Readiness Signs	69.0
Baby's was old enough to be Introduced to Solid foods	58.0
Baby is Hungry	55.0
Baby Waking at Night	33.0
Recommended by Health Professional	27.0
Recommended by Family and/or Friend	5.0

4.4.5 Parent Reported Advice and Support for Introducing Complementary Feeding

Mother's identified who had suggested their infant start solid foods, more than one answer could be chosen. The majority of mothers (65%) said they themselves had made the decision, followed by Plunket (58%), family and friends (14.5%), GP (13%), paediatrician (11%) and dietitian (7%). At the nine month corrected age questionnaire mothers were asked where they received information on introducing solids, 86% had sought information regarding introducing of solids to their preterm infant. Mothers then identified which resources they used to introduce solids to their infant, with Plunket cited as the most common source (69.7%), followed by friends (30%) and a Wattie's resource titled "guide to baby feeding" with (30%).

4.4.6 Fluids Intake in Preterm Infants

4.4.6.1 Cow's Milk and Soy Milk

By 12 months corrected age 12 infants (21%) were consuming full fat cow's milk as their main milk drink. The earliest chronological age an infant was introduced to cow's milk was eleven months, with majority (n= 9) of mothers introducing cow's milk at one year chronological age. One infant was introduced to soy milk as their main milk drink at twelve months corrected age due to a suspected allergy.

4.4.6.2 Fluids

By six months corrected age, 46 (82%) infants had been introduced to a fluid other than breastmilk or formula **Table 4.11**. Five (9%) infants had been introduced to juice at six months corrected age which continued to rise to 16 (28%) infants by twelve months

corrected age. By twelve months nearly a third (n= 22) of infants were consuming drinks higher in sugar (fruit juice, flavoured milk and soft drink). At twelve months corrected age, 5 (9%) infants were consuming tea as a drink, three were Asian, one was Pacific Island and one was Indian.

Table 4.11 *Introduction of Fluids at Six, Nine and Twelve Months Corrected Age*

Fluid, n, (%)	**Six Months Corrected Age (n= 56)**	**Nine Months Corrected Age (n= 58)**	**Twelve Months Corrected Age (n= 57)**
Water	46, (82.0)	51, (88.0)	52, (91.0)
Fruit Juice	5, (9.0)	9, (15.5)	16, (28.0)
Flavoured Milk	2, (3.6)	2, (3.4)	2, (3.6)
Tea	0, (0)	0, (0)	5, (9.0)
Soft Drink	1, (1.8)	1, (1.7)	4, (7.1)

4.5 Vitamin and Mineral Supplementation Practices

At four months post discharge, (missing data for one infant), 33 (47% of 67 infants) were taking vitamin and mineral supplements. By twelve months corrected age, the number continuing to take supplements had declined to four (7% of 57 infants) infants by twelve months corrected age **Table 4.12**. Many of the infants given supplements were taking more than one. At six months corrected age majority of infants were taking iron (n= 14) and Vitadol C (n= 14). By nine months corrected age, 4 infants were taking iron supplements which had been recommended by a health professional.

Table 4.12 *Infants Taking Supplements at Six, Nine and Twelve Months Corrected Age*

Type of Supplement, n, (%)	**Four Months Post Discharge (n= 67)**	**Six Months Corrected Age (n= 56)**	**Nine Months Corrected Age (n= 58)**	**Twelve Months Corrected Age (n= 57)**
Iron	32, (47.0)	14, (25.0)	4, (6.8)	0, (0)
Vitadol C	33, (48.5)	14, (25.0)	3, (5.1)	4, (7.0)
Probiotics	0, (0)	3, (5.3)	0, (0)	1, (1.7)
Vitamin D	0, (0)	2, (3.5)	3, (5.1)	0, (0)
Fish Oil	0, (0)	0, (0)	0, (0)	1, (1.7)

4.6 Growth in Preterm Infants

4.6.1 Z-score analysis for Weight, Length and Head Circumference

Z-scores were calculated using the WHO growth charts for weight (**Figure 4.4**), length (**Figure 4.5**) and head circumference (**Figure 4.6**) at birth, discharge, four months after discharge and twelve months corrected age and the mean (±SD) are reported

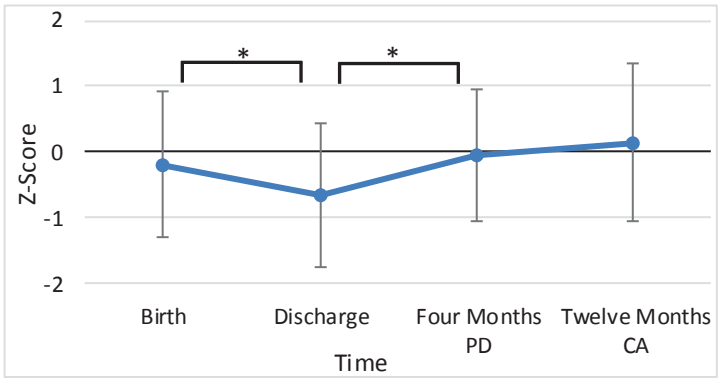


Figure 4.4 *Mean (±SD) Weight Z-scores for Preterm Infants at Birth, Discharge, Four months Post Discharge (PD) and Twelve Month Corrected Age (CA)*

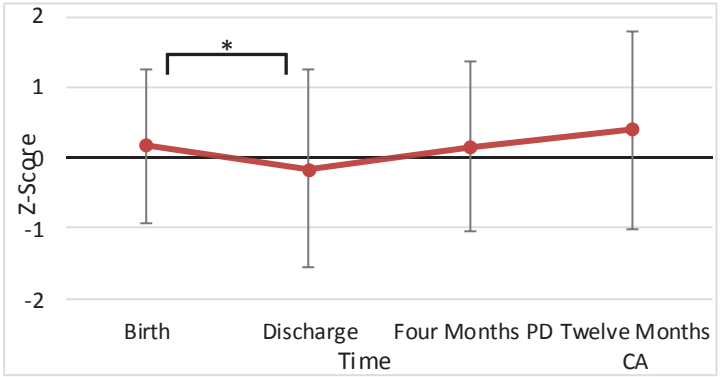


Figure 4.5 Mean (±SD) *Length Z-scores for Preterm Infants at Birth, Discharge, Four months Post Discharge (PD) and Twelve Month Corrected Age (CA)*

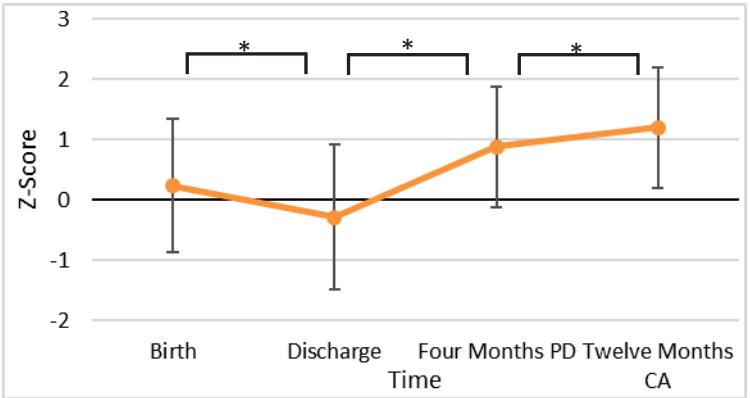


Figure 4.6 *Mean Head Circumference Z-scores for Preterm Infants at Birth, Discharge, Four months Post Discharge (PD) and Twelve Month Corrected Age (CA)*

The results show that the Z-scores for weight, were significantly affected by the time point, F (2.47, 119) = 14.4, p<0.001, χ^2 (5)= 15.9, p=0.007 (n=49). There was a significant fall in Z-scores for weight between birth and discharge mean change (± SD) -0.54 ± 0.8, *P*< 0.001, (-0.19 ± 1.1 versus -0.67 ± 1.1). After discharge there was a significant increase in Z-scores for weight between discharge and four months with a mean (± SD) change of 0.63 ± 0.9, *P* <0.001. There was a positive mean (± SD) change between four months post discharge and twelve months corrected age although this did not reach significance, 0.164 ± 1.0, *P*= 0.212.

The results show that the Z-scores for length, were not significantly affected by the time point, F (2.60, 119) =2.13, p= 0.109, χ^2 (5)= 14.4, P= 0.013 (n= 47).However, there was a significant difference in length Z-scores between birth and discharge, mean change -0.28 ± 0.9, *P*= 0.023. There was no significant change in mean (± SD) length Z-score between discharge and four months, -0.19 ± 1.3, *P*= 0.311, or between four months and twelve months corrected age, -0.11 ± 1.3, *P*= 0.531.

The results show that the Z-scores for head circumference, were not significantly affected by the time point, F (2.4, 110.6) =2.13, p= 0.109, χ^2 (5)= 15.4, P< 0.001 (n= 47). However there was a significant negative change in mean Z-scores between birth and discharge, -0.42 ± 0.9, *P* <0.001. There was a significant increase in Z-scores between discharge and four months corrected age (*P*<0.001), with a change of 1.04 ± 1.2. By twelve months corrected age the mean head circumference had increased by almost one Z-score since birth, there was a significant difference since four months with a change of 0.31 ± 0.8, *P*= 0.006.

4.6.3 Z-Score Change as an Indicator of Faltering Growth

The number of infants showing faltering growth between birth and hospital discharge, birth and four months post discharge and twelve months corrected, as indicated by a decrease in one or more Z-scores was determined (**Table 4.14**).

Table 4.13 *Infants with a Negative Change in Z-Score by One or More Standard Deviations*

	Between Birth and Hospital Discharge (n= 67)	Between Birth and Four months Post Discharge (n= 55)	Between Birth and Twelve Months Corrected Age (n= 60)
Weight, n, (%)	11, (20.0)	6, (8.9)	9, (15.0)
Length, n, (%)	9, (16.9)†	11, (16.6)	11, (18.6)
Head Circumference, n, (%)	12, (22.6)†	1, (1.5)	3, (4.8)

† Missing data for n=2.

The number of infants who increased by one or more standard deviations between the same time period was also investigated (**Table 4.15**).

Table 4.14 *Preterm Infants with a Positive Change in Z-Score by One or More Standard Deviations*

	Between Birth and Hospital Discharge (n= 67)	Between Birth Four Months Post Discharge (n= 55)	Between Birth and Twelve Months Corrected Age (n= 60)
Weight, n, (%)	1, (1.8)	12, (17.9)	15, (25.0)
Length, n, (%)	2, (3.8) †	11, (16.6)	14, (23.7)
Head Circumference, n, (%)	2, (3.8) †	29, (43.9)	34, (57.6)

† Missing data for n= 2.

4.6.5 Growth and Timing of Complementary Feeding

The effect of timing of complementary feeding on growth at twelve months corrected age was investigated (**Figure 4.7**

Infants were separated into groups depending on whether they were introduced according to preterm feeding guidelines (n= 46), introduced earlier than the guideline (before 13 weeks corrected age) (n= 10) or later than the guideline (after 7 months chronological age) (n= 4).

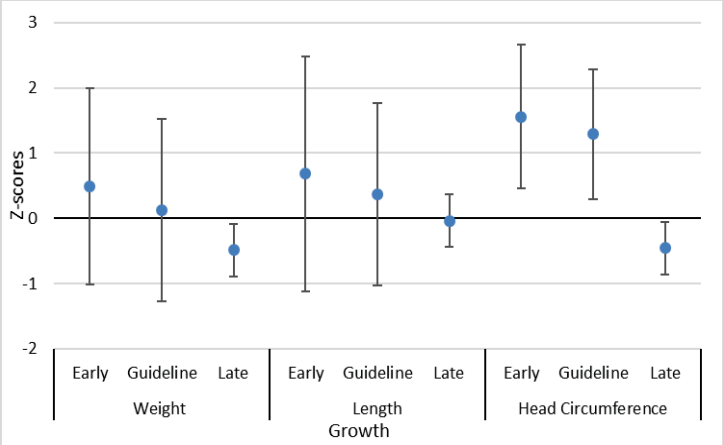


Figure 4.7 *Growth at Twelve Months Corrected Age in Relation to Introduction of Complementary Feeding According to and not According to Guidelines*

There were no significant differences in weight (*P*= 0.384), length (*P*= 0.537) or head circumference (*P*= 0.450) between infants introduced to complementary feeding early or according to the guidelines. However infants introduced to solids early had a trend of higher Z-scores for weight, length and head circumference than those introduced according to the guideline or late.

There were only four infants who were introduced to solids later than the current recommendations, this group of infants had significantly lower head circumference Z-scores compared to both infants introduced according to guidelines (*P* <0.001) and infants introduced to early (*P*= 0.003). In addition, there was a significant difference between weights of those introduced to complementary feeding at the recommended time and those introduced late, with those introduced later having a lower weight (*P*= 0.035).

Chapter 5.0 Discussion

The aim of this observational study was to investigate the feeding practices and growth of preterm infants from hospital discharge until twelve months corrected age. This included type and duration of milk feeding, introduction of complementary feeding, first foods given to infants, feeding habits and supplement use. One of the strengths of this study is that home visits were conducted at four months after discharge and twelve months corrected age. Thus, feeding practices and growth can be compared to determine whether post discharge feeding practices were adequate to support growth.

To date, the majority of research in preterm infants has focused on nutrition in the early period during hospitalisation. Despite this, by the time a preterm infant is discharged from the NICU many leave nutritionally compromised and growth restricted (Marriott *et al.*, 2003). There is a small window of opportunity of two to three years for preterm infants to regain growth deficits. If not regained, the infant faces a higher risk of developmental delays and medical problems than preterm infants with a normal growth rate (Trachtenbarg & Golemon, 1998).

The findings from this study add to the small body of evidence on the feeding practices, particularly around complementary feeding and growth outcomes for the preterm infant. Hence, changing focus to nutrition in the post discharge period in preterm infants will help to identify areas of need and aid in developing practices to ensure nutrition in this period is optimised. This will lead to better growth outcomes and development for preterm infants.

The post discharge period poses a variety of challenges as infants leave a controlled clinical setting to the home environment. Preterm infants often have delayed development of feeding skills and new skills must be acquired for the transition to complementary feeding (Ross & Browne, 2013). Furthermore, evidence on which to base guidelines for feeding a preterm infant in the post discharge period has been lacking which has led to a lack of clarity in the advice given regarding complementary feeding (McLeod *et al.*, 2011).

5.1 Study Characteristics

The study population was recruited from Auckland City Hospital NICU between February and August 2013. In total 68 preterm infants were recruited to the study, of which 32 were from singleton births and 36 were from twin births. There were more male infants recruited to this study (54%). The study population mainly consisted of moderate to late preterm infants (76%) which is reflective of the population from which the infants were recruited. National Women's Hospital reported that 73% of the preterm population were moderate to late preterm births (Pot & Sadler, 2013). The mean (±SD) birth weight of infants was 1.98 ±0.65kg, with majority (45%) of infants classified as low birth weight.

The mean (±SD) age of mothers was 34.7 ± 5.0 years, this is slightly higher than the median age of mothers in New Zealand, 30 years (Statistics New Zealand, 2011). The mothers in this sample self-selected to take part in this study and thus are not a representative sample. None of the mothers in this study reported cigarette smoking whereas in the Growing Up in New Zealand (GUINZ) study 14% of mothers smoked cigarettes. This indicates that the mothers in our study were more likely to be health conscience.

5.2 Breastfeeding and Other Milk Feeding in Preterm Infants from Discharge until Twelve Months Corrected age

5.2.1 Breastfeeding at Hospital Discharge

At hospital discharge 70.5% of the preterm infants were being exclusively breastfed. The number of infants being breastfed in this study was significantly lower than the GUINZ study. At birth 96.3% of infants were exclusively breastfeeding and 92.8% continued by one week (Morton *et al.*, 2012). This difference is likely due to the high number of term infants in the GUINZ study. It is well documented that preterm infants have poorer rates of breastfeeding than term infants (Donath & Amir, 2008; Flacking, Nyqvist & Ewald, 2007). In an audit by the ANZNN 74.8% of preterm infants were breastfeeding at discharge, numbers more representative of this study (Chow, 2013). These findings contribute to the current literature that being born preterm contributes to being less likely to be exclusively breastfed at hospital discharge. Therefore, even at discharge disparities exist between term and preterm infants with more preterm infants missing the benefits of breastmilk.

5.2.2 Breastfeeding and Milk Feeding at Four Months Post Discharge

At four months post discharge the median [25th, 75th percentile] chronological age of infants was 19 weeks +3 days, [18 +4 - 22 +5]. By this time there was a significant decrease in breastfeeding, down to 46% (P <0.01). As a result, infants receiving formula milk increased from 2 at discharge to 22 (33%). The percentage of infants continuing to be breastfed at four months in the GUINZ study, 47.3%, was similar (Morton *et al.,* 2012). This indicates that for both term-born and preterm infants, difficulties with maintaining breastfeeding arise in the post discharge period. The reduction could be due to the difficulties faced with transitioning from feeding in the NICU to feeding at home (Ericson *et al.*, 2013). Full oral suck feeds are often not achieved prior to going home and breastfeeding may not be well established (McLeod et al., 2011). This increases stress on families to establish breastfeeding and is likely a contributor to breastfeeding cessation at home. A systematic review investigating the effectiveness of interventions on supporting parents of preterm infants found that support during the NICU stay, which included counselling, practical support and breastfeeding clinics, increased mother's confidence for breastfeeding. Furthermore, parents provided with breastfeeding support prior to discharge continued to breastfeed for up to one month longer (Brett *et al.*, 2011). Exploring the barriers to and reasons for cessation of breastfeeding could identify potential areas for improvement in this area although this was beyond the scope of this study.

5.2.3 Breastfeeding and Milk Feeding until Twelve Months Corrected Age

According to the systematic review by Ross and Sundseth (2013) which investigated feeding outcomes in preterm infants post NICU discharge, the breastfeeding rate of preterm infant's declines through the first year of life in all countries with reliable data. This study also found the number of infants being breastfed continued to decline between six, nine and twelve months corrected age, with 24 (43%), 16 (27.5%) and 12 (21%) infants breastfed respectively.

In a study in Sweden by Flacking, Nyqvist*, et al.* (2007) breastfeeding was defined as a combination of both exclusive and partial breast feeding compared to no breastfeeding at all. At six months of age 60% of infants were receiving breastmilk, this is similar to this study where 62.5% of infants received some type of breastmilk either by breastmilk alone or

through mixed feeding. Furthermore, by nine months corrected age this study showed that 41% of infants received any breastmilk compared to only 28% in Flacking *et al*., (2007) study. Differences were also seen at 12 months where 38.6% of infants in this study received breastmilk compared to only 9% (Flacking et al., 2009). This is likely a reflection on the mothers recruited to this study, with mothers having interest in infant nutrition thus more interested in infant feeding practices. Thulier & Mercer (2009) reviewed the psychological factors associated with breastfeeding duration, of which maternal infant feeding attitudes, interest in breastfeeding and maternal intention were all strong predictors of breastfeeding duration. The finding of higher rates of breastfeeding present in this study are promising as this study used corrected age therefore mothers had been breastfeeding for a longer period than six months depending on their infants gestational age at birth.

There are difficulties in comparing studies on breastfeeding rates due to the variety of definitions and ways in which breastfeeding is reported in the literature as identified by other authors (Davanzo *et al.,* 2013; Harmon-Jones, 2006; Noel-Weiss, Boersma, & Kujawa-Myles, 2012; Thulier, 2010). The general consensus is for research studies to use the same definitions for defining breastfeeding to ensure comparisons and reliable conclusions can be made between studies.

5.2.4 Singleton and Twin Birth and Breastfeeding

Although not the purpose of this study differences in breastfeeding between preterm singleton and twin births were found. At hospital discharge singleton infants were more likely to be breastfed than twin infants, 93% versus 57% respectively (*P*= 0.002).This difference continued at four months post discharge with only 11 (31%) twin infants receiving breastmilk compared to 19 (63%) infants from singleton births (P= 0.008).

Infants from multiple births have higher rates of not being exclusively breastfed than their singleton counterparts (Maastrup *et al*, 2014). Mothers of multiple births are likely to encounter difficulties with breastfeeding, which is further complicated by the infants being born preterm. Ostlund et al., (2010) investigated breastfeeding between term and preterm twins, and found significantly fewer preterm twins were breastfed than term. In a systematic review by Renfrew *et al.* (2009) strategies to improve breastfeeding in multiple

births were investigated. Kangaroo skin-to-skin contact, peer support systems, simultaneous breastmilk pumping and accreditation for the Baby Friendly Hospital Initiative were effective. Although, the review highlights that the majority of the research involved clinically stable infants and therefore could impact on the generalisability of the findings to all preterm infants.

The clear association between breastfeeding and improved neonatal outcomes (Menon & Williams, 2013) indicate that improving breastfeeding rates among multiple births could be a cost effective health strategy. More than half of the infants in this study were from twin births and whilst multiple births in New Zealand are still relatively uncommon the rate of multiple births is increasing (Statistics New Zealand, 2011). This is due to a combination of older mothers giving birth and the increased use of fertility enhancing treatments (Statistics New Zealand, 2002). Hence strategies targeted to improve outcomes for this group would be beneficial.

5.2.5 Ethnicity

Ethnicity was not a specific outcome measure of this study and subject numbers in each ethnic group were too small to make conclusions. However an interesting trend was seen for breastfeeding differences between ethnic groups, which may warrant further investigation.

All Asian infants (n= 8) received breastmilk at hospital discharge and at four months post discharge. Interestingly, in the GUINZ study 50.6% of Asian infants continued to be breastfed at nine months age, the second highest ethnic group in the study (Morton *et al.,* 2012). Furthermore, the Plunket Society of New Zealand has also identified an increase in breastfeeding among the Asian population. Between 2004 and 2009 the Asian ethnic group had the largest increase in exclusive breastfeeding rates increasing from 23% of infants being breastfed at seven months to 30% (Royal New Zealand Plunket Society, 2010).

In contrast, Pacific Island and Indian infants in this study showed a shorter duration of breastfeeding. At discharge Pacific Island and Indian infants were less likely to be exclusively breastfed. By four months post discharge none of either the Indian or Pacific Island infants received exclusive breastmilk, with majority of Indian infants transitioning to formula and

majority of Pacific Island to mixed feeding. Plunket reports that Pacific people, along with Māori, have lower rates of breastfeeding than any other ethnicities and no improvements have been seen over time (Royal New Zealand Plunket Society, 2010). This highlighted that further research with larger sample sizes of ethnic groups could look into the factors affecting duration of breastfeeding. This could identify any contextual factors within the Asian ethnic group that assist in increasing the duration and look at any barriers within the Pacific Island or Indian ethnicities and address these in future interventions.

5.2.6 Type of Formula used by Preterm Infants at Six and Twelve Months Corrected Age

Majority of the infants in this cohort using infant formula were using a gold branded infant formula. This finding could indicate certain characteristics of the mothers recruited to the study. The gold branded infant formulas tend to be more expensive and this may indicate a higher economic status and parents who are more interested in nutrition.

5.3 Complementary Feeding in Preterm Infants

Complementary feeding is defined as a process when breastmilk is no longer sufficient to meet nutritional requirements and introduction of other foods and liquids is necessary to meet these requirements (World Health Organisation, 2009a).

5.3. Age of Introduction of Complementary Feeding

In this study the mean (±SD) chronological age preterm infants were introduced to complementary feeding was 23 ± 4 weeks, with an age range of 12 - 34 weeks. In terms of corrected age the mean (±SD) age of introduction was 16 ± 4 weeks. Majority of infants were introduced to solids between 16 - 20 weeks corrected age.

Currently there is a gap in the literature with very few studies reporting the age of complementary feeding introduction in preterm infants (Fanaro *et al.*, 2007; Fewtrell *et al.*, 2003; Marriott *et al.*, 2003; Norris *et al.*, 2002; Yee *et al.*, 2001). The ages of introduction in this study were similar to the Fanaro *at al.*, (2007) which found the mean chronological age of introduction was 22.2 ± 0.4 weeks corresponding to 15.1 ± 0.39 weeks corrected age. Whilst, this study introduced complementary feeding later than Norris *et al.,* (2002) where the mean chronological age was 17.1 ± 0.23 weeks and a mean corrected age of 11.5 ± 0.21 weeks. One possible explanation for this finding is the differences in feeding

recommendations for term infants between the different countries. At the time of the Norris *et al*., (2002) study in England the Department of Health recommended infants were introduced to solids between 4-6 months, whilst in Italy and New Zealand the recommendation was 6 months. These recommendations are made for healthy term infants. Parents who are unaware of specific preterm feeding guidelines tend to introduce solids according to the countries recommendations for term infants. This highlights the major issue found in this study. It was difficult to determine how many parents of preterm infants, introduced their infants to solids according an appropriate guideline because there is a lack of evidence in the literature and therefore clear guidelines on the optimal timing of introducing complementary feeding to the preterm infant.

5.3 Infants Meeting Preterm Complementary Feeding Guidelines

The post discharge period has been relatively neglected and only recently has the need for appropriate feeding guidelines been recognised. Fanaro *et al.,* (2007) highlights that lack of literature in this field has led to delay in developing complementary feeding recommendations. However, in recent years two evidenced-based guidelines have been developed by King (2009) and Palmer and Makrides (2012). Currently, there are no published studies in the literature determining compliance with these new evidenced-based guidelines for preterm feeding.

For this study the most recent recommendations from Palmer and Makrides (2012) were used, which recommend preterm infants are introduced to complementary feeding at 13 weeks corrected age. According to these guidelines 84% of preterm infants met current recommendations. A total of ten infants did not meet the guideline through being introduced to solid foods before 13 weeks corrected age. The early introduction of solids is discouraged due to concerns regarding immaturity of organ systems, displacement of nutrients from milk, increased allergy risk and poor head control (King, 2009; Palmer & Makrides, 2012).

Palmer and Makrides (2012) also outline that before four months chronological age would be too early, based on an infant born at 36 weeks and after seven months chronological age would be too late based on an infant born at 23 weeks (Palmer and Makrides, 2012). Also of concern were the 5 infants who were introduced to solids after seven months chronological

age. Introducing solids too late is of concern as infants miss various developmental opportunities for the starting of complementary feeding (McLeod *et al*., 2013) and increased risk of nutritional deficiencies (Marriott & Foote, 2003). An important consideration is that infants in this study are from a self-selected sample of mothers with increased interest in their infant's nutrition. Therefore it is concerning that 10 infants were introduced to solids too early and five infants were introduced too late. A larger sample with a more representative sample of mothers may find that more preterm infants are not being fed to current best practice.

An issue identified from this study was the lack of preterm feeding recommendations within the New Zealand setting. The New Zealand Ministry of Health infant feeding guidelines are recommended for healthy infants thus are not appropriate for preterm infants. The Neonatal and Infant nutrition handbook outlines Palmer and Makrides (2012) recommendations for introducing solids. Although, these are the most recent recommendations they are currently only accessible by New Zealand registered dietitians. Some parents of preterm infants are given a resource of introducing complementary feeding on discharge from Auckland City Hospital, although what happens in other District Health Boards is unclear. As a result it is unknown how many parents of preterm infants in New Zealand have access to these guidelines. A strategy to increase access to these guidelines should be investigated to ensure preterm infants in New Zealand can be fed optimally.

5.3. Supports for Introducing Complementary Feeding to Preterm Infants

This study found that majority of mothers made the decision themselves to start complementary feeding (65%), followed by recommendations from Plunket (58%), family and friends (14.5%) and the GP (13%). In addition, 86% of mothers had sought information regarding the introduction of solids to their preterm infant. Most mothers cited Plunket as being their main resource (69.7%) followed by friends (30%).

This finding highlights that Plunket is an opportunity to reach parents of preterm infants for future interventions for complementary feeding. Plunket states that preterm infants may not be ready for solids at six months of age (Royal New Zealand Plunket Society, 2014). Plunket nurses use a developmental approach to feeding preterm infants based on a needs assessment (A. Jamieson, personal communication, December, 12, 2014). Thus, Plunket is a

good opportunity for providing information on the introduction of solids. The ADHB do have a fact sheet for parents on complementary feeding for the preterm infant (Cormack, 2011). This is given to parents at discharge from the NICU or later at follow up clinic visits. Giving this information on discharge may not be the appropriate timing as it is likely that complementary feeding is not the parent's priority when first going home, further highlighting the potential relevance of Plunket as an intervention.

Presently, the Plunket Society of New Zealand reaches 90% of New Zealand infants and conducts home visits during the child's infancy to check growth and development (Royal New Zealand Plunket Society, 2014). Plunket is a well-regarded source of infant advice and information in New Zealand. Plunket nurses delivering a message to mothers regarding preterm infant feeding could be an appropriate strategy to improve the number of infants meeting these recommendations.

5.3. First Foods Introduced to Preterm Infants

The first food offered to the majority of infants was an iron fortified baby rice (45.3%), followed by pureed fruit (28.3%) and pureed vegetables (26.4%). None of the infants were offered meat as a first food. These first foods are similar to the GUINZ study with the most common first foods being baby rice, fruit and vegetables (Morton *et al.* 2012).

There is very little research into the first foods offered to preterm infants worldwide although, these findings are similar to the literature (Fanaro *et al,* 2007; Norris *et al.,* 2002). Of the minimal literature available it is highlighted that preterm infants are consistently being offered low energy density first foods, which are low in protein, iron and zinc. More than half of the infants in this study were introduced to these foods (54.7%). This highlights a concern for preterm infants in New Zealand as the introduction of appropriate first foods can optimise nutritional status and growth. In only one study were preterm infants introduced to meat as a first food (9.5%) (Fanaro *et al.,* 2007). In Palmer and Makrides (2012) evidence based guideline they recommend that healthy preterm infants be introduced to high protein, energy and nutrient dense first foods. Furthermore, Foote and Marriott (2003) recommend that preterm infants should be introduced to meat or iron fortified foods early in order to increase their iron intake. The introduction of first foods

based on traditional and plant-based complementary foods is common, therefore more work is needed to encourage meat as a first or early food for preterm and term infants.

5.3 Commonly Eaten Foods at Six, Nine and Twelve Months Corrected age

At six months corrected age the foods consumed by most infants were fruits (96.3%) and vegetables (98.1%), followed by an iron fortified infant cereal consumed by 85.4% of infants. At this time, 74.5% of infants had been introduced to beef and 70.9% to chicken. Fanaro & Vigi (2007) found that preterm infants were generally introduced to meat five weeks after starting complementary feeding. Furthermore, McLeod *et al*, (2011) reported in their study that preterm infants were more likely to be introduced to a variety of fruits and vegetables before the introduction of meat and dairy into the diet.

Preterm infants are at an increased risk of iron and zinc deficiency due to lower stores at birth, increased growth demand and low amounts in breastmilk. Consequently, iron and zinc stores often become depleted and the provision of these nutrients is necessary through complementary foods (Giugliani & Victoria, 2000; Krebs & Hambidge, 2007; Ministry of Health, 2008). Thus, the tendency to introduce meats later could be detrimental in the preterm infant population. The New Zealand Ministry of Health recommend introducing iron-rich age-appropriate meats such as cooked and pureed beef, lamb, pork, chicken and fish as a first food (Ministry of Health, 2008). Giugliani & Victoria, (2000) suggest that consuming adequate amounts of iron in complementary foods could only be achieved via consumption of iron fortified foods and consuming large amounts of animal products. The findings of this study are similar to the literature in regard to predominantly plant-based diets of infants during early complementary feeding and delays in the introduction of meat. In this study the mean corrected age of complementary feeding introduction was around four months corrected age, however the recommended age is three months. By six months corrected age majority of infants should be well established on meat but in this study not all infants had been introduced to meat at six months corrected age.

By nine months corrected age most infants had been introduced to a variety of iron rich food sources with the majority eating chicken (93.1%), beef (87.6%), lamb (86.2%) and eggs (72.4%). These findings are similar to the New Zealand National Children's Nutrition Survey (NCNS) with chicken being the most common meat, eaten by 80% of children (Ministry of

Health, 2003). Although, the findings from the NCNS are from children aged 5-14years. The GUINZ study also reports the commonly eaten foods at nine months age of which vegetables, fruit, meat and bread were the most common (Morton, 2012). This study also found that infants were often consuming a wide range of fruit and vegetables and breads, cereals and rice and since six months corrected age there was an increase in the use of dairy foods.

In this study the intake of snack foods which are high in sugar, sodium and/or fat was investigated. From six months corrected age until twelve months corrected age there was increasing consumption of snack foods such as chips and fries. Snack food consumption increased dramatically between nine and twelve months corrected age with 26.3% of infants eating potato chips and 38.5% fries. These findings are similar to GUINZ study, where 53% of infants had been introduced to either sweets, chocolate, hot chips or potato chips by nine months of age (Morton, 2012). The Ministry of Health infant feeding recommendations advise parents to choose snacks low in salt and added sugar (Ministry of Health, 2008). These high energy nutrient poor foods are an inappropriate food for infants during a time when micronutrient needs are so high (Briefel *et al.*, 2004). Preterm infants have high energy and nutrient requirements, which are already difficult to meet, thus the introduction of inappropriate snack foods are not recommended due to displacement of nutrients

By twelve months of age infants should be well established on a diet of solids, by this time apples, pears, starchy vegetables and bread had been introduced to all infants. In the NCNS bread was the largest contributor to energy and a main source of iron in the children's diets in New Zealand, along with breakfast cereals (Ministry of Health, 2003). Majority of infants were now eating beef (92.9%), lamb (87.8%), chicken (98.2%) and eggs (91.2%). This study found that by twelve months the majority of infants were consuming a wide variety of foods which is important for ensuring nutrient requirements are met. After nine months the contribution of nutrients provided by complementary feeding needs to be high, with 97% of iron requirements and 86% of zinc needing to be supplied by complementary feeding. Thus, given the small amount of food consumed by infants the nutrient and energy density of complementary foods should be high (World Health Organisation, 2001). It is apparent from this study that preterm infants over the first year of life are introduced to a wide variety of

foods. Education for parents to inform the use of nutrient and energy dense foods for complementary feeding is needed especially at initiation of complementary feeding.

5.4 Feeding Practices in Preterm Infants

5.3 Sequence of Infant Feeding

At six months corrected age 82% of infants in this study were offered milk before solids. By nine months age, when the recommendation changes to solids before milk, 67% were following the recommendation. By twelve months corrected age 91% were following the recommendation. Therefore the majority of infants are meeting the current recommendation from the MOH (2008). However a few infants were not following these recommendations which increases concerns that these infants were not meeting their nutritional requirements due to displacement of complementary foods with milk.

5.3 Texture of Complementary Foods

By nine months corrected age the majority of infants were receiving mashed foods (72.4%) and by twelve months corrected age more than half were receiving finger foods (56.1%). A small number of infants (n= 6) continued to be offered a 'thick smooth' texture at twelve months corrected age. This is of concern because developmentally there is only a small window of opportunity for exposure to textures in the mouth. If delayed the infant can develop an aversion to anything in their mouth other than milk (Palmer & Makrides, 2012). Northstone, Emmett, and Nethersole (2001) found that infants introduced to new textures after 10 months of age have difficulties in learning new oral movement, increasing the likelihood of food refusal and poor oral intake. The transition to different textures is a development process requiring that the infant had developed the appropriate gross and fine motor skills as outlined by Delaney and Arvedson (2008). Therefore investigating infants at their corrected age is a strength of this study. This also highlights that awareness around preterm feeding skills also needs to take the infants prematurity into consideration. Guidelines for feeding preterm infants should include the importance of transitioning through textures as not to avoid the critical window of exposure but also caution parents to consider the infants developmental readiness.

5.4. Introduction of Other Fluids to the Preterm Infant Over Until Twelve Months Corrected Age

This study found the intake of fluids increased and by twelve months corrected age almost a third of infants (n= 22) were consuming drinks high in sugar, which included fruit juice, flavoured milk and soft drinks. Also at twelve months corrected age 5 (9%) of infants had been introduced to tea as a drink. These findings are similar to the GUINZ where over one third of all infants had tried fruit juice (Morton, 2012). The introduction of sugary drinks is not recommended in infancy due to the possible negative health consequences. This includes increasing preference of sweet foods (Schwartz *et al.*, 2011), and displacement of nutrient rich foods such as milk with nutrient poor foods such as juice (Skinner *et al.*, 2004). Furthermore the introduction of tea as a drink can increase the likelihood of iron deficiency due to its effect on iron absorption (P. Emmett *et al.*, 2000). A high number of preterm infants in this study were drinking inappropriate fluids which are unnecessary and possible detrimental.

Furthermore, by twelve months corrected age 12 infants (21%) had been introduced to full fat cow's milk. Most infants were introduced to cow's milk at one year corrected age, with one infant introduced earlier at eleven months corrected age. A study in Dunedin in 2002 reported that 54% of infants were given cow's milk as a drink before 12 months, at a mean age of 39.9 ± 9.3 weeks (Heath *et al.,* 2002). The majority of the infants in this study were introduced to cow's milk at an age appropriate time. This is important as the early introduction of cow's milk can cause anaemia (Woldu *et al.*, 2014). This finding could indicate that parents in this study were more affluent as formula milk is more expensive than cow's milk.

5.5 Supplementation Practices from Hospital Discharge until Twelve Months Corrected Age

At the time of this study Auckland City Hospital guidelines were for preterm infants to continue on vitamin and mineral supplements until on a mixed diet of solids. It is therefore not surprising that in this study there was a steep decline in the number of infants receiving supplements after six months corrected age. The minimal research in preterm infants published on this topic indicates that compliance with supplements has been found to be low. Milton & King (2012) found that only 18% of infants were given supplements as

recommended whilst 49% were not given supplements despite being recommended to (Milton & King, 2012). Furthermore, in the study conducted in the initial phase of this large trial, iron status of preterm infants was investigated. This found that preterm infants who were not supplemented were almost five times more likely to have iron deficiency or iron deficiency anaemia at four months after hospital (Moor, 2013). As a result of this finding, policy changes have been made to the criteria and duration of both iron and vitamin supplementation. More research is needed in to determine the compliance to and effectiveness of these new supplementation strategies.

Particular alarms have been raised regarding compliance with supplementations especially in exclusively breastfed infants. Dube *et al.* (2010) found that infants EBF for four months were at higher risk of iron deficiency. By seven months of age 21% of formerly breastfed infant had iron deficiency anaemia despite the introduction of meat as a complementary food. This study was conducted in healthy term infants and poses the question of what would happen in at risk populations such as preterm infants. Formula fed infants are not as vulnerable due to the fortification of formula. These studies clearly highlight the importance of supplementation in preterm infants, thus understanding the barriers to supplementation and addressing these could decrease the incidence of iron deficiency in this vulnerable group. Furthermore if compliance continues to remain low, the recommendation for iron rich first foods is further supported (American Academy of Pediatrics, 2010).

5.6 Preterm Infant Growth

This study investigated the growth of preterm infants from birth until twelve months corrected age. Measurements were converted to Z-scores using the WHO growth standards to standardise for gender and age. The WHO growth standards represent human growth under optimal environmental conditions (Mehta *et al.*, 2013).

5.6.1 Mean Growth of Preterm Infants from Birth until Twelve Months Corrected Age

5.6.1.1 Birth until Hospital Discharge

This study found a significant change in Z-scores for weight (*P*= 0.000), length (*P*= 0.023) and head circumference (*P*= 0.001) between birth and hospital discharge. It is well documented in the literature that many preterm infants leave hospital with faltering growth (Clark *et al.*,

2003; Funkquist *et al.*, 2010; Kurl *et al.*, 2003). This study showing negative changes in Z-score for all three parameters at discharge is consistent with that literature. Furthermore, this study also investigated faltering growth post hospital discharge. A Z-score (standard deviation) change of >1 is an indication that an infant is at risk of faltering growth whilst a decrease of 2 or more is an indication of growth faltering (Holdsworth *et al.*, 2006; Mehta *et al.*, 2013; Shields *et al.*, 2012). In this current study found faltering growth occurred in 20% of infants for weight, 16.9% for length and 22.6% for head circumference between birth and discharge.

Poor growth in infancy can leave infants with functional losses. The preterm infants with greater increases in weight until term have been associated with improved neurodevelopmental outcomes (Belfort *et al.*, 2011; Ehrenkranz *et al.*, 2006). Growth monitoring, as suggested by ESPGHAN, in the post discharge period is essential to identify preterm infants at risk of poor growth and who may require additional nutrition support (Aggett *et al.,* 2006). In New Zealand growth monitoring is currently undertaken by Plunket over the infant's first year of life.

5.6.1.2 Hospital Discharge until Four Months Post Discharge

A strength of this study is the follow up of infants after discharge. Whilst there is much research reporting the faltering growth of preterm infants at the time of hospital discharge, few studies have followed up these infants to determine their growth after discharge.

In this study there was a significant increase in weight (*P*= 0.000) and head circumference (*P*= 0.000) Z-scores from discharge to four months post discharge. There was also an increase in length although this did not reach significance. In a study by Belfort *et al.* (2011) preterm infants at four months corrected age were found to have decreased in weight and length since term and were found to have Z scores below 0. By contrast, in this study, at four months post discharge preterm infants had made increases above 0 in length and head circumference with weight marginal only just below 0. It should be noted that these time points are not directly comparable due to the measurement in this study being four months post discharge and not corrected age as in the study by Belfort *et al.* (2011). Leaving the controlled NICU environment with intensive care, growth monitoring and individualised nutritional management can be a vulnerable time for many preterm infants and their

families. However, these results indicate that for the majority of preterm infants in this study the feeding practices in the post discharge period were adequate to support growth.

Between birth and four months post hospital discharge there was an indication of faltering growth faltering in 8.9% of infants for weight, 16.6% for length and 1.5% for head circumference. The high number of infants with faltering growth was an interesting finding. This is unusual as when there is inadequate nutrition, weight is usually affected first with sparing of length and head growth not occurring until the period of poor nutrition has lasted for three months or longer (Cameron & Bogin, 2012). This raises the possibility that length and head circumference growth are affected much more quickly in preterm infants that in term infants or that the faltering length growth may be a lasting effect of the deficits that occurred in the early NICU period manifesting months later after discharge.

5.6.1.3 Four Months post Dishcarge to Twelve Months Correted Age

In this study the mean Z-scores continued to increase from four months post discharge to twelve months corrected age. There was a significant increase in head circumference Z-scores (*P*= 0.006). The mean head circumference at twelve months corrected age increased by almost one whole Z score between birth and twelve months corrected age. This finding is unusual and unexpected. In a study by Belfort *et al*., (2011) preterm infants were also found to have higher mean head circumference, although the head circumference found in this study were greater than this those found by Belfort *et al.,* (2011). A study by Daymont *et al.* (2010) with a sample of 75,412 LBW infants or infants born less than 33 weeks compared the head circumference values below the 5th and above the 95th percentile using different growth charts. Daymount *et* al. (2010) found that the WHO growth charts, used in this study, had significantly more infants above the 95th percentile than the other growth charts. This could explain some of the findings in this study, although the mean Z-scores for head circumference in this study are unusually high. More research is needed in the post discharge period in preterm infants to assess growth and how feeding practices may affect head circumference.

Between birth and twelve months corrected age 15% of infants had faltering growth for weight, 18.6% for length and 4.8% for head circumference. This indicates a number of preterm infants had faltering growth that was undetected or untreated. It unknown

whether these infants had been monitored for growth in the post discharge period. More research is needed into the monitoring of growth in preterm infants in the post discharge period, and to determine the optimal interventions in this vulnerable and at risk group.

5.6.2 Preterm Infant Growth According to Meeting Preterm Feeding Guidelines

The effect of timing of complementary feeding according to preterm feeding guidelines was investigated. Although this sample is not powered to determine the effect of feeding practices on growth the results are reported due to the minimal research and only one RCT (Marriott & Foote, 2003) available in this area.

This study found that no differences between the twelve month corrected age weight (*P*= 0.384), length (*P*= 0.537) or head circumference (*P*= 0.450) Z-scores between infants that were introduced to solids early (before 13 weeks corrected age) or those fed according to the guideline (after 13 weeks corrected age). Although not statistically significant infants introduced earlier were slightly heavier and longer. This is consistent with the research with preterm infants introduced to solids earlier being heavier (Morgan *et al.*, 2004) and longer (Marriott *et al.*, 2003; Morgan *et al.*, 2004).

Furthermore, the recommendations also highlight that the introduction of solids after seven months chronological age is detrimental. There were only five infants in this group which growth data was only available for four. This is a very small sample size and results should be interpreted with caution. They are reported due to the little evidence in this area and also as this is an observational study and it would not be ethical to replicate these results in another study. Infants introduced to solids later than recommended had significantly lower head circumference Z-scores compared to infants fed prior to (*P*= 0.003) and according to recommendations (*P* <0.001). In addition, there was a significant difference in weight (*P*= 0.035) between late introduction and those fed according to recommendations. The MOH outlines that iron and micronutrient deficiency, growth faltering and wheat allergy are associated with the late introduction of solids (Ministry of Health, 2008). Furthermore, concern for these infants is raised due to head circumference being a measure of brain growth and subsequent development (Raymond & Holmes, 1994). These results indicate that the introduction of solids too late does affect growth in preterm infants, although due to the small sample size the results should be interpreted with caution.

The investigations of type of milk feeding and growth would have been interesting to investigate as part of this study although, due to the small sample size in this study and the growing literature base regarding mode of feeding and growth in preterm infants this was not investigated (Funkquist *et al.*, 2010; Morgan *et al.*, 2004; O'Connor *et al.*, 2003; Wauben *et al.*, 1998; Zachariassen *et al.*, 2010). With majority of growth deficits occurring in exclusively breastfed infants (Aimone *et al.*, 2009). The literature clearly identifies that growth in breastfed infant's lags behind growth of formula fed infants.

Chapter 6.0 Conclusion

6.1 Summary of the Study

This observational study was designed to provide a situational analysis of feeding practices and growth in preterm infants after hospital discharge until twelve months corrected age. A total of 68 preterm infants were recruited from the Neonatal Intensive Care Unit at Auckland City Hospital, New Zealand. An important strength of this study was that prospective data on feeding practices was collected at six, nine and twelve months corrected age. In addition, home visits were conducted at four months post discharge and twelve months corrected age allowing the same researcher to undertake anthropometric measurements. This study design allowed a longitudinal assessment of preterm infants which has not previously been reported in New Zealand. Statistical analysis was performed using χ^2, Fishers exact test and paired T-test. A *P*-value of <0.05 was considered statistically significant.

The first objective of this study aimed to determine the type and duration of different types of milk feeding from hospital discharge until twelve months corrected age in preterm infants. The results of this study showed that majority of preterm infants at discharge were receiving some breastmilk (96%) with 73% receiving exclusive breastmilk. The rates of breast feeding found in this study are similar to the preterm literature. By four months post hospital discharge there was a significant decrease in exclusive breastfeeding (53%). This highlights that the months following discharge pose a vulnerable period for breastfeeding maintenance. The duration of breastfeeding continued to decline until twelve months corrected age when only 21% of infants continued to be breastfed. This hypothesis that preterm infants would not be meeting current recommendations for breastfeeding was accepted.

The second objective was to determine the age of introduction of complementary feeding, the types of foods introduced and the progression of introduction of foods until twelve months corrected age. This study found that preterm infants were introduced to

complementary feeding at a mean corrected age of 16 ± 4.0 weeks. The hypothesis that preterm infants were not meeting current recommendations for introducing solids was accepted. A high proportion of the first foods were relatively energy and nutrient poor. From when complementary feeding was commenced until twelve months corrected age infants were progressively introduced to a wider variety of foods.

Thirdly the objective was to identify what resources caregivers of preterm infants currently have and use to guide the introduction of solid food to their infant. This study found that Plunket was a major feeding recommendations resource for parents. This is an important finding to guide future directions of how best to provide feeding information for parents of preterm infants after discharge from the hospital.

The fourth objective was to identify the supplementation practices of preterm infants following hospital discharge until twelve months corrected age. This study found that the number of infants receiving supplements after six months corrected age declined and by twelve months corrected age very few infants received supplements.

The final objective explored growth of preterm infants and any relationships between feeding practices. As expected there was a mean decrease in Z-scores for weight, length and head circumference from birth to hospital discharge. By four months after discharge there was an increase in mean Z-scores for the group, indicating that current feeding practices in the post discharge period supported growth for the majority of the preterm infants. Although, a few infants in this study were at risk of growth faltering. This was still the case at twelve months corrected age. However there were a small number of infants in this study who displayed signs of undetected or untreated faltering growth. The hypothesis that preterm infants are not meeting growth outcomes at twelve months corrected age was rejected as the majority of infants were meeting growth outcomes by this age.

6.2 Conclusion

This study has highlighted the paucity of literature available regarding complementary feeding and post discharge feeding practices in preterm infants. It has highlighted that more high quality research is required for the development of robust recommendations for feeding preterm infants. This study will add to the limited literature available.

Furthermore, this study recognised that preterm infants are starting complementary feeding with energy poor foods and the introduction of iron rich foods is delayed. It is recommended that preterm infants start on energy and nutrient dense complementary foods (Palmer & Makrides, 2012). Meat should be introduced as one of the first complementary foods. In addition, the use of Plunket, which parents identified as their main source of feeding information, could ensure parents receive complementary feeding advice specifically for preterm-born infants at an appropriate time developmentally for the child and practically for the parent.

Majority of infants in this study were introduced to complementary feeding after 13 weeks corrected age. Although there were five infants who were introduced to solids at very late age. Interestingly, these infants had significantly worse growth in weight and head circumference than infants who were introduced to solids early and at an age appropriate time. Although, the small number of infants in this group indicate that these results need to be interpreted with caution.

Finally, this study showed that despite a significant decrease in Z-scores at discharge, by four months post discharge and twelve months corrected age majority of infants regained their growth deficit and maintained growth over the first year. This indicates that the feeding practices over this time are adequate to support growth in this group of preterm infants.

6.3 Strengths

Currently, only a small number of research papers have investigated the post discharge feeding practices of preterm infants. This study adds to this limited research and additionally provides results for preterm infants in Auckland, New Zealand. The longitudinal and prospective nature of this study was an important strength of the research design. This also ensured that parents were not relying on retrospective recall of feeding practices, therefore ensuring more reliable data on feeding practices at four months post discharge and six, nine and twelve months corrected age.

Another strength of this study was the broad eligibility criteria for inclusion into the study. This along with recruitment from a tertiary level hospital allowed a more varied sample of preterm infants to be included in the study. The distribution of preterm infant

characteristics is similar in terms of gender and gestational age to the infants found in NICU. This provides a strength as infants of varying gestational age, singleton and twin births and a variation of birth weights could be investigated.

Furthermore, growth measurements after discharge at the four month post discharge and twelve month corrected age visit were undertaken by the same trained research assistant. This decreases the variability in measurements that can arise when different researchers are taking measurements. Conducting these visits within the infant's home or childcare centre ensured that measurements were taken at the mother's convenience and hence aided in decreasing subject burden and importantly prevented undue stress on the infant.

Finally, another strength of the study was in the administration of questionnaires via the online survey. This standardised the way in which data were collected by decreasing the potential of interviewer bias. The use of an online survey also meant mothers could complete the surveys at their own convenience thus decreasing subject burden and drop-out rates.

6.4 Limitations

Despite the various strengths of this research, there were also limitations. A total of 68 infants were recruited to the study although by twelve months only 61 infants remained in the study. Participation numbers for the questionnaires were lower than the home visits resulting in 56, 58 and 57 participants at the six, nine and twelve month corrected age questionnaires. Thus, the small sample size is a limitation to this study and therefore the study was not statistically powered to determine the significance between different feeding groups and infant characteristics between those groups. There was a short recruitment period for this study, due to time constraints. A longer period of recruitment would have meant higher participation was possible.

In addition to the small sample size there was not a complete data set for all infants at all stages of the study. Majority of parents took part in the home visits and this is where the highest numbers of participation were seen. Despite online administration of surveys being a strength it also meant that parents did not always complete this part of the study. This raises the questions whether home visits over the first year of life would have been more effective, although the resources needed for this were beyond the scope of this study.

Furthermore, it is likely that as mothers start to return to paid employment this would pose difficulties in a practical sense.

There were 208 possible families that could have been recruited to this study, however, 128 were not able to be contacted and a further 24 declined participation. This resulted in a self-selected sample of mothers who opted into participating in this research. The sample is therefore not necessarily a representative sample of all preterm infants in the Auckland City Hospital NICU. This can lead to bias in the results because mothers who take part are more likely to have an interest in their infant's nutrition than those who did not take part.

Another limitation was the sample of infants was only taken from within the Auckland region. Infant family homes ranged from as far South as the Bombay Hills and as far North as Whangaparoa. This is a wide geographical spread over the Auckland region, although means that the results of this study could not be generalised to other urban or rural settings in New Zealand. A larger multi-centre study in New Zealand would help to eliminate this and provide a representative sample of families with preterm infants from all over New Zealand.

The final limitation for consideration was the use of data from the four month post discharge period. Due to this study being part of a larger trial, of which outcomes of Vitamin D and iron status were assessed at four months it meant that data were collected for this time point. This was therefore not a standardised time point with infants ranging from 2 months and 9 days to 4 months and 23 days corrected age at four months post hospital discharge. Corrected age is useful as it standardises for the infant's developmental ability. Despite four months post discharge not being a standardised measure, growth data from this time was able to be standardised by conversion to Z-scores which take into consideration the infant's gender and corrected gestational age. Furthermore, due to the lack of longitudinal growth data in preterm infants in New Zealand it was important that this data was included to provide information on growth in the early periods after hospital discharge.

6.5 Recommendations for Future Research

1.0. Further research with larger sample sizes and a wider distribution of ethnic groups to investigate factors affecting the duration of breastfeeding. This could identify any contextual factors within the Asian ethnic group that promote a longer duration and identify any breastfeeding barriers for Māori, Pacific Island or Indian ethnicities.

2.0. This research has highlighted the lack of studies in preterm infants regarding feeding in the post discharge period. Current feeding guidelines are evidenced based but the author identifies that the recommendations are based on a paucity of literature available (Palmer & Makrides). This highlights the potential for further high quality research. In addition research to determine the effectiveness of the evidenced based guidelines would be invaluable in terms of progress into the development of national recommendations. These studies should include assessments of diet quality, nutritional status, growth, neurodevelopment and long term metabolic health to determine the appropriateness of these guidelines for preterm infants.

3.0. In this group of infants the majority of infants maintained their growth over the first year of life, although, there were a few infants who were at a higher risk of growth faltering. Unfortunately the sample size was too small in this study to investigate these factors and determine if they were related to feeding practices. A larger sample size of infants with a more representative sample of mothers could provide this information for future research and identify at risk groups of preterm infants.

Reference List

Abel, S., Park, J., Tipene-Leach, D., Finau, S., & Lennan, M. (2001). Infant care practices in New Zealand: a cross-cultural qualitative study. *Social Science & Medicine, 53*(9), 1135-1148.

Aggett, P., Agostoni, C., Axelsson, I., De Curtis, M., Goulet, O., Hernell, O.*, et al.* (2006). Feeding preterm infants after hospital discharge: A commentary by the ESPGHAN Committee on Nutrition. *Journal of Pediatric Gastroenterology and Nutrition, 42*, 596-603.

Agostoni, C., Buonocore, V., Carnielli, M., De Curtis, M., Darmaun, D., Desci, T.*, et al.* (2012). Enteral nutrient supply for preterm infants: Commentary from the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition Committee on Nutrition. *Journal of Pediatric Gastroenterology and Nutrition, 50*(1), 85-91.

Agostoni, C., Decsi, T., Fewtrell, M., Goulet, O., Kolacek, S., Koletzko, B.*, et al.* (2008). Complementary feeding: A commentary by the ESPGHAN Committee on nutrition. *Journal of Pediatric Gastroenterology and Nutrition, 46*, 99-110.

Aimone, A., Rovet, J., Ward, W., Jefferies, A., Campbell, D., Asztalos, E.*, et al.* (2009). Growth and body composition of human milk–fed premature infants provided with extra energy and nutrients early after hospital discharge: 1-year follow-up. *Journal of Pediatric Gastroenterology and Nutrition, 49*(4), 456-466.

Åkerström, S., Asplund, I., & Norman, M. (2007). Successful breastfeeding after discharge of preterm and sick newborn infants. *Acta Pædiatrica, 96*(10), 1450-1454.

American Academy of Pediatrics. (1997). Work group on breastfeeding: Breastfeeding and the use of human milk. *Pediatrics, 100*(6), 1035-1039.

American Academy of Pediatrics. (2004). Age terminology during the perinatal period. *Pediatrics, 114*(5), 1362-1364.

Ananth, C., & Vintzileos, A. (2006). Maternal-fetal conditions necessitating a medical intervention resulting in preterm birth. *American Journal of Obstetrics and Gynecology, 195*(6), 1557-1563.

Anderson, D. (2013). Nutritional management of the preterm infant. In J. Lott, & C. Kenner (Eds.), *Comprehensive Neonatal Nursing Care*. New York, NY: Springer Publishing Company.

Auckland District Healthboard. (2007). Management of pregnancies at borderline viability. Retrieved 14/10/2014, 2014, from http://www.adhb.govt.nz/newborn/Guidelines/Admission/BorderlineViability.htm

Auckland District Healthboard. (2014a). Neonatal nutrition guideline. Retrieved 06/07/2014, from http://www.adhb.govt.nz/newborn/Guidelines/Nutrition/Nutrition.htm

Auckland District Healthboard. (2014b). Newborn services. Retrieved 25/05, 2014, from http://www.adhb.govt.nz./newborn/

Barker, D. (1997). Maternal nutrition, fetal nutrition, and disease in later life. *Nutrition, 13*(9), 807-813.

Barker, D., Godfrey, K., Gluckman, P., Harding, J., Owens, J., & Robinson, J. (1993). Fetal nutrition and cardiovascular disease in adult life. *The Lancet, 341*(8850), 938-941.

Barois, J., Grognet, S., Tourneux, P., & Leke, A. (2013). Facteurs maternels et néonatals associés au succès de l'allaitement maternel à la sortie d'un service de néonatologie chez les grands prématurés. *Archives de Pédiatrie, 20*(9), 969-973.

Beck, S., Wojdyla, D., Say, L., Betran, A., Merialdi, M., Requejo, J.*, et al.* (2010). The worldwide incidence of preterm birth: A systematic review of maternal mortality and morbidity. *Bulletin of the World Health Organization, 88*, 31-38.

Behrman, R., & Butler, A. (2007). *Preterm birth: Causes, consequences, and prevention*. Washington D.C: The National Academies Press.

Belfort, M., Rifas-Shiman, S., Sullivan, T., Collins, C., McPhee, A., Ryan, P.*, et al.* (2011). Infant growth before and after term: Effects on neurodevelopment in preterm infants. *Pediatrics, 128*(4), 899-906.

Bernardi, J., Goulart, A., & Amancio, O. (2003). Growth and energy and protein intake of preterm newborns in the first year of gestation-corrected age. *Sao Paulo Medical Journal, 121*, 05-08.

Bhatia, J. (2013). Growth curves: How to best measure growth of the preterm infant. *The Journal of Pediatrics, 162*(3), 2-6.

Bhatia, J., Griffin, I., Anderson, D., Kler, N., & Domellöf, M. (2013). Selected macro/micronutrient needs of the routine preterm infant. *The Journal of Pediatrics, 162*(3), 48-54.

Birch, L., & Doub, A. (2014). Learning to eat: Birth to age 2 years. *The American Journal of Clinical Nutrition, 99*(3), 723-728.

Blackburn, S. (1995). Problems of preterm infants after discharge. *Journal of Obstetric, Gynecologic, & Neonatal Nursing, 24*(1), 43-49.

Blencowe, H., Cousens, S., Oestergaard, M., Chou, D., Moller, A., Narwal, R.*, et al.* (2012). National, regional, and worldwide estimates of preterm birth rates in the year 2010 with time trends since 1990 for selected countries: A systematic analysis and implications. *The Lancet, 379*(9832), 2162-2172.

BLISS. (2011). Weaning your premature baby. Retrieved 21/01/2014, from http://www.bliss.org.uk/wp-content/uploads/2012/02/Weaning.pdf

Bonet, M., Blondel, B., Agostino, R., Combier, E., Maier, R., Cuttini, M.*, et al.* (2011). Variations in breastfeeding rates for very preterm infants between regions and neonatal units in Europe: Results from the MOSAIC cohort. *Achives of Disease in Childhood Fetal and Neonatal Edition, 96*, 450 - 452.

Brett, J., Staniszewska, S., Newburn, M., Jones, N., & Taylor, L. (2011). A systematic mapping review of effective interventions for communicating with, supporting and providing information to parents of preterm infants. *British Medical Journal, 1*(1).

Briefel, R., Reidy, K., Karwe, V., & Devaney, B. (2004). Feeding infants and toddlers study: Improvements needed in meeting infant feeding recommendations. *Journal of the American Dietetic Association, 104, Supplement 1*(0), 31-37.

British Dietetics Association. (2013). *Complementary feeding: Introduction of solid foods to an infants diet*. Birmingham: British Dietetics Association.

Callen, J., & Pinelli, J. (2004). Incidence and duration of breastfeeding for term infants in Canada, United States, Europe, and Australia: a literature review. *Birth, 31*(4), 285-292.

Cameron, N., & Bogin, B. (2012). *Human Growth and Development*. London: Elsevier Science.

Canadian Academy of Paediatrics. (1995). Nutrient needs and feeding of premature infants. Nutrition Committee, Canadian Paediatric Society. *Canadian Medical Association Journal, 152*(11), 1765-1785.

Centres for Disease Control and Prevention. (2009). Infant Feeding Practices Survey ll. Retrieved 25/05/2014, from http://www.cdc.gov/breastfeeding/data/infant_feeding.htm

Chow, S. (2013). *2011 Report of the Australian and New Zealand Neonatal Network*. Sydney: Australian and New Zealand Neonatal Network. Retrieved from http://www.npesu.unsw.edu.au/sites/default/files/npesu/surveillances/Report%20of%20the%20Australian%20and%20New%20Zealand%20Neonatal%20Network%202011.pdf

Clark, R., Thomas, P., & Peabody, J. (2003). Extrauterine growth restriction remains a serious problem in prematurely born neonates. *Pediatrics, 111*(5), 986-990.

Colaizy, T., & Morriss, F. (2008). Positive effect of NICU admission on breastfeeding of preterm US infants in 2000 to 2003. *Journal of Perinatology, 28*(7), 505-510.

Conrad, A. (2013). Post-discharge nutrition for the preterm infant. *Journal of Neonatal Nursing, 19*(4), 217.

Cooke, R. (2011). Nutrition of preterm infants after discharge. *Annals of Nutrition and Metabolism, 58*(1), 32-36.

Cooke, R., Ainsworth, S., & Fenton, A. (2004). Postnatal growth retardation: a universal problem in preterm infants. *Archives of Disease in Childhood - Fetal and Neonatal Edition, 89*(5), F428-F430.

Cooke, R., McCrann, Ú., & Higgins, C. (2013). Managing weaning problems and complementary feeding. *Paediatrics and Child Health, 23*(8), 346-350.

Cormack, B. (2011). First foods for preterm babies. from http://www.adhb.govt.nz/newborn/Guidelines/Nutrition/First%20Foods%20for%20Premature%20Babies%20July%202011.pdf

Cormack, B. (2012). Newborn services - Neonatal nutrition guidelines. Retrieved 01/12/2014, from http://www.adhb.govt.nz/newborn/guidelines/Nutrition/NWH%20Nutrition%20and%20Feeding%20guidelines%20for%20the%20Preterm%20infant%202012.pdf

Cormack, B. (2013). Section 2: Preterm baby feeding. In B. Cormack (Ed.), *Neonatal and Infant Clinical Handbook* (4th ed.). Auckland: Auckland District Health Board.

Cormack, B., & Bloomfield, F. (2006). Audit of feeding practices in babies <1200 g or 30 weeks gestation during the first month of life. *Journal of Paediatrics and Child Health, 42*(7-8), 458- 463.

Craig, E., Thompson, J., & Mitchell, E. (2002). Socioeconomic status and preterm birth: New Zealand trends, 1980 to 1999. *Achives of Disease in Childhood Fetal and Neonatal Edition, 86*, 142-146.

Crapnell, T., Rogers, C., Neil, J., Inder, T., Woodward, L., & Pineda, R. (2013). Factors associated with feeding difficulties in the very preterm infant. *Acta Paediatrica, 102*(12), e539-e545.

D'Agostino, J. (2010). An evidentiary review regarding the use of chronological and adjusted age in the assessment of preterm infants. *Journal for Specialists in Pediatric Nursing, 15*(1), 26-32.

Dall'Agnola, A., & Beghini, L. (2009). Post-discharge supplementation of vitamins and minerals for preterm neonates. *Early Human Development, 85*, 27-29.

Davanzo, R., Nasta, L., Ronfani, L., Brovedani, P., & Demarini, S. (2013). Breastfeeding at NICU discharge: A multicenter italian study. *Journal of Human Lactation, 29*(3), 374-380.

Daymont, C., Hwang, W., Feudtner, C., & Rubin, D. (2010). Head-circumference distribution in a large primary care network differs from CDC and WHO curves. *Pediatrics, 126*(4), e836-e842.

de Oliveira, M., Thomson, Z., Vannuchi, M., & Matsuo, T. (2007). Feeding patterns of Brazilian preterm infants during the first 6 months of life, Londrina, Paraná, Brazil. *Journal of Human Lactation, 23*(3), 269-274.

Dee, D., Sharma, A., Cogswell, M., Grummer-Strawn, L., Fein, S., & Scanlon, K. (2008). Sources of supplemental iron among breastfed infants during the first year of life. *Pediatrics, 122*(2), S98-S104.

Delaney, A., & Arvedson, J. (2008). Development of swallowing and feeding: Prenatal through first year of life. *Developmental Disabilities Research Reviews, 14*(2), 105-117.

DeMauro, S., Patel, P., Medoff-Cooper, B., Posencheg, M., & Abbasi, S. (2011). Postdischarge feeding patterns in early and late preterm infants. *Clinical Pediatrics, 50*(10), 957-962.

Dodrill, P., Cleghorn, G., Donovan, T., & Davies, P. (2008). Growth patterns in preterm infants born appropriate for gestational age. *Journal of Paediatrics and Child Health, 44*(6), 332-337.

Donath, S., & Amir, L. (2008). Effect of gestation on initiation and duration of breastfeeding. *Archives of Disease in Childhood - Fetal and Neonatal Edition, 93*(6), F448-F450.

Dube, K., Schwartz, J., Mueller, M., Kalhoff, H., & Kersting, M. (2010). Iron intake and iron status in breastfed infants during the first year of life. *Clinical Nutrition, 29*(6), 773-778.

Dusick, A., Poindexter, B., Ehrenkranz, R., & Lemons, J. (2003). Growth failure in the preterm infant: can we catch up? *Seminars in Perinatology, 27*(4), 302-310.

Ehrenkranz, R., Dusick, A., Vohr, B., Wright, L., Wrage, L., Poole, W.*, et al.* (2006). Growth in the neonatal intensive care unit influences neurodevelopmental and growth outcomes of extremely low birth weight infants. *Pediatrics, 117*(4), 1253-1261.

Ehrenkranz, R., Younes, N., Lemons, J., Fanaroff, A., Donovan, E., Wright, L.*, et al.* (1999). Longitudinal growth of hospitalized very low birth weight infants. *Pediatrics, 104*(2), 280-289.

Embleton, N., Pang, N., & Cooke, R. (2001). Postnatal malnutrition and growth retardation: An inevitable consequence of current recommendations in preterm infants? *Pediatrics, 107*(2), 270-273.

Emmett, B. (2013). *Vitamin D status of pretetm infants at four months post discharge.* (Master of Science, Nutrition and Dietetics), Massey University, Albany.

Emmett, P., North, K., & Noble, S. (2000). Types of drinks consumed by infants at 4 and 8 months of age: a descriptive study. *Public Health Nutrition, 3*(2), 211-217.

Ericson, J., Eriksson, M., Hellstrom-W, Hagberg, L., Hoddinott, P., & Flacking, R. (2013). The effectiveness of proactive telephone support provided to breastfeeding mothers of preterm infants: study protocol for a randomized controlled trial. *BioMed Central Pediatrics, 13*(1), 73.

Espy, K., & Senn, T. (2003). Incidence and correlates of breast milk feeding in hospitalized preterm infants. *Social Science & Medicine, 57*(8), 1421-1428.

Fanaro, S., Borsari, G., & Vigi, V. (2007). Complementary feeding practices in preterm infants: An observational study in a cohort of italian infants. *Journal of Pediatric Gastroenterology and Nutrition, 45*(3), S210-S214

Fanaro, S., & Vigi, V. (2007). Weaning preterm infants: An open issue. *Journal of pediatric gastroenterology and nutrition, 45*(3), 204-209.

Fein, S., Labiner-W, Shealy, K., Li, R., Chen, R., & Grummer-S. (2008). Infant feeding practices study II: Study methods. *Pediatrics, 122*(2), S28-S35.

Fewtrell, M. (2003). Growth and nutrition after discharge. *Seminars in Neonatology, 8* (2), 169-170.

Fewtrell, M., Lucas, A., & Morgan, J. (2003). Factors associated with weaning in full term and preterm infants. *Archives of Disease in Childhood - Fetal and Neonatal Edition, 88*(4), F296-F301.

Flacking, R., Ewald, U., & Wallin, L. (2011). Positive effect of kangaroo mother care on long-term breastfeeding in very preterm infants. *Journal of Obstetric, Gynecologic, & Neonatal Nursing, 40*(2), 190-197.

Flacking, R., Nyqvist, K., & Ewald, U. (2007). Effects of socioeconomic status on breastfeeding duration in mothers of preterm and term infants. *The European Journal of Public Health, 17*(6), 579-584.

Flacking, R., Wallin, L., & Ewald, U. (2007). Perinatal and socioeconomic determinants of breastfeeding duration in very preterm infants. *Acta Pædiatrica, 96*(8), 1126-1130.

Flood, K., & Malone, F. (2012). Prevention of preterm birth. *Seminars in Fetal and Neonatal Medicine, 17*(1), 58-63.

Foote, K., & Marriott, L. (2003). Weaning of infants. *Archives of Disease in Childhood, 88*(6), 488-492.

Fransson, G., & Lönnerdal, B. (1982). Zinc, copper, calcium, and magnesium in human milk. *The Journal of Pediatrics, 101*(4), 504-508.

Franz, A., Pohlandt, F., Bode, H., Mihatsch, W., Sander, S., Kron, M.*, et al.* (2009). Intrauterine, early neonatal, and postdischarge growth and neurodevelopmental outcome at 5.4 years in extremely preterm infants after intensive neonatal nutritional support. *Pediatrics, 123*(1), e101-e109.

Funkquist, E., Tuvemo, T., Jonsson, B., Serenius, F., & Nyqvist, K. (2010). Preterm appropriate for gestational age infants: size at birth explains subsequent growth. *Acta Pædiatrica, 99*(12), 1828-1833.

Giugliani, E., & Victoria, C. (2000). Complementary Feeding. *Jornal De Pediatria, 76*(3), 253-262.

Goldenberg, R., Culhane, J., Iams, J., & Romero, R. (2008). Epidemiology and causes of preterm birth. *The Lancet, 371*(9606), 75-84.

Golding, J. (1991). Children of the nineties: My daughter/son questionnaire. Retrieved 18/06/2014, from http://www.bristol.ac.uk/alspac/researchers/resources-available/data-details/questionnaires/documents/ques-cb02-my-daughter.pdf

Greer, F. (2007). Post-discharge nutrition: What does the evidence support? *Seminars in Perinatology, 31*(2), 89-95.

Growing up in New Zealand. (2010). Questionnaires and Technical Documents. Retrieved 25/05/2014, from http://www.growingup.co.nz/antenatal.shtml

Grummer-Strawn, L., Scanlon, K., & Fein, S. (2008). Infant feeding and feeding transitions during the first year of life. *Pediatrics, 122*(2), S36-S42.

Harmon-Jones, C. (2006). Duration, intensity, and exclusivity of breastfeeding: Recent research confirms the importance of these variables. *Breastfeeding Abstracts, 25*(3), 17-20.

Hawdon, J., Beauregard, N., Slattery, J., & Kennedy, G. (2000). Identification of neonates at risk of developing feeding problems in infancy. *Developmental Medicine & Child Neurology, 42*(4), 235-239.

Hay, W. (2008). Strategies for feeding the preterm infant. *Neonatology, 94*(4), 245-254.

Health and Social Care Information Centre. (2010). *Infant feeding survey*. UK: National Health Service.

Heath, A., Tuttle, C., Simons, M., Cleghorn, C., & Parnell, W. (2002). A longitudinal study of breastfeeding and weaning practices during the first year of life in Dunedin, New Zealand. *Journal of the American Dietetic Association, 102*(7), 937-943.

Henderson, G., Fahey, T., & McGuire, W. (2005). Calorie and protein-enriched formula versus standard term formula for improving growth and development in preterm or low birth weight infants following hospital discharge. *Cochrane Neonatal Group, 18*(2).

Holdsworth, M., Madden, A., & Webster, G. (2006). *Oxford Handbook of Nutrition and Dietetics*. Oxford: Oxford University Press.

Hunter, C., Upperman, J., Ford, H., & Camerini, V. (2008). Understanding the susceptibility of the premature infant to necrotizing enterocolitis (NEC). *Pediatric Research, 63*(2), 117-123.

King, C. (2009). An evidence based guide to weaning preterm infants. *Paediatrics and Child Health, 19*(9), 405-414.

King, C., & Aloysius, A. (2011). Joint consensus statement on weaning preterm babies Retrieved 21/07/2014, from http://www.bapm.org/nutrition/documents/Joint_consensus_Statement_on_weaning_Preterm_babies2011.pdf

Krebs, N., & Hambidge, K. (2007). Complementary feeding: clinically relevant factors affecting timing and composition. *The American Journal of Clinical Nutrition, 85*(2), 639S-645S.

Kurl, S., Heinonen, K., & Länsimies, E. (2003). Pre- and post-discharge feeding of very preterm infants: impact on growth and bone mineralization. *Clinical Physiology & Functional Imaging, 23*(4), 182-189.

Kuschel, C., & Harding, J. (2004). Multicomponent fortified human milk for promoting growth in preterm infants. *Cochrane Database of Systematic Reviews, 1*.

Lanigan, J., Bishop, J., Kimber, A., & Morgan, J. (2001). Systematic review concerning the age of introduction of complementary foods to the healthy full-term infant. *European Journal of Clinical Nutrition, 55*(5), 309-320.

Lapillonne, A., & Griffin, I. (2013). Feeding preterm infants today for later metabolic and cardiovascular outcomes. *The Journal of Pediatrics, 162*(3), S7-S16.

Lapillonne, A., O'Connor, D., Wang, D., & Rigo, J. (2013). Nutritional recommendations for the late-preterm infant and the preterm infant after hospital discharge. *The Journal of Pediatrics, 162*(3), S90-S100.

Latal-H, S, v., H, K., Bucher, H., & Largo, R. (2003). Postnatal growth in VLBW infants: significant association with neurodevelopmental outcome. *The Journal of Pediatrics, 143*(2), 163-170.

Lee, H., & Gould, J. (2009). Factors influencing breast milk versus formula feeding at discharge for very low birth weight infants in California. *The Journal of pediatrics, 155*(5), 657-662.

Levene, M., Tudehope, D., & Thearle, J. (2000). *Essentials of Neonatal Medicine*. London: Blackwell Science.

Lombard, M., & Labuschagne, I. (2012). Introducing solid foods. *Professional Nursing Today, 16*(5), 29-31.

Maastrup, R. (2014). *Breastfeeding of preterm infants: Associated factors in infants, mothers and clinical practice* Sweden: Lund University. Retrieved from http://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=4431661&fileOId=4431668

Maastrup, R., Hansen, B., Kronborg, H., Bojesen, S., Hallum, K., Frandsen, A.*, et al.* (2014). Factors associated with exclusive breastfeeding of preterm infants. Results from a prospective national cohort study. *Plos One, 9*(2), e89077.

Mamemoto, K., Kubota, M., Nagai, A., Takahashi, Y., Kamamoto, T., Minowa, H.*, et al.* (2013). Factors associated with exclusive breastfeeding in low birth weight infants at NICU discharge and the start of complementary feeding. *Asia Pacific Journal of Clinical Nutrition, 22*(2), 270-275.

Marriott, L., & Foote, K. (2003). Advances in the nutrition of preterm infants. *The Journal of the Royal Society for the Promotion of Health, 123*(3), 159-164.

Marriott, L., Foote, K., Bishop, J., Kimber, A., & Morgan, J. (2003). Weaning preterm infants: a randomised controlled trial. *Archives of Disease in Childhood - Fetal and Neonatal Edition, 88*(4), F302-F307.

Marriott, L. D., Foote, K. D., Bishop, J. A., Kimber, A. C., & Morgan, J. B. (2003). Weaning preterm infants: a randomised controlled trial. *Archives of Disease in Childhood, 88*(4), 302-307.

Martis, R., & Stufkens, J. (2013). The New Zealand/Aotearoa Baby-Friendly Hospital Initiative Implementation Journey: Piki Ake Te Tihi—"Strive for Excellence". *Journal of Human Lactation, 29*(2), 140-146.

Mason, S., Harris, G., & Blissett, J. (2005). Tube feeding in infancy: Implications for the developmentof normal eating and drinking skills. *Dysphagia, 20*(1), 46-61.

McGuire, W., Henderson, G., & Fowlie, P. (2004). Feeding the preterm infant. *British Medical Journal, 329*(7476), 1227-1230.

McLeod, G., Sherriff, J., & Patole, S. (2013). Post-Discharge nutrition for high-risk preterm neonates. In S. Patole (Ed.), *Nutrition for the Preterm Neonate* (pp. 173-190). Perth: Springer Netherlands.

McLeod, G., Simmer, K., Benninger, H., Mitoulas, L., Doherty, D., & Sherriff, J. (2011). Preterm infants with chronic lung disease: Are protein and energy intakes after discharge sufficient for optimal growth? *Journal of Paediatrics & Child Health, 47*(3), 127-133.

Mehta, N., Corkins, M., Lyman, B., Malone, A., Goday, P., Carney, L.*, et al.* (2013). Defining pediatric malnutrition: a paradigm shift toward etiology-related definitions. *Journal of Parenteral & Enteral Nutrition, 37*(4), 460-481.

Menon, G., & Williams, T. (2013). Human milk for preterm infants: why, what, when and how? *Archives of Disease in Childhood - Fetal and Neonatal Edition, 98*(6), F559-F562.

Merhav, H., Amitai, Y., Palti, H., & Godfrey, S. (1985). Tea drinking and microcytic anemia in infants. *The American Journal of Clinical Nutrition, 41*(6), 1210-1213.

Michaelsen, K., Hoppe, C., Lauritzen, L., & Mølgaard, C. (2007). Whole cow's milk: Why, what and when? *Karger, 60*, 201-219.

Milton, J., & King, C. (2012). Cup introduction, drink type and vitamin supplementation in preterm babies at 11-25 months. *Journal of Human Nutrition and Dietetics, 25*(2), 148-154.

Ministry of Health. (2003). *NZ Food NZ Children: Key results of the 2002 National Childrens Nutrition survey*. Wellington: Ministry of Health. Retrieved from http://www.moh.govt.nz/notebook/nbbooks.nsf/0/658d849a2bac7421cc256dd9006cc7ec/$FILE/nzfoodnzchildren.pdf

Ministry of Health. (2008). *Food and nutrition guidelines for healthy infants and toddlers (Aged 0–2): A background paper*. Wellington: Ministry of Health.

Ministry of Health. (2010). Fact Sheet 5: Plotting preterm infants. Retrieved 28/08/2014, from https://www.health.govt.nz/system/files/documents/pages/factsheet-5-growth-charts-well-child.pdf

Ministry of Health. (2012). *Report on maternity, 2010*. Wellington: Ministry of Health. Retrieved from http://www.health.govt.nz/publication/report-maternity-2010

Ministry of Health. (2013). *New Zealand maternity clinical indicators 2011*. Wellington: Ministry of Health.

Moor, C. (2013). *Iron status of preterm infants after discharge.* (Masters of Science, Nutrition and Dietetics), Massey University, Albany.

More, J., Jenkins, C., King, C., & Shaw, V. (2010). British Dietetics Association paediatric group position statement: Weaning infants onto solid foods. Retrieved 21/07/2014, from http://www.hipp4hcps.co.uk/dynamic-content/media/documents/PositionStatementWeaning~%20April%202010.pdf

Morgan, J., Lucas, A., & Fewtrell, M. (2004). Does weaning influence growth and health up to 18 months? *Archives of Disease in Childhood, 89*(8), 728-733.

Morgan, J., Williams, P., Norris, F., Williams, C., Larkin, M., & Hampton, S. (2004). Eczema and early solid feeding in preterm infants. *Archives of Disease in Childhood, 89*(4), 309-314.

Morgan, J., Young, L., McCormick, F., & McGuire, W. (2012). Promoting growth for preterm infants following hospital discharge. *Archives of Disease in Childhood - Fetal and Neonatal Edition, 97*(4), F295-F298.

Morley, R., & Lucas, A. (2000). Randomized diet in the neonatal period and growth performance until 7.5–8 y of age in preterm children. *The American Journal of Clinical Nutrition, 71*(3), 822-828.

Morton, S., Atatoa Carr, P., Grant, C., Lee, A., Bandara, D., Mohal, J.*, et al.* (2012). *Growing up in New Zealand: A longitudinal study of New Zealand children and their families. Report 2: Now we are born*. Auckland: Growing Up in New Zealand.

Moyer-Mileur, L. (2007). Anthropometric and laboratory assessment of very low birth weight infants: The most helpful measurements and why. *Seminars in Perinatology, 31*(2), 96-103.

National Maternity Monitoring Group. (2013). *National Maternity Monitoring Group: Annual Report 2013*.

Noel-Weiss, J., Boersma, S., & Kujawa-Myles, S. (2012). Questioning current definitions for breastfeeding research. *International Breastfeeding Journal, 7*(1), 9.

Norris, F., Larkin, M., Williams, C., Hampton, S., & Morgan, J. (2002). Factors affecting the introduction of complementary foods in the preterm infant.*European Journal of Clinical Nutrition, 56*(5), 448-454.

Northstone, K., Emmett, P., & Nethersole, F. (2001). The effect of age of introduction to lumpy solids on foods eaten and reported feeding difficulties at 6 and 15 months. *Journal of Human Nutrition & Dietetics, 14*(1), 43-54.

O'Connor, D., Jacobs, J., Hall, R., Adamkin, D., Auestad, N., Castillo, M.*, et al.* (2003). Growth and development of premature infants fed predominantly human milk, predominantly premature infant

formula, or a combination of human milk and premature formula. *Journal of Pediatric Gastroenterology and Nutrition, 37*(4), 437-446.

O'Connor, D., & Unger, S. (2013). Post-discharge nutrition of the breastfed preterm infant. *Seminars in Fetal and Neonatal Medicine, 18*(3), 124-128.

Ostlund, A., Nordström, M., Dykes, F., & Flacking, R. (2010). Breastfeeding in preterm and term twins - maternal factors associated with early cessation: a population-based study. *Journal Of Human Lactation: Official Journal Of International Lactation Consultant Association, 26*(3), 235-241.

Palmer, D., & Makrides, M. (2012). Introducing solid foods to preterm infants in developed countries. *Annals of Nutrition and Metabolism, 60*(2), 31-38.

Parsons, H., George, M., & Innis, S. (2011). Growth assessment in clinical practice: Whose growth curve? *Current Gastroenterology Reports, 13*(3), 286-292.

PHARMAC; Pharmaceutical Management Agency New Zealand. (2013). PTAC meeting held on 1 &2 August 2013. Retrieved from https://www.pharmac.health.nz/assets/ptac-minutes-2013-08.pdf

Pineda, R. (2011). Predictors of breastfeeding and breastmilk feeding among very low birth weight infants. *Breastfeeding Medicine, 6*(1), 15-19.

Pot, S., & Sadler, L. (2013). *National womens annual clinical report 2013*. Auckland: Auckland District Health Board.

Pot, S., Sadler, L., McDougall, J., Harillal, M., & Battin, M. (2012). *National Women's Annual Clinical Report 2012*. Auckland, New Zealand: Auckland District Health Board.

Raymond, G., & Holmes, L. (1994). Head circumference standards in neonates. *Journal of Child Neurology, 9*(1), 63.

Renfrew, M., Craig, D., Dyson, L., McCormick, F., Rice, S., King, S.*, et al.* (2009). Breastfeeding promotion for infants in neonatal units: a systematic review and economic analysis. *Health Technology Assessment, 13*(40), 1-146.

Ross, E., & Browne, J. (2013). Feeding outcomes in preterm infants after discharge from the neonatal intensive care unit (NICU): A Systematic Review. *Newborn and Infant Nursing Reviews, 13*(2), 87-93.

Royal New Zealand Plunket Society. (2010). *Breastfeeding data: Analysis of 2004-2009 data*. New Zealand: Royal New Zealand Plunket Society.

Royal New Zealand Plunket Society. (2014). Annual breastfeeding statistics. Retrieved 21/09/2014, 2014, from http://www.plunket.org.nz/news-and-research/research-from-plunket/plunket-breastfeeding-data-analysis/annual-breastfeeding-statistics/

Sassá, A., Lopes, C., Bengozi, T., Rossetto, E., Hegeto de Souza, S., & Dalmas, J. (2013). Prevalence of breastfeeding in premature infants with very low birth weight in the first six months of life *Acta Scientiarum, 35*(2), 151-159.

Schanler, R. (2005). Post-discharge nutrition for the preterm infant. *Acta Pædiatrica, 94*, 68-73.

Schanler, R., Shulman, R., & Lau, C. (1999). Feeding strategies for premature infants: Beneficial outcomes of feeding fortified human milk versus preterm formula. *Pediatrics, 103*(6), 1150-1157.

Schwartz, C., Scholtens, P., Lalanne, A., Weenen, H., & Nicklaus, S. (2011). Development of healthy eating habits early in life. Review of recent evidence and selected guidelines. *Appetite, 57*(3), 796.

Shah, M., & Shah, S. (2009). Nutrient Deficiencies in the Premature Infant. *Paediatric Clinics of North America, 56*(5), 1069-1083.

Shields, B., Wacogne, I., & Wright, C. M. (2012). Weight faltering and failure to thrive in infancy and early childhood. *345*, e5931.

Siltanen, M., Wehkalampi, K., Hovi, P., Eriksson, J., Strang-Karlsson, S., Järvenpää, A.*, et al.* (2011). Preterm birth reduces the incidence of atopy in adulthood. *Journal of Allergy and Clinical Immunology, 127*(4), 935-942.

Skinner, J., Ziegler, P., & Ponza, M. (2004). Transitions in infants' and toddlers' beverage patterns. *Journal of the American Dietetic Association, 104*(1), 45-50.

South Island Alliance. (n.d). *Preterm birth*. South Island Alliance. Retrieved from http://www.sialliance.health.nz/UserFiles/SouthIslandAlliance/File/PDFs/Child%20Health%20Status/South%20Island%20Preterm%20Births.pdf

Statistics New Zealand. (2002). Birth and deaths. from http://www2.stats.govt.nz/domino/external/pasfull/pasfull.nsf/84bf91b1a7b5d7204c256809000460a4/4c2567ef00247c6acc256c0f000101dd?OpenDocument

Statistics New Zealand. (2011). Births and deaths: Year ended December 2010. Retrieved 06/12/2014, from http://www.stats.govt.nz/browse_for_stats/population/births/BirthsAndDeaths_HOTPYeDec10/Commentary.aspx

Steer, P. (2005). The epidemiology of preterm labour. *International Journal of Obstetrics & Gynaecology, 112*(1), 1-3.

Su, B.-H. (2014). Optimizing Nutrition in Preterm Infants. *Pediatrics and neonatology, 55*(1), 5-13.

Taylor, L., Lim, K., & Neville, S. (2010). Newborn feeding practices at the time of discharge from hospital in NSW in 2007: a descriptive study. *New South Wales Public Health Bulletin, 20*(12), 177-181.

Thulier, D. (2010). A call for clarity in infant breast and bottle-feeding definitions for research. *JOGNN: Journal of Obstetric, Gynecologic & Neonatal Nursing, 39*(6), 627-634.

Trachtenbarg, D., & Golemon, T. (1998). Care of the preterm infant: Part I. Monitoring Growth and Development. *American Family Physician 57*(9), 2123-2130.

Tucker, J., & McGuire, W. (2004). Abc Of Preterm Birth: Epidemiology Of Preterm Birth. *BMJ: British Medical Journal*(7467), 675.

Tudehope, D. (2013). Human milk and the nutritional needs of preterm infants. *The Journal of Pediatrics, 162*(3), S17-S25.

Tudehope, D., Page, D., & Gilroy, M. (2012). Infant formulas for preterm infants: In-hospital and post-discharge. *Journal of Paediatrics and Child Health, 48*(9), 768-776.

van Dijk, M., Hunnius, S., & van Geert, P. (2012). The dynamics of feeding during the introduction to solid food. *Infant Behavior and Development, 35*(2), 226-239.

Watson, R., Grimble, G., Preedy, V., & Zibadi, S. (2013). *Nutrition in Infancy* (Vol. 1). London: Humana Press.

Wauben, I., Atkinson, S., Shah, J., & Paes, B. (1998). Growth and body composition of preterm infants: influence of nutrient fortification of mother's milk in hospital and breastfeeding post-hospital discharge. *Acta Pædiatrica, 87*(7), 780-785.

WHO Multicentre Growth Reference Study Group. (2009). *WHO child growth standards: Growth velocity based on weight, length and head circumference: Methods and development.* . Geneva: WHO.

Wijndaele, K., Lakshman, R., Landsbaugh, J., Ong, K., & Ogilvie, D. (2009). Determinants of early weaning and use of unmodified cow's milk in infants: A Systematic Review. *Journal of the American Dietetic Association, 109*(12), 2017-2028.

Woldu, M., Mezgebe, H., & Lekisa, J. (2014). Consumption of unmodified cow's milk and the risk of iron deficiency anaemia in infants and toddlers and its management. *International Journal of Pharmaceutical Science and Research, 5*(1), 51-59.

World Health Organisation. (2007). *Safe preparation, storage and handling of powdered infant formula: Guidelines*. Geneva: WHO. Retrieved from http://www.who.int/foodsafety/publications/micro/pif_guidelines.pdf?ua=1

World Health Organisation. (2009a). *Infant and Young Child Feeding: Model Chapters for Textbooks for Medical Students and Allied Health Professionals*. Geneva: WHO.

World Health Organisation. (2009b). The worldwide incidence of preterm birth: a systematic review of maternal mortality and morbidity. Retrieved 09/06/2014, from http://www.who.int/bulletin/volumes/88/1/08-062554/en/

World Health Organisation. (2011). *Guidelines on optimal feeding of low-birth-weight infants in low and middle-income countries*. Geneva: WHO.

World Health Organisation. (2012). *Born too soon: The global action report on preterm birth*. Geneva: WHO.

World Health Organisation. (2014). Maternal, newborn, child and adolescent health: Abbreviations and explanation of terms. Retrieved 06/07/2014, from http://www.who.int/maternal_child_adolescent/topics/child/nutrition/hivif_qa/abbrev/en/

Yee, J., Smith, A., O'Connor, D., Auestad, N., Adamkin, D., Connor, W.*, et al.* (2001). Introduction of complementary foods in preterm infants varies amongcountries. *Journal of the American Dietetic Association, 101*(9), A-76.

Young, B., & Krebs, N. (2013). Complementary feeding: critical considerations to optimize growth, nutrition and feeding behaviour. *Current Pediatric Reports, 1*(4), 247-256.

Zachariassen, G., Faerk, J., Esberg, B., Fenger-Gron, J., Mortensen, S., Christesen, H.*, et al.* (2011). Allergic diseases among very preterm infants according to nutrition after hospital discharge. *Pediatric Allergy and Immunology, 22*(5), 515-520.

Zachariassen, G., Faerk, J., Grytter, C., Esberg, B., Juvonen, P., & Halken, S. (2010). Factors associated with successful establishment of breastfeeding in very preterm infants. *Acta Pædiatrica, 99*(7), 1000-1004.

Appendices

Appendix A: Post Discharge Nutrition of Preterm Infants: Study Information Sheet

Post discharge nutrition of preterm babies: micronutrient status and feeding practices of preterm babies after hospital discharge

INFORMATION SHEET

You have been sent or given the information sheet about this research study because your baby was born preterm (before 37 weeks' gestation) and we would like to invite you to take part in a study looking at the nutrition of preterm babies after hospital discharge. Thank you for taking the time to think about enrolling your baby in this study.

About the researchers

We are a group of researchers from Massey University in Albany and the Neonatal Intensive Care Unit (NICU) at Auckland Hospital. Our research team includes Cath Conlon (PhD), Pamela von Hurst (PhD) and Owen Mugridge (Research Trials Manager) (Massey University), Professor Frank Bloomfield (Professor of Neonatology and Specialist neonatologist, National Women's Health, Auckland City Hospital), Barbara Cormack (Neonatal Dietitian, Auckland City Hospital), Briar Emmett and Charlotte Moor who are both doing their MSc in Nutrition and Dietetics at Massey University.

Project Description and Invitation

Feeding preterm babies is often hard. We are recruiting **all** babies born before 37 weeks' gestation in the Auckland area, including extremely preterm babies, moderately preterm babies and late preterm babies (who may not have experienced any problems due to being born preterm) in order to look at their nutrition after they have been discharged from hospital. Because preterm babies are born too soon, they often have not had enough time to develop sufficient nutrient stores. Iron and vitamins D, A and E are some of these nutrients which are often low in preterm babies. These nutrients all have important roles within in the body. They are needed for the normal growth, brain development and the health and well-being of your baby. Therefore, we would like to find out whether the current feeding and supplementation practices are enough to prevent deficiencies in these babies. Results of this study will hopefully guide future feeding and supplementation practices of preterm babies.

We are asking you to consider including your baby in this study as she/he was born preterm (before 37 weeks' gestation). Preterm babies are unlike any other babies and it is therefore not possible to conduct this research in any other group.

Project Procedures

This study will involve 2 home visits over your baby's first year of life to find out about feeding, nutrition and how she/he has grown. We would like to visit you in your home or you can attend our research facilities at Massey University in Albany, Auckland at a time which is convenient to you. Our first visit would be 4 months after your baby was discharged home from hospital and our second visit would be when your baby is 1 year old (corrected age).

At each visit we would like to take a small blood sample from your baby so that we can look at his/her iron and vitamin status. This may cause your baby some discomfort. If you are breastfeeding, we would also like to take a blood sample from you. This will be to determine whether you are deficient in iron or vitamin D which could affect your baby's nutritional status.

If you or your baby are found to be deficient in iron or vitamin D we will send your results directly to you GP so that they can advise you.

Obtaining information on how preterm babies grow after they have been discharged is one of the key outcomes of the research, so we will measure your baby's weight, length and head circumference at each visit.

We would also like to collect some additional information using 4 simple questionnaires. These questionnaires will be used to collect information about you and your baby, on feeding practices, nutritional supplementation and sun exposure. At the second visit when your baby is 1 year corrected age we will also ask about starting solid foods.

Taking part in the study will take about an hour on each visit. The questionnaires will take between 20 to 30 minutes. Other measures which include weight, length and head circumference and a blood test will take between 10 to 15 minutes. We also allow time for you to ask questions. All blood samples will be taken by a trained phlebotomist or neonatal research nurse who has experience with taking bloods from babies.

We will also collect some health information about your baby from baby's medical notes. This is to record how your baby was fed after birth, his/her birth weight, head circumference and length, and whether any assessment of nutritional status was made during the hospital admission or after birth.

Benefits

By taking part in this study you will receive your baby's individual blood results on their iron and vitamin D status. Both of these nutrients are essential for optimal development and growth of your baby. If we find that your baby is low in these nutrients then we will refer you to your GP, often the solution is as easy as providing a supplement but it's important that this is decided by your medical practitioner. You will also find out your baby's length, weight and head circumference, these will be taken by trained researchers. If you are breastfeeding and consent to giving a blood sample, you will also find out whether you are sufficient in iron and vitamin D. If these values are outside of the normal ranges you will be notified and these will be forwarded on to your GP. Your GP will be able to provide you with best advice and if any treatment is needed.

By taking part in this study you and your baby are helping us find out whether feeding and supplementation practices currently followed are appropriate to prevent iron and vitamin D deficiencies in babies born preterm. With your help we can find out whether feeding and supplementation practices are currently sufficient or whether these need changing or if babies need to be routinely monitored.

Data Management

Any information collected from you and your baby will be used only for the purposes of this study. This information will be stored in a secure manner at Massey University. Once collected, data will be entered into a database and analysed in a way that does not identify you or your baby.

We will not be sharing information about you or your baby outside of the research team. The information that we collect from this research project will be kept confidential. All questionnaires with information about you and your baby will be given a number and will not display any names.

A summary of your baby's results will be given to you. In addition, the overall findings from the study will be shared with all parents; however, individual results will be kept private. We will also publish the results of this study so that we can make sure that future feeding and supplementation practices are in the best interests of preterm babies.

If we find that any of the results from the blood sampling are outside of a normal range we will, with your permission, contact your baby's General Practitioner directly and give them a copy of the results.

Participant's Rights

You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

- *decline to answer any particular question;*
- *decline to have the blood sample taken from your baby or yourself (if breast feeding)*
- *withdraw from the study within the timeframe of data collection;*
- *ask any questions about the study at any time during participation;*
- *provide information on the understanding that your name or your baby's name will not be used unless you give permission to the researcher;*
- *be given access to a summary of the project findings when it is concluded.*

Project Contacts

If you have any questions, you may ask them now or later. If you wish to ask questions later, you may contact any of the following

Researcher:

Owen Mugridge
O.Mugridge@massey.ac.nz
09 414 0800 extension 41174
TXT 021 160 5949
Massey University Oteha Rohe
Albany Highway,
Albany 0632
New Zealand

Supervisor:

Cath Conlon (PhD)

09 414 0800 extension 41206

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A, Application 13/06. If you have any concerns about the conduct of this research, please contact Dr Brian Finch, Chair, Massey University Human Ethics Committee: Southern A, telephone 06 350 5799 x 84459, email humanethicsoutha@massey.ac.nz.

Compensation for Injury

If physical injury results from your participation in this study, you should visit a treatment provider to make a claim to ACC as soon as possible. ACC cover and entitlements are not automatic and your claim will be assessed by ACC in accordance with the Accident Compensation Act 2001. If your claim is accepted, ACC must inform you of your entitlements, and must help you access those entitlements. Entitlements may include, but not be limited to, treatment costs, travel costs for rehabilitation, loss of earnings, and/or lump sum for permanent impairment. Compensation for mental trauma may also be included, but only if this is incurred as a result of physical injury.

If your ACC claim is not accepted you should immediately contact the researcher. The researcher will initiate processes to ensure you receive compensation equivalent to that to which you would have been entitled had ACC accepted your claim.

Appendix B: Contact letter for Study Participation

Post discharge nutrition of preterm babies: micronutrient status and feeding practices of preterm babies after hospital discharge

Dear Parent or Caregiver,

We are writing to you because your baby was born preterm (before 37 completed weeks of gestation).

Preterm babies are at risk of having iron and fat soluble vitamin deficiencies. Preterm babies are born too soon, which can mean they have not had enough time to develop adequate nutrient stores. These nutrients all have important roles within the body and are needed for the normal growth, health and well being of your baby. Preterm babies are particularly at risk of having iron and vitamin D deficiencies. We would therefore like to find out whether the current feeding and supplementation practices are enough to stop deficiencies developing in these babies born preterm. From this study you will find out if your baby is deficient in any of these nutrients.

We are interested in investigating nutrient stores in any baby born preterm, including those with varying degrees of immaturity (from those babies born extremely preterm to those who are only just preterm). The study is being run through Massey University in collaboration with Auckland District Health Board and specialist health professionals from the Neonatal Intensive Care Unit. If your baby was born before 37 weeks gestation and you live in the Auckland area you may qualify to take part in this study. The aim of the study is to look at the nutrient status and feeding practices of preterm babies after they have been discharged from hospital.

If you think you might be interested in this study, please complete the sheet below and leave at reception OR contact Owen Mugridge on:

O.Mugridge@massey.ac.nz
OR 09 414 0800 extension 41174
OR TXT 021 160 5949

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A, Application 13/06. If you have any concerns about

the conduct of this research, please contact Dr Brian Finch, Chair, Massey University Human Ethics Committee: Southern A, telephone 06 350 5799 x 84459, email humanethicsoutha@massey.ac.nz.

Post Discharge Nutrition of Preterm Babies: micronutrient status and feeding practices of preterm babies after hospital discharge

Contact Details

Your Name: _____

Phone Number: _____

Mobile Number: _____

Email Address: _____

Appendix C: Infant Consent Form

Post-discharge nutrition of preterm babies: micronutrient status and feeding practices of preterm babies after hospital discharge

PARTICIPANT CONSENT FORM

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

We would also like to ask your permission to have access to your babies medical records, these will only be used for the purpose of this study, and all data obtained will be kept confidential.

As the parent/legal caregiver to my baby

Baby's Name
Please print .....

I agree to have myself and my baby participate in this study under the conditions set out in the Information Sheet.

Signature: ..... **Date:** .....

Full Name of Parent/legal caregiver
Please print .....

Appendix D: Maternal Informed Consent Form

Post discharge nutrition of preterm babies: micronutrient status and feeding practices of preterm babies after hospital discharge

PARTICIPANT CONSENT FORM

Maternal blood testing

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I am currently breast feeding my baby and I agree to have a blood test taken, under the conditions set out in the Information Sheet.

Signature: ..... **Date:** .....

Full Name - printed .....

Appendix E: Data Collection from Medical Notes

Post discharge nutrition of preterm babies: micronutrient status and feeding practices of preterm babies after hospital discharge

Data Collection from Medical Notes

Date___/___/___
Participant ID:_____
Date of discharge from hospital___/___/___

About the Birth

1. **Patient's DOB: _____**

2. **Patient's Gestational Age at birth:_____**

3. **Birth weight:_____**

4. **Birth length:_____**

5. **Head circumference at birth: _____**

6. **Is the baby a** Single baby
   Twins
   Triplets
   Other (Please state)_____

7. **Time of Cord clamping: _____**

8. **Type of delivery:**
   Caesarean
   Vaginal birth

9. **What was the reason for the premature birth?**(please circle)
   Spontaneous preterm labour
   Severe infant growth restriction
   Pre-eclampsia
   Foetal distress
   Placental abruption

Gestational diabetes
Infection
Other:_____

Inpatient relevant data

1. **After the baby was born, was he or she put in an intensive care unit?** (Please circle)

Yes
No

2. **Did the baby have any medical complications after birth?** (please circle)

Respiratory distress syndrome
Pneumonia
Jaundice
Sepsis
Necrotizing enterocolitis
Anaemia
PDA
ASD
VSD
Other:_____
_____
_____
_____
_____

3. **Did the baby receive any blood/erythrocyte transfusions when they were in the NICU after birth?**

Yes
No

If yes, how many?_____

4. **How old was the baby when he/she was discharged from hospital?**

Date of discharge: _____
Corrected Age: _____
Chronological Age:_____

Feeding and Supplement History

1. **Did the baby receive parenteral nutrition?**
   Yes, how long? (Days)_____
   No

2. **Whilst in hospital did the baby receive enteral nutrition (EXPRESSED BREAST MILK and/or infant formula)?**
   Yes
   No

3. **If baby was fed formula, which formula were they fed?**

_____
_____
_____

4. **Whilst in hospital was the baby breast fed?**
   Yes
   No

5. **How was the baby fed when discharged?**
   Nasogastric or orogastric
   Breast feeding
   Bottle feeding

6. **What was the baby being fed upon discharge** (please tick all that apply)
   EN = EXPRESSED BREAST MILK without fortifier
   EN = EXPRESSED BREAST MILK + fortifier
   EN = EXPRESSED BREAST MILK + infant formula
   EN = EXPRESSED BREAST MILK + post-discharge formula
   EN = EXPRESSED BREAST MILK + fortifier + infant formula
   EN = EXPRESSED BREAST MILK + fortifier + post discharge formula
   EN = infant formula
   EN = post discharge formula
   Oral = Breast feeding and EN top up = EXPRESSED BREAST MILK
   Oral = Breast feeding and EN top up = EXPRESSED BREAST MILK + fortifier
   Oral = Breast feeding and EN top up = infant formula
   Oral = Breastfeeding and EN top up = post discharge formula
   Oral = EXPRESSED BREAST MILK and EN top up = EXPRESSED BREAST MILK
   Oral = EXPRESSED BREAST MILK and EN top up = EXPRESSED BREAST MILK + fortifier
   Oral = EXPRESSED BREAST MILK and EN top up = infant formula

Oral = EXPRESSED BREAST MILK and EN top up = post discharge formula
Oral = EXPRESSED BREAST MILK + fortifier and EN top up = EXPRESSED BREAST MILK
Oral = EXPRESSED BREAST MILK + fortifier and EN top up = EXPRESSED BREAST MILK + fortifier
Oral = EXPRESSED BREAST MILK + fortifier and EN top up = infant formula
Oral = EXPRESSED BREAST MILK + fortifier and EN top up = post discharge formula
Oral = Infant formula and EN top up = EXPRESSED BREAST MILK
Oral = Infant formula and EN top up = EXPRESSED BREAST MILK + fortifier
Oral = Infant formula and EN top up = infant formula
Oral = Infant formula and EN top up = post discharge formula
Oral = Post discharge formula and EN top up = EXPRESSED BREAST MILK
Oral = Post discharge and EN top up = EXPRESSED BREAST MILK + fortifier
Oral = Post discharge formula and EN top up = infant formula
Oral = Post discharge formula and EN top up = post discharge formula
Oral = Breast Feeding
Oral = EXPRESSED BREAST MILK
Oral = EXPRESSED BREAST MILK + fortifier
Oral = infant formula
Other=
_____
_____
_____

7. **If baby was fed formula, which formula were they fed?**

_____
_____
_____

8. **What supplements did the baby receive whilst in hospital?** (please tick all that apply)
   Vitadol C □
   Ferro-Liquid/ Ferrous Sulphate □
   Other:_____
   None: _____

9. **When were supplements started?**(*Date*)
   Vitadol C: _____
   Ferro-Liquid/ Ferrous Sulphate: _____
   Was this 4 weeks after birth Yes/No
   Other: _____

10. **What dose were supplements initially prescribed at?**
    Vitadol C: _____
    Ferro-Liquid/ Ferrous Sulphate: _____
    Other: _____

11. **What supplements were the baby discharged on?** (please tick all that apply)
    Vitadol C ☐
    Ferro-Liquid/ Ferrous Sulphate ☐
    Other:_____
    None: _____

12. **What dose of supplements was the baby discharged on?**
    Vitadol C: _____
    Ferro-Liquid/ Ferrous Sulphate: _____
    Other: _____

Infant Biochemistry (**please note that many of these parameters are not routinely measured at birth or prior to discharge however the researchers should check the medical notes and record if measured, please also record date of measurement)*

Blood Sample Analysis of Preterm Infants at birth*		**Cut off Values**	**Date**
Serum Ferritin (ìg/L)		<10 μg/L>400 μg/L	
Haemoglobin (g/L)		<105g/L	
RBC		2.7-5.3 x 10E12/L	
Haematocrit		0.29 -0.43	
MCV		68fL	
Mean Cell Hb		23-31 pg	
Iron		4-27μmol/L	
Iron binding capacity		36-75 μmol/L	
Iron saturation		0.10-0.46	
C-Reactive Protein (mg/L)		<5mg/L	
25 hydroxyvitamin D (25(OH)D) (nmol/L)		<27.5nmol/L	
Vitamin A			
Vitamin E			
Beta carotene			

Blood Sample Analysis of Preterm Infants at discharge or prior to discharge*		**Cut off Values**	**Date**
Serum Ferritin (ìg/L)		<10 μg/L >400 μg/L	
Haemoglobin (g/L)		<105g/L	
RBC		2.7-5.3 x 10E12/L	
Haematocrit		0.29 -0.43	
MCV		68fL	
Mean Cell Hb		23-31 pg	
Iron		4-27μmol/L	
Iron binding capacity		36-75 μmol/L	
Iron saturation		0.10-0.46	
C-Reactive Protein (mg/L)		<5mg/L	
25 hydroxyvitamin D (25(OH)D) (nmol/L)		<27.5nmol/L	
Vitamin A			
Vitamin E			
Beta carotene			

Hospital Admissions after Birth

1. **Since their discharge, has baby had any hospital admissions?**
   Yes (if yes answer the following questions)
   No (if no questionnaire is complete)

2. **What was the reason for their visit**?
   _____
   _____
   _____

3. **How long was their stay? _____**

4. **During their hospital stay, did baby receive any blood/erythrocyte transfusions?**
   Yes
   No

If yes, how many?_____

5. **During their hospital stay, how were they fed?** (Please circle)
   Oral
   Nasogastric/ orogastric
   Parenteral
   Combination:

_____

6. **What was baby fed during this hospital stay? (Please circle)**
   Direct breastfeeding
   Expressed breast milk
   Expressed breast milk + fortifier
   Infant Formula
   Post discharge formula
   Other (please state)_____

7. **If they were fed formula, please state which one:**
   _____

8. **Did they receive any supplements during their hospital stay?** (Please circle)
   Yes
   No

If so, what ones? (Please circle)

Vitadol C
Ferro-Liquid/ Ferrous Sulphate
Cholecalciferol Strong
Other: _____

9. **What was the dose of the supplements?**
   Vitadol C: _____
   Ferro-Liquid/ Ferrous Sulphate: _____
   Other: _____

Appendix F: Demographic Questionnaire

Post discharge nutrition of preterm babies: micronutrient status and feeding practices of preterm babies after hospital discharge

Mother and Baby Demographics Questionnaire

Date: _____

Participant ID: _____

Mother Name: _____

Mother age: _____

Mother DOB: _____

Address:

Tel: _____

Email: _____

Baby gender: _____

Baby name: _____

Baby DOB: _____

Discharge date: _____

Venue: _____

Appointment date/time: _____

Appointment location: _____

Section 1

What we need to know about the mother

1. Which ethnic group do you/the baby's mother belong to? (Please circle the one that most applies to you)

- New Zealand/European
- Other European
- New Zealand Maori
- Cook Island Maori
- Fijian
- Niuean
- Samoan
- Tongan
- Tokelauan
- Other Pacific Island
- Chinese
- Other Asian
- Indian
- South East Asian
- Other

3. Was this your first baby? (Please circle) Yes No

If no, how many other children do you (the mother) have and what are their ages? (Please state)

_____

_____

Section 2 - What we need to know about your baby

4. Which ethnic group does your baby belong to? (Please circle the one that most applies to your baby)

- New Zealand/European
- Other European
- New Zealand Maori
- Cook Island Maori
- Fijian
- Niuean
- Samoan
- Tongan
- Tokelauan
- Other Pacific Island
- Chinese
- Other Asian
- Indian
- South East Asian
- Other

5. What gestational age was your baby born at?

_____Weeks_____Days

Appendix G: Infant Feeding Practices Questionnaire: Four Months Post Hospital Discharge

Post discharge nutrition of preterm babies: micronutrient status and feeding practices of preterm babies after hospital discharge

Interviewer Administered Feeding Questionnaire

Date___/___/___
Participant ID:_____
Participant DOB___/___/___

Instructions that will be given to parents or prompts for interviewer are shown in italics. Substitute 'your baby' for the baby's name if the interview is taking place with the legal caregiver and not the parent

When your baby was discharged

These questions relate back to when your baby was discharged from the hospital.

1. On the day you were discharged from hospital how was your baby fed? (please circle the one which most applies)

   Breast fed
   Bottle fed
   Tube fed (*tube through their nose or mouth*)
   Combination of breast/bottle /tube
   Please specify for example breast fed and topped up with a tube feed
   _____
   _____
   _____
   _____
   _____

2. What was your baby fed when first discharged? (You can chose more than one option if relevant)
   Breast milk (Go to question 3)
   Breast milk and formula (Go to question 3)
   Formula (Go to question 4)
   Cow's milk (go to question 4)
   Other: _____

3. If you were breast feeding or giving expressed breast milk, how long did you continue this after discharge? (or document if still breast feeding/providing EBM)

(*Find out to the nearest week i.e. less than 1 week, 1 week, 2 weeks etc, if mother can't remember try to find out approximately, ask about the baby's age when breast feeding or expressing breast milk stopped* but clarify *whether this is their chronological age (age since their birth) or their corrected age).*

3b. Are you currently:

Exclusively breast feeding	☐	
Breast feeding and solids	☐	
Partially breastfeeding/ formula feeding	☐	_____
Formula feeding	☐	_____

3a. If you are currently breast feeding have you/the mother been diagnosed with iron deficiency? (*Please circle*)

Yes

No

Don't know (*any blood testing, previous anaemia, please provide details and if the mother is on any supplements/treatment*)

_____
_____
_____
_____
_____

3b. Are you currently vitamin D deficient? (*Please circle*)

Yes

No

Don't know (*any blood testing, please provide details and if the mother is on any supplements/treatment*)

_____
_____
_____
_____
_____

4. After you were discharged from hospital were you adding anything to your baby's feeds or giving any supplements after feeds?

Yes _____(specify)
No

5. If formula fed, what formula was your baby fed after discharge? (*Please circle*)
   Post discharge preterm formula (S-26 Gold Pregro)

De- Lact	Neocate LCP
Heparon Junior	Novalac AC
Karicare Gold Plus 1 from Birth	Novalac AR
Karicare Gold Plus 2 from 6 months	Novalac IT
Karicare AR All Ages	Novalac SD
Karicare Follow On 2 From 6 months	Novalac Stage 1 and 2
Karicare Goat 1 From Birth	Nurture Follow-on Formula 2
Karicare Goat 2 From 6 months	Nurture Gold Follow-on Formula 2
Karicare Gold 1 From Birth	Nurture Gold Infant Formula 1
Karicare Gold 2 From 6 months	Nurture Plus Gold Infant Formula All Ages
Karicare HA AR All ages	Nurture Infant Formula 1
Karicare HA Gold Plus All ages	Pepti-Junior Gold
Karicare Infant 1 From Birth	S-26 Gold AR
Karicare Soy All ages	S-26 Gold Lactose Free
Kindergen	S-26 Gold Newborn
Locasol	S-26 Gold Progress
MCT Peptide	S-26 Original Newborn
Monogen	S-26 Original Progress
NAN HA 3	S26 Soy
NAN HA GOLD 1	SMA
NAN HA GOLD 2	Other
Neocate Advance (unflavoured)	_____(specify)
Neocate Advance (vanilla)	Don't remember

If mother is currently breast feeding or expressing breast milk go to question 6 otherwise skip to section on starting solids

6. If you are currently breast feeding or expressing breast milk (fully or partially) are you willing to have a blood test to check your iron and vitamin D status?*(please tick)*
   Not applicable ☐ (Go to section on starting solids)
   Yes ☐ (*arrange for mother to sign consent form and have a blood sample taken*)
   No ☐

7. Are you taking any supplements during this time? If yes, which ones (*collect brand name of any supplements the mother is taking*)*(please tick)*

   Elevit ☐
   Blackmores Pregnancy and Breastfeeding Gold ☐
   Other multivitamin ☐
   *state which*_____

   Iron ☐
   Calcium ☐
   Vitamin D ☐
   Iodine ☐

   Other

8. Are you a vegetarian/vegan? *(please tick)*

   Yes ☐
   No ☐

Baby's First Foods

1. Is your baby currently eating any solids?*(please circle)*
   Yes
   No (Go to question 10)

2. Who suggested that you started solids?*(please tick)*
   Plunket nurse
   General practitioner
   Neonatologist/paediatrician
   Family member
   Myself
   Other (please state)_____

   Explore the reason for starting solids (Find out if it was due to advice or because the baby seemed hungry)

   _____
   _____
   _____

3. When did your baby start eating solids? _____(Date)
   or if not known – age

   Weeks_____
   Months_____
   (ask whether this is their chronological age (age since their birth) or their corrected age).
   Don't remember

4. What was your baby's first food?*(please circle)*
   Ready-made baby food
   Homemade foods
   Rusk
   Baby rice
   Fruit
   Vegetables
   Yoghurt
   Breakfast cereal
   Meat
   Other _____

5. When did you introduce red meat?
   Date:_____
   Or if you are unsure of date, how long after introducing the first food did your baby eat red meat?
   Days:_____
   Weeks: _____
   Haven't introduced red meat yet (*please circle if this applies*)

6. When did you introduce other meat, for example chicken, pork or fish?
   Date:_____
   Or if you are unsure of date, how long after introducing the first food did your baby eat other meat?
   Days:_____
   Weeks: _____
   Haven't introduced other meat yet (*please circle if this applies*)

7. How many times a day does your baby eat solid foods?

   _____

8. Approximately how much does your baby eat at each time? (*hint: teaspoons, tablespoons etc*)

_____

_____

_____

9. How often do you usually give your baby these types of solid foods?

	> once per day	Once per day	3 or more times per week	Once or twice per week	< once per week	Never
Fresh fruits						
Fresh Vegetables						
Ready made foods						
Breakfast cereals						
Rice or Pasta						
Breads						
Potatoes						
Potato products e.g. chips, crisps						
Butter or margarine						
Beef						
Lamb						
Pork including ham						
Chicken & other poultry						
Fish						
Eggs						
Beans, lentils, chickpeas						
Tofu						
Nuts						
Cheese or yoghurt						
Puddings or desserts						
Biscuits, sweets or cake						

10. Has your baby ever had any liquids other than breast milk or infant formula? *(please circle)*
    Yes
    No (Finish interview)

11. How old was your new baby the first time he or she drank liquids other than breast milk or formula?
    Weeks_____
    Months_____
    Don't remember

12. What was your baby's first liquid other than breast milk or formula?*(please circle)*
    Cow's Milk
    Soya Milk
    Goats Milk
    Juice
    Tea
    Water
    Other:_____

References

Centres for Disease Control and Prevention. (2009). *Pregnancy Risk Assessment Monitoring System (PRAMS): Phase 6 Core Questionnaire*. Atlanta, GA: CDC.

Cormack, B. (2004). *First Foods for Premature Babies*. Auckland, New Zealand: ADHB.

Cormack, B. (2009). *Neonatal and Infant Nutrition handbook: A nutrition handbook for health professionals*. Auckland, New Zealand: ADHB.

Golding, J. (1991). Children of the Nineties: My Daughter/Son Questionnaire. Bristol, UK: ALSPAC

Health and Social Care Information Centre. (2010). *Infant Feeding Survey: 2010*. UK, NHS

Ministry of Health. 2003.NZ Food, NZ Children: *Key results of the 2002 National Children's Nutrition Survey*. Wellington: Ministry of Health.

Appendix H: Infant Feeding Practices Questionnaire: Six Months Corrected Age

6 month - Post discharge nutrition of preterm babies

1. Feeding Your Baby

This questionnaire asks about how your baby is being fed at 6 months corrected age. There are no “right” or “wrong” answers. Accurate and thoughtful responses will allow us to pinpoint current practices.

If you have more than one baby enrolled in this study, please fill out a separate questionnaire for each child.

All of the data collected is anonymous and your answers will be held in strict confidence.

*** 1. What is your baby's unique ID code? (Note: this number is attached to the email i.e. PT_ _ _ _B)**

*** 2. What is your baby's date of birth?**

DD MM YYYY

DOB / /

*** 3. As of now, which of the following would describe milk feeding of your baby?**

- Breast fed
- Mixed feeding (breast & formula)
- Formula feeding

6 month - Post discharge nutrition of preterm babies

2. Breast Feeding

*** 1. During the day (6 am - 7 pm), how often do you breastfeed? I breast feed every _____hour/s. Please fill blank.**

- On Demand
- 1
- 2
- 3
- 4
- 5
- Other

(please specify)

*** 2. When breastfeeding, how many minutes in total would you usually feed for? Please choose one.**

- 0 - 5 minutes
- 5- 10 minutes
- 10 - 15 minutes
- 15 - 20 minutes
- 20 - 25 minutes
- 25 - 30 minutes
- 30 - 35 minutes
- 35 - 40 minutes
- More than 40 minutes

Other (please specify)

*** 3. During the past month, have you taken any supplements?**

- Yes
- No

6 month - Post discharge nutrition of preterm babies

3. Breast Feeding

1. Please indicate from the drop down menu, which supplement you are taking and whom it was recommended by.

	What Supplement?	Who recommended the supplement?
Supplement 1		
Supplement 2		
Supplement 3		
Supplement 4		
Supplement 5		

Other (please specify supplement and whom it was recommended by)

6 month - Post discharge nutrition of preterm babies

4. Breast Feeding

1. Are you a vegetarian or vegan?

- Yes
- No

* 2. For majority of feeds is your baby fed from: (please choose one)

- Breast?
- Expressed milk in a bottle?
- Tube fed?
- Other (please specify)

6 month - Post discharge nutrition of preterm babies

5. Mixed Feeding

*** 1. During the day (6 am- 7 pm), how often do you feed your baby? I feed every ____hours.**

- On Demand
- 1
- 2
- 3
- 4
- 5
- Other

please specify

*** 2. If breastfeeding, how many minutes in total would you usually feed for? Please choose one.**

- 0 - 5 minutes
- 5- 10 minutes
- 10 - 15 minutes
- 15 - 20 minutes
- 20 - 25 minutes
- 25 - 30 minutes
- 30 - 35 minutes
- 35 - 40 minutes
- More than 40 minutes
- N/A - only expressing and using formula

Other (please specify)

6 month - Post discharge nutrition of preterm babies

3. If using a bottle, at each feed, approximately how many milliliters does your baby drink?

- ○ less than 50 ml
- ○ 50 - 100 ml
- ○ 100 - 150 ml
- ○ 150 - 200 ml
- ○ 200 - 250 ml
- ○ 250 - 300 ml

Other (please specify)

4. During the past month, have you taken any supplements?

- ○ Yes
- ○ No

6 month - Post discharge nutrition of preterm babies

6. Mixed Feeding

1. Please indicate from the drop down menu, which supplement you are taking and whom it was recommended by.

	What Supplement?	Who recommended the supplement?
Supplement 1		
Supplement 2		
Supplement 3		
Supplement 4		
Supplement 5		

Other (please specify supplement and whom it was recommended by)

2. Are you a vegetarian or vegan?

- Yes
- No

3. Please indicate what formula you are using.

	Formula types
Formula 1	
Formula 2	
Formula 3	
Formula 4	

Other (please specify brand, type and stage)

* 4. As of today, how many different infant formulas have you tried?

- 1 (the one you are currently using)
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Other (please specify)

6 month - Post discharge nutrition of preterm babies

7. Mixed Feeding

1. What were your reasons for changing formulas? Choose all that apply.

- [ ] Doctor recommended change
- [ ] Baby has/had colic
- [ ] Baby has/had reflux
- [ ] Baby has/had allergies
- [ ] Baby's age
- [ ] Baby was hungry - not satisfied
- [ ] Constipation
- [ ] Media/ advertising
- [ ] Internet
- [ ] Family / friends / word of mouth

Other (please specify)

2. If you would like to, please elaborate on your answer above

3. Why are you using your current infant formula? Choose all that apply.

- [ ] Baby tolerates it well
- [ ] Recommended by GP/ family doctor
- [ ] Recommended by paediatrician
- [ ] Recommended by family and/ or friends
- [ ] Affordable price
- [ ] Nutrition formulation suits your baby's needs
- [ ] Media/ advertising

Other (please specify)

4. If you would like to, please elaborate on your answer above

* 5. Using your baby's chronological age, please state how old your baby was when he/she started mixed feeding, if you cannot remember please give an approximate.

6 month - Post discharge nutrition of preterm babies

8. Formula feeding

*** 1. During the day (6am - 7pm), how often do you bottle feed your baby? e.g.I bottle feed every ____ hour/s**

- On demand
- 1
- 2
- 3
- 4
- 5
- more than 5 hours

2. During their feed, approximately how many milliliters would your baby drink?

- less than 50ml
- 50 - 100ml
- 100 - 150ml
- 150 - 200ml
- 200 - 250ml
- 250 - 300ml

Other (please specify)

3. Please indicate what formula you are using.

	Formula types
Formula 1	
Formula 2	
Formula 3	
Formula 4	

Other (please specify brand and stage of formula)

6 month - Post discharge nutrition of preterm babies

4. As of today, how many different infant formulas have you tried?

- 1 (the one you are currently using)
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Other (please specify)

6 month - Post discharge nutrition of preterm babies

9. Formula feeding

1. What were your reasons for changing formulas? Choose all that apply.

- [ ] Doctor recommended change
- [ ] Baby has colic
- [ ] Baby has reflux
- [ ] Baby has allergies
- [ ] Baby's age
- [ ] Baby was hungry - not satisfied
- [ ] Constipation

Other (please specify)

2. If you would like to, please elaborate on your answer above

3. Why are you using your current infant formula? Choose all that apply.

- [ ] Baby tolerates it well
- [ ] Recommended by GP/ family doctor
- [ ] Recommended by paediatrician
- [ ] Recommended by family and/ or friends
- [ ] Affordable price
- [ ] Nutrition formulation suits your baby's needs

Other (please specify)

4. If you would like to, please elaborate on your answer above

*** 5. Using your baby's chronological age, please state how old your baby was when he/she started formula feeding, if you cannot remember please give an approximate.**

6 month - Post discharge nutrition of preterm babies

*** 6. For majority of feeds is your baby fed from: (please choose one)**

- Formula in bottle
- Breast
- Breast and bottle?
- Expressed milk and formula in a bottle?
- Tube fed?
- Other (please specify)

6 month - Post discharge nutrition of preterm babies

10. First foods/ Solids

1. At this time, is your baby eating solids?

- Yes
- No

6 month - Post discharge nutrition of preterm babies

11. Solids

*** 1. If your baby has not started solids is this because (choose all that apply)**

- [ ] Baby is not interested in foods
- [ ] Baby is satisfied from milk feeds
- [ ] Baby not ready physically (sitting up)
- [ ] Recommended by Health professional
- [ ] Recommended by family or friends
- [ ] Other

please specify

6 month - Post discharge nutrition of preterm babies

12. Solids

*** 1. Using your baby's chronological age, please state how old your baby was when he/she started solids, if you cannot remember please give an approximate.**

*** 2. Who suggested that your baby started solids? Pick all that apply.**

- [ ] Plunket Nurse
- [ ] General Practitioner/ Family Doctor
- [ ] Neonatologist/ paediatrician
- [ ] Family member
- [ ] Myself
- [ ] Dietitian
- [ ] Other (please specify)

*** 3. What were the reasons for starting your baby on solids? Pick all that apply.**

- [ ] Baby is old enough
- [ ] Baby seems hungry
- [ ] Baby is waking at night
- [ ] Baby is interested in food that I eat
- [ ] Baby showed signs of readiness e.g able to sit, diminished protrusion reflex
- [ ] Recommended by family/ friends
- [ ] Recommended by health professional
- [ ] Other

please specify

4. If you would like to, please elaborate on your answer above

6 month - Post discharge nutrition of preterm babies

* 5. How many meals of solids is your baby having per day? Please choose one.

- 1
- 2
- 3
- 4
- 5
- 6

Other (please specify)

6. How many snacks is your baby having per day? Please choose one.

- 0
- 1
- 2
- 3
- 4
- 5
- 6

Other (please specify)

7. Approximately how much solid food does your baby eat? Please choose one option from each row or N/A

	1 teaspoon	1 tablespoon	1-3 tablespoons	1/4 cup	1/2 cup	1 cup	More than one cup	N/A
Breakfast								
Lunch								
Dinner								
Snack								

Other (please specify)

* 8. When feeding your baby, which is fed first?

- Milk before solids
- Solids before milk

6 month - Post discharge nutrition of preterm babies

*** 9. What texture would you use to describe the solids your baby is eating? (Choose all that apply)**

- [ ] Puree/ smooth
- [ ] Thick smooth
- [ ] Mashed
- [ ] Finger foods
- [ ] Other

please specify

*** 10. What food was your babies first food? (the first food you introduced) Please state**

*** 11. How often does your baby eat:**

	More than once per day	Once per day	Three or more times per week	Once or twice per week	Less than once per week	Not introduced yet
Rolled oats/porridge	○	○	○	○	○	○
Weetbix	○	○	○	○	○	○
Other breakfast cereals	○	○	○	○	○	○
Iron fortified baby cereal	○	○	○	○	○	○
Rice	○	○	○	○	○	○
Pasta	○	○	○	○	○	○
Bread/ toast	○	○	○	○	○	○
Crackers	○	○	○	○	○	○
Rusk/ teething biscuit	○	○	○	○	○	○

Other - Are there any other foods your baby eats often that you would like to elaborate on, please include how often your baby consumes these foods

6 month - Post discharge nutrition of preterm babies

* 12. How often does your baby eat:

	More than once per day	Once per day	Three or more times per week	Once or twice per week	Less than once per week	Not introduced yet
Beef						
Lamb						
Pork (Including ham)						
Chicken & other poultry						
Fish						
Saveloy/ luncheon sausage						
Eggs						
Beans, lentils, chickpeas						
Tofu						

* 13. How often does your baby eat:

	More than once per day	Once per day	Three or more times per week	Once or twice per week	Less than once per week	Not introduced yet
Butter or margarine						
Cheese						
Yoghurt						
Ice cream						
Custard						

* 14. How often does your baby eat:

	Once per day	Three or more times per week	Once per week	Once a fortnight	Not introduced yet
Dried fruit (raisin, apricot)					
Popcorn					
Sweets/ lollies					
Biscuits/ cakes					
Chocolate					
Muesli bar					
Hot chips/fries					
Potato products (chips/crisps					

6 month - Post discharge nutrition of preterm babies

* 15. How often does your baby eat the following vegetables and fruits

	Twice a day	once a day	Three or more times per week	Twice per week	Once per week	Once a fortnight	Not introduced yet
Starchy (potato,kumara, corn)	○	○	○	○	○	○	○
Cruciferous (broccoli, cauliflower, cabbage)	○	○	○	○	○	○	○
leafy green (spinach, silverbeet)	○	○	○	○	○	○	○
Red and orange (carrot, pumpkin)	○	○	○	○	○	○	○
Beans and peas	○	○	○	○	○	○	○
Other (avocado, zucchini, cucumber)	○	○	○	○	○	○	○
Berries (blueberry, strawberry)	○	○	○	○	○	○	○
Citrus (orange, mandarin)	○	○	○	○	○	○	○
Melon (honeydew, watermelon)	○	○	○	○	○	○	○
Stone (apricot, peach)	○	○	○	○	○	○	○
Tropical (banana, mango)	○	○	○	○	○	○	○
Other (apples, grapes, pears)	○	○	○	○	○	○	○

* 16. In regards to your babies food what would you use most often? (choose one)

- ○ Homemade foods
- ○ Pre-prepared foods (e.g. watties)
- ○ Mixture of the above

17. If so, what readymade foods have you introduced? e.g. rice and vegetables, meat and vegetables

6 month - Post discharge nutrition of preterm babies

13. Fluids

1. Has your baby ever had any liquids other than breast milk or infant formula?

- Yes
- No

6 month - Post discharge nutrition of preterm babies

14. Fluids / Supplements

1. What fluids has your baby had and how often? Tick all that apply.

	How often?
Water	
Juice	
Tea	
Raro	
Goats milk	
Soy milk	
Flavoured milk	
Soft drink	

Other (please specify)

2. Is your baby currently having any supplements?

- ○ Yes
- ○ No

6 month - Post discharge nutrition of preterm babies

15. Supplements

1. Which supplements does your baby take?

	Supplement	How many times per day/ week	Who was it recommended by?
Supplement one			
Supplement two			
Supplement three			
Supplement four			

Other (please specify supplement, dosage and whom recommended it)

6 month - Post discharge nutrition of preterm babies

16. Sun Exposure

One of the vitamins we are looking at in this study is Vitamin D which is sometimes known as the Sunshine Vitamin. This is because we are able to make Vitamin D in our skin when it is exposed to sunlight. Babies also get Vitamin D from breast milk or infant formula. We are going to ask you a few questions which will tell us about different factors which might affect your baby's vitamin D status.

* 1. Is it currently:

- Summer(September to April)
- Winter (May to August).

* 2. During the past month, when outside in the sun, how often do you:

	Always	Usually	Sometimes	Rarely	Never
apply sunscreen to your baby?					
put a hat on your baby?					
use protective clothing on him/her (e.g. rash shirt)					
consciously keep your baby in the shade?					

6 month - Post discharge nutrition of preterm babies

17. Other

*** 1. Since discharge, has your baby been readmitted to hospital?**

- Yes
- No

6 month - Post discharge nutrition of preterm babies

18. Other

1. Briefly note what for and length of their stay

*** 2. Is your child on a special diet? e.g.allergies, lactose free, gluten free**

- Yes
- No

6 month - Post discharge nutrition of preterm babies

19. Other

The survey is almost complete, thank-you so much for taking the time to complete the survey.

1. What type of special diet and who was it recommended by?

* 2. In the last month, have you experienced any difficulties with feeding your child?

- [ ] Fussiness
- [ ] Refusal to eat
- [ ] Avoidance of new foods
- [ ] Dislike of texture
- [ ] Difficulty sucking
- [ ] Difficulty chewing
- [ ] Difficulty swallowing
- [ ] Spit up, vomit, reflux
- [ ] Diarrhea
- [ ] Constipation
- [ ] Small apetite
- [ ] Tantrums
- [ ] Often gag when eating
- [ ] none

Other -Please specify one not stated or elaborate on any above

3. Are there any further comments you would like to add regarding your babies feeding?

4. Do you have any comments about the survey itself? e.g possible improvements

Appendix I: Infant Feeding Practices Questionnaire: Nine Months Corrected Age

9 Month - Post discharge nutrition of preterm babies

1. Feeding Your Baby

Thank you for continuing on with the preterm feeding study. This questionnaire asks about how your baby is being fed at 9 months corrected age. There are no “right” or “wrong” answers. Accurate and thoughtful responses will allow us to pinpoint current practices.

If you have more than one baby enrolled in this study, please fill out a separate questionnaire for each child.

All of the data collected is anonymous and your answers will be held in strict confidence.

*** 1. What is your baby's unique ID code? (Note: this number is attached to the email i.e. PT_ _ _ _B)**

*** 2. What is your baby's date of birth?**

DD MM YYYY

DOB / /

9 Month - Post discharge nutrition of preterm babies

2. BEBQ

These questions are about your baby's appetite over his/her first few months of life. We are specifically interested in the period during which your baby was fed milk only, i.e. no solid foods or pre-prepared baby food yet.

*** 1. Please answer the following questions regarding your baby's appetite over the first months of life when they were only fed milk and there was no introduction of solids. please answer one choice per row**

	Never	Rarely	Sometimes	Often	Always
1. My baby seemed contented while feeding	○	○	○	○	○
2. My baby frequently wanted more milk than I provided	○	○	○	○	○
3. My baby loved milk	○	○	○	○	○
4. My baby had a big appetite	○	○	○	○	○
5. My baby finished feeding quickly	○	○	○	○	○
6. My baby became distressed while feeding	○	○	○	○	○
7. My baby got full up easily	○	○	○	○	○
8. If allowed to, my baby would take too much milk	○	○	○	○	○
9. My baby took more than 30 minutes to finish feeding	○	○	○	○	○
10. My baby got full before taking all the milk I think he/she should have	○	○	○	○	○
11. My baby fed slowly	○	○	○	○	○
12. Even when my baby had just eaten well he/she was happy to feed again if offered	○	○	○	○	○
13. My baby found it difficult to manage a complete feed	○	○	○	○	○
14. My baby was always demanding a feed	○	○	○	○	○
15. My baby sucked more and more slowly during the course of a feed	○	○	○	○	○
16. If given the chance, my baby would always be feeding	○	○	○	○	○
17. My baby enjoyed feeding time	○	○	○	○	○
18. My baby could easily take a feed within 30	○	○	○	○	○

9 Month - Post discharge nutrition of preterm babies

minutes of the last one

9 Month - Post discharge nutrition of preterm babies

3. milk feeding

*** 1. As of now, which of the following would describe milk feeding of your baby?**

- Breast fed
- Mixed feeding (breast & formula)
- Formula feeding

9 Month - Post discharge nutrition of preterm babies

4. Breast Feeding

*** 1. During the day (6 am - 7 pm), how often do you breastfeed? I breast feed every _____hour/s. Please fill blank.**

- On Demand
- 1
- 2
- 3
- 4
- 5
- Other

(please specify)

*** 2. When breastfeeding, how many minutes in total would you usually feed for? Please choose one.**

- 0 - 5 minutes
- 5- 10 minutes
- 10 - 15 minutes
- 15 - 20 minutes
- 20 - 25 minutes
- 25 - 30 minutes
- 30 - 35 minutes
- 35 - 40 minutes
- More than 40 minutes

Other (please specify)

*** 3. During the past month, have you taken any supplements?**

- Yes
- No

9 Month - Post discharge nutrition of preterm babies

5. Breast Feeding

1. Please indicate from the drop down menu, which supplement you are taking and whom it was recommended by.

	What Supplement?	Who recommended the supplement?
Supplement 1		
Supplement 2		
Supplement 3		
Supplement 4		
Supplement 5		

Other (please specify supplement and whom it was recommended by)

9 Month - Post discharge nutrition of preterm babies

6. Breast Feeding

1. Are you a vegetarian or vegan?

- Yes
- No

* 2. For majority of feeds is your baby fed from: (please choose one)

- Breast?
- Expressed milk in a bottle?
- Tube fed?
- Other (please specify)

9 Month - Post discharge nutrition of preterm babies

7. Mixed Feeding

*** 1. During the day (6 am- 7 pm), how often do you feed your baby? I feed every ____hours.**

- On Demand
- 1
- 2
- 3
- 4
- 5
- Other

please specify

*** 2. If breastfeeding, how many minutes in total would you usually feed for? Please choose one.**

- 0 - 5 minutes
- 5- 10 minutes
- 10 - 15 minutes
- 15 - 20 minutes
- 20 - 25 minutes
- 25 - 30 minutes
- 30 - 35 minutes
- 35 - 40 minutes
- More than 40 minutes
- N/A - only expressing and using formula

Other (please specify)

9 Month - Post discharge nutrition of preterm babies

3. If using a bottle, at each feed, approximately how many milliliters does your baby drink?

- less than 50 ml
- 50 - 100 ml
- 100 - 150 ml
- 150 - 200 ml
- 200 - 250 ml
- 250 - 300 ml

Other (please specify)

4. During the past month, have you taken any supplements?

- Yes
- No

9 Month - Post discharge nutrition of preterm babies

8. Mixed Feeding

1. Please indicate from the drop down menu, which supplement you are taking and whom it was recommended by.

	What Supplement?	Who recommended the supplement?
Supplement 1		
Supplement 2		
Supplement 3		
Supplement 4		
Supplement 5		

Other (please specify supplement and whom it was recommended by)

2. Are you a vegetarian or vegan?

- Yes
- No

3. Please indicate what formula you are using.

	Formula types
Formula 1	
Formula 2	
Formula 3	
Formula 4	

Other (please specify brand, type and stage)

* 4. As of today, how many different infant formulas have you tried?

- 1 (the one you are currently using)
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Other (please specify)

9 Month - Post discharge nutrition of preterm babies

9. Mixed Feeding

1. What were your reasons for changing formulas? Choose all that apply.

- [ ] Doctor recommended change
- [ ] Baby has/had colic
- [ ] Baby has/had reflux
- [ ] Baby has/had allergies
- [ ] Baby's age
- [ ] Baby was hungry - not satisfied
- [ ] Constipation
- [ ] Media/ advertising
- [ ] Internet
- [ ] Family / friends / word of mouth

Other (please specify)

2. If you would like to, please elaborate on your answer above

3. Why are you using your current infant formula? Choose all that apply.

- [ ] Baby tolerates it well
- [ ] Recommended by GP/ family doctor
- [ ] Recommended by paediatrician
- [ ] Recommended by family and/ or friends
- [ ] Affordable price
- [ ] Nutrition formulation suits your baby's needs
- [ ] Media/ advertising

Other (please specify)

4. If you would like to, please elaborate on your answer above

* 5. Using your baby's chronological age, please state how old your baby was when he/she started mixed feeding, if you cannot remember please give an approximate.

9 Month - Post discharge nutrition of preterm babies

*** 6. For majority of feeds is your baby fed from: (please choose one)**

- Formula in bottle
- Breast
- Breast and bottle?
- Expressed milk and formula in a bottle?
- Tube fed?
- Other (please specify)

9 Month - Post discharge nutrition of preterm babies

10. Formula feeding

*** 1. During the day (6am - 7pm), how often do you bottle feed your baby? e.g.I bottle feed every ____ hour/s**

- On demand
- 1
- 2
- 3
- 4
- 5
- more than 5 hours

2. During their feed, approximately how many milliliters would your baby drink?

- less than 50ml
- 50 - 100ml
- 100 - 150ml
- 150 - 200ml
- 200 - 250ml
- 250 - 300ml

Other (please specify)

3. Please indicate what formula you are using.

	Formula types
Formula 1	
Formula 2	
Formula 3	
Formula 4	

Other (please specify brand and stage of formula)

9 Month - Post discharge nutrition of preterm babies

4. As of today, how many different infant formulas have you tried?

- 1 (the one you are currently using)
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Other (please specify)

9 Month - Post discharge nutrition of preterm babies

11. Formula feeding

1. What were your reasons for changing formulas? Choose all that apply.

- [ ] Doctor recommended change
- [ ] Baby has colic
- [ ] Baby has reflux
- [ ] Baby has allergies
- [ ] Baby's age
- [ ] Baby was hungry - not satisfied
- [ ] Constipation

Other (please specify)

2. If you would like to, please elaborate on your answer above

3. Why are you using your current infant formula? Choose all that apply.

- [ ] Baby tolerates it well
- [ ] Recommended by GP/ family doctor
- [ ] Recommended by paediatrician
- [ ] Recommended by family and/ or friends
- [ ] Affordable price
- [ ] Nutrition formulation suits your baby's needs

Other (please specify)

4. If you would like to, please elaborate on your answer above

*** 5. Using your baby's chronological age, please state how old your baby was when he/she started formula feeding, if you cannot remember please give an approximate.**

9 Month - Post discharge nutrition of preterm babies

*** 6. For majority of feeds is your baby fed from: (please choose one)**

- Formula in bottle
- Tube fed?
- Other (please specify)

9 Month - Post discharge nutrition of preterm babies

12. First foods/ Solids

1. At this time, is your baby eating solids?

- Yes
- No

9 Month - Post discharge nutrition of preterm babies

13. Solids

*** 1. How many meals of solids is your baby having per day? Please choose one.**

- 1
- 2
- 3
- 4
- 5
- 6

Other (please specify)

2. How many snacks is your baby having per day? Please choose one.

- 0
- 1
- 2
- 3
- 4
- 5
- 6

Other (please specify)

*** 3. Approximately how much solid food does your baby eat? Please choose one option from each row or N/A**

	1 teaspoon	1 tablespoon	1-3 tablespoons	1/4 cup	1/2 cup	1 cup	More than one cup	N/A
Breakfast								
Lunch								
Dinner								
Snack								

Other (please specify)

*** 4. When feeding your baby, which is fed first?**

- Milk before solids
- Solids before milk

9 Month - Post discharge nutrition of preterm babies

*** 5. What texture would you use to describe the solids your baby is eating? (Choose all that apply)**

- [ ] Puree/ smooth
- [ ] Thick smooth
- [ ] Mashed
- [ ] Finger foods
- [ ] Other

please specify

*** 6. Have you introduced self feeding to your infant? (letting them feed themselves) please choose one**

- ○ Yes
- ○ No

*** 7. Is your infant interested in self feeding? (feeding themselves)**

	Yes	No	Have not introduced
With fingers (e.g. finger foods)	○	○	○
With a spoon	○	○	○
With a fork	○	○	○

*** 8. How often does your baby eat:**

	More than once per day	Once per day	Three or more times per week	Once or twice per week	Less than once per week	Not introduced yet
Rolled oats/porridge	○	○	○	○	○	○
Weetbix	○	○	○	○	○	○
Other breakfast cereals	○	○	○	○	○	○
Iron fortified baby cereal	○	○	○	○	○	○
Rice	○	○	○	○	○	○
Pasta	○	○	○	○	○	○
Bread/ toast	○	○	○	○	○	○
Crackers	○	○	○	○	○	○
Rusk/ teething biscuit	○	○	○	○	○	○

9 Month - Post discharge nutrition of preterm babies

* 9. How often does your baby eat:

	More than once per day	Once per day	Three or more times per week	Once or twice per week	Less than once per week	Not introduced yet
Beef						
Lamb						
Pork (Including ham)						
Chicken & other poultry						
Fish						
Saveloy/ luncheon sausage						
Eggs						
Beans, lentils, chickpeas						
Tofu						
Oysters						

* 10. How often does your baby eat:

	More than once per day	Once per day	Three or more times per week	Once or twice per week	Less than once per week	Not introduced yet
Butter or margarine						
Cheese						
Yoghurt						
Ice cream						
Custard						

11. Do you use cows milk when preparing your childs meals? e.g mashed potato

- Yes
- No

* 12. How often does your baby eat:

	Once per day	Three or more times per week	Once per week	Once a fortnight	Not introduced yet
Dried fruit (raisin, apricot)					
Popcorn					
Sweets/ lollies					
Biscuits/ cakes					
Chocolate					
Muesli bar					
Hot chips/fries					
Potato products (chips/crisps					

9 Month - Post discharge nutrition of preterm babies

* 13. How often does your baby eat the following vegetables and fruits

	Twice a day	once a day	Three or more times per week	Twice per week	Once per week	Once a fortnight	Not introduced yet
Starchy (potato,kumara, corn)	○	○	○	○	○	○	○
Cruciferous (broccoli, cauliflower, cabbage)	○	○	○	○	○	○	○
leafy green (spinach, silverbeet)	○	○	○	○	○	○	○
Red and orange (carrot, pumpkin)	○	○	○	○	○	○	○
Beans and peas	○	○	○	○	○	○	○
Other (avocado, zucchini, cucumber)	○	○	○	○	○	○	○
Berries (blueberry, strawberry)	○	○	○	○	○	○	○
Citrus (orange, mandarin)	○	○	○	○	○	○	○
Melon (honeydew, watermelon)	○	○	○	○	○	○	○
Stone (apricot, peach)	○	○	○	○	○	○	○
Tropical (banana, mango)	○	○	○	○	○	○	○
Other (apples, grapes, pears)	○	○	○	○	○	○	○

14. Are there any other foods your baby eats often that you would like to elaborate on, please include how often your baby consumes these foods.

* 15. In regards to your babies food what would you use most often? (choose one)

- ○ Homemade foods
- ○ Pre-prepared foods (e.g. watties)
- ○ Mixture of the above

16. If so, what readymade foods have you introduced? e.g. rice and vegetables, meat and vegetables

9 Month - Post discharge nutrition of preterm babies

* 17. For majority of meals, where does your child sit to eat?(choose one only)

- Highchair
- Held by caregiver
- Bumbo seat
- Pram/pushchair
- Seated on the floor
- Seated on furniture/chair/couch
- Other

Other (please specify and elaborate)

* 18. Have you seeked out information regarding the introduction of solids?

- Yes
- No

* 19. Were you able to find information regarding solid feeding for preterm infants?

- Yes
- No

Other (please specify)

* 20. If you seeked out information what did you find useful?(choose all that apply)

- Family
- Friends
- General Practitioner
- Plunket Nurse
- Dietitian
- Pharmacist
- Maori health provider
- Pacific Island health provider
- Oh baby magazine
- littlies magazine
- Treasures magazine
- Books
- The parenting place
- Babycenter online
- plunket online
- For baby online
- Ministry of Health, NZ
- Huggies online
- Watties online
- homemade baby food recipes online
- First foods for premature babies - Auckland DHB
- Watties/plunket: guide to baby feeding
- Watties/plinket: finger food ideas
- None of the above

Other (please specify any other resources you found useful)

9 Month - Post discharge nutrition of preterm babies

*** 21. Are you satisfied with the amount of information available regarding introducing solids for your preterm baby?**

	Very satisfied	Satisfied	Neutral	Unsatisfied	Very unsatisfied	N/A
level of satisfaction	○	○	○	○	○	○

22. If you would like to elaborate on resources and their availability please feel free to in text box below

9 Month - Post discharge nutrition of preterm babies

14. Fluids

1. Has your baby ever had any liquids other than breast milk or infant formula?(this includes water)

- Yes
- No

9 Month - Post discharge nutrition of preterm babies

15. Fluids / Supplements

1. What fluids has your baby had and how often? Tick all that apply.

	How often?
Water	
Cows milk	
Juice	
Tea	
Raro	
Goats milk	
Soy milk	
Flavoured milk	
Soft drink	

Other (please specify)

* 2. When your child drinks fluids do they drink from

- a bottle?
- a sippy cup? (baby cup)
- a cup? (adult cup)
- N/A

Other (please specify)

3. Is your baby currently having any supplements?

- Yes
- No

9 Month - Post discharge nutrition of preterm babies

16. Supplements

1. Which supplements does your baby take?

	Supplement	How many times per day/ week	Who was it recommended by?	How often do you actually give the recommended dosage?
Supplement one				
Supplement two				
Supplement three				
Supplement four				

Other (please specify supplement, dosage and whom recommended it)

9 Month - Post discharge nutrition of preterm babies

17. Sun Exposure

One of the vitamins we are looking at in this study is Vitamin D which is sometimes known as the Sunshine Vitamin. This is because we are able to make Vitamin D in our skin when it is exposed to sunlight. Babies also get Vitamin D from breast milk or infant formula. We are going to ask you a few questions which will tell us about different factors which might affect your baby's vitamin D status.

* 1. Is it currently:

- Summer(September to April)
- Winter (May to August).

* 2. During the past month, when outside in the sun, how often do you:

	Always	Usually	Sometimes	Rarely	Never
apply sunscreen to your baby?					
put a hat on your baby?					
use protective clothing on him/her (e.g. rash shirt)					
consciously keep your baby in the shade?					

9 Month - Post discharge nutrition of preterm babies

18. Other

*** 1. Since discharge, has your baby been readmitted to hospital?**

- Yes
- No

9 Month - Post discharge nutrition of preterm babies

19. Other

1. Briefly note what for and length of their stay

*** 2. Is your child on a special diet? e.g.allergies, lactose free, gluten free**

- Yes
- No

9 Month - Post discharge nutrition of preterm babies

20. Other

The survey is almost complete, thank-you so much for taking the time to complete the survey.

1. What type of special diet and who was it recommended by?

* 2. In the last month, have you experienced any difficulties with feeding your child?

	Never/rarely	Sometimes	Often	Always
Fussiness				
Refusal to eat				
Avoidance of new foods				
Dislike of texture				
Difficulty sucking				
Difficulty chewing				
Difficulty swallowing				
Spit up, vomit, reflux				
Diarrhea				
Constipation				
Small apetite				
Tantrums				
Often gag when eating				
Inability to graduate textures				
Tantrums				
Meal refusal				
Delay in self feeding				

Other -Please specify one not stated or elaborate on any above

* 3. Since the 6 month feeding questionnaire, would you say that feeding your child has become

- [ ] More difficult
- [ ] Easier
- [ ] Stayed the same
- [ ] Don't know

Other (please specify)

9 Month - Post discharge nutrition of preterm babies

*** 4. Does your infant bring objects to their mouth to explore and play? e.g. toys, rusks (choose one)**

- Yes
- No
- Don't know

5. Is your child able to use their lips and/or mouth to remove food from the spoon by them self? choose one

- Yes
- No
- Don't know

6. Are there any further comments you would like to add regarding your babies feeding?

7. Do you have any comments about the survey itself? e.g possible improvements

Appendix J: Infant Feeding Practices Questionnaire: Twelve Months Corrected Age

12 Month - Post discharge nutrition of preterm babies

1. Feeding Your Baby

Thank you for continuing on with the preterm feeding study.
This questionnaire asks about how your baby is being fed at 12 months corrected age. This is the last questionnaire to assess your child's feeding. There are no “right” or “wrong” answers. Accurate and thoughtful responses will allow us to pinpoint current practices.

If you have more than one baby enrolled in this study, please fill out a separate questionnaire for each child.

All of the data collected is anonymous and your answers will be held in strict confidence.

*** 1. What is your baby's unique ID code? (Note: this number is attached to the email i.e. PT_ _ _ _B)**

*** 2. What is your baby's date of birth?**

DD MM YYYY

DOB / /

12 Month - Post discharge nutrition of preterm babies

2. CEBQ

These questions are about your baby's appetite and feeding at 12 months corrected age.

*** 1. Please answer the following questions regarding your baby's appetite and feeding at 12 months corrected age. Please answer one choice per row**

	Never	Rarely	Sometimes	Often	Always
1. My child loves food	○	○	○	○	○
2. My child eats more when irritable	○	○	○	○	○
3. My child has a big appetite*	○	○	○	○	○
4. My child finishes his/her meal quickly*	○	○	○	○	○
5. My child is interested in food	○	○	○	○	○
6. My child cannot eat a meal if he/she has had a snack just before	○	○	○	○	○
7. My child refuses new foods at first	○	○	○	○	○
8. My child eats slowly	○	○	○	○	○
9. My child looks forward to mealtimes	○	○	○	○	○
10. My child is always asking for food	○	○	○	○	○
11. My child eats more when grumpy	○	○	○	○	○
12. If allowed to, my child would eat too much	○	○	○	○	○
13. My child eats more when upset	○	○	○	○	○
14. My child enjoys a wide variety of foods*	○	○	○	○	○
15. My child leaves food on his/her plate or in the jar at the end of a meal	○	○	○	○	○
16. My child takes more than 30 minutes to finish a meal	○	○	○	○	○
17. Given the choice, my child would eat most of the time	○	○	○	○	○
18. My child enjoys tasting new foods*	○	○	○	○	○
19. My child gets full before his/her meal is finished	○	○	○	○	○
20. My child enjoys eating	○	○	○	○	○
21. My child is difficult to please with meals	○	○	○	○	○

12 Month - Post discharge nutrition of preterm babies

22. My child decides that he/she does not like a food, even without tasting it					
23. My child eats more and more slowly during the course of a meal					
24. Even when my child has just eaten well, he/she is happy to eat again if offered					
25. My child gets full up easily					
26. My child is interested in tasting food he/she has not tasted before*					

12 Month - Post discharge nutrition of preterm babies

3. milk feeding

*** 1. As of now, which of the following would describe milk feeding of your baby?**

- Breastfeeding
- Mixed feeding (breast & milk)
- Cows milk
- Other milk e.g. soy, rice, goat
- Formula feeding

12 Month - Post discharge nutrition of preterm babies

4. Breast Feeding

*** 1. During the day (6 am - 7 pm), how often do you breastfeed? I breast feed every _____hour/s. Please fill blank.**

- On Demand
- 1
- 2
- 3
- 4
- 5
- Other

(please specify)

*** 2. When breastfeeding, how many minutes in total would you usually feed for? Please choose one.**

- 0 - 5 minutes
- 5- 10 minutes
- 10 - 15 minutes
- 15 - 20 minutes
- 20 - 25 minutes
- 25 - 30 minutes
- 30 - 35 minutes
- 35 - 40 minutes
- More than 40 minutes

Other (please specify)

*** 3. During the past month, have you taken any supplements?**

- Yes
- No

12 Month - Post discharge nutrition of preterm babies

5. Breast Feeding

1. Please indicate from the drop down menu, which supplement you are taking and whom it was recommended by.

	What Supplement?	Who recommended the supplement?
Supplement 1		
Supplement 2		
Supplement 3		
Supplement 4		
Supplement 5		

Other (please specify supplement and whom it was recommended by)

12 Month - Post discharge nutrition of preterm babies

6. Breast Feeding

1. Are you a vegetarian or vegan?

- Yes
- No

* 2. For majority of feeds is your baby fed from: (please choose one)

- Breast?
- Expressed milk in a bottle?
- Tube fed?
- Other (please specify)

12 Month - Post discharge nutrition of preterm babies

7. Mixed Feeding

*** 1. During the day (6 am- 7 pm), how often do you feed your baby? I feed every ____hours.**

- On Demand
- 1
- 2
- 3
- 4
- 5
- Other

please specify

*** 2. If breastfeeding, how many minutes in total would you usually feed for? Please choose one.**

- 0 - 5 minutes
- 5- 10 minutes
- 10 - 15 minutes
- 15 - 20 minutes
- 20 - 25 minutes
- 25 - 30 minutes
- 30 - 35 minutes
- 35 - 40 minutes
- More than 40 minutes
- N/A - only expressing and using formula

Other (please specify)

12 Month - Post discharge nutrition of preterm babies

3. If using a bottle, at each feed, approximately how many milliliters does your baby drink?

- less than 50 ml
- 50 - 100 ml
- 100 - 150 ml
- 150 - 200 ml
- 200 - 250 ml
- 250 - 300 ml

Other (please specify)

4. During the past month, have you taken any supplements?

- Yes
- No

12 Month - Post discharge nutrition of preterm babies

8. Mixed Feeding

1. Please indicate from the drop down menu, which supplement you are taking and whom it was recommended by.

	What Supplement?	Who recommended the supplement?
Supplement 1		
Supplement 2		
Supplement 3		
Supplement 4		
Supplement 5		

Other (please specify supplement and whom it was recommended by)

2. Are you a vegetarian or vegan?

- Yes
- No

* 3. What milk are you using to mix feed?

- Cows milk
- Formula
- Soy milk
- Goats milk
- Rice milk
- Other

12 Month - Post discharge nutrition of preterm babies

9. Mixed Feeding

1. Please indicate what formula you are using.

	Formula types
Formula 1	
Formula 2	
Formula 3	
Formula 4	

Other (please specify brand, type and stage)

* 2. As of today, how many different infant formulas have you tried?

- 1 (the one you are currently using)
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Other (please specify)

12 Month - Post discharge nutrition of preterm babies

10. Mixed Feeding

1. What were your reasons for changing formulas? Choose all that apply.

- [ ] Doctor recommended change
- [ ] Baby has/had colic
- [ ] Baby has/had reflux
- [ ] Baby has/had allergies
- [ ] Baby's age
- [ ] Baby was hungry - not satisfied
- [ ] Constipation
- [ ] Media/ advertising
- [ ] Internet
- [ ] Family / friends / word of mouth

Other (please specify)

2. If you would like to, please elaborate on your answer above

3. Why are you using your current infant formula? Choose all that apply.

- [ ] Baby tolerates it well
- [ ] Recommended by GP/ family doctor
- [ ] Recommended by paediatrician
- [ ] Recommended by family and/ or friends
- [ ] Affordable price
- [ ] Nutrition formulation suits your baby's needs
- [ ] Media/ advertising

Other (please specify)

4. If you would like to, please elaborate on your answer above

*** 5. Using your baby's chronological age, please state how old your baby was when he/she started mixed feeding, if you cannot remember please give an approximate.**

12 Month - Post discharge nutrition of preterm babies

*** 6. For majority of feeds is your baby fed from: (please choose one)**

- Formula in bottle
- Breast
- Breast and bottle?
- Expressed milk and formula in a bottle?
- Tube fed?
- Other (please specify)

12 Month - Post discharge nutrition of preterm babies

11. Formula feeding

*** 1. During the day (6am - 7pm), how often do you bottle feed your baby? e.g.I bottle feed every ____ hour/s**

- On demand
- 1
- 2
- 3
- 4
- 5
- more than 5 hours

2. During their feed, approximately how many milliliters would your baby drink?

- less than 50ml
- 50 - 100ml
- 100 - 150ml
- 150 - 200ml
- 200 - 250ml
- 250 - 300ml

Other (please specify)

3. Please indicate what formula you are using.

	Formula types
Formula 1	
Formula 2	
Formula 3	
Formula 4	

Other (please specify brand and stage of formula)

12 Month - Post discharge nutrition of preterm babies

4. As of today, how many different infant formulas have you tried?

- 1 (the one you are currently using)
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Other (please specify)

12 Month - Post discharge nutrition of preterm babies

12. Formula feeding

1. What were your reasons for changing formulas? Choose all that apply.

- [ ] Doctor recommended change
- [ ] Baby has colic
- [ ] Baby has reflux
- [ ] Baby has allergies
- [ ] Baby's age
- [ ] Baby was hungry - not satisfied
- [ ] Constipation

Other (please specify)

2. If you would like to, please elaborate on your answer above

3. Why are you using your current infant formula? Choose all that apply.

- [ ] Baby tolerates it well
- [ ] Recommended by GP/ family doctor
- [ ] Recommended by paediatrician
- [ ] Recommended by family and/ or friends
- [ ] Affordable price
- [ ] Nutrition formulation suits your baby's needs

Other (please specify)

4. If you would like to, please elaborate on your answer above

*** 5. Using your baby's chronological age, please state how old your baby was when he/she started formula feeding, if you cannot remember please give an approximate.**

12 Month - Post discharge nutrition of preterm babies

*** 6. For majority of feeds is your baby fed from: (please choose one)**

- Formula in bottle
- Tube fed?
- Other (please specify)

12 Month - Post discharge nutrition of preterm babies

13. Cows milk

*** 1. During the day (6am - 7pm), how often do you bottle feed your baby? e.g.I bottle feed every ____ hour/s**

- On demand
- 1
- 2
- 3
- 4
- 5
- more than 5 hours

2. During their feed, approximately how many milliliters would your baby drink?

- less than 50ml
- 50 - 100ml
- 100 - 150ml
- 150 - 200ml
- 200 - 250ml
- 250 - 300ml

Other (please specify)

*** 3. Using your baby's chronological age (actual age), please state how old your baby was when he/she started cows milk, if you cannot remember please give an approximate.**

4. Which type of cows milk are you using? Please choose one

- Full fat (dark blue top)
- Semi-skimmed milk (light blue top)
- Skim milk (green top)
- Calci plus trim milk (yellow top)
- Lactose free milk

Other (please specify)

12 Month - Post discharge nutrition of preterm babies

14. Other milk

*** 1. During the day (6am - 7pm), how often do you bottle feed your baby? e.g.I bottle feed every ____ hour/s**

- On demand
- 1
- 2
- 3
- 4
- 5
- more than 5 hours

2. During their feed, approximately how many milliliters would your baby drink?

- less than 50ml
- 50 - 100ml
- 100 - 150ml
- 150 - 200ml
- 200 - 250ml
- 250 - 300ml

Other (please specify)

3. What kind of milk is your infant using?

- Soy milk
- Goats milk
- Rice milk
- Almond milk

Other (please specify)

*** 4. What were your reasons for choosing this type of milk? Was it recommended by anyone?**

*** 5. Using your baby's chronological age (actual age), please state how old your baby was when he/she started using this milk, if you cannot remember please give an approximate.**

12 Month - Post discharge nutrition of preterm babies

15. First foods/ Solids

1. At this time, is your baby eating solids?

- Yes
- No

*** 2. Using your baby's chronological age (actual age), please state how old your baby was when he/she started solids, if you cannot remember please give an approximate**

12 Month - Post discharge nutrition of preterm babies

16. Solids

*** 1. How many meals of solids is your baby having per day? Please choose one.**

- 1
- 2
- 3
- 4
- 5
- 6

Other (please specify)

2. How many snacks is your baby having per day? Please choose one.

- 0
- 1
- 2
- 3
- 4
- 5
- 6

Other (please specify)

*** 3. Approximately how much solid food does your baby eat? Please choose one option from each row or N/A**

	1 teaspoon	1 tablespoon	1-3 tablespoons	1/4 cup	1/2 cup	1 cup	More than one cup	N/A
Breakfast								
Lunch								
Dinner								
Snack								

Other (please specify)

*** 4. When feeding your baby, which is fed first?**

- Milk before solids
- Solids before milk

12 Month - Post discharge nutrition of preterm babies

*** 5. What texture would you use to describe the solids your baby is eating? (Choose all that apply)**

- [ ] Puree/ smooth
- [ ] Thick smooth
- [ ] Mashed
- [ ] Finger foods
- [ ] Other

please specify

6. What texture would most of your child's food be?

- ○ Puree/Smooth
- ○ Thick Smooth
- ○ Mashed
- ○ Finger foods
- ○ Other

Other (please specify)

*** 7. Is your child eating the family meal? e.g at dinner time is your child eating what you eat**

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually
- ○ Always

*** 8. Have you introduced self feeding to your infant? (letting them feed themselves) please choose one**

- ○ Yes
- ○ No

*** 9. Is your infant interested in self feeding? (feeding themselves)**

	Yes	No	Have not introduced
With fingers (e.g. finger foods)	○	○	○
With a spoon	○	○	○
With a fork	○	○	○

12 Month - Post discharge nutrition of preterm babies

* 10. How often does your baby eat:

	More than once per day	Once per day	Three or more times per week	Once or twice per week	Less than once per week	Not introduced yet
Rolled oats/porridge	○	○	○	○	○	○
Weetbix	○	○	○	○	○	○
Other breakfast cereals	○	○	○	○	○	○
Iron fortified baby cereal	○	○	○	○	○	○
Rice	○	○	○	○	○	○
Pasta	○	○	○	○	○	○
Bread/ toast	○	○	○	○	○	○
Crackers	○	○	○	○	○	○
Rusk/ teething biscuit	○	○	○	○	○	○

* 11. How often does your baby eat:

	More than once per day	Once per day	Three or more times per week	Once or twice per week	Less than once per week	Not introduced yet
Beef	○	○	○	○	○	○
Lamb	○	○	○	○	○	○
Pork (Including ham)	○	○	○	○	○	○
Chicken & other poultry	○	○	○	○	○	○
Fish	○	○	○	○	○	○
Saveloy/ luncheon sausage	○	○	○	○	○	○
Eggs	○	○	○	○	○	○
Beans, lentils, chickpeas	○	○	○	○	○	○
Tofu	○	○	○	○	○	○
Oysters	○	○	○	○	○	○

* 12. How often does your baby eat:

	More than once per day	Once per day	Three or more times per week	Once or twice per week	Less than once per week	Not introduced yet
Butter or margarine	○	○	○	○	○	○
Cheese	○	○	○	○	○	○
Yoghurt	○	○	○	○	○	○
Ice cream	○	○	○	○	○	○
Custard	○	○	○	○	○	○

13. Do you use cows milk when preparing your childs meals? e.g mashed potato

- ○ Yes
- ○ No

12 Month - Post discharge nutrition of preterm babies

* 14. How often does your baby eat:

	Once per day	Three or more times per week	Once per week	Once a fortnight	Not introduced yet
Dried fruit (raisin, apricot)	○	○	○	○	○
Popcorn	○	○	○	○	○
Sweets/ lollies	○	○	○	○	○
Biscuits/ cakes	○	○	○	○	○
Chocolate	○	○	○	○	○
Muesli bar	○	○	○	○	○
Hot chips/fries	○	○	○	○	○
Potato products (chips/crisps	○	○	○	○	○

* 15. How often does your baby eat the following vegetables and fruits

	Twice a day	once a day	Three or more times per week	Twice per week	Once per week	Once a fortnight	Not introduced yet
Starchy (potato,kumara, corn)	○	○	○	○	○	○	○
Cruciferous (broccoli, cauliflower, cabbage)	○	○	○	○	○	○	○
leafy green (spinach, silverbeet)	○	○	○	○	○	○	○
Red and orange (carrot, pumpkin)	○	○	○	○	○	○	○
Beans and peas	○	○	○	○	○	○	○
Other (avocado, zucchini, cucumber)	○	○	○	○	○	○	○
Berries (blueberry, strawberry)	○	○	○	○	○	○	○
Citrus (orange, mandarin)	○	○	○	○	○	○	○
Melon (honeydew, watermelon)	○	○	○	○	○	○	○
Stone (apricot, peach)	○	○	○	○	○	○	○
Tropical (banana, mango)	○	○	○	○	○	○	○
Other (apples, grapes, pears)	○	○	○	○	○	○	○

16. Are there any other foods your baby eats often that you would like to elaborate on, please include how often your baby consumes these foods.

* 17. In regards to your babies food what would you use most often? (choose one)

- ○ Homemade foods
- ○ Pre-prepared foods (e.g. watties)
- ○ Mixture of the above

12 Month - Post discharge nutrition of preterm babies

18. Are there any foods or food groups that you are avoiding introducing to your child?

- Yes
- No

12 Month - Post discharge nutrition of preterm babies

17. Solids and Information Access

*** 1. What foods or food groups have you been avoiding and why?**

*** 2. For majority of meals, where does your child sit to eat?(choose one only)**

- Highchair
- Held by caregiver
- Bumbo seat
- Pram/pushchair
- Seated on the floor
- Seated on furniture/chair/couch
- Other

Other (please specify and elaborate)

3. At breakfast time, does your child eat with the family?

- Never
- Rarely
- Sometimes
- Usually
- Always

4. At lunch time, does your child eat with the family?

- Never
- Rarely
- Sometimes
- Usually
- Always

5. At dinner time, does your child eat with the family?

- Never
- Rarely
- Sometimes
- Usually
- Always

12 Month - Post discharge nutrition of preterm babies

6. Do you feel the hospital provided you with enough support for introducing solids?

- ○ Yes
- ○ No

7. Do you feel the hospital provided you with enough information for introducing solids?

- ○ Yes
- ○ No

8. If you would like to, please elaborate on hospital support and information below

9. What could have been done to improve your support from the hospital for the introduction of solids in your baby? choose all that apply

- ☐ Diet sheets to take home
- ☐ Phone call from hospital dietitian/nurse
- ☐ Resources
- ☐ Support groups
- ☐ No extra support was needed

12 Month - Post discharge nutrition of preterm babies

18. Fluids

1. Has your baby ever had any liquids other than breast milk or infant formula?(this includes water)

- Yes
- No

12 Month - Post discharge nutrition of preterm babies

19. Fluids / Supplements

1. What fluids has your baby had and how often? Tick all that apply.

	How often?
Water	
Cows milk	
Juice	
Tea	
Raro	
Goats milk	
Soy milk	
Flavoured milk	
Soft drink	

Other (please specify)

* 2. When your child drinks fluids do they drink from

- a bottle?
- a sippy cup? (baby cup)
- a cup? (adult cup)
- N/A

Other (please specify)

3. Is your baby currently having any supplements?

- Yes
- No

12 Month - Post discharge nutrition of preterm babies

20. Supplements

1. Which supplements does your baby take?

	Supplement	How many times per day/ week	Who was it recommended by?	How often do you actually give the recommended dosage?
Supplement one				
Supplement two				
Supplement three				
Supplement four				

Other (please specify supplement, dosage and whom recommended it)

12 Month - Post discharge nutrition of preterm babies

21. Sun Exposure

One of the vitamins we are looking at in this study is Vitamin D which is sometimes known as the Sunshine Vitamin. This is because we are able to make Vitamin D in our skin when it is exposed to sunlight. Babies also get Vitamin D from breast milk or infant formula. We are going to ask you a few questions which will tell us about different factors which might affect your baby's vitamin D status.

* 1. Is it currently:

- Summer(September to April)
- Winter (May to August).

* 2. During the past month, when outside in the sun, how often do you:

	Always	Usually	Sometimes	Rarely	Never
apply sunscreen to your baby?					
put a hat on your baby?					
use protective clothing on him/her (e.g. rash shirt)					
consciously keep your baby in the shade?					

12 Month - Post discharge nutrition of preterm babies

22. Other

*** 1. Since discharge, has your baby been readmitted to hospital?**

- Yes
- No

12 Month - Post discharge nutrition of preterm babies

23. Other

1. Briefly note what for and length of their stay

*** 2. Is your child on a special diet? e.g.allergies, lactose free, gluten free**

- Yes
- No

12 Month - Post discharge nutrition of preterm babies

24. Other

The survey is almost complete, thank-you so much for taking the time to complete the survey.

1. What type of special diet and who was it recommended by?

2. Since the blood test taken at four months post discharge, has your child had any other blood tests taken to assess their nutritional status e.g. iron, vitamin D

- Yes
- No

12 Month - Post discharge nutrition of preterm babies

25.

1. If known, please state the results of the blood test

2. Since discharge, has your child been diagnosed with iron deficiency?

- Yes
- No

3. If yes, Who did the test? and what action was taken?

* 4. In the last month, have you experienced any difficulties with feeding your child?

	Never/rarely	Sometimes	Often	Always
Fussiness				
Refusal to eat				
Avoidance of new foods				
Dislike of texture				
Difficulty sucking				
Difficulty chewing				
Difficulty swallowing				
Spit up, vomit, reflux				
Diarrhea				
Constipation				
Small apetite				
Tantrums				
Often gag when eating				
Inability to graduate textures				
Tantrums				
Meal refusal				
Delay in self feeding				

Other -Please specify one not stated or elaborate on any above

12 Month - Post discharge nutrition of preterm babies

*** 5. Since the 9 month feeding questionnaire, would you say that feeding your child has become**

- [ ] More difficult
- [ ] Easier
- [ ] Stayed the same
- [ ] Don't know

Other (please specify)

*** 6. Does your infant bring objects to their mouth to explore and play? e.g. toys, rusks (choose one)**

- ○ Yes
- ○ No
- ○ Don't know

7. Is your child able to use their lips and/or mouth to remove food from the spoon by them self? choose one

- ○ Yes
- ○ No
- ○ Don't know

8. Are there any further comments you would like to add regarding your babies feeding?

9. Do you have any comments about the survey itself? e.g possible improvements

Appendix K: Standard Operating Procedure for Weight Measurement

Preterm Infants – Post discharge nutrition study Standard Operating Procedure – Study code: 26 - Weight

1) Weigh the baby
    a. Explain to the parent(s) that you will need to weigh the baby while they are naked to ensure that you get an accurate weight. Ask for their consent to remove their baby's clothes and nappy. If the parent(s) refuse, weigh the baby with their nappy on and record that consent was not obtained to weigh their baby naked (Clean nappies weigh approximately 30g)
    b. Ensure that the digital baby scales are clean and calibrated.
    c. Place digital baby scales on a hard surface (the back of the wooden length board works well if there is not a hard surface).
    d. Remove infant's nappy and clothing.
    e. Tare/zero the scales.
    f. Place baby in the middle of the scales, wait for the babies weight to stabilse.
    g. Record weight.
    h. Tare/zero scales again.
    i. Reposition the baby and weigh again. Record weight.
    j. If the two measurements differ by more than 100g, take a third measurement
    k. Return baby to mother to re-dress.
    l. Repeat steps 5a to 5l for the next infant if more than one baby is being assessed.

Appendix L: Standard Operating Procedure for Length Measurement

Preterm Infants – Post discharge nutrition study Standard Operating Procedure – Study code: 26 - Length

1) Measure the length of the baby using a length board with a fixed foot piece and movable headpiece
    a. Place length board on a hard surface, place cloth on middle of board.
    b. Take length measurements while baby is wearing his/her nappy.
    c. Place baby on its back with its heels on the edge of the length board so that the child is lying straight and his shoulders and buttocks are flat against the measuring surface.
    d. Ask the parent to gently but firmly hold the baby's legs in place with a hand on the infant's knees to maintain full extension
    e. Slide in the headpiece so that it is gently placed against the infant's head. Make sure that the infants head is not tucked in against their chest or stretched too far back.
    f. Record the measurement from the ruler running down the side of the board on the data collection sheet.
    g. Repeat steps 7c to 7g. Ensure that differences in length are no more than 1cm apart. If the difference is greater than 1cm, repeat steps 7c to 7g again.
    h. Repeat steps 7b to7h for the next infant if more than one baby is being assessed.

Appendix M: Standard Operating Procedure for Head Circumference Measurement

Preterm Infants – Post discharge nutrition study Standard Operating Procedure – Study code: 26 – Head Circumference

1) Measure the baby's head circumference
    a. Ask the parent(s) to hold infant upright in their arms
    b. Position the non-stretch plastic tape measure just above the eyebrows, above the ears, and round the largest part of the back of the head.
    c. Pull the tape snugly to compress the hair and underlying soft tissue.
    d. Record measurement.
    e. Repeat measurement and record. If the second measurement differs by more than 0.2cm, repeat measurement for a third time.
    f. Repeat steps 6a to 6e for the next infant if more than one baby is being assessed.

Appendix N: Infant Feeding Practices Questionnaire: Email to Parents

Hello [Insert Mother's name]

My name is Jenny Vitali from Massey University, Owen introduced me in an earlier email. For my Masters in Dietetics I am looking at feeding practices of preterm babies over the first year of life until one year corrected age. I am very excited about this research as there is practically no research in New Zealand on this topic. Thanks so much for allowing you and your baby to be a part of this exciting research. If at any time you wish to opt out of the research please contact myself or Owen.

Attached to this email is a questionnaire asking about your baby's feeding at 6 months corrected age, please be as honest as possible as there are no right or wrong answers , and all data is anonymous and will be held in strict confidence.

To fill in the questionnaire you will need your child's unique ID code, this is below and will need to be written into the first question of the questionnaire.

Your child's unique ID code is: PT00…. [insert babies name]

The questionnaire can be accessed by clicking on the following link:
http://www.surveymonkey.com/s/Prembaby6month

Once you have clicked the link, the questionnaire will open up in a new tab and will be ready to complete straight away. If you have more than one baby enrolled in this study, please fill out a separate questionnaire for each child.

If you would prefer to have a paper copy of the survey rather than do it online, please reply with a current address and I will send it to you with a return envelope or alternatively I can go through the survey with you via a phone interview.

Thank you so much for taking the time to complete the survey.

If you have any issues at all e.g. not understanding a question, wanting more information, anything! Please feel free to contact me either via email at jenny_vitali@hotmail.com or on my cell phone at 0212607568.

Thank you so much and I hope you enjoy the survey,

Jenny Vitali,
Master of Dietetics student.
Massey University,

Appendix O: Infant Feeding Practices Questionnaire: Email Reminder to Parents

Hello [Insert Mother's name]

It is Jenny Vitali here, the Dietetics student from Massey University doing my research in feeding practices of preterm babies. I am just writing a friendly reminder in regards to your child's preterm feeding questionnaire. It would be really great to receive your response to help contribute to the current research available on preterm infants.

If you are having trouble completing it via the internet I am more than happy to administer the questionnaire over the phone or I could send a paper copy to your home with a return envelope.

Each child has their own unique ID code which needs to be filled into the first section of the questionnaire. If you have two children enrolled you will be given two ID codes and will need to fill in two separate questionnaires.

Your child's unique code is: PT00

Please follow the link below to the questionnaire:
http://www.surveymonkey.com/s/Prembaby6month

Please fill in all responses for the stage your child was at at 6 months corrected age

If you need to contact me for any reason please feel free to do so. I can be contacted via email: jenny_vitali@hotmail.com or via cellphone: 0212607568

Thank you so much for giving up your time for this exciting research.

Yours sincerely,

Jenny Vitali,
Master of Dietetics student.
Massey University,

Appendix P: Data Collection Sheet for Visit Two: 12 Month Corrected Age Home Visit

Post discharge nutrition of preterm babies: micronutrient status and feeding practices of preterm babies after hospital discharge

Data collection sheets for Visit 2

Date: _____

Baby ID: _____

Baby DOB _____

Age in days _____

Health Screening Questionnaire completed ☐

Anthropometric Measurements taken ☐

Baby's weight at 12 month corrected:

_____kg

Baby's length at 12 month corrected:

_____ cm

_____ cm

_____ cm

Mean :

_____ cm

Baby's head circumference at 12 month corrected:

_____cm

_____

cm

_____ cm

Mean :

_____ cm

Infant's Blood Tests:

Completed: ☐

HemoCue Hb: ☐ ☐

Detail of any issues with blood collection

_____

_____

Feeding Questionnaire completed ☐

Sun exposure questionnaire completed ☐

3 day diet record explained - C for completed ☐

Explained to parent how they will receive their results ☐