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Nutrient intake from complementary foods of Asian New Zealand infants

A thesis presented in partial fulfilment of the requirements for the degree of
Master of Science
in
Nutrition and Dietetics

Massey University, Albany
New Zealand

Caitlin Hall

2023

Abstract

Background: The complementary feeding period (6-23 months of age) is when solid foods are introduced alongside breast milk or infant formula. The introduction of complementary foods is important to meet changing nutritional requirements. The Asian population in New Zealand (NZ) is rising, with the most relevant research on Asian infants in NZ focusing on the adherence to food and nutrition guidelines. There has been no research specifically on the energy and nutrient intakes from complementary foods of Asian infants in NZ.

Objectives: To describe Asian NZ infants' energy, carbohydrate, protein, fat, vitamin A, vitamin B12, vitamin C, iron, and zinc intake from complementary foods, and to compare the intake of energy, macronutrients, and micronutrients from complementary foods in Asian NZ infants to non-Asian infants in NZ.

Methods: This study reports a secondary analysis of the *First Foods New Zealand* cross-sectional study of infants (aged 7.0-9.9 months) in Dunedin and Auckland. 24-hour recall data were analysed using Foodworks 10 software with the NZ food composition database FOODfiles, and additional data for commercial complementary foods. The multiple source method was used to estimate usual dietary intake. Ethnicity was collected from the main questionnaire of the study, and answered by the infant's parent/caregiver. Within the Asian NZ group, three Asian subgroups were identified – South East Asian, East Asian, and South Asian. The non-Asian group included all remaining participants of non-Asian ethnicities. Intakes were compared to the nutrient reference values for the 7-12 month age group.

Results: Asian NZ infants (n=99) had a mean energy intake from complementary foods of 1253kJ, compared with 1415kJ for the non-Asian infants (n=526). The mean intake of most nutrients was lower in Asian NZ infants than non-Asian infants – carbohydrates (35g vs. 41g), protein (11g vs. 13g), fat (11g vs. 12g), vitamin A (274µg vs. 329µg), and vitamin B12 (0.49µg vs. 0.65µg). Similar mean intakes were seen in the groups for vitamin C (27.8mg vs. 28.5mg) and zinc (1.7mg vs. 1.9mg), and mean iron intakes were the same for both groups (3.0mg). The adequate intake (AI) from complementary foods for protein (7.1g), fat (7g), and vitamin A (244µg) were exceeded by Asian NZ infants, suggesting these intakes were adequate. Asian NZ infants had intakes of carbohydrates below the AI from complementary foods (51g), and significantly lower than non-Asian infants (p=.031). Asian infants' intakes of vitamin B12 and vitamin C from complementary foods were below the AI's but the AI's include all

complementary food and infant milk, and therefore conclusions around adequacy are unable to be made.

Conclusion: There are differences in the intake of energy and nutrients from complementary foods, between Asian and non-Asian infants in New Zealand. While it was found that Asian infants had a lower mean intake of energy, macronutrients, vitamin A, and vitamin B12 compared with non-Asian infants, the study found that protein, fat, and vitamin A mean intakes from complementary foods were adequate in Asian infants. These insights are important to inform health professionals, as well as the general population, of the differences in intakes between ethnic groups in NZ. Future research would be beneficial to greater understand the complementary feeding period, including infant milk data and micronutrient status.

Acknowledgements

I want to express my gratitude to everyone who has supported me during my Masters. I wouldn't have gotten to where I am today without my support network, both academically and personally.

Thank you to my academic supervisors – Professor Cathryn Conlon and Professor Anne-Louise Heath. Your expertise, knowledge, and detailed feedback has been extremely valuable in my thesis journey. Even when I felt like giving up, the reassurance and support you gave me was always appreciated. Also thank you to the wider First Foods NZ study team as well as all of the baby's and families involved in the study. Thank you also to Jillian Haszard and Karen Mumme for the statistical support you provided me.

To my mum, I don't have enough words to thank you for everything that you have done for me, in life, and throughout my university journey. Thank you for always proof reading my work, being there through the tears, and giving me endless love and support. You are the best.

Thank you to my dietetics friends for the coffee dates, beach walks, pet therapy sessions, constant reassurance, and quality distractions and entertainment when we all needed a break. I wouldn't have gotten through this degree without your support and friendship over the past two years.

To the rest of my family and friends, your support, love, and friendship has not gone unnoticed, despite being so far away from most of you. And a big thank you to my flatmate for proof reading my work. Thank you all.

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List of Abbreviations

Abbreviation or Symbol	Definition
AI	Adequate intake
EAR	Estimated average requirement
EER	Estimated energy requirement
FFNZ	First Foods New Zealand
GUiNZ	Growing Up in New Zealand Study
NRV	Nutrient reference value
NZ	New Zealand
NZDep18	New Zealand Index of Deprivation 2018
RDA	Recommended dietary allowance
RDI	Recommended dietary intake
SD	Standard deviation
kg	Kilogram
g	Gram
Kcal	Kilocalorie
kJ	Kilojoule
L	Litre
mg	Milligram
µg	Microgram
%	Percentage
%TE	Percentage of total energy
<	Less than

Chapter 1: Introduction

1.1 Background

The first 1000 days of life, from conception to two years of age, are critical in predicting health related outcomes for a child's future (Schwarzenberg et al., 2018). The complementary feeding period (between 6 and 23 months of age) is the last nutritional phase of the first 1000 days, and is when solid foods are introduced into an infant's diet, alongside breast milk and/or infant formula (Mameli et al., 2016; Tuck, 2022; UNICEF, 2020).

In New Zealand (NZ), it is recommended that complementary feeding commences around six months of age as an infant's energy and nutrient needs exceed what breast milk alone can provide by this age (Fewtrell et al., 2017; Ministry of Health, 2021). Introducing nutritious foods into an infant's diet provides essential energy and nutrients to assist with the rapid growth during this time, and to help the infant reach their physical and cognitive potential (Torlesse et al., 2022; UNICEF, 2020). The three macronutrients are carbohydrates, protein, and fat. Carbohydrates provide energy, protein helps build skeletal mass, and fat provides energy and is required for development (Beluska-Turkan et al., 2019; Stephen et al., 2012). Micronutrients are vitamins and minerals. These are required in the diet in smaller amounts than macronutrients, but are still essential (Bailey et al., 2015).

Energy, and select nutrients, including protein, vitamin A, and iron are particularly important to meet nutritional gaps, that together with breast milk, can meet the infant's nutrient needs (World Health Organization, 2009). Infants' iron and zinc stores are often depleted following the breastfeeding period, so complementary foods containing these minerals are especially important during complementary feeding (Fewtrell et al., 2017). Iron rich foods are recommended as first foods in NZ (Ministry of Health, 2021). These include iron-fortified infant cereals, cooked and puréed meats, and cooked and puréed legumes. More than 90% of the requirements of iron should be met from complementary foods during this period (Agostoni et al., 2008). Vitamin A and C are commonly found in fruits and vegetables, and are also recommended as first foods for infants (Ministry of Health, 2021). Vitamin B12 is also important during the complementary feeding period, due to the content in breast milk being dependent on the mother's diet (Pawlak et al., 2018). Vitamin B12 is commonly found in

animal products, so those following vegetarian diets may have lower intakes. Following vegetarian dietary patterns has been a common theme reported in South Asian countries (Manikam et al., 2018; Parackal et al., 2015). Milk products and eggs do contain vitamin B12, so those most at risk for lower intakes are those excluding all animal products.

Globally, complementary feeding practices can differ depending on a person's culture, ethnicity, migration status, and economic status (Lioret et al., 2013; Marvin-Dowle et al., 2021; Poskitt & Breda, 2012). Internationally, it has been found that South Asian children living in high-income countries may have complementary feeding practices differing to those of the guidelines of the country (Manikam et al., 2018). Common complementary foods offered in Asian countries include rice and rice products, legumes, grains, and homemade complementary foods consisting of rice and vegetables (Denney et al., 2018; Sirkka et al., 2022; Yu et al., 2016). To meet energy and nutrient needs, it is recommended in NZ that iron-rich foods (such as iron fortified baby cereal, and cooked and puréed minced red meat, chicken, or legumes) and fresh fruits and vegetables are introduced early in the complementary feeding period, while breastfeeding continues (Ministry of Health, 2021). By nine months of age, infants should be consuming two to three meals and one to two snacks per day, with the infant milk feed recommended to be offered to the infant after complementary foods.

International studies have shown that there are differences in feeding practices of Asian infants in high-income countries, and intakes of some nutrients are below requirements in Asian groups (Demmer et al., 2018; Jabri et al., 2020; Manikam et al., 2018). In NZ, the Asian population is rising. From the 2018 Census, people of Asian ethnicity made up 14% of the population (Statistics New Zealand, 2018). Data from Whānau Āwhina Plunket (from electronic health data including approximately 85% of infants in NZ) showed that Asian infants made up 25% of the infant population between 2017-2019 (Daniels et al., 2015). Research has investigated both Asian adults (Parackal et al., 2015), and Asian children (Lu, 2002) in NZ. Research had looked into the dietary intakes and frequency of food group consumption in NZ infants (Gontijo de Castro et al., 2018; Judd, 2018), but no studies have focused on Asian infants' nutrient intakes. This shows the need for a better understanding of nutrient intakes in an Asian group in NZ. Asian infants are a minority group in NZ, but research is required to

understand any potential differences when compared with the other ethnic groups in NZ. Additionally, it is beneficial to investigate the complementary food intake on its own, as this is the modifiable part of the complementary feeding diet, compared with infant milks.

The complementary feeding period is a transitional period, and involves changes to both macronutrient and micronutrient intakes, to meet changing nutritional requirements (Agostoni et al., 2008; Boswell, 2021). Complementary foods should aim to meet energy, macronutrient, and micronutrient requirements, in combination with infant milks. Complementary food intake are unknown, and research is required to investigate this, in an Asian NZ cohort.

1.2 Purpose of the Study

The purpose of the study is to determine the energy, macronutrient, and micronutrient dietary intake from complementary foods of Asian NZ infants, between 7.0 and 9.9 months of age. The complementary feeding period is critical for not only developing feeding practices, but also meeting nutritional gaps that breast milk cannot provide beyond six months.

1.3 Aim

To determine the energy, macronutrient, and micronutrient intake from complementary foods of Asian New Zealand infants 7.0-9.9 months of age.

1.3.1 Objectives

1. To describe Asian New Zealand infants' energy, carbohydrates, protein, and fat intake from complementary foods.
2. To describe Asian New Zealand infants' vitamin A, vitamin B12, vitamin C, iron, and zinc intake from complementary foods.
3. To compare the intake of macronutrients and micronutrients from complementary foods in Asian New Zealand infants and non-Asian infants in New Zealand.

1.4 Thesis Structure

This thesis is divided into four chapters. Chapter 1 is an introduction and contains the background, purpose of the study, aim, objectives, and researcher contributions. Chapter 2 is a literature review of the research in the area of complementary feeding, nutrients, and infant macronutrient and micronutrient intake from complementary foods. Chapter 3 is a research study manuscript and contains the abstract, introduction, results, discussion, conclusion, and references. Chapter 4 is a conclusions and recommendations chapter and contains an overview of the completion of the aim and objectives, as well as the impact that this research could provide for infant nutritional health in New Zealand. The appendices will include the advertisement of the study, participant information pamphlet, main questionnaire, 24-hour recall protocol, and decimal place values used.

1.5 Research Contributions

Research contributions to this thesis are shown in Table 1.1.

Table 1.1 Summary of author research contributions to the thesis

Author	Contributions to Thesis
Caitlin Hall **MSc Nutrition and Dietetics Student**	Primary author of the thesis, reviewed the literature, analysed the data provided, interpreted results, and produced manuscript and conclusions.
Professor Cathryn Conlon **Primary Academic Supervisor**	Academic Supervisor, Co-Investigator for FFNZ study, assisted in data analysis, revised, and approved all thesis chapters and manuscript.
Professor Anne-Louise Heath **Co-Supervisor**	Co-Supervisor, Joint Principal Investigator of FFNZ study, assisted in data analysis, revised, and approved all thesis chapters and manuscript.
Associate Professor Jillian Haszard	Statistical guidance and data preparation
Dr Karen Mumme	Statistical guidance and support with SPSS

Chapter 2: Literature Review

2.0 Introduction

Relevant literature on the topic of infant nutrient intake from complementary foods was identified through searching online databases (PubMed, Google Scholar, Web of Science, Massey Discover). Combinations of the search strategies listed in Figure 2.1 were searched, as well as reference lists, and key words. The search included evidence published between 1998 and September 2023. A focus on each of the specific nutrients of interest was applied, as well as international research of Asian infants in high-income countries. Website searches were used to identify relevant dietary guidelines (World Health Organization, Ministry of Health NZ).

Date searched: November 2022 – September 2023

Search criteria:

1. Carbohydrate OR protein OR fat OR macronutrient OR energy OR "vitamin A" OR "vitamin B12" OR "vitamin C" OR iron OR zinc OR micronutrient
2. "Dietary intake" OR intake OR "food source"
3. Baby OR infant OR babies OR toddler OR child
4. "Feeding practice" OR "complementary feeding" OR "complementary food"
5. New Zealand OR Aotearoa OR NZ
6. Asia OR Asian OR China OR India OR Thailand OR Indonesia
7. "United Kingdom" OR "United States" OR Ireland OR Singapore OR Australia OR "high-income countries"

Electronic databases: PubMed, Google Scholar, Web of Science, Massey Discover.

Figure 2.1 Search strategy for literature review

2.1 Complementary Feeding

The complementary feeding period is when solid foods are introduced into an infant's diet, alongside breast milk or infant formula, between 6 and 23 months of age (Tuck, 2022; UNICEF, 2020). During this period, foods consumed should meet essential nutritional requirements and encourage optimal food-related behaviours, skills, and attitudes (Boswell, 2021). This period is associated with changes in an infant's macronutrient and micronutrient intake to meet their changing nutritional requirements (Agostoni et al., 2008; Boswell, 2021).

The introduction of complementary foods can be initiated by traditional spoon-feeding, baby-led weaning, or a combination of both. Traditional spoon-feeding aims to progress from purées to mashed/lumpy foods and soft finger foods between six and 12 months of age (Ministry of Health, 2021). The goal is that by 12 months of age, the infant is eating the family foods served (Ministry of Health, 2021). Baby-led weaning involves finger foods being offered instead of purées, with the infant selecting the food from what is provided to them (Ministry of Health, 2021). In New Zealand (NZ), the Ministry of Health provides guidelines on traditional spoon-feeding, including safe and appropriate textural progressions (Ministry of Health, 2021). Baby-led weaning is not recommended due to a lack of research in the area, although there is advice available if parents are choosing to follow this approach (Ministry of Health, 2021). The World Health Organization provides guiding principles for complementary feeding worldwide, including starting at six months of age, practising responsive feeding, using fortified complementary foods, and gradually increasing food consistency and variety (World Health Organization, 2009). These guiding principles are in line with the Ministry of Health guidelines recommended in NZ, as well as throughout Asian countries including China, India, and Malaysia (Chinese Center for Disease Control and Prevention, 2022; Ministry of Health, 2021; Ministry of Health Malaysia, 2013; Tiwari et al., 2016).

The complementary feeding period marks the most significant dietary change that a human will experience, impacting both short and long-term health (Boswell, 2021; Lioret et al., 2013). The introduction of foods can be greatly influenced by personal and local culture, family members and relationships, food availability, economic status, the wider community, and parental feeding practices and modelling (Cook et al., 2021; Lioret et al., 2013; Poskitt & Breda, 2012). All of these factors will also be influenced by the country a family lives in, hence

feeding practices may differ from a family's country of origin compared to their country of residence. It is important that the foods consumed by infants are nutritious, as dietary intakes are likely to track from infancy through childhood, which are critical health periods (Lioret et al., 2013). In NZ, Asian is one of the minority ethnic groups, currently making up 14% of the population (Statistics New Zealand, 2018). In infants, electronic health data from Whānau Āwhina Plunket (including approximately 85% of infants in NZ) suggests that Asian infants make up 25% of the infant population in NZ (Daniels et al., 2023).

2.1.1 Age of Complementary Feeding

The World Health Organization recommends exclusive breastfeeding for six months, with complementary foods to be introduced at six months of age (World Health Organization, 2009). These recommendations are in line with the Ministry of Health NZ recommendations, that exclusive breastfeeding should continue to around six months of age (Ministry of Health, 2021). Asian countries including China, India, and Malaysia recommend introducing complementary foods from six months of age (Chinese Center for Disease Control and Prevention, 2022; Ministry of Health Malaysia, 2013; Tiwari et al., 2016). In comparison, the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition recommends complementary foods to be introduced not before 17 weeks (four months) but not beyond 26 weeks (six months) (Fewtrell et al., 2017). Starting complementary feeding before four months may increase the risk of the infant developing childhood obesity, while starting after six months may lead to faltering growth and iron deficiency anaemia (Daniels et al., 2015; Qasem et al., 2015; World Health Organization, 2009).

An infant's complementary foods intake should gradually increase, so that by nine months of age, they are consuming two to three meals a day, and one to two snacks (Ministry of Health, 2021). It is recommended that the milk feed (breast milk and/or infant formula) be given after the complementary foods from 8-9 months to focus on the intake of food (Ministry of Health, 2021).

2.1.2 Common First Foods

First foods for infants differ by countries and cultural influences. The Maternal Infant Nutrition Growth study in China in 2016, analysed food sources of food groups in 436 infants

aged 6-8 months of age (Yu et al., 2016). Rice was the most commonly consumed grain (44% of infants consuming rice daily), followed by infant cereals (40% of infants consuming infant cereals daily). Similarly, the National Nutrition Survey in the Philippines in 2013 analysed food sources of nutrients and food groups in 362 infants aged 6-11.9 months (Denney et al., 2018). Rice was also the most commonly consumed food group (70% of infants consuming rice). The Feeding Infants and Toddlers study in the United States analysed infant and toddler diets, with 249 infants aged 6.0-8.9 months included (Siega-Riz et al., 2010). Compared to Asian countries, only 3% of US infants consumed rice or pasta once per day, compared with 79% of these infants consuming infant cereals (Siega-Riz et al., 2010). In terms of protein sources, 51% of Chinese infants consumed eggs daily, and 12% consumed pork/ham daily (Yu et al., 2016), whereas, for Filipino infants, fish was the top protein source, consumed by 10% of infants aged 6-11-months (Denney et al., 2018). In comparison, <1% of American infants consumed eggs, pork/ham, or fish daily (Siega-Riz et al., 2010). These comparisons highlight the key feeding practice differences in Asian complementary foods, compared with those shown in the United States.

In NZ, it is recommended that infants are given iron-rich foods as their first foods, alongside fruits and vegetables (Ministry of Health, 2021). Iron-rich first foods include cooked and puréed meats, chicken, seafood, tofu, beans, lentils, and iron-fortified infant cereals (Ministry of Health, 2021). Fruit and vegetable-based first foods include cooked and puréed vegetables without skins (kumara, potato, and taro), and cooked and puréed fruits without skins, pips, or seeds (apple and pear) (Ministry of Health, 2021).

2.2 Nutrient Reference Values

Nutrient reference values (NRVs) are a "set of recommendations for nutritional intake based on currently available scientific knowledge" (National Health and Medical Research Council et al., 2006). These recommendations were updated for most nutrients in 2006, with the update prior to this being in 1991 by Australia (National Health and Medical Research Council (Australia), 1991). The 2006 update was joint between National Health and Medical Research Council, the Australian Government Department of Health and Ageing, and the NZ Ministry of Health (National Health and Medical Research Council et al., 2006). Recommendations are provided for macronutrients and micronutrients. For infants, these recommendations are

often set as “adequate intakes” (AI), which is “the average daily nutrient intake level based on observed or experimentally-determined approximations or estimates of nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate” and is used when a recommended dietary intake (RDI) cannot be determined (National Health and Medical Research Council et al., 2006). An RDI is “the average daily dietary intake level that is sufficient to meet the nutrient requirements of nearly all (97–98%) healthy individuals in a particular life stage and gender group”, but requires that there is enough information on requirements to set an estimated average requirement (EAR) (National Health and Medical Research Council et al., 2006). An EAR is "the average daily nutrient intake that is estimated to meet the requirement of half the healthy individuals in a particular life stage and group” (National Health and Medical Research Council et al., 2006). An estimated energy requirement (EER) is “the average dietary energy intake that is predicted to maintain energy balance in a healthy adult of defined age, gender, weight, height, and level of physical activity, consistent with good health. In children and pregnant and lactating women, the EER is taken to include the needs associated with the deposition of tissues or the secretion of milk at rates consistent with good health” (National Health and Medical Research Council et al., 2006).

When using the AI to assess group nutrient intake data, a mean usual intake at, or above, the AI will imply a low prevalence of inadequate intakes within the group (National Health and Medical Research Council et al., 2006). No estimates on nutrient inadequacy can be made for usual intakes below the AI (Institute of Medicine Subcommittee on Interpretation Uses of Dietary Reference Intakes & Institute of Medicine Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, 2000)

The EAR can be used for group nutrient intake data to estimate the prevalence of inadequate intakes within a group, however, the RDI cannot be used to assess the nutrient intake of a group (National Health and Medical Research Council et al., 2006).

Although the NRVs are the only reference values available in NZ, they were established over 20 years ago, and for infants, most values were either extrapolated from other age groups, or based on breast milk nutrient composition from a small sample of mothers (Institute of Medicine Subcommittee on Interpretation Uses of Dietary Reference Intakes & Institute of

Medicine Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, 2000; National Health and Medical Research Council et al., 2006). Additionally, the AIs for the macronutrients and vitamin A are from complementary foods only, but the EER, AIs, EARs, and RDIs for energy for the remaining micronutrients are from both complementary foods and infant milks. This means conclusions around adequacy of the nutrients are unable to be made.

2.3 Macronutrient Intake of Infants

Macronutrients are required in the diet in large amounts, daily. The consumption of adequate macronutrients during the first years of life influences growth and the potential risks of developing non-communicable diseases (Poskitt & Breda, 2012), although the specific role of these macronutrients during the complementary feeding period is not clear (Grote et al., 2018). The three macronutrients (carbohydrates, protein, and fat) all contribute energy to the diet. Table 2.1 shows the requirement (AI) of the macronutrients for infants aged 7-12 months, from complementary foods. It is recommended in NZ to consume a variety of foods from all food groups which can provide the nutrients infants require during this period (Ministry of Health, 2021).

Table 2.1 Macronutrient Adequate Intakes (aged 7–12 months)

	AI from complementary foods
Carbohydrates	51g/day
Protein	7.1g/day
Fat	7g/day

Source: Adapted from National Health and Medical Research Council (2006)

2.3.1 Energy

Infants require energy from food for biological and physiological functions, metabolic processes, and the growth and development of new tissues (National Health and Medical Research Council et al., 2006). The sources of energy are the three macronutrients (carbohydrates, protein, and fat) (National Health and Medical Research Council et al., 2006). Energy requirements are defined by the average needs of individuals within a chosen group

(Butte, 2005). For infants, this is done using age in months, and reference weights in kilograms (kg) (Table 2.2). Energy requirements are given as an overall amount from infant milks and complementary foods, but the amount of energy required from complementary foods is low (Lutter et al., 2021). It is estimated that 540kJ are required from complementary foods from the 6-8 month period, and 1300kJ are required from complementary foods from the 9-11 month period (Lutter et al., 2021). Although the amount required from complementary foods is low, the total energy required in infancy is three times as much as adults, on a per kg body weight basis (National Health and Medical Research Council et al., 2006).

Table 2.2 Estimated Energy Requirements (total requirement) of infants (aged 7-12 months)

Age (months)	Reference weight (kg)		EER (kJ/day)	
	Boys	Girls	Boys	Girls
7	8.4	7.7	2800	2500
8	8.9	8.1	3000	2700
9	9.3	8.5	3100	2800

Source: Adapted from National Health and Medical Research Council (2006)

2.3.2 Carbohydrates

Carbohydrates contribute energy to the body, specifically the brain, and are one of the main sources of energy in infancy and childhood (National Health and Medical Research Council et al., 2006; Stephen et al., 2012). Although it is known that the key function of carbohydrates is providing energy, the carbohydrate quality and quantity needs during the complementary feeding period is unknown (Poskitt & Breda, 2012; Salvatori et al., 2020). From six months up until two years of age, the amount of carbohydrates consumed should increase gradually, and contribute between 40-60% of total energy from breast milk and complementary foods (Alvisi et al., 2015; Stephen et al., 2012).

Requirements for carbohydrates for the 7-12 month age group are given as an overall amount, and an amount from complementary foods (Table 2.1), as it is assumed that 0.60L/day of breast milk or infant formula is consumed, which also provides carbohydrates,

primarily in the form of lactose (Berger et al., 2020; National Health and Medical Research Council et al., 2006).

The most common sources of carbohydrates from complementary foods in Asian countries include rice, noodles, infant cereals, and rice porridge (Lim et al., 2018; Wang et al., 2015). Comparatively, in the United States, infant cereals, juice, and bananas were the most common complementary food sources of carbohydrates (Fox et al., 2006). In South Asian infants, grain foods are the main complementary foods consumed during the complementary feeding period (Aguayo, 2017). In NZ, research on infants adherence to food and nutrition related guidelines has been analysed in 9-month old infants, as a part of the Growing Up in NZ study (Gontijo de Castro et al., 2018). Although this research did not present the food sources of carbohydrates in NZ, it found that 90% of infants consumed foods from the breads and cereals food group once or more per day. This study only presented adherence to guidelines, and not specific nutrient intakes.

2.3.3 Protein

Protein is a macronutrient made up of amino acids, with structural and functional roles (National Health and Medical Research Council et al., 2006). Protein sources in the diet also provide energy for the body, but in a lesser amount than carbohydrates and fats, but protein containing foods are often rich in vitamins and minerals, including iron, zinc, and vitamin B12 (National Health and Medical Research Council et al., 2006). During the complementary feeding period, once a wide variety of complementary foods are consumed, protein intakes are often above recommended amounts by 12 months of age (Chouraqui et al., 2020; Poskitt & Breda, 2012). Intakes of protein are important to fill the nutritional gaps that breast milk can no longer fully meet, and complementary foods should provide (World Health Organization, 2009).

Requirements for protein for the 7–12-month age group are given as an overall amount, and an amount from complementary foods, as it is assumed that 0.60L/day of breast milk or infant formula is consumed (Table 2.1), which also provides protein (National Health and Medical Research Council et al., 2006). The percentage of total energy contributed from protein should be around 10% (Alvisi et al., 2015).

Protein is found in animal products, including meat, eggs, fish, and dairy products, and plant foods, including bread, grains, and legumes (Salvatori et al., 2020). In Asian countries, eggs, rice, noodles, infant cereals, fish, pork, beef, and lamb are the top sources of protein from complementary foods (Lim et al., 2018; Wang et al., 2015). While unmodified cow's milk drinks are not recommended in NZ for infants <12 months of age (Ministry of Health, 2021), US infants were reported to consume milk drinks as their top protein source from complementary foods, followed by infant cereal and infant food dinners (Fox et al., 2006). No specific food sources were identified in NZ research, however, 61% of infants consumed foods from the meat and meat alternatives food group once or more per day (Gontijo de Castro et al., 2018).

2.3.4 Fat

Fat is required in the diet for energy, providing the most concentrated form of energy compared to carbohydrates and protein, with functions also including brain and nervous system development and the enhancing the absorption of fat-soluble vitamins (Alexy et al., 1999; Lutter & Rivera, 2003; National Health and Medical Research Council et al., 2006). Dietary fats also enhance the palatability of foods, and therefore may increase the overall intake of energy in the complementary feeding period, which is important to meet the high energy requirements in the first year of life (Lutter & Rivera, 2003; Salvatori et al., 2020). Low fat diets in infancy can result in lower energy intakes, which can then lead to growth faltering (Salvatori et al., 2020; Tuck, 2022). From ages 6–24 months, the high quantity of fat intake in the diet does not appear to be associated with health outcomes later in life, although it is uncertain whether serum lipid levels during infancy and childhood can be used to track potential cardiovascular disease risk in adulthood (Fewtrell et al., 2017; Öhlund et al., 2008).

Fat requirements for the 7–12 month age group are given as an overall amount, and an amount from complementary foods, as it is assumed that 0.60L/day of breast milk or infant formula is consumed (Table 2.1), which also provides fats (National Health and Medical Research Council et al., 2006). The World Health Organization recommends that fat intake is between 30-45% of total energy intake, from both breast milk and complementary foods (Pan American Health Organization & World Health Organization, 2003).

Infants in Asian countries reported eggs, oil, pork, beef, lamb, and fish as the main fat sources from complementary foods (Lim et al., 2018; Wang et al., 2015), whereas US infants consumed milk, butter/oil/margarine/other fats, and infant food dinners as the top sources of fat from complementary foods (Fox et al., 2006). This differs from NZ guidelines about infants not consuming unmodified cow's milk before 12 months of age (Ministry of Health, 2021).

2.4 Micronutrient Intake of Infants

Micronutrients are vitamins and minerals required in the diet in smaller amounts than macronutrients. Infants require micronutrients to replace losses from metabolic processes, and for growth (Bender, 2003). The amount of the micronutrients required for infants is given as an overall amount (including from breast milk/infant formula), as well as an amount from complementary foods for some micronutrients (National Health and Medical Research Council et al., 2006). Amounts of micronutrients required from complementary foods will vary depending on the quantity of breast milk or formula consumed, but an overall amount of 0.6L of breast milk or formula is used to create AIs for the 7-12 month age group (Table 2.3, Table 2.4) (National Health and Medical Research Council et al., 2006). An EAR and RDI are available for both iron and zinc requirements.

Complementary foods need to provide large amounts of some micronutrients, including vitamin A, iron, and zinc. These are required by infants in five times the amount on a per kg basis when compared with adults, and there is a need to fill the nutritional gap that breast milk cannot provide at this age for some of these nutrients (Dewey, 2001; National Health and Medical Research Council et al., 2006; World Health Organization, 2009). Due to these high requirements of micronutrients during infancy and childhood, micronutrient deficiencies are a greater risk during this period (Lutter et al., 2021). There are differences in the micronutrient content of breast milk and infant formulas, which makes it challenging to understand the entire nutritional status of infants, solely from complementary food intake.

Table 2.3 Vitamin requirements (aged 7-12 months)

	AI total requirement	AI from complementary foods
Vitamin A	430µg/day	244µg/day (of retinol equivalents)
Vitamin B12	0.5µg/day	-
Vitamin C	30mg/day	-

Source: Adapted from National Health and Medical Research Council (2006)

Table 2.4 Mineral requirements (aged 7-12 months)

	EAR	RDI
Iron	7mg/day	11mg/day
Zinc	2.5mg/day	3mg/day

Source: Adapted from National Health and Medical Research Council (2006)

2.4.1 Vitamin A

Vitamin A is a fat-soluble vitamin that is important for immunity, infection, inflammation, vision, and growth (National Health and Medical Research Council et al., 2006; Zinder et al., 2019). In infants and children, vitamin A also aids in preventing morbidity and mortality from infectious diseases (National Health and Medical Research Council et al., 2006). The AI for vitamin A is given as retinol equivalents. A µg retinol equivalent is equal to 1µg of all-trans retinol, and 6µg of all-trans ß-carotene (Table 2.3) (National Health and Medical Research Council et al., 2006).

Food sources of vitamin A include liver, fish, eggs, and dairy products (including milk, butter, and cheese) (Miller et al., 2002). These food sources are preformed vitamin A, and are more bioavailable in the body (Miller et al., 2002). Unmodified cow's milk is not recommended as a drink for infants under 12 months of age, so cannot be recommended as a good source of vitamin A for the infant group (Ministry of Health, 2021). The other form of vitamin A, beta-carotene, is less bioavailable but is found in fruits and vegetables, particularly green leafy vegetables, which are recommended as first foods for infants (Jiang et al., 2008; Ministry of Health, 2021; Silva et al., 2019). It is important for infants to consume vitamin A rich foods as

there is a nutritional gap where breast milk cannot provide the full requirement of vitamin A (World Health Organization, 2009).

2.4.2 Vitamin B12

Vitamin B12 is a water-soluble vitamin required for blood and neurological function (Ministry of Health, 2021; Obeid et al., 2019). It naturally occurs in animal products including meat, poultry, fish, shellfish, dairy products, and eggs (Ministry of Health, 2021). Some plant-based foods, including soy milk and marmite, can be fortified with vitamin B12, which is important for those following plant-based diets (Ministry of Health, 2021; Obeid et al., 2019).

The AI for 7-12 months is calculated based on a body weight basis from that of younger infants aged 0-6 months, then cross checked with the adult EAR (Table 2.3) (National Health and Medical Research Council et al., 2006). There is limited knowledge of the vitamin B12 content of the diet during the complementary feeding period, so there is no known portion of the AI specifically required from complementary foods during this time (National Health and Medical Research Council et al., 2006). The vitamin B12 content of breast milk is affected by maternal intake, therefore, infants will be provided with sufficient vitamin B12 in their diet through breast milk, as long as the mother has adequate status herself (Pawlak et al., 2018). This is something that is often lower amongst vegetarian and vegan women (Pawlak et al., 2018). Vegan mothers are recommended to supplement their diets with vitamin B12 during pregnancy and the breastfeeding period due to low stores in infants, and their breast milk containing limited amounts (National Health and Medical Research Council et al., 2006).

2.4.4 Vitamin C

Vitamin C is a water-soluble vitamin with antioxidant effects, which assists in the absorption of iron and copper in the body (National Health and Medical Research Council et al., 2006). Low intakes of vitamin C can cause scurvy, and in infants, this would affect active bone growth (National Health and Medical Research Council et al., 2006). Clinical signs of deficiency in adults occur at intakes <7-8mg/day (National Health and Medical Research Council et al., 2006).

The AI for 7-12 months is calculated using a body weight basis from that of younger infants aged 0-6 months (Table 2.3) (National Health and Medical Research Council et al., 2006). Vitamin C is found in fruits and vegetables, with the best sources coming from citrus fruits, capsicum, and berries (Bellows et al., 2012; Ministry of Health, 2021).

Despite citrus fruits being sources of vitamin C, only 10% of infants consumed these at least once per day in a study of infants in China (Yu et al., 2016), and 33% of NZ infants (Morgan, 2021). Comparatively, apples and bananas were consumed by 41% of the Chinese infants (Yu et al., 2016), and bananas were consumed by 86% of the NZ infants (Morgan, 2021). Apples and bananas contain ten times less vitamin C than citrus fruits (~5-10mg compared with ~100-150mg per 100g) (Plant and Food Research & Ministry of Health, 2022). Although citrus fruits are good sources of vitamin C, these are less commonly consumed by infants compared with apples and bananas by both infants in NZ and infants in China.

2.4.5 Iron

Iron is a mineral used in the body to make haemoglobin in red blood cells and myoglobin in muscles (Lopez et al., 2016). Inadequate intakes of iron can result in deficiencies ranging in severity, from low iron stores to iron-deficiency anaemia (National Health and Medical Research Council et al., 2006). One of the risk factors for developing iron-deficiency anaemia in infants is a low intake of iron-rich complementary foods (Domellöf et al., 2014; Fewtrell et al., 2017). Children (aged 0-5 years), women of childbearing age, and pregnant women are most at risk due to increased needs during these physiological life stages, with infants aged 6-24 months having the highest iron requirements per kg of body weight of any age group (Bailey et al., 2015; Domellöf et al., 2014; Lopez et al., 2016). This presents a nutritional gap where breast milk cannot provide the entire iron requirement, so complementary foods must contribute dietary iron (World Health Organization, 2009).

In NZ, wholegrain cereal products, meat, fish, and poultry contribute the highest amounts to iron intake across the population (National Health and Medical Research Council et al., 2006). It is known that iron obtained from plant-sources (non-haem iron, such as wholegrain cereals) is less bioavailable in the body, whereas iron obtained from animal-sources, containing haem iron (e.g. meat, fish, poultry), is more bioavailable (Anderson & Frazer, 2017; National Health

and Medical Research Council et al., 2006). For infants starting complementary feeding, iron-rich first foods are recommended including meat products and iron-fortified cereals (Domellöf et al., 2014). Data from the United States found that infant cereals were the highest contributor of dietary iron for the ages 6-11.9 months old (Finn et al., 2017), whereas in NZ, infant food, fruits and vegetables, and cereals all equally contributed to dietary iron intake in infants under 12 months old (Soh et al., 2002), although, this NZ research is over 20 years old, and infant dietary patterns may have changed since then.

For Asian adults in NZ, having an Asian dietary pattern has been found to be a risk factor for having suboptimal iron status, due to the reduced meat intakes seen in Asian adults in NZ compared with other ethnicities (Parackal et al., 2015). Findings from the Adult National Nutrition Survey in NZ found that Asian adults did not have significantly lower intakes of iron compared with NZ European and other adults (Parackal et al., 2015). However, as the Asian groups in this study were found to be less likely to consume meat products (Parackal et al., 2015), it is possible that the iron consumed is less bioavailable as it would be from plant sources (non-haem) and therefore, less of the iron intake would be absorbed.

2.4.6 Zinc

Zinc is essential for cellular processes including helping to maintain the structure of proteins (Ackland & Michalczyk, 2016; National Health and Medical Research Council et al., 2006). During infancy, zinc intake is especially critical for growth and development, immune function, and cognitive development (Ackland & Michalczyk, 2016). It is available in a wide variety of foods, but meat, fish, and poultry provide the most to the diet, as absorption is highest from animal foods (National Health and Medical Research Council et al., 2006). Cereals and dairy products also contain substantial amounts of zinc but higher intakes of these are required to meet the same levels of absorption, therefore those following vegetarian and vegan diets are more at risk for zinc deficiencies (Fewtrell et al., 2017; National Health and Medical Research Council et al., 2006).

Similarly to iron, zinc concentrations in breast milk can decline rapidly over the post-natal period, although the bioavailability of zinc is higher than that of iron (Dewey, 2001; Krebs, 2000). Consumption of fortified cereals and meats had been shown to provide adequate

contributions to meet requirements of zinc intake in US infants in 2008 (Krebs et al., 2012). Although iron and zinc-fortified cereals are available internationally as a source of zinc for infants, in NZ, infant cereals are only fortified with iron. A study in NZ comparing infant feeding methods looked into zinc intake in the 7-month age group between 2012-2014 (Daniels et al., 2018). At 7-months of age, vegetables contributed the most zinc in a traditional spoon feeding group. It was also noted that breast milk and infant formulas were the main sources of zinc at 7 months of age. The food sources of zinc show there may not be differences in dietary zinc intake for vegetarian infants during the complementary feeding period in NZ.

2.5 Dietary Assessment in Infants

To monitor nutrient intake from infants' diets, dietary assessment tools are required (Freisling et al., 2015). In infants, this is made difficult since dietary intake habits are changing rapidly during the complementary feeding process, infants are not always consuming all food that is served, and there is often involvement of multiple caregivers (parents, child-care centres, caregivers) in the feeding process (Ortiz-Andrellucchi et al., 2009; Persson & Carlgren, 1984). Also, infant intake reporting has to be done by a caregiver which can add additional stress and burden to keep accurate records or recall food accurately (Lanigan et al., 2004; Williamson et al., 2003). Most recent studies measuring the diets of infants have used 24-hour dietary recalls (Demmer et al., 2018; Jabri et al., 2020; Sharma et al., 2013), weighed food diaries (Daniels et al., 2018), and food-frequency questionnaires (Gontijo de Castro et al., 2018). In a systematic review assessing micronutrient intake in infants, it was found that 3-day weighed dietary records were more valid measures of intake than food-frequency questionnaires (Ortiz-Andrellucchi et al., 2009). There is a burden on the participant associated with weighed dietary records, whereas food frequency questionnaires and 24-hour recalls require less participant involvement and burden. A study performed on 4-5 year old children, showed photographic diet diaries to be beneficial in increasing the validity and reliability of dietary intake recording in pre-schoolers (Small et al., 2009). Photographic methods can be used to record food diaries, or to prompt participants of foods eaten during recalls, which can be beneficial to reduce the difficulties of recalling infant intake. This can increase the validity of 24-hour recalls where participants often have trouble remembering the past 24 hours.

2.6 Energy and Macronutrient Intakes of Asian Infants Living in Non-Asian High-Income Countries

International research has been done on Asian infants' nutrient intakes from complementary foods in high-income countries, including a cross-sectional study of South Asian infants in the United Kingdom (Jabri et al., 2020) and a cross-sectional analysis of data from The National Health and Nutrition Examination Survey based in the USA, with investigations into Asian infant micronutrient intake within the cohort (Demmer et al., 2018). In NZ, 9-12 month daily nutrient intakes have been investigated without ethnicity separations (Judd, 2018), as well as Asian infants in regards to adherences to food and nutrition guidelines (Gontijo de Castro et al., 2018). Asian infant energy and macronutrient intake from complementary foods is yet to be studied.

A cross-sectional study done on South-Asian infants in the United Kingdom looked at the dietary intake of macronutrients in 7-9-month-old infants (Jabri et al., 2020). A mean daily intake of 89g of carbohydrates, 16g of protein, and 30g of fat was reported. The daily energy intake was broken down into a total amount (730kcal – 3055kJ) and an amount from complementary foods (461kcal – 1928kJ). This study did not directly compare to other infants in the United Kingdom at this time.

The National Health and Nutrition Examination Survey in the United States collects dietary recall data of children <5 years of age. Data from the surveys between 2011-2014 were analysed in a cross-sectional analysis to investigate dietary intakes during the complementary feeding period, focusing on the ethnic subgroups of the United States (Demmer et al., 2018). Asian infants aged 0-11 months had mean daily intakes of 803kcal (3369kJ), 102g of carbohydrates, 20g of protein, and 36g of total fat. These intakes were no different to those of the other ethnicities in the study (Non-Hispanic White, Non-Hispanic Black, and Hispanic). A key limitation of the cross-sectional analysis was the exclusion of those consuming breast milk from the study, due to no data being available on breast milk intakes. This excluded 260 participants, with a majority of these likely to be within the 0–11-month age group. This does not give a representative sample of the population, as it is only including formula-fed infants. A limitation of both of the international studies reviewed is the lack of separation of

complementary foods and breast milk and infant formula which makes it challenging to understand the nutritional intake of energy and macronutrients from complementary foods alone.

In NZ, 9-12 month infants nutrient intakes have been investigated through four-day food records (n=95) excluding infant milk intake (Judd, 2018). Results showed infants had mean daily intakes of energy of 1863kJ, 57g of carbohydrates, 18.9g of protein, and 14.2g of fat, from complementary foods. These results were all above the AI's provided for these macronutrients for the age group. This research did not separate infants by ethnicity, but Asian infants (n=7) were included in the total study population. The Growing Up in NZ study analysed the nutrition of 9-month-old infants using the Infant Feeding Index and compared this to sociodemographic characteristics, including self-prioritised ethnicity (Gontijo de Castro et al., 2018). The study focused on the frequencies and percentages of foods consumed each day. An advantage of this study was that it looked into the minority ethnicities of NZ, including the Asian group. It found that Asian infants had the lowest frequency of eating from all four food groups at least once a day at 9 months of age (44%, compared with 56% for the NZ European group). Eating from all four food groups would target each of the three macronutrients, and therefore, this shows the potential increased risk of not meeting nutritional requirements in this demographic group. This research did not look into specific dietary intakes which shows the need for research including Asian NZ infants' macronutrient intake from complementary foods.

2.7 Micronutrient Intakes of Asian Infants Living in Non-Asian High-Income Countries

International research has been done on the nutrient intakes from complementary food of Asian infants in high-income countries. This has included a cross-sectional study of South Asian infants in the United Kingdom (Jabri et al., 2020) and a cross-sectional analysis of data from The National Health and Nutrition Examination Survey based in the USA, with investigations into Asian toddler micronutrient intake within the cohort (Demmer et al., 2018). Additionally, a systematic review evaluated complementary feeding practices of Asian infants in high-income countries in 2018 (Manikam et al., 2018). In NZ, 9-12 month old infants' daily nutrients have been investigated without ethnic separation (Judd, 2018), Asian infants have been investigated in regards to adherences to food and nutrition guidelines (Gontijo de

Castro et al., 2018), and Chinese children in Auckland, NZ, have been investigated in comparison to NRVs (Lu, 2002). These studies are discussed below.

International research on the complementary feeding diets and practices of Asian infants has been plentiful. While complementary feeding diets in low- and middle-income countries are often low in one or more essential micronutrients, Asian infants in high-income countries do not typically show low intakes (Ortenzi & Beal, 2021). However, no studies have investigated dietary intake of micronutrients from complementary foods only.

The cross-sectional analysis of dietary intakes from the National Health and Nutrition Examination Survey's in the United States did not report micronutrient data for infants aged 0-11 months (Demmer et al., 2018). Infants aged 12-23 months did have micronutrient data available, and between 1-3% of Asian infants in this group had intakes below the EAR for vitamin A, vitamin C, iron, and zinc. In comparison, South Asian infants (aged 7-9 months) living in the United Kingdom, showed intake of micronutrients below the dietary reference values. In total, 40% of the infants in the study did not meet requirements for vitamin A, 80% did not meet the requirements for iron, 100% did not meet the requirements for zinc, while all infants met the requirements for vitamin C (Jabri et al., 2020). However, findings from Jabri et al. (2020) should be viewed with caution as the participant numbers in this study were low, with only 5 infants aged 7-9 months included. Additionally, no data were provided on the intakes of European infants in comparison to the South Asian group.

A systematic review of South Asian infants living in high-income countries including the United Kingdom, United States, Canada, and Singapore, identified that the main complementary food groups eaten were fruits and vegetables, flesh foods, and dairy products (Manikam et al., 2018). This is in contrast with the complementary food group of grains, roots, and tubers being commonly consumed in South Asian countries (Manikam et al., 2018). In addition, NZ research on infant food group intake by Gontijo de Castro et al. (2018) found that Asian infants were less likely to consume fruits and vegetables daily compared to NZ European infants, which contrasts with findings from Manikam et al. (2018). This could suggest that low intakes of vitamins A and C may be seen in the Asian NZ infant group. A range of Asian cultures, including adults of South Asian ethnicity in NZ, and in other high-income

countries, have been reported to be less likely to consume meat (Manikam et al., 2018; Parackal et al., 2015). This may potentially lead to low vitamin B12 intakes, as infant feeding practices during the complementary feeding period are decided on by parents/caregivers, and parental eating habits are likely to be passed onto their infants (Lioret et al., 2013; Poskitt & Breda, 2012). For South Asian infants, this may mean that less red meat is offered and consumed, potentially leading to lower iron, zinc, and vitamin B12 intakes in this group, due to these nutrients being found in animal sources.

Micronutrient intakes were analysed in 9-12 month infants in NZ, including all ethnicities, using four-day weighed food records (Judd, 2018). The group (n=95) had a mean intake of vitamin B12 of 0.7µg, mean intake of vitamin C of 29mg, mean intake of iron of 3.0mg, and mean intake of zinc of 2.6mg. These results focused on complementary food intake, and excluded infant milks, but all ethnicities were included and combined for the analysis. These results showed variability in nutrient adequacy when compared to the NRVs, with vitamin B12 and zinc intakes being above the respective AIs. Vitamin C and iron intakes were both below the respective AIs so inadequacy cannot be determined. The only micronutrient intake analysed in the Growing Up in NZ study in the 9-month-old infant group was iron, but this was based on frequency of intake of iron-rich foods, and did not report a mean intake. It was found that Asian and NZ European infants both had similar percentages of the groups consuming iron-rich foods daily (79% and 82% respectively). Although these percentages are high, an intake of iron-rich food daily may not represent intakes that would meet requirements for the groups.

Fruits and vegetables contribute important micronutrients to an infant's diet including vitamin A and vitamin C. Vitamin C-rich fruits and vegetables also aid in the absorption of iron in the body from non-haem sources (Tuck, 2022), which is critical during complementary feeding. In Asian 9-month-old infants in NZ, 80% consumed fruit or vegetables at least once per day, compared to 92% of NZ European infants (Gontijo de Castro et al., 2018). These findings focus on the intake of fruits and vegetables as foods, which are contributors of vitamins A and C, but it does not give an understanding of dietary vitamin intake directly and therefore cannot be used to predict adequacy of intake of these vitamins. Although, food intake does not specifically equal nutrient intake, fruit and vegetable intake during childhood

is related to intake in adulthood and is associated positively with overall health throughout life (Evans et al., 2012). Migrant Chinese children aged 7-10 years in NZ had lower consumption of fruits and vegetables compared to NZ European children (Lu, 2002), suggesting that the lower frequency of intake seen in infants may be continuing through into childhood as well. The mean intake of vitamin A was also lower in Chinese children than in the NZ European children (381µg and 761µg respectively), and below the reference nutrient intake of 500µg for 7-10 year olds. The NRV used for this group comparison was the recommended dietary allowance (RDA) which is not intended for use of assessing diets of groups (Murphy & Barr, 2011), and is not a NRV used for groups in NZ, therefore, comments cannot be made about the adequacy of the intakes in the study. The study did also find that the vitamin C, iron, and zinc intakes of Chinese children in NZ were above recommendations, and similar to those of NZ European children (Lu, 2002), but the use of the RDA as a group comparison is also inappropriate for these micronutrients and therefore, caution must be taken when interpreting these findings.

From research in NZ and in high-income countries internationally, there is mixed evidence on infant intake of micronutrients during the complementary feeding period. The potential micronutrients of concern include vitamin A, vitamin B12, vitamin C, iron, and zinc (Demmer et al., 2018; Gontijo de Castro et al., 2018; Jabri et al., 2020; Lu, 2002; Parackal et al., 2015). Asian infants have been described as less likely to consume fruits and vegetables every day compared with NZ European infants, which could potentially lead to low vitamin A and vitamin C intakes in this group (Gontijo de Castro et al., 2018). Adults of South Asian ethnicity are also less likely to consume red meat, which may cause low iron, zinc, and vitamin B12 intakes (Jabri et al., 2020; Parackal et al., 2015). To answer the questions around Asian infants' micronutrient intake in NZ, it is essential that further research of infants' complementary feeding diets are analysed and compared to appropriate NRVs.

2.8 Summary

From limited international research, it has been shown that there is a potential for low nutrient intake in Asian infants in high income countries. Intakes of macronutrients and micronutrients from complementary foods have been investigated in a 9–12-month infant group in NZ, without exploring differences between ethnic groups, as well as research

describing the adherence to nutrition guidelines in NZ, which did explore ethnic group differences. No research has been done on Asian infants' nutrient intakes from complementary foods, despite the rising Asian population in NZ. This thesis will aim to investigate the macronutrient and micronutrient intake from complementary foods of Asian NZ infants from the *First Foods NZ* study and compare these to all other ethnic groups of NZ. These results will increase the knowledge of this population group and may help inform guidelines and advice given to parents around the complementary feeding period.

Chapter 3: Manuscript

3.0 Abstract

Background: The complementary feeding period (6-23 months of age) is when solid foods are introduced alongside breast milk or infant formula. The introduction of complementary foods is important to meet changing nutritional requirements. The Asian population in New Zealand (NZ) is rising, with the most relevant research on Asian infants in NZ focusing on the adherence to food and nutrition guidelines. There has been no research specifically on the energy and nutrient intakes from complementary foods of Asian infants in NZ.

Objectives: To describe Asian NZ infants' energy, carbohydrate, protein, fat, vitamin A, vitamin B12, vitamin C, iron, and zinc intake from complementary foods, and to compare the intake of energy, macronutrients, and micronutrients from complementary foods in Asian NZ infants to non-Asian infants in NZ.

Methods: This study reports a secondary analysis of the *First Foods New Zealand* cross-sectional study of infants (aged 7.0-9.9 months) in Dunedin and Auckland. 24-hour recall data were analysed using Foodworks 10 software with the NZ food composition database FOODfiles, and additional data for commercial complementary foods. The multiple source method was used to estimate usual dietary intake. Ethnicity was collected from the main questionnaire of the study, and answered by the infant's parent/caregiver. Within the Asian NZ group, three Asian subgroups were identified – South East Asian, East Asian, and South Asian. The non-Asian group included all remaining participants of non-Asian ethnicities. Intakes were compared to the nutrient reference values for the 7-12 month age group.

Results: Asian NZ infants (n=99) had a mean energy intake from complementary foods of 1253kJ, compared with 1415kJ for the non-Asian infants (n=526). The mean intake of most nutrients was lower in Asian NZ infants than non-Asian infants – carbohydrates (35g vs. 41g), protein (11g vs. 13g), fat (11g vs. 12g), vitamin A (274µg vs. 329µg), and vitamin B12 (0.49µg vs. 0.65µg). Similar mean intakes were seen in the groups for vitamin C (27.8mg vs. 28.5mg) and zinc (1.7mg vs. 1.9mg), and mean iron intakes were the same for both groups (3.0mg). The adequate intake (AI) from complementary foods for protein (7.1g), fat (7g), and vitamin A (244µg) were exceeded by Asian NZ infants, suggesting these intakes were adequate. Asian NZ infants had intakes of carbohydrates below the AI from complementary foods (51g), and significantly lower than non-Asian infants (p=.031). Asian infants' intakes of vitamin B12 and

vitamin C from complementary foods were below the AI's but the AI's include all complementary food and infant milk, and therefore conclusions around adequacy are unable to be made.

Conclusion: There are differences in the intake of energy and nutrients from complementary foods, between Asian and non-Asian infants in NZ. While it was found that Asian infants had a lower mean intake of energy, macronutrients, vitamin A, and vitamin B12 compared with non-Asian infants, the study found that protein, fat, and vitamin A mean intakes from complementary foods were likely to be adequate in Asian infants. These insights are important to inform health professionals, as well as the general population, of the differences in intakes between ethnic groups in NZ. Future research would be beneficial to greater understand the complementary feeding period, including infant milk data and micronutrient status.

3.1 Introduction

The complementary feeding period extends from 6-23 months of age, and is defined by the time that complementary foods are introduced alongside breast milk or infant formula (Tuck, 2022; UNICEF, 2020). Complementary foods aim to meet changing nutritional requirements, and support health outcomes, while also laying the foundation for food-related behaviours and skills. (Beluska-Turkan et al., 2019; Boswell, 2021; Wrottesley et al., 2016). Many factors can influence complementary food intake during this time, including local and personal culture, economic and family status, food availability, and modelling of feeding practices (Cook et al., 2021; Lioret et al., 2013; Poskitt & Breda, 2012).

In NZ, the Ministry of Health suggests commencing complementary feeding at around six months of age (Ministry of Health, 2021). By nine months of age, it is recommended that infants are consuming two to three meals and one to two snacks per day, with the milk feed being given after the complementary foods, to encourage food intake (Ministry of Health, 2021). Iron-rich complementary foods are recommended to be introduced first into an infant's diet to ensure they meet iron requirements (Ministry of Health, 2021), as iron stores are often depleted following the breastfeeding period (Fewtrell et al., 2017; National Health and Medical Research Council et al., 2006). Infant rice-based cereals are commonly introduced first foods globally, as they are fortified with iron, are energy-dense, and are cheap and accessible (Fox et al., 2006; Lim et al., 2018; Tuck, 2022; Wang et al., 2015).

It is important that all energy and nutrient requirements are met during the complementary feeding period. This includes macronutrients (carbohydrates, protein, fat) and micronutrients (vitamins and minerals). Energy requirements are determined using weight (kg) and age (months) for infants (National Health and Medical Research Council et al., 2006). Nutrient requirements are determined using the assumption that 0.60L of breast milk or infant formula is consumed for the 7-12 month age group (National Health and Medical Research Council et al., 2006). For infants, some micronutrients including vitamin A, iron, and zinc, are especially important during the complementary feeding period due to these nutrients being required at five times greater amounts per kg of body weight than for adults (National Health and Medical Research Council et al., 2006). The intake of these nutrients from complementary foods is essential to fill nutritional gaps that breast milk cannot fill (World Health Organization, 2009).

Carbohydrates and fat are required for energy in the body while protein is required for growth and development (National Health and Medical Research Council et al., 2006). Protein rich foods, such as animal products, are also often rich sources of essential micronutrients including vitamin B12, iron, and zinc (National Health and Medical Research Council et al., 2006; Salvatori et al., 2020). It is important that these key nutrients are studied due to their overall effects on health during complementary feeding.

Few studies have investigated Asian infants in high-income countries with a focus on complementary food intake. The two most relevant international studies analysed complementary foods and breast milk and/or infant formula (Demmer et al., 2018; Jabri et al., 2020) which is not directly comparable solely to complementary food intake. There is also a lack of studies on NZ infant's nutrient intakes, especially from complementary foods. Relevant research on NZ infants has focused on the adherence to food and nutrition guidelines, and included Asian infants as a group (Gontijo de Castro et al., 2018), which informs about food group intake, but there were no investigations into nutrient intake, besides iron. The other most relevant NZ research was on 9-12 month infants, from complementary foods, but without separation into ethnic categories (Judd, 2018). Asian adults and Chinese older children have been studied in NZ (Lu, 2002; Parackal et al., 2015), with varying results on the nutrient intakes in these groups compared to the other ethnic groups in NZ. The Asian cohort in NZ makes up 14% of the population (Statistics New Zealand, 2018), and approximately 25% of the infant population (Daniels et al., 2023) while also containing various subgroups which all have different ethnic feeding practices.

This study aims to describe Asian NZ infants' energy, carbohydrate, protein, fat, vitamin A, vitamin B12, vitamin C, iron, and zinc intake from complementary foods. It will also compare the intake of energy, macronutrients, and micronutrients from complementary foods in Asian NZ infants to non-Asian infants in NZ.

3.2 Methods

3.2.1 Study Design

The *First Foods New Zealand* (FFNZ) study is an observational cross-sectional study of infants (aged 7.0-9.9 months), with the primary objective of determining whether iron status and BMI z-score differ according to food pouch use and complementary feeding approach (baby-led weaning compared with traditional spoon feeding). Secondary objectives explore growth, food and nutrient intakes, breast milk intake, eating and feeding behaviours, dental health, oral motor skills, and choking risk in the infants. Full detailed methods of the FFNZ study are described elsewhere (Taylor et al., 2021). Ethical approval for the study was granted by the Health and Disability Ethics Committees New Zealand (19/STH/151) and the study was funded by the Health Research Council of New Zealand (HRC 19/172). This current study reports a secondary analysis of data from the FFNZ study, with the focus on nutrient intakes of Asian NZ infants compared to non-Asian infants in NZ.

3.2.2 Participants and Recruitment

Infants and their caregivers in Auckland and Dunedin were recruited by advertisement (Appendix A) and word of mouth, targeting participants regardless of the feeding practices used. The intention was to recruit a sample that broadly represented both the ethnicity and socioeconomic status of NZ infants. This included targeted recruitment in suburbs with high proportions of Māori, Pacific, and Asian populations, and those of lower socioeconomic status. To achieve this, culturally appropriate advertising was used. To be eligible for participation in the study the infant was required to be aged between 7.0 and 9.9 months old. The narrow age range was chosen due to changes in infant diets happening rapidly, as well as this period being close enough to the start of complementary feeding, but with enough time for eating patterns to have an impact on iron status (which was a key objective of the *First Foods NZ* study overall). Infants had to be recruited before 9.5 months of age due to the study taking place over a 2-week period. Any infant older than 9.5 months of age at the time of recruitment was excluded. All adult participants were given information pamphlets prior to commencing the study (Appendix B), and they provided written informed consent.

3.2.3 Data Collection

Data collection commenced in July 2020, and was completed in February 2022. Data collection included a questionnaire for the respondents, dietary assessments, and anthropometric measures for the infants.

Questionnaires

The questionnaire (Appendix C) was administered at the first visit, generally in the home. This included demographic questions about the infant (ethnicity, age in months, sex, born at term, age of starting solids, geographical location of residence, and number of children in the household), and about the adult respondent (ethnicity, age, relation to the infant, education level).

Dietary Assessment

Dietary assessment comprised two interviewer-administered multiple pass 24-hour diet recalls. These were administered at the first and second appointments. In most cases, the first recall was completed in the home, with the second completed in the nutrition clinic space at either the University of Otago (Dunedin) or Massey University (Auckland). The multiple pass style recall included three key stages: a quick list, a detailed description of the food/drinks consumed, and a review of the recall. The details gathered included brand name, product name, quantity of food given, time that the meal started and ended, and how much of the food was consumed, for every food and drink consumed. The two recalls were performed on different days of the week to include potential variations in the infants' diets. The day prior to the recalls, respondents were asked to take photographs of the meals at the start of all meals and snacks, to help them remember the food consumed during the recall. The full protocol for the 24-hour recalls is further outlined in Appendix D. The 24-hour diet recalls were analysed using FoodWorks (version 10, Xyris Software) using the New Zealand Food Composition database FOODfiles 2018 Version 01, and additional data for commercial complementary foods (Katiforis et al., 2021). The recall data was analysed using the Multiple Source Method of estimating usual dietary intake (Harttig et al., 2011), where both recall day values were used to determine usual intake. The mean nutrient intakes were then calculated and reported for the macronutrients and micronutrients. These were then reported alongside

the NRVs for Australia and NZ (2006). Total percentage of energy (%TE) contributed from the macronutrients were reported.

Anthropometric Measures

Infant weight was measured at the initial visit. An electronic scale (model 354; Seca) was used for the measurements. The anthropometric data were collected by trained researchers, following the FFNZ study protocol including duplicate measures being taken for weights. If the duplicate measures were more than 0.1kg different then a third measurement was taken.

3.2.4 Statistical Analysis

Infants were separated into two categories for analysis: total response "Asian" or "non-Asian". Asian infants were further categorised into three sub-categories for analysis: South East Asian (e.g., Vietnamese, Thai, Malaysian, Indonesian, Filipino, Burmese), East Asian (e.g., Chinese, Taiwanese, Korean, Japanese), and South Asian (e.g., Indian, Sri Lankan, South African Indian, Pakistani, Fijian Indian, Nepalese). The non-Asian group included all other infants of ethnicities including NZ European, Māori, Pacific, European, South American, African, Middle Eastern, and other ethnicities. Both total response ethnicity and prioritised ethnicity of the infants were reported. Prioritised ethnicity has a prioritisation order of Māori, Pacific, Asian, European/Other. Total response ethnicity is when each ethnicity that a participant has selected is counted. For analysis of intake and demographic characteristics, total response ethnicity was used to include all Asian respondents in analysis.

Statistical analysis was carried out using Microsoft Excel and IBM SPSS statistics version 29. The categorical, descriptive data (ethnicity of infants and respondents, sex of infants, breastfeeding status, infants born at term, level of deprivation, number of children in the household, respondent relationship to the infant, and education level completed by the respondent) was analysed using numbers (n) and percentages (%). The socioeconomic deprivation category was determined using the New Zealand Index of Deprivation (NZDep18) score (Atkinson et al., 2018), and the participant's home address.

Means and standard deviations were used to report the continuous data (age of infants and respondents, and age at introduction of solid foods). These statistics were analysed in the

total Asian group, and compared to the non-Asian group. The data were checked for normality using Levene's test, before independent t-tests were performed between the total Asian and non-Asian group nutrient results. A *p*-value of <0.05 was used to determine statistical significance. The three Asian subgroups (South East Asian, East Asian, and South Asian) were also compared to each other but not statistically tested.

3.3 Results

3.3.1 Participants

A total of 625 infants were included in the FFNZ study. Of these 625 infants, 99 responded as Asian (total response) (Table 3.1). Analysing by prioritised ethnicity decreased the number of Asian infants (n=90).

Table 3.1 – Infant ethnicity (n=625)

Infant ethnicity	n (%)
Total response[1]	
Total Asian	99 (15.8%)
South East Asian[2]	28 (4.4%)
East Asian[3]	44 (7.0%)
South Asian[4]	31 (5.0%)
Non-Asian	
NZ European, Māori, Pacific, European, South American, African, and Other	526 (83.6%)
Prioritised ethnicity[5]	
Asian	90 (14.4%)
Māori, Pacific, Others, European	535 (85.6%)

[1] Total response ethnicity includes every respondent allocated to all ethnic groups they have identified with.
[2] Vietnamese, Thai, Malaysian, Indonesian, Filipino, Burmese.
[3] Chinese, Taiwanese, Korean, Japanese, Asian.
[4] Indian, Sri Lankan, South African, Indian, Pakistani, Fijian Indian, Nepalese.
[5] Prioritised ethnicity includes every respondent being allocated to only one ethnic group selected, with the prioritisation order of: Māori, Pacific, Asian and European/Other.

The demographic characteristics of the Asian NZ infants and non-Asian infants are shown in Table 3.2. The mean age of the infants in the study was 8 months, and the mean age of solid food introduction for the infants was 5 months. At the time of the study, 72% of Asian infants and 65% of non-Asian infants were still breastfeeding.

Table 3.2 – Infant characteristics[1] (n=625)

	Total Asian[2] (n=99)	Non-Asian[3] (n=526)	South East Asian (n=28)	East Asian (n=44)	South Asian (n=31)
Age in months**,** mean (SD)	8.4 (0.8)	8.3 (0.8)	8.4 (0.9)	8.3 (0.7)	8.5 (0.8)
Sex, n (%)					
Female	50 (50.5%)	239 (45.5%)	15 (53.5%)	20 (45.5%)	16 (50%)
Male	49 (49.5%)	286 (54.5%)	13 (45.5%)	24 (54.5%)	16 (50%)
Infant born at term, n (%)					
Yes	93 (94.0%)	485 (92.4%)	26 (92.8%)	42 (95.5%)	30 (93.7%)
No	6 (6.0%)	40 (7.6%)	2 (7.2%)	2 (4.5%)	2 (6.3%)
Weight, kilograms, mean (SD)	8.4 (0.97)	8.9 (1.15)	8.3 (0.90)	8.5 (1.04)	8.3 (0.94)
Solid food introduction in months, mean (SD)	5.3 (0.75)	5.2 (0.76)	5.2 (0.72)	5.2 (0.73)	5.5 (0.78)
Breastfeeding at time of study, n (%)					
Yes	71 (72%)	343 (65%)	19 (68%)	33 (75%)	22 (71%)
No	28 (28%)	183 (35%)	9 (32%)	11 (25%)	9 (29%)
Level of socioeconomic deprivation[4], n (%)					
1-3 (Low)	24 (24.2%)	156 (29.7%)	7 (25%)	9 (20.4%)	9 (29%)
4-7	49 (49.5%)	233 (44.3%)	14 (50%)	27 (61.4%)	11 (35.5%)

[1] Total response ethnicity includes every respondent allocated to all ethnic groups they have identified with.
[2] South East, East, and South Asian ethnicities included.
[3] NZ European, Māori, Pacific, European, South American, African, and other ethnicities included.
[4] Determined using the NZ Deprivation Index 2018 where 1 represents the least deprivation, and 10 represents the most deprivation Atkinson, J., Salmond, C., & Crampton, P. (2018). *NZDep2018 Index of Deprivation, Final Research Report, December 2020*. Wellington: University of Otago. https://www.otago.ac.nz/wellington/otago823833.pdf

8-10 (High)	26 (26.3%)	137 (26.0%)	7 (25%)	8 (18.2%)	11 (35.5%)
Number of children in household, n (%)					
One	60 (60.6%)	223 (42.4%)	22 (78.5%)	21 (47.7%)	19 (61.3%)
Two	25 (25.3%)	175 (33.3%)	5 (17.8%)	15 (34.1%)	7 (22.6%)
Three or more	14 (14.1%)	127 (24.1%)	1 (3.6%)	8 (18.2%)	5 (16.1%)
Childcare outside of the home, n (%)					
Yes	20 (20.2%)	89 (16.9%)	4 (14.8%)	8 (20%)	8 (25%)
No	79 (79.8%)	437 (83.1%)	23 (85.2%)	32 (80%)	24 (75%)

Table 3.3 reports respondent characteristics, showing there was a lower number of Asian respondents (12.1%) than Asian infants (15.8%) (Table 3.3). Between 92-100% of respondents were mothers, with a mean age of 32-34 years (Table 3.4). Respondent results showed 92% of Asian respondents had a university qualification, compared with 59% of the non-Asian respondents.

Table 3.3 – Respondent ethnicity (n=625)

Respondent ethnicity	n (%)
Total response[1]	
Total Asian	91 (12.1%)
South East Asian	27 (3.6%)
East Asian	39 (5.2%)
South Asian	25 (3.3%)
Non-Asian	
NZ European, Māori, Pacific, European, South American, African, and Other	655 (87.9%)
Prioritised ethnicity[2]	
Asian	84 (13.4%)
Māori, Pacific, Others, European	541 (86.6%)

[1] Total response ethnicity includes every respondent allocated to all ethnic groups they have identified with.
[2] Prioritised ethnicity includes every respondent being allocated to only one ethnic group selected, with the prioritization order of: Māori, Pacific, Asian and European/Other.

Table 3.4 – Respondent characteristics[1] (n=625)

	Total Asian[2] (n=99)	Non-Asian[3] (n=526)	South East Asian (n=28)	East Asian (n=44)	South Asian (n=31)
Relationship to infant, n (%)					
Mother	97 (98%)	520 (98.9%)	26 (92.8%)	31 (100%)	44 (100%)
Father	2 (2%)	4 (0.7%)	2 (7.2%)	0 (0%)	0 (0%)
Grandparent/guardian	0 (0%)	2 (0.4%)	0 (0%)	0 (0%)	0 (0%)
Age in years, mean (SD)	33.9 (3.8)	32.4 (4.9)	34.0 (3.9)	33.4 (3.9)	34.6 (4.2)
Highest level of education completed, n (%)					
School (primary or secondary)	2 (2.0%)	92 (17.5%)	0 (0%)	1 (3.2%)	1 (2.3%)
Polytechnic or similar tertiary institution	5 (5.1%)	120 (22.9%)	1 (3.6%)	2 (6.5%)	3 (6.8%)
University	92 (92.9%)	313 (59.6%)	27 (96.4%)	28 (90.3%)	40 (90.9%)

3.3.2 Infant's Energy and Macronutrient Intake from Complementary Foods

The total Asian infant group had a mean energy intake from complementary foods of 1253kJ, and the non-Asian infant group had a mean energy intake of 1415kJ (Table 3.5). Per kilogram of body weight, the Asian infants consumed 149kJ/kg, and non-Asian infants consumed 159kJ/kg. When comparing total Asian and non-Asian energy intakes, there was no significant difference (p=.086), as well as no significant differences when separated by sex of the infants (p=.349). Mean energy intakes in all groups were below the EER (total requirement).

Table 3.6 reports the mean macronutrient intakes and compares these to the NRVs. Intake of carbohydrates in total Asian infants (35.3g) was significantly lower than non-Asian infants (41.2g) (p=.031). Additionally, all groups had a mean intake of carbohydrates that were below

[1] Total response ethnicity includes every respondent allocated to all ethnic groups they have identified with.
[2] South East, East, and South Asian ethnicities included.
[3] NZ European, Māori, Pacific, European, South American, African, and Other ethnicities included.

the AI. Neither protein or fat intakes showed significant differences between total Asian and non-Asian infants, and all group mean intakes were above the AI for these macronutrients as well. The %TE contribution from carbohydrates was between 47-49%, protein was between 15-16%, and fat was between 32-34% for all groups. Mean macronutrient intakes were higher in the South East Asian infant subgroup compared with the East Asian and South Asian infants, but no statistical significance was calculated.

Table 3.5 – Energy intake from complementary foods (n=625)

	Total Asian[1] (n=99)	**Non-Asian[1] (n=526)**		**South East Asian[1] (n=28)**	**East Asian[1] (n=44)**	**South Asian[1] (n=31)**	**Nutrient reference value[2]**
	Mean (SD)		*p*-value[3]	Mean (SD)			
Energy, kJ (total)	1253 (892)	1415 (851)	0.086	1467 (1449)	1147 (749)	1213 (735)	
Girls	1073 (600)	1312 (764)		1090 (676)	1050 (571)	1070 (586)	2700 kJ[4]
Boys	1438 (1089)	1501 (910)	0.349	1903 (1478)	1229 (875)	1366 (861)	3000 kJ[4]

[1] Total response ethnicity includes every respondent allocated to all ethnic groups they have identified with.
[2] Nutrient reference values from National Health and Medical Research Council, Australian Government Department of Health and Ageing, & New Zealand Ministry of Health. (2006). *Nutrient Reference Values for Australia and New Zealand.* Canberra: National Health and Medical Research Council.
[3] Independent t-test to show the difference between Total Asian and Non-Asian energy and macronutrient intake.
[4] Estimated energy requirement (total requirement from all food and milks).

Table 3.6 – Macronutrient intake from complementary foods (n=625)

	Total Asian[1] (n=99)	Non-Asian[1] (n=526)		South East Asian[1] (n=28)	East Asian[1] (n=44)	South Asian[1] (n=31)	Nutrient reference value[2]
	Mean (SD)		*p*-value[3]	Mean (SD)			
Carbohydrates							
Grams	35.3 (24.6)	41.2 (24.7)	0.031	42.5 (30.5)	32.5 (21.9)	33.2 (21.3)	51 g[4]
% Total energy from complementary foods	48%	49%		49%	48%	47%	
Protein							
Grams	11.5 (8.3)	13.0 (8.4)	0.100	12.7 (9.9)	11.0 (7.9)	10.9 (7.1)	7.1 g[5]
% Total energy from complementary foods	16%	16%		15%	16%	15%	
Fat							
Grams	11.1 (10.8)	12.1 (9.2)	0.329	12.9 (14.2)	9.8 (7.8)	11.0 (10.5)	7 g[5]
% Total energy from complementary foods	33%	32%		33%	32%	34%	

[1] Total response ethnicity includes every respondent allocated to all ethnic groups they have identified with.
[2] Nutrient reference values from National Health and Medical Research Council, Australian Government Department of Health and Ageing, & New Zealand Ministry of Health. (2006). *Nutrient Reference Values for Australia and New Zealand.* Canberra: National Health and Medical Research Council.
[3] Independent t-test to show the difference between Total Asian and Non-Asian energy and macronutrient intake.
[4] Adequate intake from complementary foods.

3.3.3 Infant's Micronutrient Intake from Complementary Foods

Table 3.7 shows the mean micronutrient intakes in the total Asian, non-Asian, and Asian subgroups. The total Asian infants had lower intakes of most micronutrients than the non-Asian infants, but these findings were not significant. When comparing mean intakes of the micronutrients to the NRVs, the mean intakes of vitamin A were mostly above the AI. Asian infants had intakes of vitamin B12 below the AI, whereas non-Asian infants had vitamin B12 intakes above the AI. Vitamin C, iron, and zinc intakes were below the NRV for both total Asian and non-Asian infants. Between the Asian subgroups, South East Asian infants had the highest intakes of all micronutrients, whereas East Asian and South Asian had the lowest intakes. Table 3.8 shows the percentage of each of the main- and sub-groups with intakes below the EAR for iron and zinc. In total, 85-96% of infants in the study had inadequate intakes of iron from complementary foods, and 73-82% had inadequate intakes of zinc from complementary foods.

Table 3.7 – Micronutrient intake from complementary foods (n=625)

	Total Asian[1] (n=99)	Non-Asian[1] (n=526)		South East Asian[1] (n=28)	East Asian[1] (n=44)	South Asian[1] (n=31)	Nutrient reference value[2]
	Mean (SD)		*p*-value[3]	Mean (SD)			
Vitamin A, µg	274 (206)	329 (308)	0.085	332 (265)	266 (168)	243 (190)	244 µg[4]
Vitamin B12, µg	0.49 (0.57)	0.65 (0.88)	0.083	0.65 (0.83)	0.46 (0.46)	0.35 (0.30)	0.5 µg[5]
Vitamin C, mg	27.8 (29.5)	28.5 (22.3)	0.780	39.1 (38.0)	27.4 (29.1)	18.6 (12.1)	30 mg[5]
Iron, mg	3.0 (3.1)	3.0 (2.1)	0.980	3.5 (4.2)	2.7 (2.4)	3.0 (2.5)	7 mg[6]
Zinc, mg	1.7 (1.6)	1.9 (1.3)	0.136	2.1 (2.5)	1.5 (1.1)	1.5 (1.0)	2.5 mg[6]

Table 3.8 – Prevalence of inadequate intakes of iron and zinc from complementary foods (n=625)

	Total Asian[1] (n=99)	Non-Asian[1] (n=526)	South East Asian[1] (n=28)	East Asian[1] (n=44)	South Asian[1] (n=31)
Iron	92.9%	94.1%	85.7%	95.5%	96.8%
Zinc	81.8%	72.8%	75.0%	84.1%	83.9%

[1] Total response ethnicity includes every respondent allocated to all ethnic groups they have identified with.
[2] Nutrient reference values from National Health and Medical Research Council, Australian Government Department of Health and Ageing, & New Zealand Ministry of Health. (2006). *Nutrient Reference Values for Australia and New Zealand.* Canberra: National Health and Medical Research Council.
[3] Independent t-test to show the difference between Total Asian and Non-Asian micronutrient intake.
[4] Adequate intake from complementary foods.
[5] Adequate intake (total amount).
[6] Estimated average requirement (total amount).

3.4 Discussion

3.4.1 Key Findings

Asian NZ infants had intakes of energy, carbohydrate, vitamin B12 and vitamin C from complementary foods below the respective NRV's, while intakes of protein, fat, and vitamin A from complementary foods were above the respective NRV's. The only NRV's provided for the 7-12 month age group from complementary foods only were for carbohydrate, protein, fat, and vitamin A, so caution has been taken when comparing all other nutrients to the NRV's. Mean intakes of all nutrients, except iron, were lower in Asian infants, compared to non-Asian infants.

3.4.2 Asian New Zealand Infants Macronutrient Intake from Complementary Foods

Energy

Results from our study show that the mean energy intake from complementary foods in Asian infants was 1253kJ/day. The South East Asian infants had the highest mean intake (1467kJ), and East Asian infants had the lowest mean intake (1147kJ). When comparing the girls and boys, results were similar between the Asian subgroups, with girls having a lower mean intake than boys. These results are unable to be directly compared to the EER for the 8-month age group (National Health and Medical Research Council et al., 2006) as it is calculated including consumption of both infant milks and complementary foods. Thus, there is a large difference between the EER (2700-3000kJ) and the mean energy intake of the infants in this study. Currently, there are no NZ recommendations on the energy required from complementary foods only. International evidence, including from WHO Programme of Nutrition (1998) and Lutter et al. (2021), suggest that infants aged 6-8 months require between 540-820kJ of energy from complementary foods, based on average breast milk intakes. Based on these guidelines, the Asian infants had a mean intake within the recommendations from complementary foods. Comparing to NZ research of 9-12 month infants of all ethnicities (Judd, 2018), energy intakes from complementary foods were lower in our study. Judd (2018) reported a mean intake of 1853kJ. This is likely due to the higher mean age of the infants in Judd (2018), where complementary food intake continually increases.

Demmer et al. (2018) presented results of the National Health and Nutrition Examination Survey in the United States in 2011-2014, with the focus on the ethnic subgroups of the United States population. The 0–11-month Asian infant group of this study had low respondent numbers (4.7% of infants in the study, n=25). They reported energy intakes of 3369 kJ from all food and infant formulas, excluding those consuming breast milk, as data was not available on breast milk consumption. Jabri et al. (2020) studied South Asian infants in the United Kingdom, with a focus on the results from the 7-9 month infants, also with low respondent numbers (n=5). Jabri et al. (2020) reported an energy intake from complementary foods of 1928kJ, with a total energy intake of 3054kJ. The energy intake from complementary foods is higher than that of the Asian infants in our study. A key difference of the international studies is that both analysed all food and infant milks consumed. This shows large differences in the energy intakes, as infant milks continue to contribute substantially to energy intake at this age. When analysing the macronutrients and micronutrients of our study, and comparing these to international studies, it would be expected that our study would show lower nutrient intakes due to the lower energy intakes.

Carbohydrates

In our study, the mean carbohydrate intake from complementary foods in the Asian subgroups was 35g (48% of total energy intakes). The highest carbohydrate intake was in the South East Asian infants (43g), while lower intakes were seen in East Asian (33g) and South Asian infants (33g). All intakes were below the AI of 51g/day from complementary foods (National Health and Medical Research Council et al., 2006), but within the recommended range of 40-60% of total energy intakes (Alvisi et al., 2015; Stephen et al., 2012). In the study of 9-12 month infants in NZ, a mean carbohydrate intake of 57g was reported, equalling 52% of total energy intakes (Judd, 2018), which is above the AI, and within the recommended %TE range. This suggests that NZ infants are meeting carbohydrate requirements in a 9-12 month age group, compared with the 7-9 month infants in our study.

The mean carbohydrate intakes in our study were lower than those reported in other studies on Asian infants in high-income countries. Demmer et al. (2018) reported intakes of carbohydrates of 102g, and Jabri et al. (2020) reported intakes of 89g. The large differences seen in the published findings and our study, is likely due to the inclusion of food and infant

milks intake in the results, whereas our study only calculated complementary food intake. Interestingly, the %TE contributions were similar in this current study and the studies by Demmer et al. (2018) and Jabri et al. (2020) (48-51%). The majority of Asian infants were still breastfeeding at the time of our study (75%), which contributes carbohydrates, in the form of lactose. Some iron-rich complementary foods recommended early in the complementary feeding period are high in carbohydrates, such as iron-fortified infant cereals, whereas meat is low in carbohydrates, so intake is likely to be varied depending on infant feeding patterns and practises.

Protein

In our study, the mean protein intake from complementary foods in the Asian subgroups was 12g, equalling 16% of total energy intake. The highest protein intakes were seen in South East Asian infants (13g), with lower intakes in East Asian (11g) and South Asian (11g) infants. The mean protein intakes for all the Asian subgroups were above the AI from complementary foods of 7.1g/day (National Health and Medical Research Council et al., 2006), therefore it can be assumed that these intakes are adequate. The percentage of total energy intake from protein is also within the recommended range of ~10% of total energy (Alvisi et al., 2015). In another NZ study, infants aged 9-12 months had a mean intake of 19g of protein from complementary foods, equalling 17% of their total energy intake (Judd, 2018). As with carbohydrates, this is higher than the Asian infants in our study and may be due to infants being older in those studies and consuming more complementary foods by this age. The mean protein intakes in our study were again below those reported in Demmer et al. (2018) and Jabri et al. (2020) (20g and 28g respectively). Similarly, the %TE contributions in Jabri et al. (2020) were 14%, which is in line with our findings, whereas Demmer et al. (2018) reported a lower %TE contribution from protein of 10%.

Fat

In our study, the mean fat intake from complementary foods in the Asian subgroups was 11g equalling 33% of total energy intake. Similar to energy and other macronutrients, the highest fat intake was seen in the South East Asian group (13g), with lower intakes in the East Asian (10g) and South Asian groups (11g). The mean fat intakes of all Asian subgroups were above the AI from complementary foods of 7g/day (National Health and Medical Research Council

et al., 2006), therefore it can be assumed that these intakes are adequate. The percentage of total energy intake from fat in this study is within the recommendations of 25-40% of total energy (Pan American Health Organization & World Health Organization, 2003). In another NZ study, infants aged 9-12 months reported intakes of 14g from complementary foods, which is 28% of total energy intake (Judd, 2018). Interestingly, the %TE is lower in the 9-12 month NZ infants, than in Asian infants in our study. In contrast, the mean intake in 9-12-month infants was reported to be higher. This may be due to the infants being older and consuming more complementary foods by this age. The mean intakes in our study were below those reported in Demmer et al. (2018) and Jabri et al. (2020) (36g and 30g respectively). The %TE contributions from both of these studies were also higher than those reported in our study (39-40%).

3.4.3 Asian New Zealand Infants' Micronutrient Intake from Complementary Foods

Due to the exclusion of infant milks from this analysis, no conclusions can be made about mean intakes below the NRV for vitamin B12, vitamin C, iron, and zinc. There are variations in the nutritional composition of infant milks, where breast milk is low in iron and zinc while infant formula is higher. Therefore, as the NRVs for all micronutrients, besides vitamin A, are from complementary foods and infant milks, no conclusions can be made about inadequate intakes of these nutrients.

Vitamin A and Vitamin C

Vitamin A and vitamin C are both micronutrients found in fruits and vegetables, providing good sources for infants (Cribb et al., 2013; Ministry of Health, 2021). Therefore, for the discussion, these will be grouped together. In our study, the mean vitamin A intake from complementary foods of Asian infants was 274µg. Almost all subgroups had mean intakes above the AI of 244µg (National Health and Medical Research Council et al., 2006), with the South Asian subgroup being approximately the same as this value with their mean intake being 243µg. The AI for vitamin A is an estimated requirement from complementary foods and only allows comments for adequacy, and not inadequacy, to be made around it. Judd (2018) did not report vitamin A intake in 9-12 month NZ infants. Jabri et al. (2020) found that 40% of South Asian infants had intakes below the UK RNI. Interestingly, the mean intake of vitamin A seen in Jabri et al. (2020) was higher than any mean intakes seen in this study

(377µg). Demmer et al. (2018) did not report micronutrient intake in the 0–11 month group so findings cannot be compared.

In our study, the mean vitamin C intake from complementary foods of Asian infants was 28mg. The South East Asian subgroup was the only group with mean intakes above the AI of 30mg (National Health and Medical Research Council et al., 2006) so this is the only subgroup likely to be adequate. The AI for vitamin C is from complementary foods and infant milks, so intakes below this are unable to be quantified. Judd (2018) reported a similar mean intake of vitamin C in 9-12 month NZ infants (29mg), whereas Jabri et al. (2020) reported a mean intake of 66mg.

The NZ based study Growing Up in New Zealand (GUiNZ) focussed on 9 month old infants (n=6359 total, n=905 Asian) and found 80% of Asian infants consumed fruits or vegetables at least once per day (Gontijo de Castro et al., 2018). Although food frequency is not the same as nutrient intake, these results show that the Asian infant cohort were consuming fruits and vegetables, which are recommended as first foods in NZ (Ministry of Health, 2021), and are good sources of vitamin A and C for infants. This is also reflected in the adequate vitamin A intakes from complementary foods in the South East Asian and East Asian infants, and adequate vitamin C intakes in South East Asian infants.

Vitamin B12, Iron, and Zinc

Vitamin B12, iron, and zinc are micronutrients found in animal products, and need to be consumed from complementary foods due to their low concentrations in breast milk, and increased requirements in infants (Dewey, 2001; Lutter et al., 2021; Ministry of Health, 2021; National Health and Medical Research Council et al., 2006). In our study, the Asian infant mean intake of vitamin B12 from complementary food was 0.49µg. The South East Asian subgroup was the only group with intakes of vitamin B12 above the AI of 0.5µg (mean intake - 0.65µg) (National Health and Medical Research Council et al., 2006) so this is the only subgroup we can state are likely to have an adequate intake. The AI for vitamin B12 is from all complementary foods and milks. No studies have investigated vitamin B12 intake in an Asian infant cohort so comparisons to published literature cannot be made. In another NZ study, infants aged 9-12 months had a mean intake of 0.7µg, which is above the AI and above the results of our study (Judd, 2018).

The mean intakes of iron and zinc cannot be compared directly to the NRV available (EAR), but using the EAR cut point method, the percentage of infants with intakes below the nutrient reference value can be calculated. Between 86-97% of Asian infants had inadequate intakes of iron, and 75-85% had inadequate intakes of zinc. It is important to recognise that the EAR includes intakes from both complementary foods and infant milks. Infant milks differ in their composition of iron and zinc, with an average intake of 690mL of breast milk (Dewey, 2001) containing 0.48mg of iron and 2.0mg of zinc (Plant and Food Research & Ministry of Health, 2022). The same intake of typical infant formula would contain 5.9 mg of iron and 3.7 mg of zinc (Food Standards Australia & New Zealand, 2021). Therefore, the prevalence of inadequate intakes of both iron and zinc cannot be used to draw conclusions on intakes, without analysing infant milk intakes. For a breastfed infant, complementary foods would need to provide iron, due to the bioavailability being low in breast milk (Dewey, 2001; National Health and Medical Research Council et al., 2006). The mean intakes of these nutrients were 3.0mg of iron, and 1.7mg of zinc. Judd (2018) similarly reported a mean intake of iron in 9–12 month infants of 3.0mg, whereas the mean zinc intake was 2.6mg. The Asian infants of our study had lower intakes than Jabri et al. (2020), with the reported mean iron intakes of 5.8mg, and zinc intakes of 3.8mg in the South Asian UK cohort.

3.4.4 Comparison of Asian New Zealand Infant's and all Other Infant's Nutrient Intake from Complementary Foods

The total Asian group in this study had a mean intake of energy, macronutrients, and micronutrients except iron, lower than the non-Asian group in NZ. The only significant difference was in carbohydrate intakes (p=.031)

Energy and Macronutrients

The mean intake of energy and macronutrients in the total Asian group was lower than the non-Asian group in our study, but this finding was not significant as a total group (p=.086) or significantly different between sexes (p=.349). Both the total Asian and non-Asian groups had a mean intake of carbohydrates from complementary foods below the AI, while the mean intake of protein and fat from complementary foods was above the AI. The results of GUiNZ showed that 44% of Asian infants consumed all four food groups daily, compared with 56%

of NZ European infants (Gontijo de Castro et al., 2018). These small differences in the frequency are consistent with the small differences seen in the mean intakes of macronutrients in our study. While food frequency is not synonymous with nutrient intake, it can provide an indicator of what complementary foods are being consumed. As the total Asian infants in our study had a lower intake of macronutrients, and there was a reported lower frequency of consuming foods from all four food groups daily from the GUiNZ study (Gontijo de Castro et al., 2018), we can infer that Asian infants may be at additional risks for not meeting macronutrient requirements during infancy. The total Asian infants in our study had significantly lower carbohydrate intakes than the non-Asian infants (p=.031), but the %TE intakes in our study are within the same ranges for both total Asian and non-Asian groups, and within the recommended ranges. However, neither the total Asian nor the non-Asian group had mean carbohydrates intakes above the AI, but it is important to recognise the limiting factors when comparing results to the AI, as it only estimates adequacy. Intakes below the AI do not indicate inadequacy, therefore, no concerns should be directly raised about these intakes.

Results from the Asian cohort of the Adult National Nutrition Survey in NZ (n=267 Asian, n=2728 NZ European and Other) (Parackal et al., 2015), found that Asian adults had lower intakes of energy, protein, and fat compared to the NZ European and other groups. These results are similar to our study. Interestingly, the Asian adults had a mean intake of carbohydrate higher than the NZ European and Other adults, and a higher percentage of energy from carbohydrates (Parackal et al., 2015). This was related to the predominantly carbohydrate-based diets reported in this Asian adult group. This contrasts with the Asian infants in our study, who had significantly lower carbohydrate intakes than the non-Asian group. While feeding practices develop throughout infancy, it is important to recognise that dietary changes may still change through childhood and adulthood.

Micronutrients

In our study, the mean intakes of all micronutrients in the total Asian group were lower than the non-Asian, but not statistically significantly. In the total Asian group, the only micronutrient with a mean intake above the AI was vitamin A (274µg), compared to the non-Asian group, who had a mean intake of both vitamin A (329µg) and vitamin B12 (0.65µg)

above the AIs. The most relevant study in NZ (GUiNZ), found that Asian infants were less likely to consume fruits and vegetables compared with NZ European infants (Gontijo de Castro et al., 2018). As discussed previously, it is important to recognise that frequency of food group consumption does not equal nutrient intake, however fruits and vegetables do contain good sources of both vitamin A and vitamin C. In our study, the mean intake of vitamin A was lower in the total Asian infant group (274µg) compared with the non-Asian infant group (329µg). This is similar to the findings of Lu (2002) where Chinese children in NZ had intakes of vitamin A lower than NZ European children, and a lower consumption of fruits and vegetables. Additionally, vitamin A intakes were reported lower in Asian NZ adults, compared with NZ European and other adults, while vitamin C intakes were reported higher in the Asian adult groups (Parackal et al., 2015). In our study, vitamin C intakes were similar in the total Asian infant group (28mg) and the non-Asian group (29mg), with both being merely below the AI (30mg). Although, this AI includes intakes from complementary foods and infant milks, which additionally adds to the uncertainty of inadequate intakes. The AI is also extrapolated from younger infants (0-6 month) breastmilk intakes, so there is less accuracy for the 7–12 month infant AI.

The GUiNZ study found similar percentages of each of the ethnic groups consuming iron rich foods daily (79% of Asian infants, 82% of NZ European infants) (Gontijo de Castro et al., 2018), but, in our study, both the Asian and non-Asian groups had high prevalence of inadequate iron intakes from complementary foods. This shows the importance of measuring intakes, in addition to frequency of food consumption. Intakes of iron rich foods are recommended during the complementary feeding period to meet requirements due to the low amount of iron in breast milk (Dewey, 2001; Lönnerdal, 2017; National Health and Medical Research Council et al., 2006). There was more variation in the zinc intakes below the EAR between the groups in our study. In the total Asian group, 82% had zinc intakes from complementary foods below the EAR, compared to 73% of the non-Asian group. Daniels et al. (2018) found, in 7-month infants in NZ, the complementary foods contributing the most zinc were breads and cereals, red meat, and vegetables, but breast milk and infant formulas contributed the most dietary zinc. From these sources of zinc, there should be less concern around the zinc intakes from complementary foods below the EAR, due to infant milks contributing dietary zinc at this age. As previously stated, the composition of iron and zinc differs between breast milk

and infant formulas, so no conclusions can be drawn around the prevalence of inadequacy of these intakes from applying the EAR which is based on the whole diet, to intakes from complementary foods alone. Additionally, 9-12 month infants in another NZ study had a mean intake of zinc above the EAR (Judd, 2018), so it is possible that the intakes seen in our study are likely to increase with age.

In Asian NZ adults, there were no significant differences in iron or zinc intakes compared to NZ European and other adults (Parackal et al., 2015). That being said, dietary iron intakes are not directly associated with adequacy, as non-haem iron is less bioavailable, and intakes of this need to be greater to reach a similar amount of iron absorbed to that from haem iron (Anderson & Frazer, 2017). Thus, although intakes of iron are the same between the total Asian adult group and non-Asian group (3.0 mg), the bioavailability of the iron is unknown. South Asian adults in NZ were reported to be less likely to consume red meat or chicken compared with the other Asian cohorts of NZ, and NZ European adults (Parackal et al., 2015). This may show that although the mean intakes are the same, some Asian groups may not be consuming haem iron sources.

As vitamin B12 occurs naturally in animal products only, and rich iron- and zinc-sources are in animal foods, those excluding animal products from their diets are less likely to meet requirements (Ministry of Health, 2021). Vitamin B12 intakes were also lower in the Asian adults (1.6-2.7mg) compared with the NZ European and others (2.5-3.7mg), potentially due to the decreased intake of meat in some Asian groups (Parackal et al., 2015). This is similar to findings in our study, where the total Asian group had a mean intake of 0.49µg, and the non-Asian group had a mean intake of 0.65µg.

Despite the differences in intakes between the Asian and non-Asian infants, it is important to recognise the importance of infant milks during this period. A total of 72% of Asian infants were still breastfeeding at the time of the study, and 65% of non-Asian infants. Although no comments can be made regarding the breast milk intake, it is important to keep in mind the additional nutrition that will be supplied from this.

3.4.5 Strengths and Limitations

The main strength of this analysis was the separation of the Asian infants into the three subgroups. Grouping all Asian ethnicities together limits the abilities to show differences in the Asian countries and cultures. Different Asian subgroups have different dietary profiles, so should not automatically be grouped together for nutritional analyses, or for health and nutrition related studies (Parackal et al., 2015; Rasanathan et al., 2006).

A key limitation of this analysis is the exclusion of infant milks, as most of the NRVs for micronutrients are for all complementary foods and infant milks consumed, besides vitamin A. This means that conclusions cannot be drawn around mean intakes below these NRVs and therefore, any potential inadequacies. Despite this, complementary food analysis is important to see the nutrient intakes from complementary foods and is important to comment on due to complementary foods being the modifiable part of the complementary feeding diet. Additionally, the duration of residence in NZ was not asked, which may have been useful to understand the level of acculturation that may impact feeding practises.

3.4.6 Conclusion

In summary, Asian NZ infants had adequate intakes of protein, fat, and vitamin A from complementary foods, when compared with the AI. When comparing Asian NZ infants to the non-Asian infants in NZ, there was no significant differences in energy, macronutrient, or micronutrient intakes, besides carbohydrate intakes where Asian NZ infants had significantly lower intakes. As this study is only concentrated around the complementary food intake of Asian NZ infants, further investigations into the infant milk intakes, and micronutrient status is necessary to understand the entire nutritional picture of these infants.

Chapter 4: Conclusions and Recommendations

4.1 Summary of Results

Asian NZ infants had intakes of energy, carbohydrate, vitamin B12 and vitamin C from complementary foods below the respective NRV's, while intakes of protein, fat, and vitamin A from complementary foods were above the respective NRV's. The only NRV's provided for the 7-12 month age group from complementary foods only was carbohydrate, protein, fat, and vitamin A, so caution has been taken when comparing all other nutrients to the NRV's. Mean intakes of all nutrients, except iron, were lower in Asian infants, compared to non-Asian infants.

4.2 Achievement of Aim and Objectives

The aim of this research was to determine the macronutrient and micronutrient intake from complementary foods of Asian NZ infants aged between 7.0-9.9 months. Objectives focused on describing the macronutrient and micronutrient intake in Asian infants, and comparing these to non-Asian infants in NZ. Between the sub-groups of Asian infants, South East Asian infants in NZ had higher mean intakes of energy, macronutrients, and micronutrients compared with South Asian infants and East Asian infants. Total Asian infants had lower intakes of energy, macronutrients, and most micronutrients compared with non-Asian infants. These results have given insight into Asian infants in NZ, and their nutrient intake from complementary foods.

4.3 Research Impact

This is the first study that has explored the nutritional intakes of different subgroups of Asian NZ infants. Results show that Asian NZ infants have lower intakes of energy, macronutrients, and some micronutrients than non-Asian infants at 7-9.9 months. The unique aspect of the study will be beneficial for aiding in future complementary feeding diet research. Additionally, it may be beneficial in informing health professionals who advise all new mothers on complementary feeding.

One of the limitations of the impact of this research is the lack of NRVs for nutrients from complementary foods only. From this study it is known that iron and zinc intakes are below

the recommended NRVs in all infant groups, but these NRVs are from complementary food and infant milk intake. There are variations in the nutritional composition of infant milks, where breast milk is low in iron and zinc while infant formula is higher. General practitioners and Whānau Āwhina Plunket could place further emphasis and ongoing encouragement of including iron- and zinc-rich complementary food sources specifically for breastfed infants to ensure all infants are consuming adequate sources. Specific ethnic education around these iron- and zinc-rich complementary food sources could also be beneficial for Asian families who are less likely to consume iron-rich foods, such as meat, as evidenced by Asian adult research in NZ (Parackal et al., 2015).

4.4 Strengths

In NZ, it is common to use "Asian" as a group, particularly in a health setting, which lacks the ability to show the specificity and differences in the group, as shown in this study. The main strength of this secondary analysis was the separation of the Asian infants into the three subgroups (South East Asian, South Asian, and East Asian). This aided in exploration of the differences in intakes between the various groups. Although eating patterns were not explored in this analysis, it was evident that South East Asian infants had the highest mean intake of energy, macronutrients, and micronutrients, compared with the East Asian infants and South Asian infants.

Additionally, this is the first study in NZ to investigate Asian infant nutrient intake from complementary foods. This helps gain an understanding into the differences between Asian and non-Asian infant intakes in NZ. Despite the inability for conclusions to be made around adequacy of most of these nutrients due to the NRVs including both complementary foods and infant milks, this analysis gives an understanding of the intakes from complementary foods and is the first study to do so in an Asian cohort. When treating dietary nutrient inadequacies, foods are the first modifiable factor to be drawn on by healthcare professionals. Therefore, looking at the nutrient intakes from complementary foods only, gives useful insights for modifying infant diets.

4.5 Limitations

Several limitations presented from the analysis of this study. The main limitation was the difficulty of comparing the intakes from complementary foods to NRVs available. Firstly, the NRV that was available for the macronutrients and vitamin A, vitamin B12, and vitamin C, was an AI so only estimated adequacy, so intakes below this value were unable to be interpreted. The EAR for iron and zinc for the 7-12 month infants could not be used to determine adequacy of intakes as it included all food and infant milks. Additionally, the only nutrients with AIs from complementary foods alone were the macronutrients, and vitamin A, with the remaining being from all food and infant milks. This meant, due to the exclusion of infant milks, intakes of the remaining nutrients were unable to be used to draw conclusions. As breast milk and infant formulas contain varying amounts of micronutrients, and varying volumes can be consumed, estimates around infant milk intake could not be used.

Many factors influence nutrient status, including nutrient intakes, nutrient bioavailability, and biological factors. Nutrient intakes alone do not directly reflect nutrient status, and blood samples are needed to determine any specific nutritional deficiencies. This is particularly the case for iron because of the different bioavailability of iron-containing foods, and the differences in absorption rates between people. Further studies could be strengthened by using blood samples in conjunction with other data collection methods to determine specific nutritional deficiencies. However, intakes below requirements do increase the risk of developing nutrient deficiencies, and complementary foods are the modifiable part of the diet in the second half of infancy, and so the results of this study are important.

Another limitation of the comparison of the Asian infants to the non-Asian infants was the lower respondent numbers in the Asian group compared to the non-Asian group (n=99 Asian, n=526 non-Asian). The proportion of Asian infants in this study is the same as the proportion for the total Asian population in NZ (14%) (Statistics New Zealand, 2018), however, national electronic health data has suggested that the percentage of Asian infants in NZ is around 25% (Daniels et al., 2023).

4.6 Recommendations and Future Direction for Research

Further studies that explore intake of both complementary foods as well as infant milk intakes would be beneficial to gain a better understanding of complementary feeding practices in this group. A qualitative analysis into the complementary foods consumed in Asian infants in NZ could assist in the knowledge of this infant groups' diet, as it has been found that Asian adults in NZ consume predominantly carbohydrate-based diets (Parackal et al., 2015). Also, due to many NRVs including complementary foods and infant milks, infant milk intake data would complement this nutrient intake research and provide a better understanding of feeding practices and nutrient intakes of Asian NZ infants.

This study looked at nutrient intakes from complementary foods for infants aged 7.0-9.9 months. This is early in the introduction to complementary food. Further research into Asian NZ nutrient intakes at different ages through infancy and childhood would be valuable. This would assist in explaining whether the lower energy and nutrient intakes seen infancy in Asian NZ infants continue into childhood, when compared with non-Asian infants. Previous research (Lu, 2002) has investigated Chinese children in Auckland, NZ, but inclusion of all Asian children, broken down into subgroups, would be beneficial.

A key recommendation for the Ministry of Health in NZ is to develop NRVs for solely complementary foods for more nutrients in the infant (7-12 month) group. Currently, the macronutrients and vitamin A are the only nutrients with NRVs from complementary foods. Although these are available, these are in the form of AI's which only estimate adequacy, so any intakes below these values cannot be used to draw conclusions on the prevalence of inadequate intakes.

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Appendices

Appendix A: Advertisement

FIRST FOODS
— New Zealand —

Feeding our babies – are we getting it right?

The First Foods New Zealand Study is looking for parents/guardians from Dunedin with infants under 10 months to take part in an exciting new study when their baby is 7, 8 or 9 months old. The study will look at what and how New Zealand babies are being fed and how that might affect their health.

What would I be asked to do?

We would like to meet with you 3-5 times over about two weeks. We will ask you about what your baby eats, ask you to video them eating a meal, and will check your baby's teeth and iron levels. If you are breastfeeding, we may invite you to be in another part of the study as well, where we would measure how much breast milk your baby drinks. This should take 4-6 hours in total. You will be given a total of $150 in grocery or petrol vouchers as a thank you.

What are the benefits if I take part?

There are a number of benefits to being in the First Foods NZ study:

- Know that you are helping improve the health of NZ infants
- And helping health workers give parents and whānau advice they can trust
- Find out if your baby isn't getting enough iron

Investigators:

Associate Professor Anne-Louise Heath, Department of Human Nutrition, University of Otago

Professor Rachael Taylor, Department of Medicine, University of Otago

This project has been reviewed and approved by the Health and Disability Ethics Committee: 19/STH/151

First Foods New Zealand (FFNZ) Study Study email dunedin@firstfoods.co.nz Study phone number 021 279 0553	First Foods New Zealand (FFNZ) Study Study email dunedin@firstfoods.co.nz Study phone number 021 279 0553	First Foods New Zealand (FFNZ) Study Study email dunedin@firstfoods.co.nz Study phone number 021 279 0553	First Foods New Zealand (FFNZ) Study Study email dunedin@firstfoods.co.nz Study phone number 021 279 0553	First Foods New Zealand (FFNZ) Study Study email dunedin@firstfoods.co.nz Study phone number 021 279 0553	First Foods New Zealand (FFNZ) Study Study email dunedin@firstfoods.co.nz Study phone number 021 279 0553	First Foods New Zealand (FFNZ) Study Study email dunedin@firstfoods.co.nz Study phone number 021 279 0553	First Foods New Zealand (FFNZ) Study Study email dunedin@firstfoods.co.nz Study phone number 021 279 0553	First Foods New Zealand (FFNZ) Study Study email dunedin@firstfoods.co.nz Study phone number 021 279 0553	First Foods New Zealand (FFNZ) Study Study email dunedin@firstfoods.co.nz Study phone number 021 279 0553	First Foods New Zealand (FFNZ) Study Study email dunedin@firstfoods.co.nz Study phone number 021 279 0553	First Foods New Zealand (FFNZ) Study Study email dunedin@firstfoods.co.nz Study phone number 021 279 0553

Feeding our babies – are we getting it right?

FIRST FOODS
— New Zealand —

We would like to invite you to take part in the First Foods New Zealand (FFNZ) study – an exciting new project about how and what New Zealand babies are being fed

July, 2020

Investigators

Assoc Prof Anne-Louise Heath, University of Otago (Dunedin)
Prof Rachael Taylor, University of Otago (Dunedin)
Dr Cathryn Conlon, Massey University (Albany)
Dr Kathryn Beck, Massey University (Albany)
Dr Lisa Te Morenga, Victoria University (Wellington)

Why?

How babies are introduced to solid foods might be important for baby's health, including how they grow, how healthy their teeth are, and whether they are getting enough nutrients like iron. We want to look at how and what babies are being fed, and what effect that has on their nutrition and health. This research will provide important information so that health professionals and policy makers can advise whānau on how to introduce solids safely to their babies. This study has ethical approval from the Health and Disability Ethics Committee: 19/STH/151.

What does this study involve?

We are looking for parents or guardians from Dunedin, Auckland or Wellington with infants who are 7, 8, or 9 months of age to take part in this study. First Foods NZ is an 'observational' study, looking at what and how babies are fed. You will **not** have to change the way you feed your baby in any way or do anything different. We need to recruit a large number of families – a total of 625 – so expect that the study will finish in 2022.

What would I be asked to do?

Attend three visits when your baby is between 7 and 10 months old. If you are breastfeeding, you may have two extra visits. These visits will take place over two weeks and will take 4-7 hours in total.

First visit

We will come to your home for this visit and will measure baby's weight and length and ask you to fill out a couple of questionnaires about baby's feeding and health. We will ask you to tell us what, and how much, baby ate the day before. Because this can be difficult to remember, we will ask you to take photos of baby's food at the start of their meals and snacks the day before we visit. These are just taken on a phone or camera – we can lend you one if needed. This visit will take about one and a half hours.

Between visits

We will lend you a camera and tripod to film your baby eating a meal at home before you come to your second visit. We will also ask you to complete a short questionnaire about the meal.

Second visit

This visit is in our clinic at the hospital. We have free parking available for the appointment. One of our staff will take some photographs of baby's mouth and teeth. Then we will ask you to tell us what, and how much, baby ate the previous day (like you did for the first visit). This visit will take less than one hour.

There will be one last online questionnaire after this visit.

Third visit

At this visit we would like to do a blood test, so we can measure baby's iron levels. The blood test will be done by someone who is very experienced at collecting blood samples from babies, and we use a numbing gel to make sure it doesn't hurt. We have done lots of these types of blood tests before with infants and toddlers. This visit will take no more than 30 minutes and is held in our clinic.

We will ask your permission to let us access information from your baby's "B4 School Check" when they are four years old so that we can see how their growth and dental health are tracking. We will need to access your baby's National Health Index (NHI) number to do this.

If you are breastfeeding

If you are breastfeeding, we may invite you to be in another part of the study. We would ask you to drink a small amount of "special" water that lets us track how much breast milk your baby drinks. This method is very safe and is used all over the world. If you did this part of the study, then you would do the same study as everyone else but complete some extra tasks at the first and second visits and have two extra visits. This part of the study would take about 20-30 minutes at each of the four visits. At the first visit you would drink the water. At all four visits we would collect some saliva (spit) from you and your baby, so that we can measure how much of the "special" water your baby has got from your breast milk. At a couple of the visits, we would collect your height and weight. We'd also like to ask you to collect a small amount of breast milk so that we can analyse the nutrients it contains.

This is an important part of the study because, for the first time, parents and health professionals will know how much breast milk New Zealand babies are getting.

Who pays for the study?

This study is funded by the Health Research Council of New Zealand. There is no cost for you to take part. However, as a recognition for taking part in the study we will give you a $150 voucher as a thank you.

What if I don't want to take part in certain parts of this study?

We would really appreciate it if you could take part in all parts of the study, but know that that won't be possible for all families. You can let us know on the Consent Form whether there are any sections you already know you do not want to take part in, and you can choose not to do parts of the study after you've started, or withdraw from the study completely, if you change your mind.

What are the benefits if I take part?

There are a number of benefits to being in the First Foods NZ study. For example, you will:

- Know that you are helping improve the health of NZ infants
- And helping health workers give parents and whānau advice they can trust
- Find out if your baby isn't getting enough iron

What are the potential risks?

We don't think there are any large risks to taking part in this study. Giving blood may cause minor discomfort and bruising but we will use a numbing gel to prevent pain, and in the unlikely event that bruising does occur, it should fade in about a day. No adverse side effects have been reported in mothers or babies given the "special water" in a wide range of other studies across multiple countries.

What if something goes wrong?

If we find that your baby has low iron status or problems with their teeth, then we will let you and your GP, or dentist or dental therapist know. In the unlikely event of a physical injury as a result of taking part in this study, you would be eligible to apply for compensation from ACC. If you have private health or life insurance, you may wish to check with your insurer that taking part in this study won't affect your cover.

What are my rights?

Deciding to take part in this study is entirely your choice. You may have a friend, family or whānau support who can help you understand the risks and benefits of this study and decide whether you would like to take part. If you choose not to take part, it will have no impact on yours or your baby's health care. If you choose to take part you are free to withdraw from the study at any time, you don't have to give a reason, and you wouldn't be disadvantaged in any way. You may choose not to give a sample at any time, even if you have previously given consent to providing a sample. You have the right to access information about yourself and your baby collected as part of this study.

You may hold beliefs about a sacred or shared value of tissue samples removed. Feel free to discuss with your family/whānau the cultural issues associated with sending your samples overseas and/or storing your tissue. Māori people hold a range of views around these issues; some iwi disagree with storage of samples referring to whakapapa, and advise their people seek information before participating in research where this occurs. However, it is acknowledged that individuals have the right to choose.

How will my information be used?

Only the researchers will have access to the information. All information will be made anonymous and kept confidential, for both this study and in any future research. Group results of the project will be published, but not in a way that could identify you, your child or your family. It is possible that new research questions may arise in the future in related areas that your data could contribute to in useful and relevant ways. Please indicate on the Consent Form if you would not feel comfortable about your anonymous data being used in such future research.

What happens after the study?

We will send you a summary of the study results when they have been published – please let us know if your address changes before then.

We will store information, including videos and images, on a secure online storage system overseen by the University of Otago for at least 10 years after your baby turns 16 years old, after which time the information will be destroyed. Researchers will only have access to this information for specific study-related tasks (e.g., when carrying out analyses or coding videos).

Saliva and breast milk samples will be stored until lab analysis is complete. We are planning to keep any leftover blood sample for up to three years before destroying it, so that more nutrients can be measured if funding becomes available. All left over sample will be destroyed, with an appropriate karakia (Māori prayer) if you wish.

What if I have any questions?

For questions day-to-day see our contact details on our website:

www.firstfoods.co.nz

If you have any other questions about our project either now or in the future, please feel free to contact us:

Co-Principal Investigator (Dunedin)
Anne-Louise Heath
03 479 8379
anne-louise.heath@otago.ac.nz

Investigator (Auckland)
Cathryn Conlon
09 414 0800 ext. 43658
C.Conlon@massey.ac.nz

Investigator (Wellington)
Lisa Te Morenga
04 463 4757
lisa.temorenga@vuw.ac.nz

If you want to talk to someone who isn't involved with the study, you can contact an independent health and disability advocate on:

Phone: 0800 555 050
Fax: 0800 2 SUPPORT (0800 2787 7678)
Email: advocacy@advocacy.org.nz

For Māori health support, please contact:

Arai Te Uru Whare Hauora
Phone: 03 471 9960
Email: reception@araiteuru.co.nz

You can also contact the Health and Disability Ethics Committee (HDEC) that approved this study on:

Phone: 0800 4 ETHICS
Email: hdecs@moh.govt.nz

Appendix C: Main Questionnaire

Office use only

Date:

Participant ID:

Researchers name:

Main Questionnaire (first visit)

Welcome and thank you for being part of the FFNZ Study.
This questionnaire is split into 9 sections and should take about 20 minutes to complete.
Please answer every question - *there are no right or wrong answers*.
Please ask the researchers if you have any questions – **thank you for your time**.

Section 1: Some questions about you

1. How are you related to this baby?

- ○ Mother
- ○ Father
- ○ Grandparent
- ○ Guardian
- ○ Other Please state: _____

2. What is your date of birth? _____ / _____ / _____
day month year

2a. What is today's date? _____ / _____ / _____
day month year

Section 2: Some questions about your pregnancy and baby

3. Did you (or baby's mother) experience any medical problems during your pregnancy?

- ○ Yes Please describe: _____
- ○ No
- ○ Don't know

4. Did you (or baby's mother) take any prescribed medication during your pregnancy?

- ○ Yes
- ○ No
- ○ Don't know

*If answer is 'No' or 'Don't know' – skip [Q4a-c]; go to **Question 5***

4a-i. **Medication 1:** What was the name of the prescribed medication?

_____

4a-ii. When was this prescribed medication taken? *Please select <u>all</u> that apply*.

- ○ First trimester
- ○ Second trimester
- ○ Third trimester

4a-iii. Did you (or baby's mother) take any other prescribed medications during your pregnancy?

- ○ Yes
- ○ No

If answer is 'No' – skip [Q4b & 4c]

4b-i. **Medication 2:** What was the name of the prescribed medication?

_____

4b-ii. When was this prescribed medication taken? *Please select <u>all</u> that apply*.

- ○ First trimester
- ○ Second trimester
- ○ Third trimester

4b-iii. Did you (or baby's mother) take any other prescribed medications during your pregnancy?

- ○ Yes
- ○ No

If answer is 'No' – skip [Q4c]

4c-i. **Medication 3:** What was the name of the prescribed medication?

_____

4c-ii. When was this prescribed medication taken? *Please select <u>all</u> that apply*.

- ○ First trimester
- ○ Second trimester
- ○ Third trimester

4c-iii. Did you (or baby's mother) take any other prescribed medications during your pregnancy?

- ○ Yes
- ○ No

If answer is 'No' – skip [Q4d]

4d-i. **Medication 4:** What was the name of the prescribed medication?

_____

4d-ii. When was this prescribed medication taken? *Please select <u>all</u> that apply*.

- ○ First trimester
- ○ Second trimester
- ○ Third trimester

4d-iii. Did you (or baby's mother) take any other prescribed medications during your pregnancy?

- ○ Yes
- ○ No

If answer is 'No' – skip [Q4e]

4e-i. **Medication 5:** What was the name of the prescribed medication?

_____

4e-ii. When was this prescribed medication taken? *Please select <u>all</u> that apply*.

- ○ First trimester
- ○ Second trimester
- ○ Third trimester

5. Were there any interventions during your baby's birth?

- ○ Forceps were used
- ○ Caesarean birth

- ○ Other Please describe: _____
- ○ There were no interventions

6. Was your baby born pre-term or term?

- ○ Preterm (less than 37 weeks gestation)
- ○ Term (37 weeks gestation or older)
- ○ I don't know

7. Is your baby a girl or a boy?

- ○ Girl
- ○ Boy
- ○ I would rather not say

8. Was your baby born singly, or were they a twin or multiple?

- ○ Single (one baby)
- ○ Twin (one of two babies)
- ○ Multiple (one of three or more babies)

9. Which ethnic group does your child belong to? *Select all that apply to your child.*

- ○ NZ European
- ○ Māori
- ○ Samoan
- ○ Cook Island Māori
- ○ Tongan
- ○ Niuean
- ○ Chinese
- ○ Indian
- ○ other, eg Dutch, Japanese, Tokelauan. Please state: _____

10. Is your child descended from a Māori (that is, did they have a Māori birth parent, grandparent or great-grandparent, etc)?

- ○ Yes
- ○ Don't know
- ○ No

*If answer is 'No' – go to **Q11***

10a. Do you know the name(s) of your child's iwi (tribe or tribes)?

See the Guide Notes for a list of iwi.

○ Yes
○ No

*If answer is 'No' – go to **Q11***

10b. Enter the name(s) and region(s) of your child's iwi (tribe or tribes):
See the Guide Notes for a list of iwi.

Iwi: _____

Region: _____

Iwi: _____

Region: _____

Iwi: _____

Region: _____

Iwi: _____

Region: _____

11. Does your baby have any diagnosed health conditions or disabilities?

○ Yes Please state: _____
○ No

Section 3: Some questions about your baby and food

12. How old was your baby when they first had anything to drink that was not breast milk? (e.g., infant formula, water, other liquids)

- ○ They did not have any breast milk
- ○ Breast milk is the only drink my baby has had so far
- ○ Less than 1 month old
- ○ 1 month old
- ○ 2 months old
- ○ 3 months old
- ○ 4 months old
- ○ 5 months old
- ○ 6 months old
- ○ 7 months old
- ○ 8 months old
- ○ 9 months old
- ○ 10 months old
- ○ 11 months old

If answer is 'They didn't have any breast milk' – skip [Q13a-d]

13. Is baby still being breastfed?

- ○ Yes
- ○ No

*If answer is 'No' – go to **Q13d***
*If answer is 'Yes' – **answer Q13a, Q13b, Q13c**; skip [Q13d]*

13a. How many breastfeeds does your baby have a day? *Please include night feeds, and think about the average over the past week.*

_____ per day (including night feeds)

13b. What quantity of breast milk does your baby spill/vomit for each feed? *Please think about the average over the past week.*

- ○ None
- ○ A little
- ○ Some
- ○ Most
- ○ All

13c. Is your baby breastfed on demand or by schedule? *On demand is when baby decides when feeding happens, by schedule is where you have set times when feeding happens.*

- ○ On demand only
- ○ By schedule only
- ○ On demand during the day, by schedule overnight
- ○ By schedule during the day, on demand overnight

13d. How old was your baby when they stopped being breastfed?

- ○ Less than 1 month old
- ○ 1 month old
- ○ 2 months old
- ○ 3 months old
- ○ 4 months old
- ○ 5 months old
- ○ 6 months old
- ○ 7 months old
- ○ 8 months old
- ○ 9 months old
- ○ 10 months old
- ○ 11 months old

14. Has your baby *ever* had infant formula?

- ○ Yes
- ○ No

If answer is 'No' – skip [Q14a-c]

14a. How old was your baby when they first had infant formula?

- ○ Less than 1 month old
- ○ 1 month old
- ○ 2 months old
- ○ 3 months old
- ○ 4 months old
- ○ 5 months old
- ○ 6 months old
- ○ 7 months old
- ○ 8 months old
- ○ 9 months old
- ○ 10 months old
- ○ 11 months old

14b. Does your baby still drink infant formula?

- ○ Yes
- ○ No

If answer is 'Yes' – skip [Q14c]

14c. How old was your baby when they stopped drinking infant formula?

- ○ Less than 1 month old
- ○ 1 month old
- ○ 2 months old
- ○ 3 months old
- ○ 4 months old
- ○ 5 months old
- ○ 6 months old
- ○ 7 months old
- ○ 8 months old
- ○ 9 months old
- ○ 10 months old
- ○ 11 months old

15. Are you *currently* offering your baby any drinks other than water, breast milk or infant formula?

- ○ Yes
- ○ No

If answer is 'No' – skip [Q15a]

15a. What other drinks are you *currently* offering your baby? *Please select all that apply*.

- ○ Cow's milk – undiluted
- ○ Cow's milk – diluted
- ○ Soy milk or other milk alternative
- ○ Tea
- ○ Juice or fruit drink
- ○ Other Please state: ____

16. Do you *usually* offer your baby milk feeds (breast milk or formula) before or after solid food is offered (meals or snacks)?

- ○ Before
- ○ After
- ○ Both before and after
- ○ Baby isn't having milk feeds
- ○ Baby isn't having solid food

17. How old was your baby when they first had solid foods? *(solid foods are anything that isn't breast milk, infant formula or other drinks. They don't have to be thick – some solids are runny, and some have drinks like breast milk or infant formula mixed into them)*

- ○ They haven't had solids yet
- ○ Less than 1 month old
- ○ 1 month old
- ○ 2 months old
- ○ 3 months old
- ○ 4 months old
- ○ 5 months old
- ○ 6 months old
- ○ 7 months old
- ○ 8 months old
- ○ 9 months old
- ○ 10 months old
- ○ 11 months old

If answer is 'They haven't had solids yet' – skip [rest of solids Q's, incl. rest of section 3, section 4 & 5, and choking on food Q's]
*If answer is '6 months' – skip [double up 6-7 mo/started solids Q's [**Q18 & Q42-42b & 43-43a**]*

17a. What was the first food you gave your baby?

_____

17b. What texture was the first food you gave your baby?

- ○ Puréed
- ○ Mashed
- ○ Chopped
- ○ Finger food
- ○ Other

18. How was your baby fed when they *first started* eating solids?

- ○ Spoon fed by an adult
- ○ Mostly spoon fed by adult, some baby feeding themselves
- ○ About half spoon fed by an adult and half baby feeding themselves
- ○ Mostly baby feeding themselves, some spoon feeding by an adult
- ○ Baby feeding themselves

19. How was your baby fed at *around 6 months of age*?

- ○ Spoon fed by an adult
- ○ Mostly spoon fed by adult, some baby feeding themselves
- ○ About half spoon fed by an adult and half baby feeding themselves
- ○ Mostly baby feeding themselves, some spoon feeding by an adult
- ○ Baby feeding themselves
- ○ Baby was not eating solids at around 6 months of age

20. How is your baby being fed solids *now*?

- ○ Spoon fed by an adult
- ○ Mostly spoon fed by adult, some baby feeding themselves
- ○ About half spoon fed by an adult and half baby feeding themselves
- ○ Mostly baby feeding themselves, some spoon feeding by an adult
- ○ Baby feeding themselves
- ○ Baby does not eat solids

21. Have you *ever* used baby-led weaning with your baby?

- ○ I don't know what baby-led weaning is
- ○ Yes, we have followed baby-led weaning most or all of the time
- ○ Yes, we have followed baby-led weaning some of the time
- ○ Yes, we tried baby-led weaning, but we stopped
- ○ No, we did not try baby-led weaning

If answer is 'No' or 'Don't know what BLW is' – skip [Q21a]

21a. How old was your baby when you first tried baby-led weaning?

- ○ Less than 1 month old
- ○ 1 month old
- ○ 2 months old
- ○ 3 months old
- ○ 4 months old
- ○ 5 months old
- ○ 6 months old
- ○ 7 months old
- ○ 8 months old
- ○ 9 months old
- ○ 10 months old
- ○ 11 months old

22. Have you used any traditional foods or practices when starting baby on solids? You might have chosen them because they are traditional to your culture, or your family or whānau.

- ○ Yes Please describe: _____
- ○ No

22a. Are there any traditional or cultural (family or whānau) foods you like your baby to have now?

- ○ Yes Please describe: _____
- ○ No

23. When your baby was *<u>around 6 months</u>* of age, did they eat bought baby rice cereal? (foods like Farex rice cereal, Only Organic baby rice)

- ○ Yes
- ○ No - I offered it but they wouldn't eat it
- ○ No - I didn't offer it because I don't agree with my baby eating it
- ○ No - I didn't offer it because I didn't think it would be safe for my baby
- ○ No - I didn't offer it because my baby hadn't started eating solids yet
- ○ No - I didn't offer it for another reason Please state: _____

If answer is 'No…' – skip [Q23a]

23a. How often did they eat baby rice cereal?

- ○ More than once a day
- ○ Once a day
- ○ 5-6 times a week
- ○ 2-4 times a week
- ○ Once a week
- ○ 2-3 times a month
- ○ Once a month

24. When your baby was *around 6 months* of age, did they eat red meat (like beef or lamb)?

- ○ Yes
- ○ No - I offered it but they wouldn't eat it
- ○ No - I didn't offer it because I don't agree with my baby eating it
- ○ No - I didn't offer it because I didn't think it would be safe for my baby
- ○ No - I didn't offer it because my baby hadn't started eating solids yet
- ○ No - I didn't offer it for another reason Please state: _____

If answer is 'No…' – skip [Q24a]

24a. How often did they eat red meat (like beef or lamb)?

- ○ More than once a day
- ○ Once a day
- ○ 5-6 times a week
- ○ 2-4 times a week
- ○ Once a week
- ○ 2-3 times a month
- ○ Once a month

25. Have you offered these foods to your baby? *Please select all options that apply.*

- ○ Egg (cooked)
- ○ Dairy (e.g., milk, yoghurt, cheese)
- ○ Peanut (including peanut butter)
- ○ Tree nuts (e.g., almond, cashew, walnuts)
- ○ Sesame (e.g., as seeds on top of some breads, in hummus, tahini)
- ○ Wheat (e.g., breakfast cereal, pasta, flour, bread (excluding gluten-free))
- ○ Soy (e.g., tofu, soy milk, soy sauce)
- ○ Seafood (fish and shellfish)
- ○ Bread (common commercial varieties, excluding soy-free bread)
- ○ None of the above

26. Have you, or do you plan to, ***avoid*** offering any foods to your baby in their first year of life?

- ○ Yes
- ○ No

26a. Please comment:

_____

27. Does your baby have any known food allergies?

- ○ Yes Please state which food(s): ____
- ○ No

If answer is 'No' – skip [Q27a]

27a. Comments (especially how these allergies were diagnosed)

_____

Section 4: Your baby and baby food pouches

28. Has your baby ever eaten food from a baby food pouch?

- ○ Yes
- ○ No

If the answer is 'No' – go to [pouch dislikes; ***Q41****]*

29. How often has your baby eaten from a 'ready-to-eat' baby food pouch *in the past month*? (i.e. pouches that are filled when you buy them)

- ○ Never
- ○ More than once a day
- ○ Once a day
- ○ 5-6 times a week
- ○ 2-4 times a week
- ○ Once a week
- ○ 2-3 times a month
- ○ Once a month
- ○ Less than once a month

30. How often has your baby eaten from a 'home-filled' baby food pouch *in the past month*? (i.e. pouches that you have to put the food in at home)

- ○ Never
- ○ More than once a day
- ○ Once a day
- ○ 5-6 times a week
- ○ 2-4 times a week
- ○ Once a week
- ○ 2-3 times a month
- ○ Once a month
- ○ Less than once a month

31. When baby has food from a baby food pouch, how does baby get the food?

- ○ Always suck it straight from the pouch nozzle
- ○ Mostly suck it straight from the pouch nozzle, sometimes on a spoon
- ○ About half the time suck it straight from the pouch nozzle and half the time on a spoon
- ○ Mostly from a spoon, sometimes suck it straight from the pouch nozzle
- ○ Always on a spoon

If answer is 'Always on a spoon' – skip [pouch nozzle Q's: ***Q31a, Q33, Q34, 35, 36****]*

31a. When baby has food straight from a baby food pouch nozzle, who puts the nozzle in baby's mouth?

- ○ An adult
- ○ Mostly an adult, sometimes baby
- ○ About half of the time an adult and half of the time baby
- ○ Mostly baby, sometimes an adult
- ○ Baby

32. What are the three most common baby food pouches your baby eats?

32a-i

Flavour and brand of baby food pouch baby <u>eats most commonly</u>:

_____

32a-ii How often has your baby eaten this food <u>*in the past month*</u>?

- ○ Never
- ○ More than once a day
- ○ Once a day
- ○ 5-6 times a week
- ○ 2-4 times a week
- ○ Once a week
- ○ 2-3 times a month
- ○ Once a month
- ○ Less than once a month

32b-i

Flavour and brand of baby food pouch baby eats second most commonly:

_____

32b-ii How often has your baby eaten this food <u>*in the past month*</u>?

- ○ Never
- ○ More than once a day
- ○ Once a day
- ○ 5-6 times a week
- ○ 2-4 times a week
- ○ Once a week
- ○ 2-3 times a month
- ○ Once a month
- ○ Less than once a month

32c-i

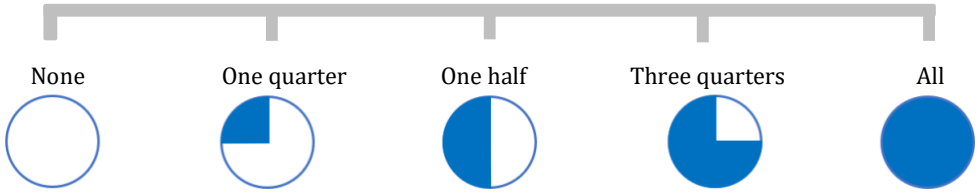
Flavour and brand of baby food pouch baby eats third most commonly

_____

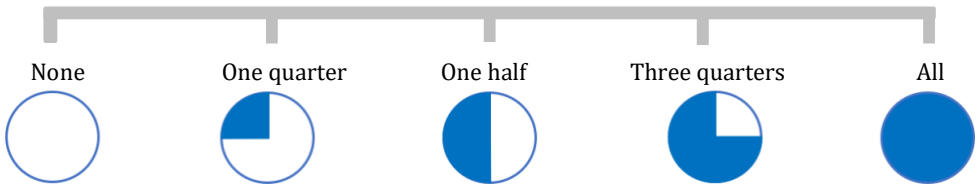
32c-ii How often has your baby eaten this food *in the past month*?

- ○ Never
- ○ More than once a day
- ○ Once a day
- ○ 5-6 times a week
- ○ 2-4 times a week
- ○ Once a week
- ○ 2-3 times a month
- ○ Once a month
- ○ Less than once a month

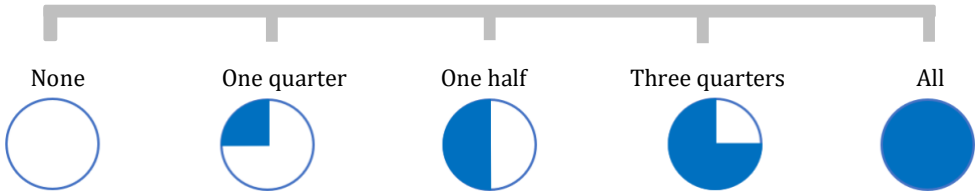
33. Out *of all the food your baby eats*, what proportion do they eat by feeding themselves directly from a pouch (holding a pouch themselves and sucking through the nozzle)? Show this on the sliding scale:



34. Out *of all the food your baby eats*, what proportion do they eat by *you* holding a pouch while baby sucks through the nozzle? Show this on the sliding scale:



35. When your baby feeds themselves directly from a baby food pouch (holding a pouch and sucking through the nozzle), how much of it do they *usually* eat during a *single* eating occasion? Show this on the sliding scale:



If the answer is 'None' – skip [Q36]; go to ***Q37***

36. When your baby feeds themselves directly from a baby food pouch (holding a pouch and sucking through the nozzle), how long do they *usually* spend eating it during a *single* eating occasion?

- ○ Less than 5 minutes
- ○ 5 to 9 minutes
- ○ 10 to 14 minutes
- ○ 15 to 19 minutes
- ○ 20 to 29 minutes

37. Where is your baby usually when they are given a baby food pouch? *Please select the option that is the most common.*

- ○ Chair
- ○ Highchair
- ○ Floor
- ○ On someone's knee
- ○ In an early childhood centre
- ○ In homebased care
- ○ While being looked after by someone else
- ○ While in the car
- ○ While in a buggy or pram
- ○ While on the go
- ○ Other Please state: ___

38. Does baby eat from baby food pouches anywhere else? *Please select <u>all</u> options that apply.*

- ○ Chair
- ○ Highchair
- ○ Floor
- ○ On someone's knee
- ○ In an early childhood centre
- ○ In homebased care
- ○ While being looked after by someone else
- ○ While in the car
- ○ While in a buggy or pram
- ○ While on the go
- ○ Nowhere else
- ○ Other Please state: ___

39. How often do you, or another adult, sit with your baby when they are eating from a baby food pouch? *Please only include sitting with them when you can see them – for instance please don't include driving when they're in the back seat.*

- ○ Never
- ○ Sometimes
- ○ About half the time
- ○ Almost always
- ○ Always

40. Why do you use baby food pouches? *Please select <u>all</u> options that apply.*

- ○ Easy to use
- ○ Less mess
- ○ Cost less
- ○ Takes less time
- ○ Practical
- ○ I have my hands free to do other things
- ○ My baby likes them
- ○ I have heard good things about them
- ○ Easy way to get fruit and vegetables into them
- ○ Easy way to get meat into them
- ○ To increase the types of food my baby eats
- ○ Healthier than foods the family eats
- ○ The food in them is good for baby
- ○ Organic
- ○ Doesn't waste as much food
- ○ The packaging keeps the food fresh
- ○ Safety
- ○ Other Please state: ___

41. Is there anything you do not like about using baby food pouches?

- ○ Yes Please state: ____
- ○ No

42. When your baby first *started eating solids*, were they having food from a baby food pouch?

- ○ Yes
- ○ No

If answer is 'No' – go to ***[Q44]***

42a. When your baby first *started eating solids*, how often would they have food from a 'ready-to-eat' baby food pouch? (i.e. a pouch that was filled when you bought it)

- ○ Never
- ○ More than once a day
- ○ Once a day
- ○ 5-6 times a week
- ○ 2-4 times a week
- ○ Once a week
- ○ 2-3 times a month
- ○ Once a month
- ○ Less than once a month

42b When your baby first *started eating solids*, how often did your baby eat from a 'home-filled' baby food pouch? (i.e. pouches that you have to put the food in at home)

- ○ Never
- ○ More than once a day
- ○ Once a day
- ○ 5-6 times a week
- ○ 2-4 times a week
- ○ Once a week
- ○ 2-3 times a month
- ○ Once a month
- ○ Less than once a month

43 When baby had food from a baby food pouch when they *first started solids*, how did baby get the food?

- ○ Always sucked it straight from the pouch nozzle
- ○ Mostly sucked it straight from the pouch nozzle, sometimes on a spoon
- ○ About half the time sucked it straight from the pouch nozzle and half the time on a spoon
- ○ Mostly from a spoon, sometimes sucked it straight from the pouch nozzle
- ○ Always on a spoon

If answer is 'Always on a spoon' – go to ***[Q44]***

43a When baby had food straight from a baby food pouch nozzle when they *first started solids*, who put the nozzle in baby's mouth?

- ○ An adult
- ○ Mostly an adult, sometimes baby
- ○ About half of the time an adult and half of the time baby
- ○ Mostly baby, sometimes an adult
- ○ Baby

44. Was your baby eating food from a baby food pouch when they were *around 6 months* of age?

- ○ Yes
- ○ No

If answer is 'No' – go to ***[Section 5]***

44a. How often did baby eat food from a 'ready-to-eat' baby food pouch when they were *around 6 months* of age? (i.e. a pouch that was filled when you bought it)

- ○ Never
- ○ More than once a day
- ○ Once a day
- ○ 5-6 times a week
- ○ 2-4 times a week
- ○ Once a week
- ○ 2-3 times a month
- ○ Once a month
- ○ Less than once a month

44b. How often did your baby eat from a 'home-filled' baby food pouch when they were *around 6 months* of age? (i.e. pouches that you have to put the food in at home)

- ○ Never
- ○ More than once a day
- ○ Once a day
- ○ 5-6 times a week
- ○ 2-4 times a week
- ○ Once a week
- ○ 2-3 times a month
- ○ Once a month
- ○ Less than once a month

45 When baby had food from a baby food pouch at *around 6 months* of age, how did baby get the food?

- ○ Always sucked it straight from the pouch nozzle
- ○ Mostly sucked it straight from the pouch nozzle, sometimes on a spoon
- ○ About half the time sucked it straight from the pouch nozzle and half the time on a spoon
- ○ Mostly from a spoon, sometimes sucked it straight from the pouch nozzle
- ○ Always on a spoon

If answer is 'Always on a spoon' – go to ***[Section 5]***

45a When baby had food straight from a baby food pouch nozzle at *around 6 months* of age, who put the nozzle in baby's mouth?

- ○ An adult
- ○ Mostly an adult, sometimes baby
- ○ About half of the time an adult and half of the time baby
- ○ Mostly baby, sometimes an adult
- ○ Baby

Section 5: Some questions about your baby's eating behaviour

Children's Eating Behaviour Questionnaire – satiety responsiveness, food responsiveness, enjoyment of food and slowness in eating subscale (Wardle); Toddler-Parent Mealtime Behavior Questionnaire – Picky eater subscale (*Horodynski)*

Please read the following statements and select the answer most appropriate to your baby's eating behaviour now.

46. My baby loves food

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

47. My baby has a big appetite

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

48. My baby finishes his/her meal quickly

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

49. My baby is interested in food

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

50. My baby eats slowly

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

51. My baby's always asking for food

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

52. If allowed to, my baby would eat too much

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

53. My baby leaves food on his/her plate at the end of a meal

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

54. My baby takes more than 30 minutes to finish a meal

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

55. Given the choice, my baby would eat most of the time

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

56. My baby looks forward to mealtimes

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

57. My baby gets full before his/her meal is finished

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

58. My baby enjoys eating

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

59. My baby gets full up easily

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

60. Even if my baby is full up, s/he finds room to eat his/her favourite food

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

61. My baby cannot eat a meal if s/he had a snack just before

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

62. If given the chance, my baby would always have food in his/her mouth

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

63. My baby eats more and more slowly during the course of a meal

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

64. My baby tries new foods (for example, will take a bite or taste of a new food)

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

65. My baby refuses vegetables

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

66. My baby is a picky eater

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

67. My baby refuses fruits

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

68. My baby accepts new foods

○	○	○	○	○
Never	Rarely	Sometimes	Often	Always

69. Please add any comments here if you wish:

_____

Section 6: Some questions about your baby's health

70. Does your baby currently have reflux?

- ○ Yes
- ○ No

If answer is 'No' – skip [Q70a]

70a. Does this change how or what you feed them?

- ○ Yes Please describe: _____
- ○ No

71. Has your baby ever choked on any liquid (e.g., breast milk, infant formula, or water)? *Please only count times when baby's airway was blocked (partially or totally) – they may have coughed or spluttered. Please don't count gagging, or spitting or vomiting to get food out of the mouth.*

- ○ Yes How many times? _____
- ○ No

72. Has your baby ever choked on any other food? *Please only count times when baby's airway was blocked (partially or totally) – they may have coughed or spluttered. Please don't count gagging, or spitting or vomiting to get food out of the mouth.*

- ○ Yes How many times? _____
- ○ No

*If answer is 'No' – skip [Q72a-72f]; go to **Q73***

72a. Thinking of the most serious choking episode (on food) which of the following did your baby do? *Choose as many as apply.*

- ○ Eyes watered
- ○ Pushed tongue out
- ○ Coughed
- ○ Gasped
- ○ Retched
- ○ Vomited
- ○ Cried
- ○ Went silent
- ○ Other Please state: _____

72b. Thinking again of the most serious choking episode (on food), which of the following happened? *Choose as many as apply.*

- ○ Baby resolved it themselves
- ○ Parent resolved it
- ○ A health professional resolved it
- ○ Another person resolved it
- ○ A health professional was involved
- ○ Baby was admitted to hospital
- ○ Other Please state: _____

72c. Thinking again of the most serious choking episode (on food), what was the food responsible?

_____

72d. Thinking again of the most serious choking episode (on food), what form was the food in?

- ○ *Thin* liquid
- ○ *Thick* liquid
- ○ Puréed
- ○ Mashed
- ○ Diced
- ○ Sliced
- ○ Whole

72e. Thinking again of the most serious choking episode (on food), who fed the baby the food that was responsible?

- ○ Baby him/herself
- ○ Parent
- ○ Another adult
- ○ Brother or sister
- ○ Another child

72f. How old was your baby when this incident happened?

- ○ Less than 1 month old
- ○ 1 month old
- ○ 2 months old
- ○ 3 months old
- ○ 4 months old
- ○ 5 months old
- ○ 6 months old
- ○ 7 months old
- ○ 8 months old
- ○ 9 months old
- ○ 10 months old
- ○ 11 months old

73. Has baby ever choked on food from a baby food pouch? *Please only count times when baby's airway was blocked (partially or totally) – they may have coughed or spluttered. Please don't count gagging, or spitting or vomiting to get food out of the mouth.*

- ○ Yes How many times? _____
- ○ No

If answer is 'No' – skip [Q73a-73e]; go to ***Section 7***

73a. Was the most serious choking episode (on food from a baby food pouch) the same as an incident you described above?

- ○ Yes
- ○ No

If answer is 'Yes' – skip [73b-73e]; go to ***Section 7***

73b. Thinking of the most serious choking episode (on food from a baby food pouch) which of the following did your baby do? *Choose as many as apply.*

- ○ Eyes watered
- ○ Pushed tongue out
- ○ Coughed
- ○ Gasped
- ○ Retched
- ○ Vomited
- ○ Cried
- ○ Went silent
- ○ Other Please state: _____

73c. Thinking again of the most serious choking episode (on food from a baby food pouch), which of the following happened? *Choose as many as apply.*

- ○ Baby resolved it themselves
- ○ Parent resolved it
- ○ A health professional resolved it
- ○ Another person resolved it
- ○ A health professional was involved
- ○ Baby was admitted to hospital
- ○ Other Please state: _____

73d. Thinking again of the most serious choking episode (on food from a baby pouch), who fed the baby the food that was responsible?

- ○ Baby him/herself
- ○ Parent
- ○ Another adult
- ○ Brother or sister
- ○ Another child

73e. How old was your baby when this incident happened?

- ○ Less than 1 month old
- ○ 1 month old
- ○ 2 months old
- ○ 3 months old
- ○ 4 months old
- ○ 5 months old
- ○ 6 months old
- ○ 7 months old
- ○ 8 months old
- ○ 9 months old
- ○ 10 months old
- ○ 11 months old

Section 7: Some questions about your baby's teeth

74. How old was your baby when you first saw a tooth in your baby's mouth? *Please think about the white tip of the tooth or the whole tooth rather than a bump or reddening*.

- ○ My baby does not have any teeth
- ○ Birth
- ○ 1 month old
- ○ 2 months old
- ○ 3 months old
- ○ 4 months old
- ○ 5 months old
- ○ 6 months old
- ○ 7 months old
- ○ 8 months old
- ○ 9 months old
- ○ 10 months old
- ○ 11 months old

75. Do you clean your baby's teeth (or mouth if they don't have any teeth)?

- ○ Yes
- ○ No
- ○ Sometimes

If answer is 'No' – skip [Q75a]

75a. How do you clean baby's teeth (or mouth if they don't have any teeth)? (e.g., brush with a soft brush, wipe with a damp cloth)

_____

76. Do you do anything else to look after your baby's teeth (or mouth if they don't have any teeth)?

- ○ Yes
- ○ No

If answer is 'No' – skip [Q76a]

76a. What else do you do to look after your baby's teeth (or mouth if they don't have any teeth)?

_____

77. Do you have any concerns about your baby's teeth (or mouth if they don't have any teeth)?

- ○ Yes
- ○ No

If answer is 'No' – skip [Q77a]

77a. What concerns do you have about your baby's teeth (or mouth if they don't have any teeth)?

_____

Section 8: Some questions about supplements

78. Has your baby taken any supplements in the past month?

- ○ Yes
- ○ No

*If answer is 'No' – skip [Q79-81]; go to **Section 9***

79. What type of supplement was it? *Please select <u>all</u> that apply.*

- ○ Multivitamin and/or multimineral
- ○ Single vitamin or mineral
- ○ Other Please specify ____

[Complete Q79-81 as appropriate]

79a-i. Multivitamin and/or multimineral: How often did your baby take the supplement in the past month?

- ○ More than once a day
- ○ Once a day
- ○ 5-6 times a week
- ○ 2-4 times a week
- ○ Once a week
- ○ 2-3 times a month
- ○ Once a month
- ○ Less than once a month
- ○ Regularly, but for a limited time

79a-ii. Multivitamin and/or multimineral: Is your baby currently taking this supplement?

- ○ Yes
- ○ No

79a-iii. Multivitamin and/or multimineral: If you know the brand name and/or the product name please write them here. Please provide as much information about the product as possible.

_____

79a-iv. Multivitamin and/or multimineral: If you have the supplement please could the researcher take a photo of it.

[*upload photo*]

[repeat option]

80a-i. Single vitamin or mineral: Please tell us what vitamin or mineral it was:

_____

80a-ii. Single vitamin or mineral: How often did your baby take the supplement in the past month?

- ○ More than once a day
- ○ Once a day
- ○ 5-6 times a week
- ○ 2-4 times a week
- ○ Once a week
- ○ 2-3 times a month
- ○ Once a month
- ○ Less than once a month
- ○ Regularly, but for a limited time

80a-iii. Single vitamin or mineral: Is your baby currently taking this supplement?

- ○ Yes
- ○ No

80a-iv. Single vitamin or mineral: If you know the brand name and/or the product name please write them here. Please provide as much information as possible.

_____

80a-v. Single vitamin or mineral: If you have the supplement please could the researcher take a photo of it.

[*upload photo*]

[repeat option]

81a-i. Other: How often did your baby take the supplement in the past month?

- ○ More than once a day
- ○ Once a day
- ○ 5-6 times a week
- ○ 2-4 times a week
- ○ Once a week
- ○ 2-3 times a month
- ○ Once a month
- ○ Less than once a month
- ○ Regularly, but for a limited time

81a-ii. Other: Is your baby currently taking this supplement?

- ○ Yes
- ○ No

81a-iii. Other: If you know the brand name and/or the product name please write them here. Please provide as much information as possible.

_____

81a-iv. Other: If you have the supplement please could the researcher take a photo of it.

[*upload photo*]

[repeat option]

Section 9: Some final questions

This is a short set of questions about you and your baby to help us group your answers with those of similar people for analysis purposes.

82. Which ethnic group do you belong to? *Select all that apply to you.*

- ○ NZ European
- ○ Māori
- ○ Samoan
- ○ Cook Island Māori
- ○ Tongan
- ○ Niuean
- ○ Chinese
- ○ Indian
- ○ other, eg Dutch, Japanese, Tokelauan. Please state: _____

83 Are you descended from a Māori (that is, did you have a Māori birth parent, grandparent or great-grandparent, etc)?

- ○ Yes
- ○ Don't know
- ○ No

If answer is 'No' – go to Q84

83a Do you know the name(s) of your iwi (tribe or tribes)?
See the Guide Notes for a list of iwi.

- ○ Yes
- ○ No

If answer is 'No' – go to Q84

83b Enter the name(s) and region(s) of your iwi (tribe or tribes):
See the Guide Notes for a list of iwi.

Iwi: _____

Region: _____

Iwi: _____

Region: _____

Iwi: _____

Region: _____

Iwi: _____

Region: _____

84. Do you currently have paid employment?

- ○ No
- ○ Yes – part-time
- ○ Yes – full-time
- ○ Paid parental leave
- ○ Unpaid parental leave

85. What is the highest level of education you have completed?

- ○ School
- ○ Polytechnic or similar
- ○ University
- ○ Other Please state: ___

86. How tall are you without shoes?

_____ cm *or* _____ feet and _____ inches

87. How much do you weigh?

_____ kg *or* _____ pounds *or* _____ stone and _____ pounds

88. How many children have you (or baby's mother) given birth to (including this baby)?

- ○ One
- ○ Two
- ○ Three
- ○ Four or more

89. How many *children* usually (at least half the time) live in your household (including this baby)?

- ○ One
- ○ Two
- ○ Three
- ○ Four or more

90. How many *adults* usually live in your household (including yourself)?

- ○ One
- ○ Two

- ○ Three
- ○ Four or more

91. Is your baby regularly looked after by someone other than yourself? *Please select <u>all</u> answers that apply.*

- ○ No
- ○ Yes, by another family member
- ○ Yes, by a nanny
- ○ Yes, they go to an early childhood centre
- ○ Yes, they go to homebased care
- ○ Yes, other Please state: ___

Thank you very much for completing this questionnaire

Guide notes

List of iwi by region

The list is a guide only and is not exhaustive. Enter your iwi even if it does not appear on the list.

Te Tai Tokerau / Tāmaki-makaurau (Northland /Auckland) Region
Ngāti Whātua
Te Aupōuri
Ngāti Kahu
Ngāti Kurī
Ngāpuhi
Ngāpuhi ki Whaingaroa-Ngāti Kahu ki Whaingaroa
Te Rarawa
Ngāi Takoto
Ngāti Wai
Ngāti Whātua (not Ōrākei or Kaipara)
Te Kawerau ā Maki
Te Uri-o-Hau
Te Roroa
Ngāti Whātua o Kaipara
Ngāti Whātua o Ōrākei
Ngāi Tai ki Tāmaki
Ngāti Hine (Te Tai Tokerau)
Te Paatu
Ngāti Manuhiri
Ngāti Rēhua

Hauraki (Coromandel) Region
Ngāti Hako
Ngāti Hei
Ngāti Maru (Hauraki)
Ngāti Paoa
Patukirikiri
Ngāti Porou ki Harataunga ki Mataora
Ngāti Pūkenga ki Waiau
Ngāti Rāhiri Tumutumu
Ngāti Tamaterā
Ngāti Tara Tokanui
Ngāti Whanaunga

Te Arawa / Taupō (Rotorua / Taupō) Region
Ngāti Pikiao (Te Arawa)
Ngāti Rangiteaorere (Te Arawa)
Ngāti Rangitihi (Te Arawa)
Ngāti Rangiwewehi (Te Arawa)
Tapuika (Te Arawa)
Ngāti Tarāwhai (Te Arawa)
Tūhourangi (Te Arawa)
Uenuku-Kōpako (Te Arawa)
Waitaha (Te Arawa)
Ngāti Whakaue (Te Arawa)
Ngāti Tūwharetoa (ki Taupō)
Ngāti Tahu-Ngāti Whaoa (Te Arawa)
Ngāti Mākino
Ngāti Kearoa / Ngāti Tuarā
Ngāti Rongomai (Te Arawa)

Tauranga Moana / Mātaatua (Bay of Plenty) Region
Ngāti Pūkenga
Ngāi Te Rangi
Ngāti Ranginui
Ngāti Awa
Ngāti Manawa
Ngāi Tai (Tauranga Moana/Mātaatua)
Tūhoe
Whakatōhea
Te Whānau-ā-Apanui
Ngāti Whare
Ngā Pōtiki ā Tamapahore
Te Upokorehe
Ngāti Tūwharetoa ki Kawerau

Te Tai Rāwhiti (East Coast) Region
Ngāti Porou
Te Aitanga-a-Māhaki
Rongowhakaata
Ngāi Tāmanuhiri
Te Aitanga ā Hauiti

List of iwi by region (continued)

Waikato / Te Rohe Pōtae (Waikato / King Country) Region
Ngāti Haua (Waikato)
Ngāti Maniapoto
Raukawa (Waikato)
Waikato
Ngāti Te Ata
Ngāti Hīkairo
Rereahu
Ngāti Tipa
Ngāti Korokī Kahukura
Ngāti Tamaoho
Te Ākitai-Waiohua

Te Matau-a-Māui/Wairarapa (Hawke's Bay/Wairarapa) Region
Rongomaiwahine (Te Māhia)
Ngāti Kahungunu ki Te Wairoa
Ngāti Kahungunu ki Heretaunga
Ngāti Kahungunu ki Wairarapa
Rangitāne (Te Matau-a-Māui/Hawke's Bay/Wairarapa)
Ngāti Kahungunu ki Te Whanganui-a-Orotu
Ngāti Kahungunu ki Tamatea
Ngāti Kahungunu ki Tamakinui a Rua
Ngāti Pāhauwera
Ngāti Rākaipaaka
Ngāti Hineuru
Maungaharuru Tangitū
Rangitāne o Tamaki nui ā Rua
Ngāti Ruapani ki Waikaremoana
Te Hika o Pāpāuma

Whanganui/Rangitīkei (Wanganui/Rangitīkei) Region
Ngāti Apa (Rangitīkei)
Te Ati Haunui-a-Pāpārangi
Ngāti Haua (Taumarunui)
Ngāti Hauiti (Rangitīkei)
Ngāti Whitikaupeka (Rangitīkei)
Ngāi Te Ohuake (Rangitīkei)
Ngāti Tamakōpiri (Rangitīkei)
Ngāti Rangi (Ruapehu, Whanganui)
Uenuku (Ruapehu, Waimarino)
Tamahaki (Ruapehu, Waimarino)
Tamakana (Ruapehu, Waimarino)

Taranaki Region
Te Atiawa (Taranaki)
Ngāti Maru (Taranaki)
Ngāti Mutunga (Taranaki)
Ngā Rauru
Ngā Ruahine
Ngāti Ruanui
Ngāti Tama (Taranaki)
Taranaki
Tangāhoe
Pakakohi

Manawatū/Horowhenua/Te Whanganui-a-Tara (Manawatū/Horowhenua/Wellington) Region
Te Atiawa (Te Whanganui-a-Tara/Wellington)
Muaūpoko
Rangitāne (Manawatū)
Ngāti Raukawa (Horowhenua/Manawatū)
Ngāti Toarangatira (Te Whanganui-a-Tara/Wellington)
Te Atiawa ki Whakarongotai
Ngāti Tama ki Te Upoko o Te Ika (Te Whanganui-a-Tara/Wellington)
Ngāti Kauwhata
Ngāti Tukorehe

Te Waipounamu/Wharekauri (South Island/Chatham Islands) Region
Te Atiawa (Te Waipounamu/South Island)
Ngāti Koata
Ngāti Kuia
Kāti Māmoe
Moriori
Ngāti Mutunga (Wharekauri/Chatham Islands)
Rangitāne (Te Waipounamu/South Island)
Ngāti Rārua
Ngāi Tahu / Kāi Tahu
Ngāti Tama (Te Waipounamu/South Island)
Ngāti Toarangatira (Te Waipounamu/South Island)
Waitaha (Te Waipounamu/South Island)
Ngāti Apa ki Te Rā Tō

P-6b1: 24-h recall protocol

Copy no. _____

Study:	FFNZ	*Version number:*	Version 6
Prepared by:	NM, LF, ALH, HD	*Date prepared:*	08/06/2020

Objective

- Capture a detailed assessment of the infant's diet from the previous day, while also capturing data relevant to baby food pouch use, Baby-Led Weaning, dental health, and speed of eating.

Equipment required

Protocols:	**P-6b1: 24-h recall protocol** (this protocol) **P-6b2: Transfer 24-h recall photos** **P-6b3: Foods fed by other adults – follow up**
Documents:	**O-15: 24-h recall recording sheets** **O-16: 'Food Description Prompts' sheet** **O-37: Sheet with grids and circles** (measurement aid)
Equipment:	Measurements aids set (includes household measures, food models and **O-37: Sheet with grids and circles**) Laptop and Vodem Stapler (check plenty of staples)
Participant to provide:	Photos of eating occasions **O-12: 'Foods Fed by Other Adults' form** (if used)

Process – Before

In office:

- Ensure details are correctly recorded on ***all*** 24-h recall recording sheets (participant ID, interviewer, date, day of the week). Tick box on first page to indicate whether this is the participant's first or second recall.
- Ensure Countdown website is bookmarked on laptop

At appointment:

- Download photos following **P-6b2: Transfer 24-h recall photos**.
- Open Countdown website on laptop.
- Set out measurement aids and visuals. ***Caution*****:** This set contains dried beans which are a choking hazard for young children.

Process – During

Introduction

Invite the participant to take a seat. Explain what is going to happen during the 24-h recall interview.

"I'm going to ask you about what [*baby's name*] ate and drank yesterday. We're interested in finding out everything they ate and drank, whether it was at home or away from home. So that includes snacks, drinks, water, even just having a small taste of something, as well as meals."

"A quick question before we start." (*ask illness question; record answer*)

Carry out 24-h recall interview.

Stage One: Quicklist

"First, we'll make a quick list of all the things [*baby's name*] ate and drank yesterday. ***After*** we have made a list of the foods and drinks they've had, we'll go through the photos to get more details about each food and drink, like the amounts and where they had them. We can easily add to the list if you remember other things when we're looking through the photos later. At the end, we'll go back through the list one more time to make sure we have everything."

"To help you remember what [*baby's name*] ate and drank, it may be useful to think about where they were, who they were with, or what they were doing yesterday. For example, going to childcare, visiting family or a friend's houses, or playing at home. Feel free to keep these activities in mind, and to say them aloud if that helps."

"So, we're going to be thinking about what [*baby's name*] had yesterday – [*insert day that was yesterday*]. Let's start right at the beginning – from midnight then we'll go through the morning, afternoon and evening. What was the first thing [*baby's name*] ate or drank?"

Record Quicklist – keep prompting until finished. Note: Do not go through the photos during this step (this is to avoid repetition of details).

"Sometimes people forget to tell us about drinks and snacks when we do this list."

"How much water did [*baby's name*] drink yesterday?" (*record*)

"Did [*baby's name*] have any [*more*] breastmilk or formula yesterday?" (*record*)

"Did [*baby's name*] have any other drinks like milk or juice yesterday?" (*record*)

"How about any other snacks, like muesli bars, crackers, sweets, or desserts?" (*record*)

"Were there any other meals or snacks that [*baby's name*] ate yesterday that someone else gave [*him/her*]?" (*note this on Quick List; ask question below*)

<u>If baby consumed food/drink while in the care of another adult/in childcare</u>:

"Do you have any information about what [*baby's name*] ate or drank yesterday while in their care? For example, did this person fill out the 'Foods Fed by Other Adults' form, or did you provide food for [*baby's name*] to eat while in their care?"

YES **(NOTE THIS ON QUICKLIST; GO TO DETAILED LIST)**
NO **(GO TO P-6b2: Foods Fed by Other Adults Follow Up – START AT A1; GO TO DETAILED LIST)**

Stage Two: Detailed list

"I'm now going to ask you some questions about each food and drink. We're going to work out <u>how much</u> of each food [*baby's name*] ate and drank, <u>where</u> they were fed, and <u>how</u> they were fed. I'd also like to know whether any of the foods came from a baby food pouch."

"It usually works well if you click through the photos that you took on our laptop while I ask you questions about the foods and drinks eaten. Does that sound okay?"

Pull the Quicklist page from the staple and have it next to the detailed list table when going through the food/drink items, ticking off each item on the Quicklist as you go along.

"Let's start at the beginning - from one-minute past midnight yesterday morning. The first thing you remembered [*baby's name*] eating/drinking was [*XXX*]." (*record*)

"What time did [*baby's name*] eat/drink that? (*record*)

Complete the 'Detailed 24-h recall' form, recording each food/drink on a new line:

- **Time**. Collect time of consumption of the first mouthful of food for each meal/snack. *NB*: You may find this information by viewing the image details.
- **Place**. Collect location fed for each eating occasion – include both specific (where was the child sitting e.g., highchair, car seat, buggy, floor, bed, couch) and broad place fed (what setting where they in e.g., home, friend's house, park, supermarket, car, childcare).
- **Description of Food/Drink**. Record the name of the food and cooking method used. Use **O-16: Food Description Prompts sheet** to guide you about specific details to obtain from certain foods and drinks. Record each food/drink item in a different row. *NB*: If breastfed – add duration of each breastfeed instead of amount (unless expressed breast milk given in which case record amount).
- **Brand**. Record <u>the product brand</u> (or record '<u>brand unknown</u>') (*note*: to identify the brand, look at the product packaging on the photograph, in the home (visit 1), or search for the product on Countdown website). Alternatively, note if the food/drink item was '<u>homemade</u>' (if so, ask for recipe – record in the 'Recipe' section).
- **Amount**. Record both the amount <u>offered</u> (i.e. the amount baby was given the opportunity to eat), and amount <u>consumed</u>. Use size of packet information if possible (see product package). Alternatively, use bottles, dishes and utensils in the home (visit 1), or measurement aids and visuals, to help the participant estimate the

portion size. *Note*: in visit 1 (home) record in the 'Notes' section of your recording sheet a description of the size of the bottle/dish/utensil (e.g., 120 mL Sippy cup), so you can refer to this to compare sizing in visit 2 (clinic).

- **Fed by**. Tick the option that best describes who put the food in baby's mouth. You can tick both options if it was a combined effort (e.g., a breastfeed, both holding the spoon).
- **Used pouch**. Tick to indicate whether food was from (stored in or served from) a baby food pouch (including commercial and home-filled pouches). If so, tick the option that best describes how the pouch was used:
    - Baby fed self directly (i.e. baby holds pouch and sucks through nozzle)
    - Adult fed baby directly (i.e. adult holds pouch and baby sucks through nozzle)
    - Adult fed baby via spoon
    - If another method was used, record this.

Probe about additions to food before moving to the next food/drink item on the Quicklist. Keep your prompts neutral, for example:

"Did they have anything with that?"

<u>If baby consumed food/drink while in the care of another adult/in childcare:</u>

- *If <u>'Foods Fed by Other Adults' form was attempted</u>, write 'SEE FFOA FORM' on the recording sheet. Check the 'Foods Fed by Other Adults' form has been filled out correctly and completely.*
- *If <u>participant provided food to eat while in their care</u> (e.g., packed lunch box), find out what food was provided and how much was sent home. Record this on the 24-h recall recording sheet.*

<u>If you identify any significant missing information</u> *(i.e. no data on amount eaten, Pouch Used, Fed by, and, in some cases, the brand name (e.g., to determine whether a food was iron fortified)), record this in the 'Notes' section of the recording sheet. If there is significant missing information,* ***GO TO P-6b3: Foods Fed by Other Adults Follow Up – START AT A1****.*

Stage Three: Review and probe for forgotten foods

Ask about and record:

1. *Time spent eating at each occasion (first to last mouthful of <u>solid</u> food).*
2. *If applicable: Duration of each formula feed. NB: Breastfeeding duration (from the breast or expressed) is to be recorded separately (see O-5: First Foods NZ FAQs, 24-h recall section, for examples).*
3. *Forgotten foods/liquids*
4. *Home-filled pouch use*

"Thanks for working with me to provide all that detail. We are now going to go through the list one last time to make sure we haven't missed anything. I am going to read this list back to you – please interrupt me if you remember anything else that [*baby's name*] ate

or drank so we can record it. As we go through, we also need to work out how long each eating (and formula-feeding) occasion lasted."

Make sure this is done slowly so the participant has an opportunity to remember each eating/drinking occasion.

Review the list of foods and beverages with the participant and determine how long baby spent eating or drinking, for:

1. *Solid foods: From their first to last mouthful of food for each meal/snack (E.g.* "At 8 am, [baby's name] ate a rice cracker and some peanut butter toast while in the car going to day care. How long did they spend eating these, from first to last mouthful?").
   Note: if they continued to consume liquids such as water or juice after their last mouthful of solid food, don't include this drinking in the time estimate.

2. *Formula (if applicable): From their first to last mouthful of formula at each formula-feeding occasion.* (E.g. "At 6pm [baby's name] had a drink of formula while sitting on the couch at home. How long did they spend drinking the formula, from first to last mouthful?")

Record the length of each eating/formula-feeding occasion in the 'Time' column (or in the left-hand column if multiple foods consumed at one occasion – see examples in 24-h recall section of **O-5_FAQ***) and use a horizontal line to separate different eating occasions.*

3. *Forgotten foods/liquids*
   "Is there anything you can think of that we need to add in?" (*record as necessary*)

4. *Ask about home-filled pouch use:*
   1. Has the parent/guardian reported any pouch use
      YES **(GO TO 'b')**
      NO **(END)**

   2. "Finally: we're interested to know about home-filled pouches – by that I mean pouches that you put the food in yourself at home (*show example from measurement aid set*). Were any of the pouches baby had yesterday home-filled pouches?"

      YES "Which ones?" (*circle and label with 'HF' beside the row*)
      "Was it filled with homemade food, or ready-to-eat bought food?" (*ensure this is recorded in the 'Brand' column)*

Thank the participant for their time.

Process – After

1. Staple the forms back together in the following order:
   a. Quicklist
   b. Detailed 24-h recall

c. Recipes
d. Notes
e. 'Foods Fed by Other Adults' form (if applicable).

2. If follow up is required for the 24-h recall foods fed by other adults, complete follow up contact (phone call to other caregiver or email to participant) as soon after the appointment as possible (see **P-6b2: Foods fed by other adults follow up protocol**).

3. Scan all completed 24-h recall documentation and download this to the University High-Capacity Central File Storage system (*location: 24-h recall > 24-h recall documents > [area] > 1. New*) – please use the format shown below for file and folder names.

   Save files to a folder labelled in the following format:
   [*Participant ID*]_DR[*1/2*]
   E.g., FF1001AB_DR1

   Label each file with Participant ID, diet recall number, document name, and date:
   [*Participant ID*]_DR[*1/2*]_[*document name*]_[*date*]
   E.g., FF1001AB_DR1_RecordingSheet_10Jun2020

4. All 24-h recalls will be entered in Dunedin for quality control and logistical purposes, following protocol **P-19: 24-h recall dietary data entry (to FoodWorks)**.

5. Download 24-h recall photos to the University High-Capacity Central File Storage system (*location: 24-h recall > 24-h recall images > [area]*) – please use the format shown below for file and folder names.

   Save files to a folder labelled in the following format:
   [*Participant ID*]_DR[*1/2*]
   E.g., FF1001AB_DR1

   Label each file with Participant ID, diet recall number, document name, and date:
   [*Participant ID*]_DR[*1/2*]_[*date*]
   E.g., FF1001AB_DR1_10Jun2020

6. Complete the **Diet Recall form** (under Main Visit 1 + BF1) in REDCap – when all fields have been answered mark the form status as 'Complete'.

Appendix E: Decimal Places Used

Number	Decimal places used
0s	2DP
1-10s	1DP
100-1000s	0DP