Parent-reported offering of allergen foods to infants during complementary feeding: an observational study

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

Master of Science

in

Nutrition and Dietetics

at Massey University, Albany,

New Zealand

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2023

Abstract

Background: The prevalence of food allergies in New Zealand infants is unknown; however, it is thought to be similar to Australia, where the prevalence is over 10% of infants 12 months of age. Current New Zealand recommendations for reducing the risk of food allergies are to: offer all infants major food allergens (age-appropriate texture) at the start of complementary feeding (around six months), ensure major allergens are given to all infants before 12 months; maintain tolerance of major food allergens by regularly (approximately twice a week) offering the food; and to continue breastfeeding while introducing complementary foods. We know little about parental practices around introducing major food allergens during complementary feeding.

Aim: The study aims to explore parental offering of major food allergens to infants during complementary feeding and parent-reported food allergies.

Methods: The cross-sectional study included 625 parent-infant dyads from the multi-centred (Auckland and Dunedin) First Foods New Zealand study. Participants were recruited in 2020-2022, and infants were 7-10 months of age. This secondary analysis included the use of study questionnaire and 24-hour diet recall data. The questionnaire included determining current breastfeeding status, offering of major food allergens, avoidance of foods during the infant's first year of life, infant food allergies and their diagnosis. For assessing consumers of major food allergens, 24-hour diet recall data were used (two days per infant).

Results: The questionnaire was used to determine that all major food allergens were offered to 9.1% of infants aged 7-10 months and 17% of infants aged 9-10 months. Dairy (94.4%) and wheat (91.2%) were the most common major food allergens consumed on the diet recall days. Breastfed infants (n=414) were more likely to consume sesame than non-breastfed infants (n=211) (48.8% vs 33.7%, $p \leq 0.001$). Overall, 12.6% of infants had a parent-reported food allergy and a symptomatic response after exposure was the most common diagnostic tool.

Conclusion: Most infants are not offered all major food allergens during early complementary feeding. Only 17% of infants aged 9-10 months were offered all major food allergens, with some parents actively avoiding major food allergens in the first year of life.

Acknowledgements

I would like to acknowledge several people involved in this study. To Dr Lisa Daniels and Professor Cath Conlon, thank you for your continued support and guidance. I appreciate all the time, feedback, and encouragement you have both provided. Thank you for pushing me academically, your expertise in infant nutrition and academic writing is invaluable. I have gained immeasurable knowledge from you both that I will take with me into the future.

I would also like to thank Jill Haszard for providing me with the relevant FFNZ data and supporting me with the statistical analysis. I really appreciate your guidance and expertise. Thank you to the wider FFNZ team, both staff and students, who worked to collect the data, I appreciate you all for allowing me access to the data to complete the study. To all the parents and their infants who participated in the FFNZ study, thank you for taking the time to be involved.

To my parents and partner, you have supported me in all ways possible over the last five years. Thank you for providing me with financial and emotional support. Your encouragement every step of the way did not go unnoticed. You always believed in me, and for this, I am forever grateful. This would not have been possible without you. Thank you.

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List of Abbreviations

Abbreviation	Definition
AAP	American Academy of Paediatrics
ASCIA	Australasian Society of Clinical Immunology and Allergy
EAACI	European Academy of Allergy and Clinical Immunology
EAST	Enzyme allergosorbent testing
EAT	Enquiring About Tolerance
FFNZ	First Foods New Zealand
FFQ	Food Frequency Questionnaire
FIA	Food Induced Anaphylaxis
GP	General practitioner
GUiNZ	Growing up in New Zealand
IgE	Immunoglobulin E
LEAP	Learning Early about Peanut Allergy
MOH	Ministry of Health
NZDEP	NZ Index of Deprivation
OFC	Oral food challenge
ONZFG2023	Otago New Zealand Food Group 2023
RAST	Radioallergosorbent test
SD	Standard Deviation
sIgE	specific immunoglobulin E
SPSS	Statistical Package for the Social Sciences
ssIgE	serum specific IgE
SPT	Skin prick test
UK	United Kingdom
USA	United States of America
WHO	World Health Organization

Chapter 1 Introduction

1.1 Background

When infants reach around six months of age, solid foods should be introduced alongside continuing infant milk intake (breast milk or infant formula); this is referred to as complementary feeding (Ministry of Health [MOH], 2021). Infants have increased nutrient, and energy needs at this age and are developmentally ready to consume and process solid food (Butte et al., 2004; MOH, 2021). Solid foods must be introduced appropriately to avoid the risk of faltering growth, nutrient deficiencies and food aversions (Fewtrell et al., 2017; Gould, 2017; World Health Organization [WHO], 2021). Therefore, evidence-based infant feeding guidelines have been developed globally and in New Zealand for health professionals to communicate with parents. These guidelines include recommendations for introducing major food allergens (dairy, egg, peanut, tree nuts, soy, fish, shellfish, sesame and wheat) into the infant's diet. Parents may be apprehensive about introducing new foods to their infants due to the possibility of an allergic reaction; however, the recommendations ensure the best practices for parents to follow.

The recommendations and guidelines globally and in New Zealand for introducing major food allergens to infants have changed over the years (Joshi et al., 2019). In the early 2000's major food allergens were previously recommended to be avoided by high-risk infants (those with a first degree relative with an allergy such as an allergy to food, atopic dermatitis, asthma, or allergic rhinitis) in the first years of life (American Academy of Pediatrics Committee on Nutrition [AAP], 2000). However, food allergies continued to rise, and more recent studies identified that delaying the introduction of major food allergens may lead to an increased risk of developing a food allergy (Du Toit et al., 2008; Koplin et al., 2010). This led to the Australasian Society of Clinical Immunology and Allergy (ASCIA) releasing infant feeding and allergy prevention guidelines in 2008 that no longer recommended the delay of introducing allergenic foods (Mullins et al., 2022). The recommendation for the early introduction of major food allergens was stated globally in 2015 – 2016 (Mullins et al., 2022). ASCIA revised their infant feeding and allergy prevention guidelines in 2016, with a further update in 2020 (ASCIA, 2020b). These guidelines included the recommendation to introduce all major allergenic foods in the infant's first year of life, even high-risk infants.

Early introduction of major food allergens, at around six months but not before four months, has become the most favourable approach to prevent food allergy development (McWilliam et al., 2022). The current New Zealand guidelines recommend that all infants are introduced to all

major food allergens at the start of complementary feeding, around six months of age (MOH, 2021). This will ensure that all major food allergens are given to all infants before 12 months of age. It is recommended that once a major food allergen is tolerated, it should be given to infants regularly (approximately twice a week) to maintain tolerance. Breastfeeding is also recommended to be continued during the complementary feeding period. It is important to understand if parents are following these recommendations, as it is crucial in reducing their infant's risk of food allergy development.

Food allergies are immune system reactions to a food (ASCIA, 2021b). Food allergies may appear after one or two exposures to a new food but can also appear after multiple exposures to a food (Du Toit et al., 2009). Food allergies include immunoglobulin E (IgE) mediated food allergies, non-IgE-mediated food allergies, mixed food allergies (IgE/non-IgE) and cell-mediated food allergies, which can each produce a variety of different reactions at different times after the ingestion of a specific food (ASCIA, 2019). IgE-mediated food allergies are the most well-known and more common in children under five years old (ASCIA, 2021b; Elghoudi & Narchi, 2022). They produce IgE antibodies, which can lead to the physical signs and symptoms of a food allergy (ASCIA, 2021b). IgE-mediated food allergies can result in severe reactions, including anaphylaxis (potentially fatal), that may occur minutes to hours after exposure to a food (Anvari et al., 2019; Burks et al., 2012).

Parents are likely to over-report food allergies, which may be due to a misunderstanding of food allergy symptoms. Therefore, an accurate diagnosis is crucial to ensure no unnecessary exclusion of foods from the infant's diet and to ensure appropriate ongoing management (Chafen et al., 2010; O'Sullivan et al., 2020). Skin prick tests (SPT) and serum specific IgE (ssIgE) blood tests can aid in the confirmation of IgE-mediated food allergies as they identify the specific immunoglobulin E (sIgE) antibodies in response to the food (ASCIA, 2021b). The SPT is the subcutaneous introduction of commercial extracts of an allergen onto the forearm or back; this can identify sIgE antibodies to a particular allergen by showing up with a small itchy wheal and red flare in 15-20 minutes (ASCIA, 2020a; Domenico et al., 2021). Blood tests detect the sIgE antibody concentrations in the blood, as this can indicate a food allergy in combination with clinical adverse reactions (ASCIA, 2020a; Dupont, 2011). It is possible to have sIgE antibodies present without a physical reaction; this is called sensitisation (ASCIA, 2021b). The concentration of sIgE antibodies indicates how likely a physical reaction will occur after exposure to a potential food allergen (Devdas et al., 2018; Zhang et al., 2021). Therefore,

covering relevant clinical history and symptoms with a health professional is important if a food allergy is suspected. Health professionals may follow up with oral food challenges (OFC), which are the medically supervised consumption of specific amounts of the suspected food with the response observed in a clinical setting (ASCIA, 2020a; Domenico et al., 2021). These OFCs can confirm or rule out food allergies previously suspected to have caused a reaction (ASCIA, 2022a).

Around the world, the prevalence of food allergies is increasing across the lifecycle (Warren et al., 2020). The overall prevalence of infant food allergies in young New Zealand children is unknown. One of the highest rates of food allergies in infants has been identified in Australia, with over 10% of Australian infants under 12 months of age having a proven food allergy (Osborne et al., 2011). More recent data of parent-reported infant food allergies suggests this prevalence remains consistent in Australia (Netting et al., 2022b; O'Sullivan et al., 2020). The high prevalence in Australia is thought to be similar in New Zealand. This is due to New Zealand having comparable levels of asthma prevalence to Australia (Asher et al., 2008). Asthma is an atopic disease commonly seen alongside food allergies; therefore, the similar prevalence of asthma in New Zealand and Australia is thought to relate to the similar prevalence of food allergies between the two countries (Asher et al., 2008; Ferreira et al., 2022).

1.2 Purpose

In New Zealand, health professionals and parents can refer to MOH “Healthy Eating Guidelines for New Zealand Babies and Toddlers (0-2 years old)” and the ASCIA “ASCIA Guidelines – Infant Feeding and Allergy Prevention”, which provide current recommendations for introducing major food allergens to infants (ASCIA, 2020b; MOH, 2021). However, the changing recommendations over the last two decades have led to varying knowledge and practices among parents introducing major food allergens to their infants (McWilliam et al., 2022).

There has been an improvement in the early consumption of major food allergens among infants in Australia, suggesting a positive uptake in using the most recent guidelines (Netting et al., 2022b; Soriano et al., 2019). However, adherence to guidelines needs improvement in other countries (Almutairi et al., 2021; Kostecka et al., 2021; Kwong et al., 2022; Rowan & Brown, 2023). In New Zealand, it is important to determine if parents follow the current recommendations for introducing major food allergens for food allergy prevention. Therefore, by evaluating parental offering of major food allergens to infants in New Zealand and parent-

reported food allergy in their infant, this thesis will provide new knowledge of the current practices and if more targeted advice around allergy prevention is required.

1.3 Aim

The study aims to explore parental offering of major food allergens to infants during complementary feeding and parent-reported food allergies.

1.3.1 Objectives

The specific objectives are to:

1) describe the parental reported offering of major food allergens during the complementary feeding period in infants aged 7 to 10 months;
2) determine the proportion of infants who have consumed major food allergens between 7 to 10 months;
3) compare the consumption of major food allergens between breastfed and non-breastfed infants aged 7 to 10 months;
4) describe the avoidance of any foods in the first year of life;
5) describe the parental reported prevalence of food allergies and how they were diagnosed in infants between 7 and 10 months.

1.4 Thesis Structure

This thesis is divided into four chapters. **Chapter One** is an introduction; this provides a background to the thesis topic and describes the purpose of the study, including the aims and objectives and researchers' contributions. **Chapter Two** is a literature review of the guidelines for introducing major food allergens, the diagnosis of food allergies, relevant research on introducing major food allergens and the prevalence of food allergies during infancy. **Chapter Three** presents the results of the research and is presented as a manuscript for publication. **Chapter Four** is the conclusion-recommendation chapter, which states the achievement of the aim and objectives, the impact of this research and future research recommendations. Strengths and limitations of the study and final recommendations are also included. The **appendices** include the relevant study questionnaire and an example of data coding work completed as part of this thesis.

1.5 Researchers Contributions

Table 1.1 provides a summary of the researchers contributing to this thesis. This includes myself, my two academic supervisors Dr Lisa Daniels and Professor Cath Conlon, as well as the biostatistician Associate Professor Jill Haszard.

Table 1.1 Summary of researcher's contributions to study

Author	**Contribution to Thesis**
Jade Medemblik MSc Nutrition and Dietetic candidate	Primary author of the thesis. Completed the literature review, data coding, the statistical analyses and interpretation of results for this secondary analysis.
Dr Lisa Daniels Academic Supervisor	Academic supervisor. Developed the study design and advised data analysis. Provided guidance and feedback on all components of the thesis. Approved thesis chapters and manuscript.
Professor Cath Conlon Academic Supervisor	Academic supervisor. Advised data analysis and provided guidance and feedback on all components of the thesis. Approved thesis chapters and manuscript.
Associate Professor Jill Haszard FFNZ Co-Investigator & Biostatistician	Provided cleaned data relevant to this thesis and assisted with the statistical analysis.

Chapter 2 Literature Review

2.0 Introduction

Over the last two decades, recommendations for introducing food allergens to infants have changed. Although international studies have investigated parental practices of introducing major food allergens to infants, there is very little New Zealand specific evidence. This chapter reviews the current literature on complementary feeding, food allergies, the diagnosis of food allergies, guidelines and recommendations for introducing major food allergens, the offering of major food allergens to infants and the prevalence of infant food allergies worldwide and in New Zealand.

Relevant literature was identified by undertaking searches of online electronic databases, including Massey Discover, Google Scholar, PubMed, and Web of Science, using a combination of the search terms below (Figure 2.1). Further literature was identified from reference lists of relevant articles. Website searches were used for dietary guideline documents. Journal articles were full-text English and retrieved between November 2022 and November 2023. Relevant literature was exported to EndNote 20 (The EndNote Team, 2013).

Date Searched: November 2022 – November 2023

Electronic Databases: Massey Discover, Google Scholar, PubMed, Web of Science

Search Terms:

- Infant OR baby OR babies OR toddler
- Food AND Allerg* OR peanut* OR nut* OR milk OR egg* OR wheat* OR atopic
- Parent* OR mother OR father OR maternal OR caregiver
- Knowledge OR aware OR understanding
- Introduc* OR timing OR offer*
- Avoid OR restrict OR fear OR concern
- Zealand OR Aotearoa OR NZ
- Prevalence AND Global
- Diagnosis OR diagnos* OR SPT OR OFC

Figure 2.1 Search Strategy for Literature Review limited to evidence published between 1999 and October 2023

2.1 Importance of Complementary Feeding

Babies aged between 0-12 months old are defined as infants. When infants reach around six months, the introduction of solid food should begin, alongside continuing milk feeding (breast milk or infant formula); this is termed complementary feeding (MOH, 2021). The infant's tongue, mouth, renal function, and digestive system have developed sufficiently to consume and process solid foods at this age (Butte et al., 2004; MOH, 2021). Parents are advised to begin complementary feeding at around six months of age as infants have increased energy and nutrient needs (MOH, 2021; WHO, 2021). Breast milk alone cannot meet the infant's increased energy demands from six months of age; therefore, complementary foods must be introduced alongside breast milk (or infant formula). Infants must be offered solid food appropriately to avoid the development of nutrient deficiencies (particularly iron), faltering growth and food aversions (Fewtrell et al., 2017; Gould, 2017; WHO, 2021).

There is a high bioavailability of iron in breast milk, and this can meet the infant's requirements for the first six months if they are term (born at 37 weeks gestation or older), healthy infants and born with adequate stores of iron (Castenmiller et al., 2019). However, once infants reach six months of age, the iron stores infants receive from their mothers before birth begin to diminish (MOH, 2021). Therefore, iron from food is important, and foods high in iron should be offered to the infant daily. A variety of foods from the food groups should be offered to infants to ensure they meet their growing nutrient requirements as they transition to meeting more of their requirements from food.

The complementary feeding guidelines by the New Zealand Ministry of Health recommend that a range of fruits, vegetables, grain foods, milk products, legumes, nut butters, eggs, fish, seafood and chicken or lean red meat to be offered to infants daily (MOH, 2021). Parents should feed their infant in response to their hunger and fullness cues, this is known as responsive feeding, and it teaches infants self-regulation of their food intake (MOH, 2021). Breastfeeding is recommended to continue throughout complementary feeding for up to two years or longer. Breast milk (or commercial infant formula) and water are the only recommended drinks for infants (once complementary feeding has begun). Cow’s milk as a drink can be introduced after 12 months of age. Salt and sugar should not be added to infants’ food, and if parents choose to offer commercially prepared food, they should be low in sodium with no added sugars. As honey is another form of sugar, this should not be added to an infant’s food, and consumption before 12 months of age can lead to food poisoning. The

recommendations to avoid these foods adds a layer of complexity to the recommendations, as allergen foods need to be avoided for infants with a known food allergy, but the addition of salt, sugar, honey and cow's milk as a drink must be avoided for all infants.

2.2 Atopic Disease

Atopic disease is commonly seen alongside food allergies, starting early in life (Han et al., 2020). An atopic disease can result in other atopic manifestations, referred to as the atopic march. The atopic march is the natural course of atopic manifestations where one atopic disease, usually starting with atopic dermatitis, can lead to a progression of other clinical signs of atopic diseases such as food allergy, asthma and allergic rhinitis (Matsumoto et al., 2020; Spergel, 2003). A small proportion of children with atopic dermatitis develop other allergic manifestations (food allergy, asthma and allergic rhinitis); however, atopic dermatitis is a determinant for the development of food allergy and asthma (Matsumoto et al., 2020).

A study by Röhrl et al. (2022) highlighted the risk of having an atopic disease and food allergy development. This study investigated food allergies in two prospective German birth cohorts, KUNO Kids and Ulm SPATZ health studies. Parents completed questionnaires involving questions regarding food allergies at their infant's birth and after 6, 12 and 24 months of age. They found that there was a significant association between the infant already having an atopic disease (eczema, allergic rhinitis, or asthma) and having a food allergy at both one and two years old ($p<0.05$). There is research also reporting an increased risk of children developing an atopic disease if their parent has an atopic disease (Thomsen, 2015). In Japan, Saito-Abe et al. (2022) investigated parental allergic diseases (food allergy, atopic dermatitis, asthma, and rhinitis) with their children's food allergies at 18 months and 3 years of age. The study reported a significant positive association between one or both parents having an allergic disease and their child's food allergy at 18 months and 3 years of age. If both parents had an allergic disease, compared to one parent, the child had a higher adjusted odds ratio (p for trend <0.0001) (Saito-Abe et al., 2022). The adjusted odds ratio was the highest (2.60) when both parents had a food allergy.

2.3 What is a Food Allergy?

An immune system reaction to a food is termed a food allergy (MOH, 2021b). Food allergies are immune-mediated and can be classified into IgE-mediated, non-IgE-mediated, Mixed IgE/non-IgE-mediated and cell-mediated. Food allergies can produce a range of symptoms, from a rash to anaphylactic shock, which is potentially fatal (Allen et al., 2006). Food allergies are more common in children under five years old as they are exposed to new foods (ASCIA, 2021b). Adults can also develop food allergies due to the loss in oral tolerance of specific foods; however, the mechanisms are unclear (Unhapipatpong et al., 2022). Adverse reactions that are not food allergies can also occur; these are non-immune mediated and primarily identified as food intolerances. These are uncommon in children under two years of age (Arora & Singla, 2011).

Allergies to peanuts are more likely to show after the first or second exposure, whereas other allergies to foods such as milk, wheat and fish can appear after several exposures (Du Toit et al., 2009). Allergic reactions most commonly occur after the food allergen is orally consumed; however, some children can react from a small exposure, such as their skin coming into contact with the food allergen or inhaling the food allergen (Du Toit et al., 2009; Sampson et al., 2014). The processing of a food allergen may influence if there is an allergic reaction (Du Toit et al., 2009). This can be seen with egg allergies as some children allergic to egg can eat baked egg; however, may react to lightly cooked or raw egg, such as in a runny omelette.

2.3.1 Food Allergy Presentations

Early childhood food allergies are commonly IgE-mediated (Longo et al., 2013). IgE-mediated food allergies produce sIgE antibodies to the food, commonly followed by physical signs and symptoms of a food allergy (Boyce et al., 2010; Turnbull et al., 2015). However, there can be the presence of sIgE antibodies without a physical reaction to a food; this indicates a sensitisation (Boyce et al., 2010). The concentration of sIgE indicates how likely an allergic reaction will occur after exposure to a potential allergen; the more sIgE antibodies present, the more likely a physical reaction will occur (Devdas et al., 2018; Zhang et al., 2021). Symptoms of IgE-mediated food allergies occur within minutes to a couple of hours after consuming a food (Anvari et al., 2019; Burks et al., 2012; Elghoudi & Narchi, 2022). Symptoms range from mild to severe and can involve the skin, gastrointestinal tract, respiratory tract and sometimes the circulatory system (Anvari et al., 2019; Burks et al., 2012). Mild to moderate reactions can include face, lip and eye swelling, hives or welts on the skin, abdominal pain or vomiting

(ASCIA, 2021b; Burks et al., 2012). Severe IgE-mediated reactions can include difficulty or noisy breathing, tongue swelling, tightness or swelling of the throat, a cough that is wheezy or persistent, ongoing dizziness or collapse, and young children may also present as pale and floppy (ASCIA, 2021b; Burks et al., 2012). In a severe reaction, anaphylaxis (potentially fatal) is also possible.

Unlike IgE-mediated food allergies, non-IgE-mediated food allergies are immune-mediated reactions without producing sIgE antibodies (Allen et al., 2006; Burks et al., 2012; Dellon et al., 2013). Non-IgE-mediated food allergies can include food protein-induced enterocolitis syndrome, proctocolitis and food-protein-induced enteropathy, primarily affecting young children (Anvari et al., 2019; Burks et al., 2012). Symptoms of non-IgE-mediated food allergies have a delayed onset and can present several hours to a week after consuming a food (Roxane et al., 2020). Non-IgE-mediated food allergies mainly affect the gastrointestinal tract, but the lungs and skin may also be affected (Connors et al., 2018; Nowak-Węgrzyn et al., 2015; Zhang et al., 2021). Symptoms can present as abdominal cramps, vomiting, diarrhoea, blood in the stool, poor weight gain and failure to thrive (Burks et al., 2012). Coeliac disease is an immune system response to foods containing gluten (ASCIA, 2019).There is gut inflammation, resulting in poor nutrient absorption when gluten is consumed by someone with coeliac disease. Non-coeliac gluten intolerance is a newly identified condition that may cause an abdominal disturbance; however, the mechanism behind non-coeliac gluten intolerance is unknown (ASCIA, 2019).

There are also mixed IgE/non-IgE mediated food allergies (Ho et al., 2014). The immune mechanisms involved in mixed IgE/non-IgE mediated food allergies are poorly understood (Calvani et al., 2021). Symptoms are usually associated with the skin or gastrointestinal tract (Manuyakorn & Tanpowpong, 2019). Mixed food allergies can include eosinophilic gastrointestinal disorders and eosinophilic oesophagitis (Zhang et al., 2021). Eosinophilic oesophagitis is an example of a mixed food allergy where the lining of the oesophagus has white blood cells settle; this can be due to a food or environment allergic reaction (ASCIA, 2021a). Symptoms can include eating slowly, abdominal pain, choking or gagging on food and regurgitation. Food allergies can also be cell-mediated. This includes allergic contact dermatitis, which presents as eczema to a small chemical molecule in additives or naturally occurring in food. The typical age for presentation is adults (Sicherer & Sampson, 2014).

Figure 2.3 shows the four different groups of food allergies with examples of their presentations. It is possible to have other adverse reactions to food that are not food allergies but may appear similar. These are often intolerances (e.g. enzyme deficiency) and not immune-mediated (Boyce et al., 2010; Turnbull et al., 2015). However, intolerances are uncommon in children under two years of age (Arora & Singla, 2011).

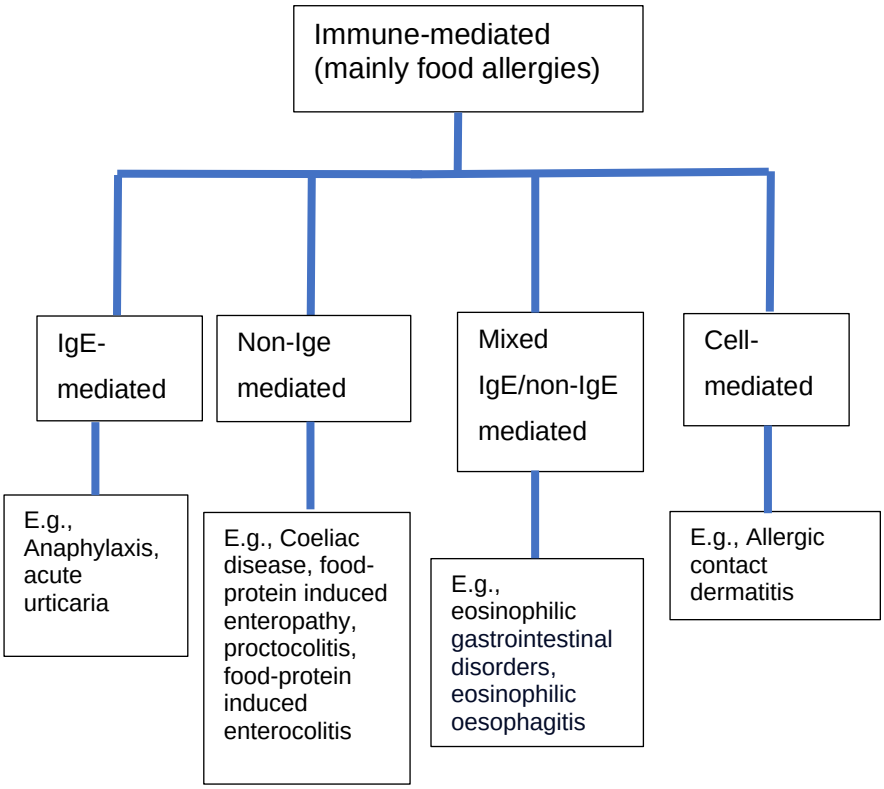

Figure 2.3 Diagram of immune-mediated food allergies with examples. Adapted from (ASCIA, 2019; Sampson et al., 2014).

2.3.2 The Diagnosis of Food Allergies

To obtain an accurate food allergy diagnosis, an individual must visit a qualified health professional (ASCIA, 2022a). The individual's clinical history must be analysed, including relevant symptoms. It is common to then follow with reliable, evidence-based tests to confirm individual food allergen diagnoses by testing for an individual food (ASCIA, 2022a). The health professional must cover the individual's full clinical picture (food intake, symptoms, family history, child growth, and approved allergy testing results), as it is insufficient to diagnose on tests alone (ASCIA, 2022a). Health professionals trained in allergy diagnosis and management must order, perform and interpret the tests (ASCIA, 2022a). The SPT and ssIgE blood tests,

also known as radioallergosorbent test (RAST) or enzyme allergosorbent testing (EAST), and OFC are recommended evidence-based allergy tests (Australasian Society of Clinical Immunology and Allergy, 2022a). Food allergies that have previously caused a reaction or suspected reaction can be confirmed or excluded by OFC (ASCIA, 2022a). OFC is the gold standard for confirming food allergy diagnosis after an individual has completed an elimination diet and symptoms have resolved, or it can be used to assess the development of tolerance. Although it has been indicated that OFC are the gold standard for food allergy confirmation, they are not always practical to confirm and an intensive process is required (Prescott et al., 2013; Tang & Mullins, 2017).

SPT and ssIgE blood tests are used for IgE-mediated food allergies, as IgE-mediated food allergies produce sIgE antibodies in response to the food. These tests can establish the concentration of sIgE against a particular allergen (Boyce et al., 2010; Burks et al., 2012). Non-IgE mediated food allergies, mixed IgE/non-IgE mediated and cell-mediated food allergies cannot be tested for through SPT and sIgE as they are immunological reactions without the production of sIgE antibodies (Allen et al., 2006; Burks et al., 2012; Dellon et al., 2013). The array and delay of symptoms can make it hard to identify non-IgE-mediated food allergies (Elghoudi & Narchi, 2022). The best approach for all suspected food allergies is to see a health professional to cover a detailed medical history with a full clinical picture (ASCIA, 2022b). The individual may then be advised to eliminate the potential allergen food (ASCIA, 2022b). OFC may be completed by a health professional for non-IgE mediated food allergies when there is not a clear history, or it may be to establish when a child has outgrown the food allergy (ASCIA, 2022b). Managing food allergies involves avoiding the food altogether (ASCIA, 2021b).

2.3.2.1 How Infants are being Diagnosed with Food Allergies

A correct food allergy diagnosis is crucial as research highlights that before performing tests, parents are likely to over-report the self-diagnosis of their infant's food allergy (Peters et al., 2021). The over-reporting of food allergies was evident in a systemic review by Chafen et al. (2010), which found that the prevalence was higher in self-reported studies than studies using SPT or double blind placebo controlled food challenges or food-specific IgE determinations. An example of this was the pooled estimate of self-reported cow's milk allergy prevalence 3.5%, whereas using the other three different methods the prevalence was 0.6-0.9%. A limitation from this systemic review was the heterogeneity across studies in the variables used for food allergy diagnosis. There are also differences among population estimates of self-reported individual

food allergies. A meta-analysis by Rona et al. (2007) included infants/preschool children, school children and adults. It found that the prevalence of self-reported milk allergies ranged between 1.2-17%, eggs were between 0.2-7%, peanuts and fish were 0-2%, shellfish were 0-10%, and any food was between 3-35%. Although this was just indicative of self-reporting, this may translate to parents over-reporting their infant's food allergies.

Overreporting food allergies can lead to unnecessary stress trying to manage a food allergy, excluding food that may not be required (Elghoudi & Narchi, 2022). Knibb and Semper (2013) found that of the 124 parents attending their first allergy clinic with their child, most parents removed foods from their child's diet; however, only one-third of parents had received advice about this. It was found that foods were removed from children's diets but not replaced with alternatives or appropriate supplements. Therefore, nutrient intake can be impacted if parents remove food without seeing a health professional and completing diagnostic testing. Some major food allergens, such as peanuts, may not impact the infant's overall nutrient intake if excluded from the diet. However, if eggs are avoided, then it is possible a wide range of food may be excluded from the diet as egg or egg extracts are present and hidden in many foods. This is similar to cow's milk; however, the avoidance is not as concerning if the infant is breastfeeding. With all major food allergens, if they are inappropriately avoided in the infant's diet due to concerns about a suspected allergy, this risks the development of a food allergy to the food later in life, as tolerance was not maintained by regular inclusion in the infant's diet.

A United States of America (USA) study by Gupta et al. (2013) collected household data identifying children with a food allergy, it was reported that 2,355 children (0-17 years of age) in a sample of 38,480 had a food allergy. This study found that 30% of parents stated that a health professional did not diagnose the infant's food allergy. The study also reported that more children with a severe food allergy had a health professional instigate allergy testing and diagnosis compared to those with a mild to moderate food allergy. There was a health professional diagnosis in 70% of children with a reported food allergy, with peanut, tree nuts and milk allergies more likely to result in a health professional diagnosis. Of the children with health professional diagnosed food allergy, only one in five (20.2%) completed an OFC. Other diagnostic tools used by health professionals to diagnose food allergy were SPT in 47.3%, ssIgE test in 39.9%, and no testing completed in 32.6%.

Another study in the USA by Mathias et al. (2019) collected food allergy information from mothers of infants at ages 4, 9, 12 months and then at 6 years of age. Participants were asked if a medical doctor had diagnosed their infant as having an allergy to any food; this also included a question surrounding the testing method used to test for the food allergy. This study found that only 25 to 36% of children with food allergy symptoms saw a health professional for diagnosis. However, of those whom a health professional diagnosed, 4 to 29% did not have any diagnostic tests completed. This may be due to the reliability of diagnostic tests impacting the health professionals' decision to complete them, or they may feel the infant is too young to complete diagnostic tests (Foong & Santos, 2021).

In New Zealand, a cross-sectional survey by Crooks et al. (2010) was completed in the Royal New Zealand Plunket Society clinics (major provider of the Well Child Programme in New Zealand (Royal New Zealand Plunket Trust, 2023)). This study found that 91% of children aged 0-5 years whose parents reported having an adverse reaction to a food did not have their food allergy investigated. However, it is important to understand that there was only a 65% participation rate; therefore, only 110 parents/caregivers participated in the survey.

There is limited evidence of the use of diagnostic tests to detect food allergies in infants and children in New Zealand. Knowledge of how infants are being diagnosed is important to improving the diagnosis and management of their care, as food allergies impact infants' lives before diagnosis (Gupta et al., 2013; Knibb & Semper, 2013). However, access to health professionals and diagnostic tests can take time and effort. The Growing Up in New Zealand (GUiNZ) study, a longitudinal study of children in their first five years of life in New Zealand, provided nationally generalisable information. This study by Morton et al. (2017) investigated children at four years of age and found that 94% of children visited a general practitioner (GP) at least once in the last year, with the average child visiting five times. This indicates that most parents are able to access a GP for their child and therefore most children should be able to visit a GP if there was a suspected food allergy. However, 5% of parents faced barriers getting their child to the GP. This was most commonly due to not being able to secure an appointment fast enough or at an appropriate time (54%); requiring a doctor after hours, which was either unavailable or too expensive (23%); not being able to get to the doctor due to transport (5%); or parents not having the time to take their child (5%). Therefore, these barriers may impact whether some children can obtain an accurate diagnosis of a suspected food allergy from a health professional.

2.4 Major Food Allergens

Major food allergens vary slightly between countries due to different eating patterns, cultures, and availability of foods (Loh & Tang, 2018). While there are known common food allergens, any food has the potential to cause a food allergy (Burks et al., 2012). New Zealand's major allergenic foods are eggs, cow's milk, peanuts, tree nuts, soy, sesame, wheat, fish and shellfish (MOH, 2021).

Major food allergens can differ slightly between age groups, with children older than 5 years showing wider variability in the major food allergens (Prescott et al., 2013). Allen et al. (2006) highlight that over 90% of children's food allergies are from eight foods: cow's milk, soy, egg, peanuts, tree nuts (and seeds), wheat, fish, and shellfish. Children with food allergies may develop tolerance with age, but this likely depends on what food they are allergic to (Turnbull et al., 2015).

Cow's milk, egg, soy, and wheat allergies commonly resolve during childhood (ASCIA, 2021b). The mechanism for children losing their sensitivity and becoming tolerant to these foods, mainly during 3-5 years of age, is not well understood; however, it may be due to the gut maturing, which can lead to reduced systemic absorption and immune responses maturing (McMilin, 2015). Research shows that over 50% of children will outgrow these allergies by 10 years of age (Hansen et al., 2021; Kotaniemi-Syrjänen et al., 2010; Peters et al., 2014; Savage et al., 2010). Allergies to peanuts, tree nuts, and seafood are less likely to resolve during childhood (Sicherer & Sampson, 2018; Waserman & Watson, 2011). Of the children with allergies to peanuts, tree nuts, sesame seeds and seafood, around 75% will have their allergies persist (ASCIA, 2021b).

Food allergies may persist into adulthood but can also develop in adulthood for the first time (ASCIA, 2021b). Kamdar et al. (2015) highlighted variance in the age of adult food allergy development, but there was a peak in early 30-year-olds. This study found that shellfish, tree nuts, non-shellfish, soy and peanut were the five most common allergies to develop in adults. If food allergies develop in adulthood, they are likely to persist and rarely resolve (ASCIA, 2021b; Moneret-Vautrin & Morisset, 2005).

Infants and young children must have an accurate diagnosis, follow-up testing, and reassessment as young children's food allergies are likely to resolve. It is difficult to manage a

food allergy as major allergens can be present in various foods, with examples of food containing major allergens shown in Table 2.1.

Table 2.1 Foods containing major allergens

Major allergen	Food examples
Egg	Cake/cake mixes, pancakes, pizza bases, muffins, dressings, crumbed foods
Cows Milk	Butter, ice-cream, cream, custard, cheese, yoghurt
Peanuts	Peanut butter, satay sauce, peanut oil, mixed nuts
Tree nuts	Almonds, walnuts, pistachios, pecan, pine nuts, Brazil nuts, nut butter, cashews
Soy	Bread, tofu, edamame, tamari, miso, soy sauce, bean curd, tempeh
Wheat	Gluten, couscous, bulgur, spelt, tabouleh, cracker meal, durum
Fish	Salmon, anchovies, cod, tuna, snapper, whitebait
Shellfish	Crayfish, calamari, prawns, scallops, lobster, crab, mussels, octopus
Sesame	Hummus, tahini, sesame seeds, sesame oil

Source: Adapted from (Australasian Society of Clinical Immunology and Allergy, 2023)

2.5 Food Allergy Guidelines and Recommendations

Evidenced-based food allergy guidelines and recommendations have been developed for parents and healthcare professionals to help prevent food allergy development in infants and young children (ASCIA, 2020b; MOH, 2021).

2.5.1 Changes in International Recommendations on Major Food Allergen Introduction

The recommendations for introducing major food allergens to infants have changed significantly over time. In the early 2000s, there was a hypothesis that due to the immaturity and permeability of the infant's gut mucosal barrier, consuming solid food in early infancy could lead to a higher risk of allergic sensitisation (Høst et al., 1999). As a result, internationally, guidelines from the AAP, American College of Asthma Allergy and Immunology and the European Academy of Allergy and Clinical Immunology (EAACI) recommended that pregnant and breastfeeding mothers avoid major food allergens to prevent high-risk infants (those with a first-degree relative with an atopic disease) developing allergies (AAP, 2000; Fiocchi et al., 2006; Muraro et al., 2004). There was also the recommendation for high-risk infants to not consume

solid food until 6 months of age, cow's milk until 12 months of age, eggs until 2 years of age, and peanuts, tree nuts, and fish until 3 years of age (AAP, 2000). In 2005, ASCIA stated in a position statement that the avoidance of peanuts, nuts and shellfish for the first 2 to 4 years of life may be recommended (Prescott & Tang, 2005).

Despite these recommendations, food allergies continued to rise in Western countries (Prescott et al., 2013). Various studies highlighted that delaying major food allergens could put infants at increased risk of IgE sensitisation and food allergies (Du Toit et al., 2008; Koplin et al., 2010). A study in 2008 by Du Toit et al. (2008) which used two validated questionnaires, highlighted a 10-fold higher prevalence of peanut allergy in infants in the United Kingdom (UK). At this time, the recommendations were for parents in the UK to avoid peanuts for their infant, compared to Israeli children of similar ancestry, where peanut introduction is at 6 to 7 months of age. These findings were consistent with a population based study by Koplin et al. (2010) on egg exposure. This study found that introducing eggs later than 4 to 6 months of age increased the infant's risk of developing an egg allergy at 12 months of age. To confirm egg allergies a SPT was completed, followed by an OFC to raw egg whites if the SPT was positive. Of the infants introduced to eggs at 4 to 6 months, 5.6% developed an egg allergy at 12 months of age. Of the infants introduced to eggs at 10-12 months, 10.1% had an egg allergy at 12 months of age, and 27.6% of infants who had not been introduced to eggs before 12 months of age had an egg allergy at 12 months of age. Due to increasing evidence supporting not delaying allergen foods introduction, ASCIA released the infant feeding and allergy prevention guidelines in 2008 that no longer recommend the delay of introducing allergenic food (Mullins et al., 2022).

Further evidence was found in the Learning Early about Peanut Allergy (LEAP) study by Du Toit et al. (2015), where there was the randomisation of 640 infants aged between 4 months and 11 months to consume 6g of peanut protein per week or avoid peanut-containing food until 5 years of age. These infants were all considered high-risk as they either had an egg allergy, severe eczema or both. This study found that of those with a negative SPT initially, 13.7% developed a peanut allergy at 5 years if they were avoiding peanut products, and 1.9% developed a peanut allergy at 5 years if they consumed peanut products from 4 to 11 months. Of those who initially had a positive SPT, 35.3% developed a peanut allergy if they avoided peanut products, and 10.6% developed a peanut allergy if they consumed peanut products from 4-11 months. A limitation of this study was that infants who were at low risk of a food allergy but had a large SPT wheals were not included in the study. However, this study led to further shifts in infant

feeding recommendations, especially with the introduction of peanuts. It led to the release of the global consensus guidelines recommending the early introduction of peanuts during complementary feeding (Fleischer et al., 2015).

In 2015 – 2016, it was stated globally that the food allergy prevention guidelines recommended the early introduction of major food allergens (Mullins et al., 2022). Following this, in 2016, with a further update in 2020, ASCIA revised its infant feeding and allergy prevention guidelines (ASCIA, 2020b). These infant feeding and allergy prevention guidelines included the recommendation to introduce all major allergenic foods in the first year of life, even to infants at high-risk of allergy.

In 2016, the Enquiring About Tolerance (EAT) study investigated the introduction of major food allergens (peanuts, cooked egg, cow milk, sesame, whitefish and wheat) early, at 3 months of age or the recommended age of 6 months (Perkin et al., 2016). There were 1303 infants in the study randomly assigned to either the 3-month or 6-month group for introduction. In the 3-month introduction group, a 20% decrease in overall food allergies was found; however, this was not statistically significant. The main limitation of the study was that only 42.8% of participants in the 3-month introduction group adhered to the protocol. Despite this, in a subset of participants consuming at least 2g of peanut or egg white protein each week from 3 months of age, a significant reduction in the prevalence of peanut and egg allergy was found. Perkin et al. (2019) completed a secondary intention to treat analysis. This analysis found that the early introduction successfully prevented food allergies among a group of infants considered at high-risk for developing a food allergy. A further analysis from the EAT study by Logan et al. (2020) found an association between introducing gluten at 4-6 months and a decreased prevalence of coeliac disease.

In 2020, it was recommended to introduce major food allergens at the start of complementary feeding, around 6 months, but not before 4 months of age (ASCIA, 2020b). Recommendations state that more evidence is needed to recommend an optimal timing for each allergen food (ASCIA, 2020b).

Table 2.2 shows that guidelines have changed dramatically and have differed between countries and organisations. Some guidelines do not specify exact aspects such as maternal

food allergen recommendations, high-risk recommendations, or general recommendations. This highlights the complexity for both parents and health professionals.

Table 2.2 Summary of the change in global food allergen guidelines

Year	Organisation	Solid food timing	General infant food allergy prevention recommendations	High-Risk infant food allergy prevention recommendations	Pregnancy and breastfeeding allergy prevention recommendations
2021	MOH (MOH, 2021)	Around 6 months. Continue BF when introducing solids.	Introduce all major food allergens with the introduction of complementary food, before 12 months. Offer allergens one at a time, and around twice a week.	No change.	Do not exclude major food allergens.
2020	EAACI (Halken et al., 2021)	Not specified.	Introduce egg and peanut from 4 to 6 months. Other allergens are not specified.	No change.	Do not exclude major food allergens.
	ASCIA (ASCIA, 2020b)	Around 6 months not before 4 months. Continue BF when introducing solids.	Introduce all major allergens before 12 months, around 6 months but not before 4 months. Offer allergens one at a time, and around twice a week.	No change.	Do not exclude major food allergens.
2019	AAP (Greer et al., 2019)	4 – 6 months.	Don't delay common allergens.	Consider evaluation by an allergy specialist before peanut introduction and earliest age to introduce peanut is 4-6 months.	No restrictions.
	CPS/CSACI (Abrams et al., 2019)	6 months.	Don't delay major allergens.	Introduce major food allergens around 6 months but not before 4 months.	Not specified.

		Continue BF when introducing solids.	Offer allergens one at a time, and a few times a week.		
2018	BSACI (Stiefel et al., 2017; Turner et al., 2018)	Solids around 6 months, not before 4 months. HRI – solids from 4 months. Continue BF when introducing solids.	Introduce major allergens before 12 months of age. Continue to regularly include in the diet.	May be beneficial to be introduced to peanut and egg from 4 months alongside other food.	Not specified.
2017	APAPARI (Tham et al., 2018)	From 6 months. Continue BF when introducing solids.	Don't delay major food allergens.	Do not delay the introduction of allergenic foods for at risk infants. Allergy testing to egg and peanut recommended for high-risk infants.	Not specified.
	ESPGHAN (Fewtrell et al., 2017)	Not before 17 weeks. Continue BF when introducing solids.	Don't delay major allergens.	Introduce peanut between 4-11 months	Not specified
	JSPACI (Ebisawa et al., 2017)	From 5-6 months.	Don't delay major allergens; introduce peanuts soon after weaning.	Not specified.	Not specified.
	NIAID (Togias et al., 2017)	4-6 months.	Introduce major food allergens from 4 to 6 months of age.	Introduce peanut at 4 – 6 months. Evaluation by an allergy specialist before peanut introduction should be considered.	Not specified.

				Infants with mild to moderate eczema should be introduced to peanut no earlier than 6 months.	
	PSAAI/PSPGHN (Recto et al., 2017)	From 6 months.	Introduce cooked egg 4-6 months; wheat before 6 months; fish 6-9 months; peanut 4-11 months.	Not specified.	It is not recommended to avoid major food allergens.
2016	ASCIA (Campbell et al., 2016)	Around 6 months not before 4 months. Continue BF when introducing solids.	Introduce all major allergens, peanut and egg should be introduced before 12 months. Continue to offer allergen foods twice a week.	Early introduction of common allergens may be beneficial.	It is not recommended to avoid particular foods (e.g., peanut).
	HKIA (J. Chan et al., 2016)	Not specified.	Don't delay major allergens; introduce peanuts when introducing solids.	Skin prick test before peanut introduction. If the SPT is negative and mild positive offer 6g peanut protein/wk 3 times/wk until 5 years of age. If the SPT is positive complete an oral peanut challenge; include peanut if negative challenge an avoid peanut if positive challenge.	Not specified.
	ISPSP/ISPAI/ISP (Di Mauro et al., 2016)	After 4 months, but if possible after 6 months.	Introduce major food allergens once complementary feeding has begun.	No change.	Not specified.
2015	AAP (Fleischer et al., 2015)	Not specified.	Not specified.	Introduce peanut between 4 – 11 months. Before peanut introduction consider evaluation by an allergy specialist.	Not specified.

	HKIA (Alson et al., 2015) (A. W. Chan et al., 2016)	From 4-6 months.	Do not withhold or encourage major allergens.	Not specified.	No restrictions.
2014	DGAKI/DGKJ (Schäfer et al., 2014)	From over 4 months. Continue BF when introducing solids.	Don't delay major allergens; introduce fish before 12 months.	Not specified.	No restrictions, fish should be part of the maternal diet.
	EAACI (Muraro et al., 2014)	From 4-6 months.	Neither withhold nor encourage major allergens.	Not specified.	No restrictions.
2013	CPS/CSACI (Chan & Cummings, 2013)	By 6 months, do not delay the introduction of any specific solid food after beyond this.	Not specified.	Introduce all major allergens, and do not delay.	No restrictions.
2012	FAP (Pelkonen et al., 2012)	From 4-6 months.	Wheat and oats by 6 months; don't delay major allergens.	Not specified.	No restrictions.
2010	NIAID ("Guidelines for the Diagnosis and Management of Food Allergy in the United States: Report of the NIAID-Sponsored Expert Panel," 2010)	Do not delay beyond 4-6 months.	Don't delay major allergens, introduce when complementary feeding.	Not specified.	No restrictions.
	AMS-MOH (Lee et al., 2010)	From 4-6 months.	Not specified.	Not specified.	No restrictions.

	DGAKI/DGKJ (Muche-Borowski et al., 2010)	From the end of the 4th month.	Don't delay major allergens, introduce fish before 12 months.	Not specified.	No restrictions, fish should be part of the maternal diet.
2008	AAP (Greer et al., 2008)	From 4-6 months.	Don't delay major allergens.	Not specified.	No restrictions.
	MOH (MOH, 2008a)	From around 6 months. Introduce new foods one at a time.	Don't delay major allergens.	No change.	It is not recommended to exclude major food allergens.
	ASCIA (ASCIA, 2010)	From around 4 – 6 months. Continue BF when introducing solids. Give one new food at a time.	Don't delay major allergens.	No change.	No restrictions.
	ESPGHAN (Agostoni et al., 2008)	Do not introduce before 17 weeks. Introduce foods one at a time. Continue BF when introducing solids.	Don't delay major allergens.	No change.	Not specified.
2006	ACAAI (Fiocchi et al., 2006)	From 6 months. Introduce foods one at a time in small amounts.	Delay introduction of major allergens. With assessed risk of allergy, the optimal age for the introduction of	Not specified.	Not specified.

			selected supplemental foods should be 6 months, dairy products 12 months, hen's egg 24 months, and peanut, tree nuts, fish, and seafood at least 36 months. Egg, peanut, tree nuts, fish, and seafood introduction require caution.		
2005	ASCIA (Prescott & Tang, 2005)	From 4-6 months.	Not specified.	Avoidance of peanut, nut and shellfish for the first 2-4 years of life may be recommended.	Dietary restrictions are not recommended.
2004	EAACI (Muraro et al., 2004)	From 6 months but at least 4 months.	Don't delay major allergens. No evidence for restrictive diets beyond 6 months for major food allergens.	Not specified.	Not specified.
2000	AAP (AAP, 2000)	Not specified.	Not specified.	Introduce solids at 6 months, cows milk to be avoided until 12 months, eggs avoided until 2 years, and peanuts, tree nuts, and fish avoided until 3 years old.	Recommended to avoid allergenic foods in those having high-risk infants.

Source: Adapted from (Vale et al., 2021)

Abbreviation: BF - breastfeeding; SPT - skin prick test; AAP - American Academy of Pediatrics; ACAAI - American College of Allergy, Asthma and Immunology; APAPARI - Asia Pacific Association of Paediatric Allergy, Respirology & Immunology; ASCIA - Australasian Society of Clinical Immunology and Allergy; MOH - Ministry of Health; BSACI - British Society for Allergy & Clinical Immunology; CPS - Canadian Paediatric Society; CSACI - Canadian Society of Allergy and Clinical Immunology; DGAKI - German Society for Allergology and Clinical Immunology; DGKJ - German Society for Paediatric and Adolescent Medicine; EAACI - European Academy for Allergy and Clinical Immunology; ESPGHAN - European Society for Paediatric Gastroenterology, Hepatology and Nutrition; HKIA - Hong Kong Institute of Allergy; ISPSP - Italian Society of Preventative and

Social Paediatrics; ISPAI - Italian Society of Paediatric Allergy and Immunology; JSPACI - Japanese Society of Paediatric Allergy and Clinical Immunology; NIAID - National Institute of Allergy and Infectious Diseases; PSAAI - Philippine Society of Allergy, Asthma and Immunology; PSPGHN - Philippine Society for Paediatric Gastroenterology, Hepatology and Nutrition; AMS-MOH - Academy of Medicine, Singapore Ministry of Health

2.5.2 New Zealand Food Allergy Guidelines

Introducing major allergenic foods to an infant (0-12 months) may lower the chance of the infant developing an IgE-mediated allergy to that food (MOH, 2021; Yakaboski et al., 2021). There are evidence-based New Zealand guidelines to help support health professionals and parents through the feeding journey of infants and toddlers for optimal growth and development. The updated New Zealand guidelines published by the MOH (2021) were released in September 2021, titled "Healthy Eating Guidelines for New Zealand Babies and Toddlers (0-2 years old)." These Healthy Eating Guidelines include feeding recommendations for infants and toddlers, with allergen food recommendations from starting solid food introduction (MOH, 2021). More in-depth guidelines and resources that focus specifically on immune-mediated disorders and infant feeding and allergy prevention advice were written by ASCIA (2020b), titled "ASCIA Guidelines Infant Feeding and Allergy Prevention". ASCIA is a representative organisation which provides clinical immunology and allergy information for Australia and New Zealand (ASCIA, 2020b). ASCIA provides significantly in-depth guidelines with dietary guide resources for each major allergen. The MOH "Healthy Eating Guidelines for New Zealand Babies and Toddlers (0-2 years old)" is briefer, with an overview of general allergen introduction advice. Both guidelines agree; therefore, in New Zealand, it would be appropriate to refer to either of these guidelines for allergen food introduction in infants.

2.5.2.1 Current Recommendations for Introducing Food Allergens to Infants

ASCIA (2020b) and MOH (2021) provide the current New Zealand recommendations for introducing allergen foods to infants. The key recommendations include:

- Solid foods should be introduced at around 6 months of age but not before 4 months of age.
- All infants, including infants at high-risk of a food allergy, should be introduced to all major food allergens before 12 months of age.
- The introduction of one major food allergen at a time.
- Maintain major food allergens in the diet (twice a week) once tolerated.
- Continue breastfeeding throughout the introduction of solid foods, if possible.
- During pregnancy and breastfeeding, major food allergens should not be excluded (unless the mother has a confirmed allergy).
- Hydrolysed (partially and extensively) infant formula is not recommended for the prevention of food allergies.

2.6 The Offering of Major Food Allergens to Infants

There is a range of sources of information that parents must navigate when making health-related decisions for their infant or child (Lander et al., 2023). The approach and timing of introducing allergen foods to their infant is one decision a parent faces and can be difficult to navigate. As food allergen recommendations have changed over the years, it is important to understand whether parents know about these changes and are following current recommendations.

A study by Almutairi et al. (2021) investigated the introduction of allergenic foods to infants in Saudi Arabia. Mothers of children aged between 12 and 36 months were recruited; however due to the age of recruitment (past the stage of introducing solid food), maternal memory was a limitation to the responses. Although the recommendation for allergen food introduction was 4 to 6 months of age, the average age of introducing eggs was 9.8 months, peanuts were 14.6 months, and fish were 13.6 months. Many of the mothers were not aware or did not agree that food allergies may be prevented by the timing of allergen food introduction. Only 18.6% of those considered high-risk and 13.2% of those considered low-risk were informed of correct information from their healthcare providers. This highlights the limited knowledge that parents may have about introducing major food allergens to their infants.

Kwong et al. (2022) conducted a study in Los Angeles, US where two hundred caregivers to infants aged 12 to 24 months enrolled in a medical centre, with ongoing medical care, responded to a survey. This survey consisted of the age at which egg, soy, wheat, peanut, tree nuts, fish, shrimp and shellfish were introduced into their infant's diet, along with their infant's history of atopic diseases. The study found that the age at which caregivers introduced major allergen foods to infants ranged from 4 months to over 13 months. Between 4 to 11 months of age 65.3% of infants were introduced to egg, 55.8% to wheat, 28.6% to peanut, 28.1% to fish, 19.1% to soy,17.1% to tree nuts, 13.6% to shrimp, and 7.0% to shellfish. Although this highlights that many caregiver’s were not following the recommendations to introduce allergenic foods at 4 to 6 months of age, the children in this study were mostly Hispanic and breastfed and therefore these findings may not be relative to the wider Los Angeles population.

Another study completed in the US by Venter et al. (2022) surveyed 3062 caregivers of children aged 7 months to 3.5 years. The survey investigated demographics and feeding practices. The study found that the most common allergens introduced during the first year of life was cows

milk, wheat and soy. There were 17.2% of caregivers that introduced peanut and 15.5% of caregivers that introduced egg before 7 months. This was found to be significantly associated with an increase in the introduction of other allergen foods to the infant before 12 months of age. However, before 12 months only 58.8% of infant were introduced to peanut and 66.4% were introduced to egg, indicating that not all parents in the US are introducing major allergen foods before 12 months of age.

A UK study by Rowan and Brown (2023) found a low consumption of egg among infants in the UK. Data collected between 2015 – 2018 found that, although recommended at the start of complementary feeding, only 54% of infants aged 6 to 8 months had been offered egg. Of the infants offered egg, only 40% aged 6 to 8 months and two-thirds aged 9-12 months consumed egg in the last week. The low egg consumption highlights that infants are not exposed to egg as early as recommended. Ongoing exposure is limited for those exposed, suggesting that many parents are unaware of infant food allergy prevention guidelines.

A pilot study by Kostecka et al. (2021) asked mothers of infants aged 9 -14 months in Poland to complete a questionnaire about their infant feeding practices and knowledge of the Polish infant feeding guidelines. The Polish feeding guidelines recommend that infants with a low risk of developing a food allergy should be introduced to major allergenic foods between 4 and 6 months of age, the same age as the introduction of other solid foods. The study found that after introducing these new feeding guidelines, eggs, nuts, and fish were introduced between 8-12 months of age, regardless of whether the infant was high-risk or not; this is later than the Polish recommendations (Szajewska et al., 2021). The potential for severe allergic responses, such as asthma and anaphylactic shock, was highlighted as the reason for delayed allergen food introduction. It is important to highlight that there was a high number of questionnaires that were incorrectly filled out and therefore not used in the study. This may have impacted the results.

Research conducted in Australia reported that families from a higher socioeconomic status were more inclined to adjust the offering of major food allergens in response to the change in guidelines, as highlighted in a study by Tey et al. (2014). Families with higher socioeconomic status were more likely to introduce egg and peanut to their infants before 7 months after the change in guidelines. It should be highlighted that a limitation of this study was potential parental recall error due to the retrospective data collection at 12 months of age. This earlier introduction of major food allergens highlights an improved uptake of the infant feeding

guidelines. The difference in uptake is likely due to more accessible healthcare advice for those of higher socioeconomic status, allowing them to be more promptly informed.

Overall, there is an improvement in earlier peanut introduction in Australia, according to a study by Soriano et al. (2019), who investigated the introduction among 12-month-old infants in Melbourne, Australia. Peanut introduction by one year of age increased 3-fold in 2018 compared to 2007-2011. Peanuts were introduced to 89% of the infants within their first year of life, with a median age of 6 months. However, a few infants consumed infrequent peanuts; nearly half consumed less than one tsp of peanut butter. Despite this, 75% of infants had eaten peanuts more than four times per week, with a quarter consuming peanuts more than once per week. These findings demonstrate the increasing awareness of early peanut consumption and maintaining tolerance in infants.

Another study highlighting a higher allergen consumption among Australian infants was conducted by Netting et al. (2022b). This study was a nationwide survey of 1140 caregivers with infants aged 0-24 months covering all Australian states and territories. This study found that 95% of infants were exposed to hen's eggs and peanuts by one year. Other allergens, such as tree nuts, were consumed by 76% of infants, and sesame seeds by 82% of infants. The median age of introduction was 6 months for egg, 7 months for peanut, and 8 months for sesame.

There has been an increased uptake of the offering of major food allergens to infants in Australia compared to other international countries; however, due to limited data in New Zealand, we are unsure of the current parental practices of the offering of major food allergens to infants. The GUiNZ study of 6435 infants found that only 1.5% of infants followed all of the New Zealand Infant Feeding Guidelines, and 56.9% were introduced to solid foods at the recommended age of around six months old (Gontijo de Castro et al., 2018). A study by Ferreira et al. (2022) using data from GUiNZ found that 40.2% began complementary feeding early (<4 months) and 3.2% began late (3.2%). The food groups introduced early were fruits/vegetables (23.8%), iron-rich food (34.1%), breads and cereals (36.3%), and the food groups introduced late were meat and meat alternatives (45.9%), dairy products (46.2%) and fruits/vegetables (9.9%). Only 53% of infants aged 9 months ate across all four food groups (fruit/vegetables; breads/cereals/meat and meat alternatives; infant milk (breast milk or infant formula)). Although we cannot understand the offering of major food allergens from these results, this highlights that

many infants are exposed to only some food groups at 9 months of age. This may impact the timing of major food allergens being offered.

2.7 Parental Concerns About Offering Major Food Allergens to Infants

Fear is a determinant of some parents avoiding major food allergens during the complementary feeding period (Fagerlund et al., 2019; Garcia et al., 2019; Graf et al., 2022). A study by Graf et al. (2022) in the USA found that from the 27 mothers in their study, 23 mothers reported food allergies as a perceived threat surrounding complementary feeding. The mothers then experienced elevated emotional arousal from this perceived threat, and mothers stated they then tried to minimise the risk or prepare for an event to mitigate the threat. Some mothers said they avoided highly allergenic foods such as peanuts, shellfish and eggs until they felt an optimal time and place. In contrast, others chose to delay all allergenic foods in their infant's complementary feeding period despite a healthcare professional advising them otherwise.

A Norwegian study by Fagerlund et al. (2019) found that 34% of parents avoided introducing some foods to their 10-month-olds due to fear of allergy or hypersensitivity.
The study found a significant association between parents wanting more information about foods for their infants and avoiding giving their infants certain foods. From the avoidance group, 68.9% of parents wanted more information about foods for their infants.

Consistent with other studies, Garcia et al. (2019) found food allergies to be a concern among parents with infants aged 4-12 months in the UK. There were 64 parents included in this analysis after completing either a questionnaire or an interview. The analysis found that the most common concern among parents was allergies (70%), followed by choking (66%) and knowing what foods to offer (64%). The study found that mothers needed clarification on the correct way to offer major food allergens, as there was a divide in the participants' approaches; some followed recommendations and slowly introduced food allergens one by one to their infant, whereas others completely avoided major food allergens when complementary feeding. These approaches show that parental knowledge is inconsistent, and not all parents know the current recommendations for introducing allergen foods to their infant.

2.8 Food Allergy Prevalence in Young Children

2.8.1 Prevalence Worldwide

A UK study by Turner et al. (2015) found that hospital food-induced anaphylaxis (FIA) admissions increased from 1998 to 2012, with the highest rate in children and adults under 24 years. There was an increase from 1.2 to 2.4 per 100,000 population per annum between 1998 and 2012. An increase in FIA hospital admissions was also found in an Australian study by Mullins et al. (2022) despite a deceleration in the rate of increase since their 2016 report. Children under 12 months of age had the highest rates of FIA, with a five-fold increase from 1998-1999 to 2018-2019. The increase in FIA admissions in very young children has followed the updated ASCIA food allergen guidelines in 2016, which recommended introducing major food allergens within the first 12 months of life (ASCIA, 2020b; Mullins et al., 2022). Therefore, this increase in FIA may highlight an earlier presentation of a pre-existing food allergy in children under 12 months of age (Mullins et al., 2022).

Table 2.3 summarises studies between 2000 – 2023 on the prevalence of infant food allergies (0-12 months). This table is not an exhaustive list of studies, as studies were included if they investigated the prevalence of most major food allergens in infants (0-12 months).

These studies used differing diagnostic criteria, which makes comparability between studies difficult. A limited number of studies have investigated the overall prevalence of infant food allergies. Upon investigation, no studies with repeated measures used the same diagnostic criteria in 0-12 month old infants. Instead, studies use hospital anaphylaxis admission rates to evaluate the change in infant food allergy prevalence (Tang & Mullins, 2017).

Table 2.3 Summary of studies in countries investigating the prevalence of food allergies in infants (0-12 months)

Author, Year	Country	Number of participants	Age	Prevalence	Food allergen reaction assessment	Assessment method (skin prick, blood test, food challenge)
(Netting et al., 2022b)	Australia	922	0-24 months	0-12 months: 8.5% IgE-mediated	Not specified.	Caregiver reported medically diagnosed, confirmed by SPT or ssIgE.
(Yamamoto-Hanada et al., 2020)	Japan	92,945	1-3 years	At 12 months: 5.9% Food allergy	Egg, cow's milk, wheat, soy, fish, fruit, crustacean, buckwheat, sesame, nut and peanut.	Caregiver reported of physician diagnosed food allergy.
(O'Sullivan et al., 2020)	Australia	1831	12 months	12.8%	Wheat, dairy, egg, peanut, fish, soy, sesame, tree nut, other.	Parent-reported food allergy in response to text message question.
(Gupta et al., 2018)	USA	38,408	0-17 years	<12 months: 2.8% IgE-mediated	Peanut, tree nut, milk, shellfish, egg, fin fish, wheat, soy, sesame.	Population based survey.
(Osborne et al., 2011)	Australia	2848	12 months	>10% IgE-mediated	Raw egg, peanut, sesame, shellfish, or cow's milk.	SPT, OFC.
(Kim et al., 2011)	Korea	1177	12 months	5.3% Food allergy	Hen's egg, cow's milk, peanuts/nuts, fruit, seafood, soybean, wheat, perilla seeds.	Questionnaire, medical history.

(Chen et al., 2011)	China	477	0-12 months	3.8% IgE-mediated	Egg yolk, egg white, cow's milk, soybean, peanut, wheat, fish, shrimp, orange, carrot.	Questionnaire, SPT, OFC
(Östblom et al., 2008)	Sweden	3104	12 months	3.1% Food hypersensitivity in combination with reported food allergy	Milk, egg, fish, wheat, peanuts, soybean, tree nuts.	Parental questionnaire with reported doctor-diagnosed food allergy.

Abbreviation: IgE - immunoglobin E; SPT - Skin prick test; ssIgE - specific immunoglobulin E; OFC - oral food challenge

2.8.2 Prevalence in New Zealand

There is limited data on the prevalence of food allergies in New Zealand infants. Useful information can be obtained from studies related to asthma (Asher et al., 2008). A study carried out by Asher et al. (2008) called the International Study on Asthma and Allergies in Childhood (ISAAC) indicated that New Zealand had comparable levels of child asthma prevalence to Australia, the UK, Ireland, the USA and Canada. This similar prevalence may cross over to food allergies, assuming that the prevalence of food allergies in New Zealand children may be close to Australia, the UK, Ireland, the USA and Canada (Asher et al., 2008; Ferreira et al., 2022). Osborne et al. (2011) found that over 10% of Australian infants (0-12 months) had a proven IgE-mediated food allergy; this prevalence is thought to be similar in New Zealand.

A study conducted by Speakman et al. (2018) investigated New Zealand FIA hospital admissions among children (0-14 years). A 2.8-fold increase in FIA presentations was reported over the past ten years. Children identifying as Māori or New Zealand European had a lower rate of FIA than children identifying as Asian or Pasifika. These rates are likely due to Asian and Pasifika children forming gene-environment interactions from a new environment and dietary habits in New Zealand influencing the onset of an allergy (McMilin et al., 2020). Although there are studies on FIA hospital admissions, there is no data on the prevalence of New Zealand children's outpatient food allergy (Tang & Mullins, 2017). Therefore, true allergy prevalence in the community is unknown as not all food allergy reactions are severe enough to warrant hospitalisation.

Another New Zealand study conducted in clinics by the Royal New Zealand Plunket Society investigated adverse reactions to foods in 0-5 year old’s (Crooks et al., 2010; Royal New Zealand Plunket Trust, 2023). This study found that 40% of children had an adverse reaction to a food, with dairy (61.4%) being the most common. The limitations of this study was the small sample size of 110 participants (65%), and only those attending Plunket Clinics (Well Child visit) in person were included, those with home visits were excluded. Adverse reactions to food are not an accurate measure of food allergies and therefore the true prevalence of food allergies cannot be determined from this study.

Although the overall prevalence of infant food allergies in New Zealand is limited, a study by McMilin (2015) investigated the prevalence of peanut allergies at 2 years of age within the birth cohort study of GUiNZ. They found that 2.6% of infants had a parent-reported doctor-diagnosed

peanut allergy. This study also found that the odds of having a parent-reported peanut allergy at 2 years of age were increased for boys, children with a doctor's diagnosis of eczema since 9 months of age, children who had mothers with a history of atopy (eczema, hay fever, food allergy), and children who had mothers of Asian ethnicity compared with European ethnicity. However, no other major food allergens were reported in this study.

2.9 Summary

The recommendations for introducing major food allergens to infants during the complementary feeding period have changed over the last 20 years. Currently, there is limited research on the offering of major food allergens to infants during the complementary feeding period in New Zealand. Therefore, we cannot determine if the current recommendations for introducing major food allergens to infants are being followed. Additionally, there is limited research on the prevalence of infant food allergies in New Zealand and how infant food allergies are being diagnosed.

Chapter 3 Manuscript

3.0 Abstract

Background: The prevalence of food allergies in New Zealand infants is unknown; however, it is thought to be similar to Australia, where the prevalence is over 10% of infants 12 months of age. Current New Zealand recommendations for reducing the risk of food allergies are to: offer all infants major food allergens (age-appropriate texture) at the start of complementary feeding (around six months), ensure major allergens are given to all infants before 12 months; maintain tolerance of major food allergens by regularly (approximately twice a week) offering the food; and to continue breastfeeding while introducing complementary foods. We know little about parental practices around introducing major food allergens during complementary feeding.
Aim: The study aims to explore parental offering of major food allergens to infants during complementary feeding and parent-reported food allergies.
Methods: The cross-sectional study is a secondary analysis of the multi-centred (Auckland and Dunedin) First Foods New Zealand study which included 625 parent-infant dyads. Participants were recruited in 2020-2022, and infants were 7-10 months of age. This secondary analysis included measures of sociodemographic data (15 items), breastfeeding status, food allergen intake assessed by 2x24hour multiple pass recall and parental responses to food allergy questions from five questionnaire items.
Results: All major food allergens were offered to 9.1% of infants aged 7-10 months and 17% of infants aged 9-10 months. Dairy (94.4%) and wheat (91.2%) were the most common major food allergens consumed on the diet recall days. Breastfed infants (n=414) were more likely to consume sesame (48.8% vs 33.7%, $p \leq 0.001$), soy (64.3% vs 53.1%, $p=0.007$) and peanut (51.1% vs 40.8%, $p=0.001$) than non-breastfed infants (n=211). There was a significant association ($p<0.001$) between parental ethnicity and the avoidance of a food in the infants first year of life. Overall, 12.6% of infants had a parent-reported food allergy and a symptomatic response after exposure was the most common diagnostic tool.
Conclusion: Most infants are not offered all major food allergens during early complementary feeding. Only 17% of infants aged 9-10 months were offered all major food allergens, with some parents actively avoiding major food allergens in the first year of life. These results provide new knowledge of parents' current practices, which highlights the need for more targeted advice and strategies to improve parental support for allergy prevention and diagnosis.
Key Words: food, allergy, New Zealand, infant

3.1 Introduction

Complementary feeding should begin when infants reach around 6 months of age. Guidelines have been developed worldwide for healthcare professionals and parents to ensure the appropriate introduction of complementary foods to infants. These guidelines include recommendations around introducing major food allergen foods (dairy, egg, peanut, tree nuts, soy, fish, shellfish, sesame, and wheat) targeted towards the prevention of food allergy development. In New Zealand, it is recommended that infants are introduced to all major allergen foods at the start of complementary feeding (around 6 months) and that all food allergens are given before 12 months of age. Once a major food allergen is tolerated, offering the food regularly (approximately twice a week) is recommended to maintain tolerance. Breastfeeding is recommended to continue while introducing complementary foods (MOH, 2021).

Worldwide recommendations and guidelines for introducing major food allergens to infants have changed over the years (Joshi et al., 2019). Infants considered high-risk were previously recommended to avoid major food allergens within the first 12 months of life. However, food allergies continued to rise (Prescott et al., 2013). It has been identified that delaying the introduction of major food allergens could lead to a higher risk of IgE sensitisation and food allergy development in infants (Du Toit et al., 2008; Koplin et al., 2010). Therefore, introducing major food allergens early has become the most favourable approach to reducing the risk of food allergy development (McWilliam et al., 2022).

As recommendations have changed over time, it is important to understand if parents are following them. Studies in Australia have shown a 3-fold increase in peanut introduction by 12 months of age from 2007/2011 to 2018 (Soriano et al., 2019). Before 12 months, 97% of infants were exposed to hens' eggs, 94% to peanuts, 76% to tree nuts and 82% to sesame (Netting et al., 2022b). This highlights a positive uptake of the current recommendations in Australia; however, this is yet to be investigated in New Zealand.

The prevalence of infant food allergies in New Zealand is thought to be similar to that in Australia, where over 10% of infants were found to have a challenge-proven IgE-mediated food allergy (Osborne et al., 2011). This high prevalence remains consistent in more recent Australian data of parent-reported infant food allergies (Netting et al., 2022b; O'Sullivan et al., 2020). It was indicated that New Zealand had comparable prevalence of child asthma to

Australia, and therefore as asthma is an atopic disease commonly seen alongside food allergies, this similar prevalence may also relate to similarities in the prevalence of food allergies in young children (Asher et al., 2008; Ferreira et al., 2022). Although infant food-induced anaphylaxis hospital admissions have been investigated by Speakman et al. (2018), and adverse reactions to food have been investigated by Crooks et al. (2010) in New Zealand children, the overall prevalence of infant food allergies was unable to be determined from these studies.

Diagnosing a food allergy is challenging and requires a qualified health professional (ASCIA, 2022a). It is insufficient to diagnose a food allergy on tests alone; however, evidence-based diagnostic tests such as skin prick tests and blood tests may be used to confirm an individual food allergy after a health professional has completed an appropriate assessment. Some health professionals may also perform oral food challenges to confirm or rule out previous or suspected food allergies. Obtaining this confirmation is important as parents will likely over-report the self-diagnosis of their infant's food allergy (Elghoudi & Narchi, 2022). This may lead to unnecessary exclusion of foods and heightened parental stress when there is no confirmation that the infant has a food allergy.

To summarise, many parents are following the recommendations for food allergy prevention in Australia; however, it is important to understand if this is similar in New Zealand. There is limited research on the overall prevalence of infant food allergies in New Zealand infants. Understanding the current parental practices in New Zealand will help establish if more targeted advice around allergy prevention and diagnosis is required. Therefore, the objectives of this study are to:

1) describe the parental reported offering of major food allergens during the complementary feeding period in infants aged 7 to 10 months;
2) determine the proportion of infants who have consumed major food allergens between 7 to 10 months;
3) compare the consumption of major food allergens between breastfed and non-breastfed infants aged 7 to 10 months;
4) describe the avoidance of any foods in the first year of life;
5) describe the parental reported prevalence of food allergies and how they were diagnosed in infants between 7 and 10 months.

3.2 Methods

3.2.1 Study Design

This cross-sectional study included infants and parents from the multi-centred (Auckland and Dunedin) study First Foods New Zealand (FFNZ). The primary aim of the FFNZ study was to determine the iron status, growth, food and nutrient intakes, breast milk intake, eating and feeding behaviours, dental health, oral motor skills, and choking risk of New Zealand infants and to investigate baby food pouch use and baby-led weaning (Taylor et al., 2021). This thesis reports a secondary outcome of the study, investigating the major food allergens offered during the complementary feeding period. A protocol describing the methods for the FFNZ study has previously been published by (Taylor et al., 2021). Therefore, only methods relevant to this secondary outcome will be described here.

3.2.2 Participants and Recruitment

The FFNZ study aimed to recruit 625 participants (parent and infant). Participants were recruited between July 2020 and February 2022. Parents lived in Auckland or Dunedin, were aged 16 years or older and could communicate in English. The infant participants were aged between 7-10 months at the time of participation. The only exclusion criterion was recent participation in a nutrition intervention study, which may have impacted the infant's feeding. No other exclusion criteria were applied.

Some targeted recruitment occurred to ensure that infants and parents represented diverse ethnic groups and socioeconomic status. To help recruit diverse ethnic groups, there was engagement with Māori and Pasifika community health organisations and suburbs with a high population of Māori, Pasifika and Asian ethnicities were targeted. In Auckland there was targeted recruitment in South Auckland to ensure representation of diverse socioeconomic statuses.

Recruitment for FFNZ was completed through word of mouth and advertisements, such as on Facebook and Community Hubs. Parents interested in the study contacted the study coordinator by phone. The study coordinator explained the study, completed a screening questionnaire for the participant and sent the participant an information sheet. An initial home visit was arranged if the participant was eligible and remained interested.

Verbal consent was obtained over the phone after checking for eligibility, and written consent was obtained at the first visit before participation in the study. Ethical approval was obtained from the Health and Disability Ethics Committees New Zealand (19/STH/151). The study was registered with the Australian New Zealand Clinical Trials Registry (registration number: ACTRN12620000459921).

3.2.3 Data Collection

Participants in the FFNZ study were required to make three visits over two weeks, including home and clinic visits. A subsample (breastfeeding) completed two additional visits as part of the measurement of breast milk intake. The first visit consisted of the main questionnaire, a 24-hour diet recall, and anthropometric measurements of the infant. The second visit included another 24-hour diet recall.

3.2.3.1 Demographic Data

The demographic data collected in the study questionnaire was used to describe the study participants, including the age of the infant and their primary caregiver, ethnicity of the infant and their caregiver, primary caregiver (yes/no), caregivers' relationship to the infant (i.e., mother, father, grandparent, guardian or other), caregiver's education level and current employment, parity, born at term, the age infant started solids, current breastfeeding status, duration of exclusive breastfeeding and day-care attendance. The term parent/s was used to describe the main caregivers. Prioritised ethnicity was used to allocate participants to a single ethnic group even if they identified with more than one ethnicity (MOH, 2008b).

Socioeconomic status was estimated from the participant's home address using the NZDep2018 index of deprivation ordinal scale ranging in score from one to ten. One represents areas with the lowest level of deprivation, and ten represents areas with the highest level of deprivation (Atkinson J et al., 2019). Deprivation scores were collapsed into tertiles: scores 1-3 (low), scores 4-6, or scores 7-10 (high), and used as a proxy for socioeconomic status.

3.2.3.2 Breastfeeding Status

Breastfeeding status was assessed during the first visit via the questionnaire. The question relevant to this analysis was “Is baby still being breastfed?” with answer options of “yes” or “no”. If the infant was still breastfed (any amount) at participation, they were considered breastfed within the analysis. If the infant was not currently breastfed at participation, they were considered non-breastfed within the analysis.

3.2.3.3 24-Hour Recall Data

Two interviewer administered multiple pass 24-hour diet recalls were completed on different days, at least one week apart. The multiple-pass 24-hour recall was comprised of three steps, this included a quick list of foods eaten, a detailed description of foods (time and place consumed, cooking method, brand, amount eaten, leftovers), and a third pass, the review. Recipes were written and attached after the 24-hour recall.

To assist with the recalls, participants used photograph prompts. These prompts were photos that the participants took (on the participant’s smartphone or camera provided) of the infant’s eating surfaces before all meals and snacks from midnight to midnight the day before each 24-hour recall (at the first and second study visit).

The 24-hour recall data were entered into FoodWorks (version 10, Xyris Software), a nutrient software program using the New Zealand Food Composition database FOODfiles 2018 Version 01. The foods were grouped into The Otago New Zealand Food Group 2023 *(ONZFG2023)* system. This is a food group system used for the Adult Nutrition Survey 2008/2009; however, it has been modified. Researchers from the University of Otago in the Department of Human Nutrition completed the modifications to this food group system due to considerable changes in the New Zealand diet since the 2008/09 survey. Foods from the 24-hour diet recall (including mixed dishes) were primarily coded into major food groups. Secondary coding allocated foods into subgroups; tertiary coding assigned foods to minor groups. This allowed for the appropriate coding of each food under its major allergens (Appendix 1). A “1” was assigned to each minor food group if it contained a major allergen. The major allergens included were egg, dairy, peanuts, tree nuts, sesame, wheat, soy and seafood (fish and shellfish).

3.2.3.4 Allergy Data

During the first study visit, the main questionnaire was completed. The main questionnaire contained five allergen questions (Appendix 2). These included the offering of allergen foods, the avoidance of any food in the first year of life, any known food allergies, the food allergy, and how the allergy was diagnosed.

Parents were asked if they had offered egg, dairy, peanut, tree nuts, sesame, wheat, soy, seafood and bread to their infant. They were also asked if they intended to avoid offering any foods during their infant's first year of life. The responses to the avoidance of foods were coded into subjective categories: major allergenic foods (i.e., cow milk, dairy, soy, peanuts, tree nuts, egg, fish and other seafood, and wheat), nutrition guidelines (foods which are recommended to be avoided during the first year of life as part of the New Zealand nutrition guidelines i.e., honey, choking risk foods, sugar, salt and processed foods), other foods (i.e., grains, animal products, other food), and avoiding allergy (i.e., those avoiding a food due to the infant being allergic) (Appendix 3).

To understand the prevalence of food allergies in New Zealand infants, parents were asked if their baby had any known food allergies, what the known food allergy was, and how it was diagnosed (free text option). In some cases, parents reported their infant had a food intolerance; therefore, categories for food intolerances were also created (i.e., cow milk, soy and others being anything other than cow's milk or soy), along with food allergies to major food allergens. Comments about how the food allergy was diagnosed were categorised into different diagnostic approaches: symptom (those who displayed a symptom upon consumption of the allergen food), health professional (those who sought professional advice for a food allergy), blood test (those whose infant had a blood test to confirm their food allergy), and skin prick test (those whose infant had a skin prick test to confirm their food allergy) and was recorded for each food allergy if multiple food allergies were present.

3.2.4 Statistical Analysis

Statistical analysis was completed using SPSS (IBM) version 29 and Stata 17.0 (StataCorp), with the significance level set as $p \leq 0.05$. Categorical data were presented as numbers of participants and percentages. A Pearson chi-square test was performed to determine if there were significant associations between food avoidance in the first year of life and demographic

factors. To establish if there were significant associations between the consumption of major food allergens in breastfed and non-breastfed infants a Person chi-square test was also used.

3.3 Results

3.3.1 Participants

The flow of participants through the study is shown in Figure 3.11. The final number of infants included in the study was 625.

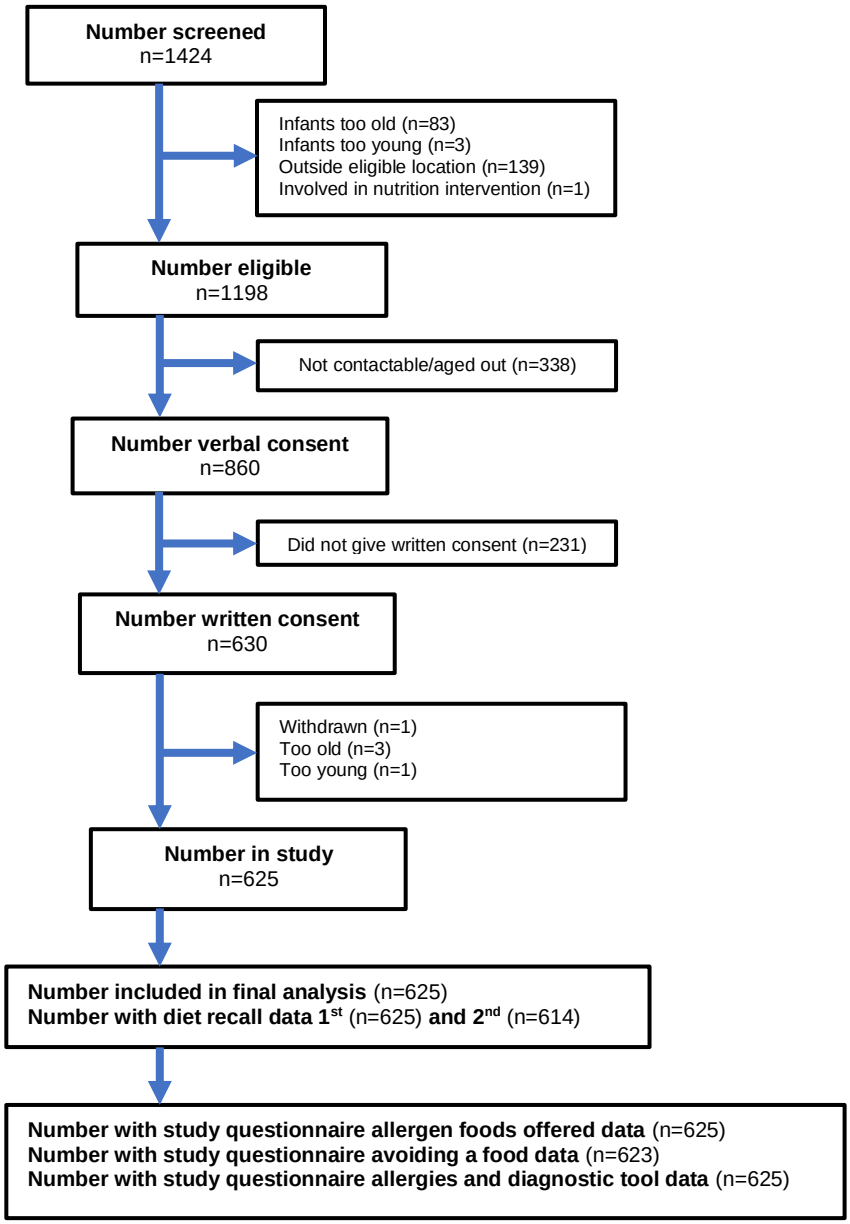

Figure 3.1 First Foods New Zealand study screening, consent and inclusion pathway

The demographic characteristics of the infants and parents are shown in Table 1. Most main caregivers were mothers; however, fathers n=6, grandparents n=1 and guardians n=1 were also included. Infants' mean (SD) age was 8.4 (0.8) months at the time of participation. Most infants were born at term (37 weeks gestation or older) (92.6%). Of the infants, 21% were of Māori ethnicity, 7% Pacific, 14.4% Asian, 2.6% other ethnicity and 55% New Zealand European. Solid food introduction began at a mean (SD) age of 5.2 months (0.9), with over half of the infants (66.2%) currently breastfed.

The primary caregivers were predominately mothers (98.7%), with a mean (SD) age of 32.7 (4.9) years. The proportion of caregivers who identified as Māori was 13.6%, 5.1% Pacific, 13.4% Asian, 2.4% other ethnicity and 65.4% New Zealand European. There was a spread of caregivers across the deprivation levels from 26.1% to 45.1%.

Table 3.1 Demographic characteristics (n=625)

Characteristics	Total n (%)[a]
Infant characteristics	
Sex (female)	289 (46.3)
Age, mean (SD) months	8.4 (0.8)
Age range (months)	7-10
Ethnicity[b]	
Māori	131 (21.0)
Pacific	44 (7.0)
Asian	90 (14.4)
Others	16 (2.6)
New Zealand European	344 (55.0)
Born at term[c] (yes)[d]	578 (92.6)
Age infant started solids, mean (SD) months	5.2 (0.9)
Currently breastfeeding (yes)	414 (66.2)
Duration of exclusive breastfeeding	
<1 month	204 (32.6)
1-4 months	151 (24.2)
5-6 months	241 (38.6)

>7 months	29 (4.6)
Childcare attendance (yes)	109 (17.4)
Caregiver	
Primary caregiver[e] (mother)	617 (98.7)
Age (years)	32.7 (4.9)
Ethnicity[b]	
Māori	85 (13.6)
Pacific	32 (5.1)
Asian	84 (13.4)
Others	15 (2.4)
New Zealand European	409 (65.4)
Education level[c]	
School	94 (15.1)
Polytech	125 (20.0)
University	405 (64.9)
Current employment	207 (33.1)
NZDep[f]	
1-3 (low)	180 (28.8)
4-6	282 (45.1)
7-10 (high)	163 (26.1)
Parity[c]	
Primiparous	303 (48.6)
Multiparous	321 (51.4)

[a] Unless otherwise specified
[b] Prioritised ethnicity
[c] Missing data (n=1)
[d] Born at 37 weeks gestation or older
[e] Six fathers, one grandparent, one guardian
[f] The New Zealand Deprivation Index 2018, ordinal scale ranges from one to ten. One represented areas with the least deprived scores, and ten represented areas with the most deprived scores, 1-3 (low), 4-6, or 7-10 (high)

3.3.2 Parent-reported Offering of Major Food Allergens to Infants

Table 3.2 highlights the major food allergens offered to each age group (one-month increments) between 7 and 10 months of age. Dairy was the most common major food allergen offered to all infants between 7 and 10 months of age (78.6%). Tree nuts were the least common of the major allergens to be offered across all three age groups: 7 to <8 months (10.4%), 8 to <9 months

(22.9%) and 9 to 10 months (32.0%). At least one major food allergen was offered to all infants aged 9 to 10 months.

The prevalence of parents offering all major food allergens to their infants was 2.9% at 7 to <8 months, 10.4% at 8 to <9 months, and 17.0% at 9 to 10 months. Overall, 9.1% of infants aged between 7 and 10 months were offered all major food allergens. No major food allergens were offered to 8.7% of infants at 7 to <8 months and 1.3% of infants at 8 to <9 months; however, all infants from 9 to 10 months were offered at least one major food allergen.

Table 3.2 Major food allergens that are offered between 7-10 months of age

Major Food Allergens Offered	7 to <8 months n (%)	8 to <9 months n (%)	9 to 10 months n (%)	Total n (%)
n	241	231	153	625
Egg[a]	142 (58.9)	197 (85.3)	137 (89.5)	476 (76.2)
Dairy[b]	159 (66.0)	196 (84.9)	136 (88.9)	491 (78.6)
Peanut[c]	102 (42.3)	144 (62.3)	103 (67.3)	349 (55.8)
Tree nuts[d]	25 (10.4)	53 (22.9)	49 (32.0)	127 (20.3)
Sesame[e]	39 (16.2)	77 (33.3)	72 (47.1)	188 (30.1)
Wheat[f]	160 (66.4)	199 (86.2)	130 (85.0)	489 (78.2)
Soy[g]	155 (64.3)	182 (78.8)	137 (89.5)	474 (75.8)
Seafood[h]	89 (36.9)	144 (62.3)	116 (75.8)	349 (55.8)

[a] Egg (cooked)
[b] Dairy (e.g., milk, yoghurt, cheese)
[c] Peanut (including peanut butter)
[d] Tree nuts (e.g., almond, cashew, walnuts)
[e] Sesame (e.g., as seeds on top of some breads, in hummus, tahini)
[f] Wheat (e.g., breakfast cereal, pasta, flour, bread (excluding gluten-free))
[g] Soy (e.g., tofu, soy milk, soy sauce) including bread (common commercial varieties, excluding soy free bread)
[h] Seafood (fish and shellfish)

3.3.3 Infant Consumption of Major Food Allergens by 24-hour Recall

Table 3.3 shows the proportion of consumers and non-consumers of the major food allergens on the diet recall days. Most infants consumed dairy (94.4%) and wheat (91.2%) on their diet

recall days. There were more non-consumers of peanuts (52.2%), tree nuts (72.2%), sesame (56.3%) and seafood (65.0%) than consumers. Seven (1.0%) infants did not consume any major food allergens on their diet recall days.

Table 3.3 The proportion of infants consuming major food allergens on their diet recall days at 7-10 months of age (n=625)

Major Food Allergens	Consumers[a] n (%)	Non-consumers n (%)
Eggs	331 (53.0)	294 (47.0)
Dairy	590 (94.4)	35 (5.6)
Peanut	299 (47.8)	326 (52.2)
Tree nuts	174 (27.8)	451 (72.2)
Sesame	273 (43.7)	352 (56.3)
Wheat	570 (91.2)	55 (8.8)
Soy	378 (60.5)	247 (39.5)
Seafood[b]	219 (35.0)	406 (65.0)

[a] Only one diet recall completed n=11
[b] Includes fish and other seafood

3.3.4 Major Food Allergen Consumption by 24-hour Recall in Breastfed and Non-breastfed Infants

Table 3.4 shows the difference in the consumption of major food allergens between breastfed and non-breastfed infants. Breastfed infants were significantly more likely to consume sesame than non-breastfed infants (48.8% vs 33.7%, $p<0.001$). Breastfed infants were also significantly more likely to consume soy and peanuts than non-breastfed infants (64.3% vs 53.1%, $p=0.007$ and 51.1% vs 40.8%, $p=0.011$, respectively).

Table 3.4 Major food allergen consumption during two diet recall days between 7-10 months of age in breastfed infants (n=414) and non-breastfed infants (n=211)

Major Food Allergens [a]	Breastfed[b] Consumers n (%)	Non-breastfed Consumers n (%)	*p* value[c]
Eggs	227 (54.8)	104 (49.3)	0.189
Dairy	389 (94.0)	201 (95.3)	0.504
Peanut	213 (51.5)	86 (40.8)	0.011
Tree nuts	125 (30.2)	49 (23.2)	0.066
Sesame	202 (48.8)	71 (33.7)	<0.001
Wheat	374 (90.3)	196 (92.9)	0.287
Soy	266 (64.3)	112 (53.1)	0.007
Seafood	156 (37.7)	63 (29.9)	0.053

[a] Only one diet recall completed n=11
[b] Those who were still breastfed (any amount) at the time of study
[c] Pearson's Chi-Square Test

3.3.5 Parent-reported Food Avoidance in the Infants First Year of Life

Table 3.5 displays the foods that parents planned to avoid offering their infant in the first year of life. Over half of the parents (56.7%) planned to avoid at least one food in their infant's first year of life, with honey being the most common (57.2%). Cow's milk was the most common major food allergen to be avoided (19.0%).

Table 3.5 Parent-reported food avoidance in the first year of life (n=623)

Foods Avoided	Yes n (%)[a]
Total[b]	353 (56.7)
Food allergens	
Cows milk[c]	67 (19.0)
Dairy[d]	18 (5.1)
Soy	5 (1.4)
Peanuts[e]	29 (8.2)
Tree nuts	17 (4.8)
Egg	14 (4.0)
Fish and other seafood[f]	20 (5.7)
Wheat[g]	15 (4.2)

Nutrition Guidelines	
Honey	202 (57.2)
Choking risk foods[h]	11 (3.1)
Sugar[i]	96 (27.2)
Salt[j]	43 (12.2)
Processed food[k]	23 (6.5)
Other Foods	
Grains[l]	16 (4.5)
Animal Products[m]	22 (6.2)
Other food[n]	17 (4.8)
Avoiding due to allergy[o]	33 (9.3)

[a] Participants could specify any number of avoided foods
[b] Missing data (n=2)
[c] Includes dairy, milk, full cream milk, vegan diet, whole milk, cows milk as a drink (n=8)
[d] Includes dairy other than cows milk; yoghurt, icecream, cheese, vegan diet
[e] Includes peanut butter
[f] Includes raw fish, shrimp, prawn, shellfish, vegan diet, vegetarian diet, meat and oysters
[g] Includes gluten, bread, breadcrumbs, cereals, white bread
[h] Includes chunky food, hard fruit, steak, whole nuts, apple, raw carrots, popcorn, sausages, peanut butter
[i] Includes refined sugar, sweet foods, added sugar, sweet drinks, biscuits, cakes, sugary food, chocolate, ice cream, tomato sauce, fizzy drink, commercial sugar, fruit juice, sauces, candy, baked items, lollies
[j] Includes added salt, foods high in salt, chips
[k] Includes takeaways/fast food, processed meats, chips, crackers, food in jars and cans, junk food, colours, thickeners, preservatives, foods with artificial additives, food colourings, fats, baked items, packaged foods, trans fat, anything other than wholefoods
[l] Includes wholegrains, cereal, rice, white rice, baby rice
[m] Includes meat, red meat, chicken, pork, raw meat, vegetarian diet, vegan diet
[n] Includes cucumber, hummus, caffeine, beetroot, rhubarb, lime, kiwifruit, fruit, citrus fruit, soft cheese, mushrooms, pepper, adult snacks, drinks other than water or breast milk or infant formula or milk
[o] Avoiding a food due to infant food allergy

Table 3.6 highlights food avoidance in the infant's first year of life by their parent's demographic factors. There was a significant association (p<0.001) between parental ethnicity and whether the parent planned to avoid a food in the infant's first year.

Table 3.6 Parent-reported food avoidance in the first year of life by demographic factors (n=623)

Demographic Factor	Parental avoidance of foods – in the first year of life[a]		
	Yes (n=353) n (%)	No (n=270) n (%)	*p*-value[b]
Parental ethnicity[c]			<0.001
Māori	42 (11.9)	43 (15.9)	
Pacific	9 (2.5)	23 (8.5)	
Asian	39 (11)	45 (16.7)	
Others	10 (2.8)	5 (1.9)	
New Zealand European	253 (71.7)	154 (57.0)	
Parental education level[d]			0.387
School	48 (13.6)	46 (17.1)	
Polytech	69 (19.5)	56 (20.8)	
University	236 (66.9)	167 (62.1)	
Socio-economic status (NZDep)			0.118
1-3 (low)	111 (31.4)	68 (25.2)	
4-6	159 (45)	122 (45.2)	
7-10 (high)	83 (23.5)	80 (29.6)	
Parity[d]			0.735
Primiparous	173 (49.1)	129 (47.8)	
Multiparous	179 (50.9)	141 (52.2)	

[a] Missing data (n=2)
[b] Pearson's Chi-Square Test
[c] Prioritised ethnicity
[d] One missing answer

3.3.6 Parent-reported Prevalence of Infant Food Allergies and the Diagnostic Tool Used to Identify the Allergy

Table 3.7 shows the prevalence of parent-reported food allergies in infants and the diagnostic tool used to identify the allergy. A total of 12.6% of infants were reported to have a food allergy, with egg allergy the most common of those reported to have a food allergy (45.6%). A symptomatic response after exposure to the food was the diagnostic tool reported by parents for infant allergies to wheat, soy, tree nuts, fish and other seafood, other foods, and intolerance to

cow milk, soy and other foods reported (100%). Of the major allergens diagnosed by a health professional, egg allergy was the most common.

Table 3.7 Parent-reported prevalence of food allergies in infants and diagnostic tool (n=625)

Prevalence n (%)		Diagnostic Tool[ab]			
		Symptom[d]	Health Professional[e]	Blood Test	Skin Prick Test
Total[c]	79 (12.6)				
Food Allergy					
Wheat[f]	4 (5.1)	4	0	1	1
Cow's milk[g]	31 (39.2)	30	11	1	3
Egg[h]	36 (45.6)	33	12	2	5
Soy	6 (7.6)	6	4	0	0
Peanuts	12 (15.2)	9	6	1	5
Tree nuts	4 (5.1)	4	1	1	1
Fish and other seafood[i]	3 (3.8)	3	0	0	0
Other[j]	8 (10.1)	8	3	0	0
Food intolerance					
Cow's milk intolerance[k]	10 (12.7)	10	7	0	1
Soy intolerance	3 (3.8)	3	3	0	1
Other intolerance[l]	4 (5.1)	4	2	0	0

[a] These values represent n infants with a diagnostic tool
[b] Those with more than one diagnostic tool included multiple times
[c] Infants with multiple allergies were included multiple times for individual allergens
[d] Includes skin reaction (hives, swelling, rash, eczema, itching), vomiting, diarrhoea, sore tummy, blood/mucus in stool, constipation, reflux, low weight gain, irritable
[e] Includes General Practitioner, Paediatrician, Specialist, Hospital Doctor
[f] Includes pasta
[g] Includes dairy products
[h] Includes egg white
[i] Includes shellfish, oysters, white fish
[j] Includes mango, processed cheese, coconut, avocado, raw tomato, chocolate, red lentils, pumpkin, banana, chocolate
[k] Includes dairy intolerance
[l] Includes an intolerance to another individual food including oat, rice, apples, egg, banana, wheat, chocolate, coconut

3.4 Discussion

This secondary analysis of the FFNZ study shows that most infants were not offered all major food allergens during the complementary feeding period, with some parents planning to avoid major food allergens in their infant's first year of life. Dairy and wheat were the most common major food allergens consumed on the diet recall days, and breastfed infants were more likely to consume sesame, peanut and soy than non-breastfed infants. In this cohort, 12.6% of infants had a parent-reported food allergy, with a symptomatic response after exposure being the most common diagnostic tool.

3.4.1 Parent-reported Offering of Major Food Allergens to Infants

This study found that only 17% of infants aged 9-10 months were introduced to all major food allergens. In Australia, it was found that nearly all infants were introduced to major food allergens by 12 months, with text message reminders to include regular peanut, egg and wheat in their infant's diet not influencing introduction (Netting et al., 2022a). Early introduction of peanuts was also reported in Australian infants, with peanuts being introduced to 86% of infants by 12 months of age in a study by O'Sullivan et al. (2020), 88.6% by 12 months of age in a study by Soriano et al. (2019) and 94% by 12 months in a study by (Netting et al., 2022b). This is higher than our present study findings of 67.3% of infants being offered peanuts at 9 to 10 months. However, this may be partially due to the infants being younger than 12 months old. Despite this, it suggests that Australian infants are introduced to major food allergens, particularly peanuts, earlier than New Zealand infants, highlighting a more improved adherence to the guidelines for allergy prevention in Australia.

Peanut introduction in infants before 12 months of age was found to be lower in other countries compared to our findings. A study by Kwong et al. (2022), found that 28.6% of infants were introduced to peanuts between 4 to 11 months; however, as the study was situated in inner-city infants enrolled in a medical centre with ongoing medical care in the greater Los Angeles (USA) area, it does not reflect a wide population as the other studies do. However a USA based population based sample of 3062 caregivers of children aged 7 months to 3.5 years found that 58.8% of infants were introduced to peanuts before 12 months (Venter et al., 2022). This population based USA study by Venter et al. (2022) highlights an increased number of infants being introduced to peanuts before 12 months compared to the Los Angeles study by Kwong et al. (2022). However peanut introduction it is still lower in the USA compared to our present study findings of 67.3%.

3.4.2 Infant Consumption of Major Food Allergens by 24-hour Recall

Dairy and wheat were the most common major food allergens consumed on the diet recall days by infants in this study. This could suggest a regular consumption of dairy and wheat; however, frequency of consumption could not be determined in this study. Therefore, we cannot establish if consuming major food allergens aligns with the current guidelines for continuing to offer food allergens regularly (twice weekly) if tolerated (MOH, 2021). The regular offering of major food allergens is important to maintain tolerance. A study by Rowan and Brown (2023) investigated the consumption of egg in infants 6-12 months by seven day food frequency questionnaire (FFQ), 24-hour recall and three day weighted food diary. Of the infants who had been introduced to egg (FFQ), consumption of egg averaged one to two times per week (14.1% and 17.8%, respectively). From the 24-hour diet recall data, this study found that 13.8% consumed egg or egg based dishes in the previous 24-hours, and 33.8% consumed egg over the three days of the weighed food diary. This highlights the importance of collecting the right type of dietary data when assessing food allergen intake in infants. This study did not investigate the consumption of any other major food allergens apart from egg. No studies were found that assessed all major food allergen consumption in infants by diet recall. The studies that have been completed on major food allergen consumption in infants were predominantly completed through questionnaires and questionnaire based surveys, which we cannot compared diet recall consumption too.

The consumption of sesame, soy and peanut was significantly higher in breastfed infants than non-breastfed infants on their diet recall days. This may suggest that those parents who continue breastfeeding throughout complementary feeding are more likely to follow the infant feeding guidelines. No studies have investigated major food allergen consumption in these two groups. This may be due to the limited number of studies investigating the consumption of major food allergens in this age group, leading to a further gap in research on allergen consumption in breastfed and non-breastfed infants.

Within this study, the consumption of the major food allergens from the diet recall contradicts the reported offering of some major food allergens. Dairy, tree nuts, sesame and wheat were consumed by a higher percentage of infants on the diet recall days than parental reports of offering those major food allergens to their infants. This may result from parents being unaware of the major food allergens present within foods, particularly processed foods. Some examples of this may be biscuits containing tree nuts or dairy, processed bread products containing dairy,

wheat in some processed meat, and spring rolls containing sesame. It is also possible this could have resulted from food substitutions made during the dietary data analysis process (in Foodworks). For example, homemade foods may have been substituted for an already-created recipe, including food allergens that may not have been present in the homemade recipe. An example may be an omelette or pancakes made at home without dairy, however the FoodWorks recipe may have dairy included. However, it is not known as to the extent that this may have occurred.

3.4.3 Parent-reported Food Avoidance in the Infants First Year of Life

In this study, 56.7% of the parents planned to avoid at least one food for their infant in their first year of life. Of those avoiding a food, avoiding honey was the most common (57.2%). This finding is expected as the Healthy Eating Guidelines for New Zealand Babies and Toddlers (0-2 years old) advise to avoid honey in the first year of life (MOH, 2021). Cow's milk was the most common major food allergen to avoid (19%), and soy was the least common (1.4%). Cow's milk should be avoided as a drink within the first year of life (MOH, 2021). Therefore, misinterpreting the question or the current guidelines may have resulted in some parents stating they are avoiding cows' milk (with or within food) in the first year of life. Regardless, some parents intentionally avoid major food allergens in the infant's first year. This avoidance may be due to parents not being aware of the current guidelines or concerns about potential allergic reactions when introducing these foods. Concern around food allergies was reported in a Norwegian study by Fagerlund et al. (2019), where 34% of parents feared allergy or hypersensitivity, so they avoided introducing some food items to their 10-month-old infants. Another study by Garcia et al. (2019) found that food allergies were the most common concern among UK parents of 4 to 12-month-olds. Parental concerns may contribute to a later introduction of major food allergens. Therefore, it is important to investigate why parents avoid major food allergens for their infants before 12 months of age.

The current study also found that food avoidance in the first year of life was significantly associated with parental ethnicity. However, we cannot determine where the significant association is between ethnicities in this study. Varying cultural practices may influence the introduction of foods into the infant's diet, and certain ethnic groups may be more aware of the New Zealand guidelines. Future studies should investigate this further.

3.4.4 Parent-reported Prevalence of Infant Food Allergies and the Diagnostic Tool Used to Identify the Allergy

This study reports that the prevalence of parent-reported infant food allergies was 12.6%. Previously, it was found that the prevalence of adverse reactions to foods in 0-5-year-olds in New Zealand was 40% (Crooks et al., 2010). However, adverse reactions to foods are not an accurate measure of food allergies. This is because food allergy symptoms can present similarly to other adverse reactions to food, such as hypersensitivity. A New Zealand study by Speakman et al. (2018) investigated FIA hospital presentations over a 10 year period in infants and children aged 0-14 years. The study found an overall increase in the annualised rate of 2.8 fold among FIA child hospital admissions. The highest annualised FIA admission rate was among infants aged 0-2 years (50.5/100 000 children). However this data was based on FIA hospital admissions and therefore does not reflect food allergy cases in New Zealand infants, as mild reactions may not result in a hospital admission. The current study adds additional data for the overall prevalence of food allergies in New Zealand infants.

Our findings compare to those reported in Australia, where over 10% of infants had a challenge-proven food allergy (Osborne et al., 2011). Our study was not challenge-proven, so a direct comparison cannot be made to this earlier study. However, our parent-reported findings are comparable to a recent Australian study by O'Sullivan et al. (2020) that found 12.8% of infants had parent-reported food related allergic reactions. Our study found that egg and cow's milk (including dairy products) allergies were the most common allergies. This is consistent with the Australian study by O'Sullivan et al. (2020), reporting that egg and dairy were the most common allergens causing a reaction suggesting IgE-mediated food allergies in infants. It is important to note that parents may over-report food allergies. The study by O'Sullivan et al. (2020) estimated that 39% of parent-reported food allergic reactions were not from IgE-mediated food allergies. Parents may over report due to a misunderstanding of food allergy symptoms, incorrect recall, or ability to determine the food causing the reaction (Chafen et al., 2010; O'Sullivan et al., 2020). Therefore, further studies should use similar diagnostic tools to ensure food allergy prevalence can be compared and monitored over time.

A symptomatic response after exposure to a food was reported by all parents of an infant with a reported allergy to wheat, soy, tree nuts, fish and other seafood, other foods, and any food intolerances reported by parents. Very few parents reported the completion of an SPT or blood test. This highlights that advice to see a health professional, followed by evidence-based testing

(SPT and blood tests) if an allergy is suspected, is not followed by all parents (ASCIA, 2022a). However, some infants in this study are only seven months old; therefore, if they have only had one exposure to a major food allergen followed by symptoms, they may not have had a chance to be followed up by a health professional before their participation in the current study. The individual prevalence of each diagnostic tool used could not be determined from the study, as some infants had multiple food allergies with differing diagnostic tools reported.

The larger number of parents reporting a symptomatic response as the diagnostic tool for their infants, compared to the amount that saw a health professional for diagnosis, is similar to an earlier New Zealand study of children aged 0-5 years by Crooks et al. (2010). Crooks et al. (2010) reported that of the young children with parent-reported adverse reaction to a food, 91% did not have this investigated by a health professional. This is of concern because if food allergies are not investigated, it is unlikely that appropriate advice for management will be provided. Therefore, there is the potential for further reactions to occur. There is also a risk of nutrient deficiencies with food exclusion. It is important that if major food allergens are excluded in the infant's diet that parents are informed of appropriate substitutions to ensure the replacement of nutrients and to prevent nutrient deficiencies(Christie et al., 2002) .

Similar to the present study, two studies in the USA by Gupta et al. (2013) and Mathias et al. (2019) found low numbers of diagnostic tests for food allergies being completed. After seeing a health professional, 32.6% of 0-17-year-olds (Gupta et al., 2013) and 4.0-29.4% of 4-month-olds to 6-year-olds (Mathias et al., 2019) had not completed diagnostic tests. This may be due to the infant or child's age or the reliability of the tests affecting health professionals' decisions (Foong & Santos, 2021).

3.4.5 Strengths and Limitations

A strength of this study was the substantial sample size of 625 participants who represented diverse ethnic backgrounds and deprivation levels in New Zealand. This study is the first to investigate the offering of major food allergens to New Zealand infants. It provides an understanding of current parental practices and whether the recommendations for introducing major food allergens to infants are followed. This is important in determining if further advice is required for parents in this critical period of allergy prevention.

A limitation of this study was the nature of parent-reported data. This can result in misinterpretation and retrospective answers. Some questions, including that around the introduction of major food allergens offered to their infant, and the 24-hour recall will have been answered retrospectively and therefore these answers are subject to memory bias. The true prevalence of infant food allergies could not be determined as other adverse reactions to food were not directly asked about in the current study. Some parents stated their infant had a food allergy and later reported this as an intolerance. Confusion around the difference between food allergies and other adverse food reactions may have resulted in parents incorrectly reporting a food allergy. An example of this acidic foods such as tomatoes and citrus fruits can cause a rash around infants mouths. Parents may mistake this rash as symptoms of a food allergy however unless the rash bothers the infant, this is just an irritation due to the acid in some foods. Therefore, other adverse reactions to food were reported within the prevalence of food allergies.

This study could not investigate the frequency of major food allergen consumption in infants; therefore, whether the guideline around regular offering of food allergens after tolerance is occurring was unable to be determined. Therefore, this is a limitation in our study, and full adherence to the guidelines should be investigated further in New Zealand.

3.4.6 Conclusion

Most infants are not offered all major food allergens during early complementary feeding. Only 17% of infants aged 9-10 months were offered all major food allergens, with some parents actively avoiding major food allergens in the first year of life. More guidance may be required to ensure current recommendations are followed and all major food allergens are introduced by 12 months of age. These results provide new knowledge around the current parental practices of New Zealand parents. It highlights the need for more targeted advice and strategies to improve parental support for allergy prevention and diagnosis.

Chapter 4 Conclusions and Recommendations

4.1 Achievement of Aims and Objectives

This study aimed to determine the parental offering of major food allergens to infants during complementary feeding. The current New Zealand recommendations are to offer all infants major food allergens (dairy, egg, peanut, tree nuts, soy, fish, shellfish, sesame, and wheat) from the start of complementary feeding, which is around six months of age (MOH, 2021). This ensures that all major food allergens are given to infants before 12 months of age. The infants recruited for this study were between 7-10 months of age and had all started complementary feeding (the mean age of starting complementary feeding was 5.2 months). Although at least one major food allergen had been offered to all infants aged 9 to 10 months, only 17% of infants from this age group were offered all major food allergens. This highlights that parents could be delaying the offering of major food allergens due to being unfamiliar with infant feeding guidelines and the recommendation to introduce major food allergens from the start of complementary feeding. Alternatively, the concern of allergic reactions when major food allergens are introduced could be a contributing factor (Fagerlund et al., 2019; Garcia et al., 2019). A delay in introduction of major food allergens may also be due to major food allergens, for example fish and shellfish not forming the usual diet for some families. Therefore, due to dietary choices some major food allergens may not be introduced to the infant before 12 months of age.

The second objective of this study was to determine the proportion of infants consuming major food allergens and compare the consumption between breastfed and non-breastfed infants. Most infants consumed dairy and wheat on their diet recall days; this may highlight regular consumption of these foods. However, the frequency of consumption cannot be established as only two 24-hour diet recalls were completed. Therefore, it could not be determined whether parents follow the recommendation to regularly offer their infant major food allergens twice weekly to maintain tolerance (MOH, 2021). Continued breastfeeding alongside complementary feeding is recommended in New Zealand and worldwide (MOH, 2021; WHO, 2021). However, there is limited evidence on consuming major food allergens in breastfed and non-breastfed infants. This study found a significant association between the intake of major food allergens and breastfeeding status, specifically that breastfed infants were more likely to consume sesame, soy, and peanut than non-breastfed infants on their diet recall days. Although other determinants can impact the continuation of breastfeeding, this may highlight that mothers who

continue breastfeeding throughout complementary feeding may be more aware of the infant feeding guidelines.

The third objective of this study was to describe the avoidance of any foods in the first year of life. The changing landscape of evidence and recommendations for introducing major food allergens may impact parents' decisions about introducing these foods during complementary feeding. Despite the current guidelines recommending that infants are introduced to all major food allergens in the first year of life, they are still intentionally avoided. Of parents avoiding a food in their infant's first year of life (56.7%), cow's milk was the most common major food allergen to be avoided (19%), and soy was the least common (1.4%). However, avoiding cow's milk may have been over-represented in this study due to misinterpretation of the guidelines around when it is appropriate to include cow's milk in the diet of infants. However, the results show that there is still the planned avoidance of major food allergens by some parents. Understanding why some parents are still avoiding major food allergens is important.

A significant association was found between parental ethnicity and whether the parent planned to avoid offering certain foods in their infant's first year of life. This may be due to varying cultural practices influencing the introduction of foods into the infant's diet. However, as a chi-square test was conducted we cannot establish causality and therefore we cannot determine the specific significance of this association from these results.

Lastly, an objective of this study was to describe the reported prevalence of food allergies in infants between 7 and 10 months of age. In the current study, 12.6% of infants had a parent-reported food allergy. Although there are New Zealand studies on infant and child prevalence of peanut allergies by McMilin (2015), FIA hospital admissions by Speakman et al. (2018) and adverse reactions to food by Crooks et al. (2010), this study adds additional data to highlight the overall prevalence of infant food allergies in New Zealand.

It was thought that the prevalence of food allergies in New Zealand infants would be similar to that in Australian infants. This was confirmed, as over 10% of Australian infants at 12 months of age have a challenge-proven food allergy (Osborne et al., 2011). However, it is important to note the different methods used to determine food allergy, with parent-reported food allergy in the current study and challenge-proven allergy in the Australian study (Osborne et al., 2011). There are limitations to parental reports, as they can over-report food allergies, incorrectly recall

the food that caused the reaction or be unaware of the difference between a food allergy and food intolerance (Chafen et al., 2010; O'Sullivan et al., 2020).

This study found that a symptomatic response after exposure to a major food allergen was the most common diagnostic tool for each allergy and intolerance. A symptomatic response after exposure to a food was reported as the diagnostic tool used by 100% of parents with infants who reported allergy to wheat, soy, tree nuts, fish and other seafood, other foods, and intolerance to cow milk, soy and other foods. As some infants had multiple food allergies with differing diagnostic tools, the overall prevalence of each diagnostic tool could not be determined. It is important to obtain an accurate diagnosis of infant food allergies by visiting a health professional. Parents may not follow up on food allergies in their infant for various reasons, including difficulty accessing health professionals (Jeffreys et al., 2022). This is concerning because parents of infants with uninvestigated food allergies are unlikely to have been provided with appropriate management advice, which creates a further risk for ongoing reactions. Blood and skin prick tests were only used by a few parents for diagnosis in this study. This may be due to doctors choosing not to complete these tests because of the infant's age or the reliability of the tests (Foong & Santos, 2021).

4.2 Research Impact

This study recruited an ethnically diverse population with various deprivation levels in New Zealand. There was a large sample size of 625 participants. This study gives insight into parental practices when introducing major food allergens to infants in New Zealand. It provides insight that may suggest that most parents in New Zealand are not following the current recommendations for introducing major food allergens. More studies are required to determine why most parents are not offering all major food allergens at the start of complementary feeding and why major food allergens are still intentionally avoided in the first year of life. This will lead to the development of more targeted advice around allergy prevention.

Although the prevalence of infant food allergies was parent-reported, it provides a broad overview of the prevalence in New Zealand infants. Previous New Zealand studies have investigated the prevalence of infant and child adverse reactions to food and hospital admissions due to FIA; however, this is not representative of all infants with food allergies. Therefore, this study adds further data for the overall infant food allergy prevalence in New Zealand. This knowledge is significant for identifying and tracking the prevalence of infant food

allergy trends over time. It highlights the importance of early detection and obtaining an accurate food allergy diagnosis. Health professionals can use this to improve their education to parents about the prevention, recognition, and management of food allergies. Awareness of this high prevalence can lead to the development of more support for parents and families affected by food allergies.

4.3 Strengths

This is the first New Zealand study to investigate the offering of major food allergens during the complementary feeding period in line with the current recommendations. Investigating the offering of major food allergens during the complementary feeding period is crucial, as introducing these foods at this time can help to reduce the risk of food allergy development. This study adds significant information about parents' current practices with allergen food introduction and highlights the need for a larger focus on allergy prevention with parents.

A novel aspect of this research is comparing breastfed and non-breastfed infants. This has not previously been investigated, and this study found a significant association with breastfed infants being more likely to consume sesame, soy and peanut than non-breastfed infants. It is recommended to continue breastfeeding while complementary feeding; therefore, the significant association identified may signify that those who continue breastfeeding are more likely to follow the infant feeding guidelines and, therefore, the recommendation for introducing major food allergens to infants. However, the consumption was only investigated on two diet recall days; therefore, this should be investigated further with a 3-4-day food diary. Alternatively, the offering of major food allergens between these two groups could also be explored. Despite this, these current findings add new and valuable information about different parental practices in breastfed and non-breastfed infants, which can be further explored.

Another strength of this study is understanding how parents diagnose their infants with food allergies. A symptomatic response after exposure to a major food allergen was the most common diagnostic tool used by parents in this study. This was consistent with an early study by Crooks et al. (2010), which found that health professionals did not subsequently investigate 91% of adverse reactions in infants. If parents do not visit a health professional for their infant's suspected food allergy, this could lead to incorrect food avoidance. Parents may inaccurately recall the suspected food allergen, risking further reactions. It is, therefore, important for parents to obtain an accurate diagnosis from a health professional for the ongoing dietary management

and prevention of serious reactions (anaphylaxis). As the infant ages, an accurate food allergy diagnosis from a health professional means they can be continually assessed to identify if the food allergy has been outgrown. This study, therefore, adds further valuable knowledge for how parents are obtaining a diagnosis of suspected food allergies. It signifies that parents need more guidance on the appropriate actions to follow when they suspect their infant has a food allergy.

4.4 Limitations

Limitations in this study should be recognised. Firstly, this study used a questionnaire to determine the offering of major food allergens, the avoidance of foods in the first year of life, the prevalence of food allergies and the diagnostic tool used. This may have impacted the results if there was recall bias with the 24-hour diet recalls and inaccurate or biased answers in the questionnaire.

Adverse reactions to food that are not food allergies were not directly asked about within the current study. This may have impacted the accuracy of the overall food allergy prevalence results as some parents reported that their infant had a food allergy and later stated it was a food intolerance. Therefore, food allergies and reported intolerances were included within the overall prevalence of infant food allergies. More adverse reactions to food that are not food allergies are likely included in this overall prevalence if some parents were unaware of the difference between a food allergy and other adverse food reactions.

A limitation of this study was the parent-reporting of cow's milk avoidance in the infant's first year of life. Cow's milk was the most common major food allergen to be avoided by parents; however, this may be inaccurately represented within these results. Cow's milk as a drink should be avoided in the first year of life, but it can be consumed in small amounts, such as with cereal, in baking and cooked meals during the complementary feeding period (MOH, 2021). Some parents in this study said they were avoiding cow's milk as a drink; this was included in the cow's milk avoidance results. Other parents may be avoiding cow's milk as a drink for their infant but did not specifically state this. There may also be confusion around the recommendation to avoid cows' milk as a drink in the first year of life. Some parents and even health professionals may not be aware that the avoidance should just be for cows' milk *as a drink*; therefore, cows' milk may be avoided altogether. This would have further impacted the representation of our results. Therefore, parental confusion and misinterpretation of the question

may have contributed to cow's milk being the most common major food allergen avoided in the first year of life.

A limitation of this study was that we could not determine the frequency of consumption of major food allergens to determine if this was in line with the current recommendations. As this study was a secondary analysis from a larger study, only two 24-hour diet recall days were completed, and therefore, the frequency of major allergen consumption could not be determined. Some infants may have been shown as non-consumers in the diet recall but may be consuming major food allergens on other days of the week; therefore, it is difficult to determine the consumption of major food allergens from the diet recalls. Further research could use a 3-4-day food diary to address this. This will allow for a greater understanding of parents following the current recommendations and parental practices around maintaining major food allergen tolerance within the infant's diet.

There were limitations between the data from the questionnaire and the 24-hour diet recalls. The major food allergens, dairy, tree nuts, sesame and wheat, were consumed by more infants on the diet recall days than the number of infants the parents stated were offered. This may result from some parents offering processed foods to their infants and not realising they may contain major allergens such as dairy, wheat or sesame. Homemade foods without a recipe would have resulted in an appropriate substitution having to be made in FoodWorks which may have also impacted these results.

4.5 Recommendations and Future Directions for Research

- More research is needed to determine the frequency at which major food allergens are offered to infants. Infants should be offered major food allergens twice a week to maintain tolerance. If an infant consumes a major food allergen once and then it is not consumed regularly, this could lead to the development of a food allergy. Therefore, knowledge of the frequency of consumption will provide a further understanding of the adherence to the allergen recommendations for infants.
- Understanding health professionals' awareness of the current recommendations for introducing major food allergens to infants is important. Health professionals are the cornerstone of advice for mothers, with many mothers relying on their guidance. Therefore, it is crucial to understand if health professionals are relaying the correct allergy prevention and management advice to mothers.

- More research is required to understand why all major food allergens are not being introduced to infants at the start of complementary feeding. It is also important to understand why some parents intentionally avoid major food allergens for their infant in the first year of life. This will help with the development of more targeted advice from health professionals.
- Further research is needed to determine the true prevalence of infant food allergy. Research has described the oral food challenge as the gold standard for confirming food allergies (Osborne et al., 2011). This is an intensive process and not always practical, therefore other evidence based diagnostic tools could be used to help determine the true prevalence of infant food allergies in New Zealand.
- This study highlighted that most parents use a symptomatic response after exposure to a major food allergen as the diagnostic tool. More research should be completed in this area to determine why most parents are using their infants symptomatic response as the diagnostic tool rather than visiting health professionals and getting tests completed. Further research can help lead to more focused advice available for parents to follow if they suspect their infant has a food allergy. This will increase the number of parents obtaining an accurate diagnosis for their infant and help with their understanding of managing infant food allergies.
- An Australian study by Vale et al. (2022) used focus groups of health professionals and parents to identify a public health approach to food allergy prevention. However, this study only consisted of 39 participants. A similar approach, with a larger sample size, may be beneficial in New Zealand. This will help determine how health professionals and parents feel the infant feeding guidelines are best communicated. This will help translate information to all New Zealanders and lead to a better understanding of the guidelines for introducing major food allergens to infants.

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Appendices

Appendix 1. Food Recall Coding

Example of how the 534 minor food group (rows) were coded into the major food allergens that they contain. The major food allergens were egg, dairy, peanut, tree nuts, sesame, wheat, soy, seafood (8 columns).

ONZFG2023 Minor Group name	Additional notes, examples	allergen_egg	allergen_dairy	allergen_peanut	allergen_treenuts	allergen_sesame	allergen_wheat	allergen_soy	allergen_seafood	allergen_query	allergen_notes
White rice (includes parboiled & basmati) (Grains and Pasta)											
Brown rice (Grains and Pasta)											
Other rice e.g. wild rice (Grains and Pasta)											
Rice noodles or rice-based pasta (Grains and Pasta)											
Rice products, plain, puffed/extruded/dried (Grains and Pasta)	wafers/cracker/cakes										
Plain pasta (Grains and Pasta)							1				
Wholemeal pasta (Grains and Pasta)							1				
Filled pasta (eg ravioli) (Grains and Pasta)		1	1				1				Can contain egg and milk depending on the flavour
Wheat noodles (Grains and Pasta)	Includes Asian style noodles, 2 minute noodles with/without flavour sachet						1	1			Flavours 621 includes soy
Egg noodles (Grains and Pasta)		1					1				
Other grain-based pasta e.g. buckwheat (Grains and Pasta)							1				
Wheat flour, white (Grains and Pasta)							1				
Wheat flour, wholemeal (Grains and Pasta)							1				
Oat flour (Grains and Pasta)											
Other flours (Grains and Pasta)	Rice, corn, rye, arrowroot, barley, etc.										
Wheat bran (Grains and Pasta)							1				
Oat bran (Grains and Pasta)											
Other brans (Grains and Pasta)										1	
Wheat germ (Grains and Pasta)							1				
Ground oats/oatmeal (Grains and Pasta)											
Rolled/flaked oats (Grains and Pasta)											
Whole oats (Grains and Pasta)											
Other grains and cereals (Grains and Pasta)	E.g., quinoa, buckwheat, cous cous, rye, millet, tapioca, polenta						1				
	Includes gluten-free										
White (Breads)							1	1			Common bread brands contain soy flour
Fibre white (Breads)							1	1			

Appendix 2. Allergen Questions from the Main Study Questionnaire

[allergen_foods]	Have you offered these foods to your baby? Please select all options that apply.	checkbox

1	allergen_foods___1	Egg (cooked)
2	allergen_foods___2	Dairy (e.g., milk, yoghurt, cheese)
3	allergen_foods___3	Peanut (including peanut butter)
4	allergen_foods___4	Tree nuts (e.g., almond, cashew, walnuts)
5	allergen_foods___5	Sesame (e.g., as seeds on top of some breads, in hummus, tahini)
6	allergen_foods___6	Wheat (e.g., breakfast cereal, pasta, flour, bread (excluding gluten-free))
7	allergen_foods___7	Soy (e.g., tofu, soy milk, soy sauce)
8	allergen_foods___8	Seafood (fish and shellfish)
9	allergen_foods___9	Bread (common commercial varieties, excluding soy-free bread)
10	allergen_foods___10	None of the above

[foods_avoiding1]	Have you, or do you plan to, avoid offering any foods to your baby in their first year of life?	yesno

1	Yes
0	No

[foods_avoiding]	Please comment:	notes

[allergies]	Does your baby have any known food allergies?	yesno 1 Yes 0 No
[allergies_food] Show the field ONLY if [allergies] = '1'	Please state which food(s):	text

[allergies_comments] Show the field ONLY if [allergies] = '1'	Comments (especially how these allergies were diagnosed)	notes

Appendix 3. Food Avoidance Coding

Example of how the 353 participants (rows) avoiding at least one food in their infants first year of life were coded into food avoidance groups. The foods were coded into 17 groups (columns) that were cow's milk, dairy, soy, peanuts, tree nuts, egg, fish and other seafood, wheat, honey, choking risk foods, sugar, salt, processed food, grains, animal products, other foods, avoiding due to allergy.

O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
foods_avoiding	foods_avoiding	avoiding_honey	avoiding_cowsmilk	avoiding_soy	avoiding_dairy	avoiding_peanuts	avoiding_egg	avoiding_treenuts	avoiding wheat	avoiding_fishandoth	avoiding_foodschok	avoiding_sugar	avoiding_salt	avoiding_processe
1	Avoid milk and hone	1	1	0	0	0	0	0	0	0	0	0	0	
1	nothing with added	0	0	0	0	0	0	0	0	0	0	1	1	
1	Avoiding wheat, dai	0	0	0	0	0	0	0	0	0	0	0	0	
1	probably avoid soy v	1	0	1	0	0	0	0	0	0	0	0	0	
1	yes, plan to avoid m	1	1	0	0	0	1	0	0	0	0	1	0	
1	Honey	1	0	0	0	0	0	0	0	0	0	0	0	
0														
1	Honey Whole milk (	1	1	0	0	0	0	0	0	0	0	0	0	
0														
1	i will avoid honey	1	0	0	0	0	0	0	0	0	0	0	0	
0														
0	I know it is important to offer the allergens early to avoid any intolerances													
0														
1	Honey and cow's mi	1	1	0	0	0	0	0	0	0	0	0	0	
0														
1	egg and dair throug	0	0	0	0	0	0	0	0	0	0	0	0	
0														
0	Not specifically avoid any foods, I would like him to sample as many foods as possible - including finding out any that may disagree with him so they can either be introduced very slowly or avoided													
1	Honey	1	0	0	0	0	0	0	0	0	0	0	0	
0														
1	Honey	1	0	0	0	0	0	0	0	0	0	0	0	
0	Honey not recomme	1	0	0	0	0	0	0	0	0	0	0	0	
1	Honey	1	0	0	0	0	0	0	0	0	0	0	0	
0														
0														
1	Popcorn, other food	1	0	0	0	0	0	0	0	0	1	0	0	
1	I don't offer other mi	0	1	1	0	0	0	0	0	0	0	0	0	
0														
1	Honey and Milk	1	1	0	0	0	0	0	0	0	0	0	0	
1	Ted has a dairy and	0	0	0	0	0	0	0	0	0	0	0	0	
0														
1	Just honey as instru	1	0	0	0	0	0	0	0	0	0	0	0	
1	Honey	1	0	0	0	0	0	0	0	0	0	0	0	
1	plan to avoid honey	1	0	0	0	0	0	0	0	0	0	0	0	
0	Believe that all foods can be safely prepared													
0														
1	nuts, eggs, dairy	0	0	0	0	0	0	0	0	0	0	0	0	
0														
1	We are now avoidin	0	0	0	0	0	0	0	0	0	0	0	0	
1	Just honey and dair	1	0	0	1	0	0	0	0	0	0	0	0	
0														
0														
1	Won't try honey and	1	0	0	0	0	0	0	0	0	0	0	0	
0	Coming from a teaching background I have had children come into the learning environment with allergies to food, but some of these seemed less drastic than we originally thought, i.e the parents had aversions to particular foods. I also do not believe in leaving foods out of children's diets													
1	honey and peanut b	1	0	0	0	1	0	0	0	0	0	0	0	