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Parent-reported offering of allergen foods to infants during complementary feeding: An observational study of New Zealand infants

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ABSTRACT

The prevalence of food allergies in New Zealand infants is uncertain but is believed to be similar to Australia, exceeding 10%. Current recommendations for reducing food allergy risk are to offer all major food allergens to infants from as early as six months of age (start of complementary feeding), and before 12 months of age. However, little is known regarding parental practices around introducing major food allergens. This study aimed to explore parental offering of major food allergens to infants during complementary feeding, and parent-reported food allergies. The cross-sectional study is a secondary analysis of the multi-centre (Auckland and Dunedin) First Foods New Zealand study of 625 parent-infant dyads. Participants were recruited in 2020–2022 when infants were 7–10 months of age. Questionnaires assessed sociodemographic characteristics, complementary feeding approach, infant pouch use and parental responses to five food allergy questions. All major food allergens had been offered to only 17% of infants by 9–10 months of age. Having offered egg, peanut, tree nuts, sesame, soy and seafood was more commonly associated with using a baby-led complementary feeding approach than a parent-led approach ($p < 0.001$). Frequent baby food pouch use was associated with a lower likelihood of offering egg and peanut (both $p < 0.001$). Overall, 12.6% of infants had a reported food allergy, with symptomatic response after exposure being the most common diagnostic tool. Most infants are not offered all major food allergens during early complementary feeding, with some parents actively avoiding major food allergens in the first year of life. These results provide up-to-date knowledge of parental practices, highlighting the need for more targeted advice and strategies to improve parental engagement with allergy prevention and diagnosis.

1. Introduction

International guidelines have been established for use by healthcare professionals and parents for the timely introduction of complementary foods to infants (at around 6 months of age), including recommendations of when to introduce major food allergens (i.e. dairy, egg, peanut, tree nuts, soy, fish, shellfish, sesame, and wheat) for the prevention of food allergies. In New Zealand, it is recommended that infants can be introduced to all major allergen foods at the start of complementary feeding (around 6 months) and that all food allergens should be given before 12 months of age. Moreover, once a major food allergen is well-tolerated, regular consumption (approximately twice weekly) is recommended to maintain tolerance, with continued breastfeeding alongside complementary feeding (Ministry of Health, 2021).

Over time, global recommendations and guidelines for introducing major food allergens to infants have evolved (Joshi et al., 2019). Initially, high-risk infants were advised to avoid major food allergens within the first year of life, but rising rates of food allergies prompted a reassessment of the recommendations (Prescott et al., 2013). There is now strong evidence that delaying the introduction of major food allergens can lead to a higher risk of immunoglobulin E (IgE) sensitisation

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Abbreviations

ASCIA	Australasian Society of Clinical Immunology and Allergy
BLW	Baby led weaning
FFNZ	First Foods New Zealand
FIA	Food induced anaphylaxis
IgE	Immunoglobulin E
SPSS	Statistical Package for the Social Sciences
TSF	Traditional spoon feeding
UK	United Kingdom
USA	United States of America

and food allergy development in infants (Du Toit et al., 2008; Koplin et al., 2010). Notably, early introduction of egg and peanut demonstrate the strongest evidence in reducing allergy risk (Scarpone et al., 2023). The current consensus of nutrition recommendations is that early introduction of all major food allergens is the most effective strategy for allergy prevention (McWilliam et al., 2022).

Monitoring adherence to these evolving recommendations is important. Studies in Australia have shown a 3-fold increase in the introduction of peanut by 12 months of age over the last decade (Soriano et al., 2019), indicating a positive uptake of current guidelines. Similarly, high rates of exposure to other major food allergens (egg, tree nuts, sesame) before 12 months have been observed (Netting et al., 2022). However, such trends in adherence are yet to be investigated in New Zealand.

The method of introducing complementary foods to infants has also shifted (Rowan & Brown, 2023), with an increasing number of parents adopting a baby-led approach, where infants self-feed finger foods from the start of complementary feeding (Rapley & Murkett, 2008), differing from a more traditional spoon-feeding approach where finger foods are included, but later and less frequently. Despite the popularity of the baby-led approach in New Zealand (Fu et al., 2018), its impact on the introduction of major allergen foods to infants is unknown. Additionally, the use of baby food pouches has surged in popularity (Finn et al., 2020; Katiforis et al., 2021), offering convenience for parents (ABC Packaging Direct: Baby food, 2017). Their predominantly fruit and vegetable content may impact the introduction of major food allergens (Netting et al., 2020), but further investigation is required in New Zealand.

The prevalence of food allergies in New Zealand infants is assumed to be similar to that in Australia, where more than 10% of infants have been diagnosed with IgE-mediated food allergies (Osborne et al., 2011). This prevalence is consistent with recent data on parent-reported food allergies in Australian infants (Netting et al., 2022b; O'Sullivan et al., 2020). In New Zealand, although infant food-induced anaphylaxis hospital admissions and adverse food reactions have been investigated (Crooks et al., 2010; Speakman et al., 2018), the overall prevalence of infant food allergies is unknown.

Accurate diagnosis of food allergies requires a qualified healthcare professional (Australasian Society of Clinical Immunology and Allergy [ASCIA], 2022). Diagnostic tests such as blood tests and skin prick tests may be used to confirm an food allergy after a healthcare professional has completed an appropriate assessment. Oral food challenges may also be performed to confirm or rule out food allergies. Over-reporting of infant food allergies by parents (Elghoudi & Narchi, 2022) underscores the need for professional assessment to prevent unnecessary dietary restrictions and alleviate parental stress associated with unconfirmed food allergies.

This study aims to explore parental offering of major food allergens to infants during complementary feeding and parent-reported food allergies. The specific objectives are to: 1) describe the parent-reported offering of major food allergens during the complementary feeding period in infants aged 7–10 months; 2) describe the avoidance of any foods in the first year of life; and 3) describe the parent-reported prevalence of food allergies (and how they were diagnosed) in infants 7–10 months of age.

2. Methods

2.1. Study design

This is a secondary analysis of a cross-sectional study of infants and caregivers in the multi-centre (Auckland and Dunedin) First Foods New Zealand (FFNZ) study. 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 in general and those who are using baby food pouches or baby-led weaning compared with those who are not" (Taylor et al., 2021). A protocol describing the methods of the FFNZ study has previously been published (Taylor et al., 2021). Therefore, only methods relevant to this secondary analysis will be described here.

2.2. Participants and recruitment

The FFNZ study aimed to recruit 625 participants (caregiver and infant pairs) between July 2020 and February 2022. Eligiblity criteria included living in the regions of Auckland or Dunedin (main urban centres in New Zealand), and caregivers being aged 16 years or older and able to communicate in English. The infants were to be aged between 7 and 10 months at the time of participation. Participants were excluded if they had recently participated in a nutrition intervention study, as this may have impacted the infant's feeding. Recruitment was completed through word of mouth and advertisement, such as on Facebook and Community Hubs. Written informed consent was obtained at the first study visit before participation. Ethical approval was obtained from the Health and Disability Ethics Committees New Zealand (19/STH/151) and the study was registered with the Australian New Zealand Clinical Trials Registry (registration number: ACTRN12620000459921).

2.2.1. Demographic data

The main study questionnaire collected information including age of the infant and their primary caregiver, ethnicity of the infant and their caregiver, whether they were the primary caregiver, caregivers' relationship to the infant (i.e., mother, father, grandparent, guardian or other), caregiver's education level and current employment, parity, whether the infant was born at term, the age when starting solid foods, current breastfeeding status, duration of exclusive breastfeeding, and day-care attendance. The term "parent/s" is used in this paper to describe the main caregivers. Participants could identify with more than one ethnic group, so prioritised ethnicity was used for data analysis in the following order: Māori, Pacific, Asian, Others, New Zealand European (Ministry of Health, 2008). Area level deprivation was estimated from the participant's home address using the NZDep2018 index of deprivation, which is split by deciles to give ten ordered groups from one (lowest level of deprivation) to ten (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.

2.2.2. Allergy data

The main questionnaire was completed during a study visit, which was usually carried out in the home. The questionnaire contained questions about the infant and their food intake, including offering of allergenic foods. The questions were not formally pre-tested but were completed by members of the research team with young infants to check for comprehension. The specific questions were: 1) "Have you offered

these foods to your baby? Please select all options that apply (egg, dairy, peanut, tree nuts, sesame, wheat, soy, seafood, bread)"; 2) "Have you, or do you plan to, avoid offering any foods to your baby in their first year of life?"; 3) "Does your baby have any known food allergies? Please state which food(s)"; and 4) Comments (referring to how these allergies were diagnosed). Supplementary Table 1 displays the full questions. Bread is a commonly consumed food in New Zealand, with the majority of commercial varieties containing soy flour. 'Bread' and 'soy' were collapsed for analysis to create an overall 'soy' variable.

The open-ended responses to the avoidance of foods question were coded into subjective categories: major allergenic foods (i.e. cow's milk, dairy, soy, peanut, tree nuts, egg, fish and shellfish, and wheat), nutrition guidelines (foods which are recommended to be avoided during the first year of life as part of the Ministry of Health "Healthy Eating Guidelines for New Zealand Babies and Toddlers (0–2 years old)" i.e. honey, choking risk foods, sugar, salt, and processed foods) (Ministry of Health, 2021), other foods (i.e. grains, animal products, other food), and personal allergenic food (i.e. those avoiding a food due to a confirmed food allergy).

Parents reported whether their baby had a known food allergy. Open-ended responses to how the food allergy was diagnosed were categorised into different diagnostic approaches: symptom (symptom displayed upon consumption of the allergenic food), health professional (food allergy diagnosis from a health professional), blood test (blood test confirmation of a food allergy), and skin prick test (skin prick test confirmation of a food allergy) and were recorded for each food allergy if multiple food allergies were present. All open-ended questions were coded based on the participants responses by a member of the research team and checked for relevance and accuracy by a senior researcher member.

2.2.3. Complementary feeding approach

The main questionnaire was also used to determine the complementary feeding approach used, described in detail in Cox et al. (2024). Baby-Led Weaning (BLW) (5 answer options) and baby food pouch use (9 answer options) was determined from two questions as follows: 'Partial BLW' was determined by parents selecting "about half spoon feeding by an adult and half baby feeding themselves". 'Full BLW' was determined by parents selecting "mostly baby feeding themselves, some spoon feeding by an adult" or "baby feeding themselves". 'Spoon feeding' was determined by parents selecting "spoon fed by an adult" or "mostly spoon fed by an adult, some baby feeding themselves". 'Frequent baby food pouch users' were defined as parents stating they were offering baby food pouches to their infant "more than once a day", "once a day", or "5 to 6 times a week" in the last month. 'Less-frequent or non-baby food pouch users' were those who responded to the same question with "never", "less than once a month", "once a month", "2–3 times a month", "once a week", or "2–4 times a week".

2.3. Statistical analysis

Data were analysed using SPSS (IBM) version 29, and Stata 17.0 (StataCorp), with the statistical significance level considered to be $p \leq 0.05$. Demographic characteristics were presented as numbers of participants and percentages. Logistic regression was used to generate p-values to assess associations between complementary feeding approaches (Traditional Spoon Feeding (TSF), partial BLW, full BLW) and the offering of major food allergens, with adjustment for age. Offering of each food allergen was the outcome variable, dichotomized by whether they had been offered it (=1) or not (=0), and models were run separately for each food allergen. Pearson chi-square tests were used to assess frequent baby food pouch use (≥5 times a week, or not) and the offering of egg and peanut (two of the major food allergens with the strongest risk reduction with early introduction). Pearson chi-square tests were also performed to assess whether there were significant associations between the demographic factors described in Section 2.3.1 (and Table 1) and food avoidance in the first year of life.

3. Results

3.1. Participants

The flow of participants through the study is shown in Fig. 1, with the final number of infants included being n = 625.

Demographic characteristics are shown in Table 1. Primary caregivers were predominately mothers (98.7%), with a mean (SD) age of 32.7 (4.9) years. 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%). Solid food introduction began at a mean (SD) age of 5.2 months (0.9), with over half of the infants (66.2%) being currently breastfed.

3.2. Parental offering of major food allergens

Table 2 highlights the major food allergens offered to each age group (one-month increments) between 7 and 10 months of age. Egg was

Table 1
Demographic characteristics of infants and caregivers (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).

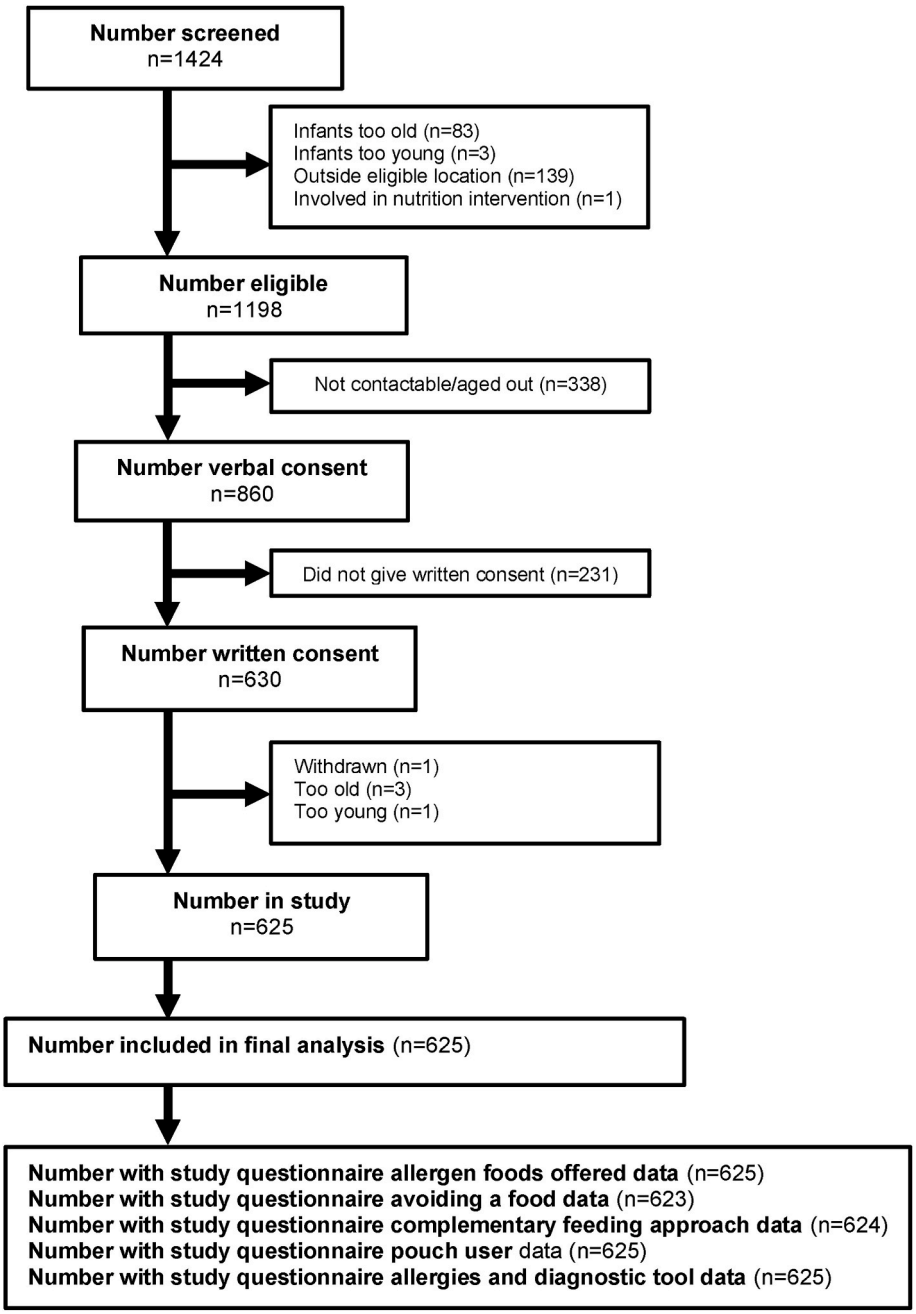

Fig. 1. First Foods New Zealand study screening, consent and inclusion pathway.

offered to 76.2% and peanut was offered to 55.8% of infants by 7–10 months of age. Dairy was the most common major food allergen offered to infants by 7–10 months of age (78.6%). Tree nuts were the least common of the major allergens to have been offered by all three age groups: 7 to <8 months (10.4%), 8 to <9 months (22.9%) and 9–10 months (32.0%). All infants aged between 9 and 10 months had been offered at least one major food allergen.

The prevalence of parents having offered all major food allergens to their infants was 2.9% by 7 to <8 months, 10.4% by 8 to <9 months, and 17.0% by 9–10 months. Overall, 9.1% of infants had been offered all major food allergens by the time they took part in the study at age 7–10 months. In total, 8.7% of infants by 7 to <8 months had never been offered any of the major food allergens. This decreased to 1.3% of infants by 8 to <9 months; and by 9–10 months, all infants had been offered at least one major food allergen.

3.3. Parental offering of major food allergens by complementary feeding approach

Differences in parental offering of major food allergens by complementary feeding approach (TSF, partial BLW and BLW) are presented in Table 3. For all allergens except dairy and wheat, infants following BLW (partial or full) were more likely to have been offered the allergenic food than those following TSF ($p < 0.001$).

Supplementary Table 2 shows the major food allergens offered to each age group by 7–10 months (1-month increments) by complementary feeding approach.

3.4. Parental offering of egg and peanut in baby food pouch users

There were 174 infants who consumed baby food pouches ≥5 times a week (defined as 'frequent pouch users'). 'Frequent pouch users' were

Table 2
Parental offering of major food allergens to infant participants between 7 and 10 months of age.

Major Food Allergens Offered	7 to <8 months n (%)	8 to <9 months n (%)	9–10 months n (%)	Total n (%)
n	241	231	153	625
Egg[a]	142 (58.9)	197 (85.3)	137 (89.5)	476 (76.2)
Peanut[b]	102 (42.3)	144 (62.3)	103 (67.3)	349 (55.8)
Dairy[c]	159 (66.0)	196 (84.9)	136 (88.9)	491 (78.6)
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] Peanut (including peanut butter).
[c] Dairy (e.g., milk, yoghurt, cheese).
[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).

Table 3
Parental offering of major food allergens by complementary feeding approach (traditional spoon feeding or baby-led weaning) (n = 624).

Major Food Allergens	TSF (n = 304)	Partial BLW (n = 153)	BLW (n = 167)	P value[b]
	Offered n (%)[a]	Offered n (%)[a]	Offered n (%)[a]	
Egg	199 (65.5)	128 (16.3)	148 (88.6)	<0.001
Peanut	126 (41.5)	105 (68.6)	118 (70.7)	<0.001
Dairy	219 (72.0)	129 (84.3)	142 (85.0)	0.632
Tree nuts	29 (9.5)	37 (24.2)	61 (36.5)	<0.001
Sesame	42 (13.8)	63 (41.2)	83 (49.7)	<0.001
Wheat	205 (67.4)	133 (86.9)	150 (89.8)	0.644
Soy	44 (14.5)	46 (30.1)	72 (43.1)	<0.001
Seafood	140 (46.1)	93 (60.8)	116 (69.5)	<0.001

Abbreviation: TSF – traditional spoon feeding; BLW – baby-led weaning.
Missing data (n = 1).
[a] Percentages represent the percentage of each feeding approach group that consumed the major food allergen.
[b] p-value calculated from a logistic regression model with adjustment for age group.

less likely to be offered egg than 'less-frequent pouch users' (63.8% compared with 80.9%, respectively; $p < 0.001$). 'Frequent pouch users' were also less likely to be offered peanut than 'less-frequent pouch users' (42.0% compared with 61.2%, respectively; $p < 0.001$) (data not shown).

3.5. Food avoidance in the Infant's first year of life

Table 4 displays the foods that parents planned to avoid offering their infant in the first year of life. Over half of 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%).

Parental ethnicity was significantly associated ($p < 0.001$) with whether the parent planned to avoid a food in the infant's first year (data not shown). Parents identifying as New Zealand European and "other" ethnicites were more likely to plan to avoid offering a food in the infants first year of life than not. Whereas parents identifying as Māori, Pacific and Asian were more likely not to be planning to avoid offering any food in the infant's first year of life.

Table 4
Parent-reported planned food avoidance in the first year of life (n = 623).

Foods Avoided	Yes n (%)[a]
Total[b]	353 (56.7)
Food allergens	
Cow's milk[c]	67 (19.0)
Dairy[d]	18 (5.1)
Soy	5 (1.4)
Peanut[e]	29 (8.2)
Tree nuts	17 (4.8)
Egg	14 (4.0)
Fish and shellfish[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, cow's milk as a drink (n = 8).
[d] Includes dairy other than cow's milk; yoghurt, icecream, cheese, vegan diet.
[e] Includes peanut butter.
[f] Includes raw fish, shrimp, prawn, shellfish, vegan diet, vegetarian diet, 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 (Ministry of Health, 2021).
[i] Includes refined sugar, sweet foods, added sugar, sweet drinks, biscuit, cake, sugary food, chocolate, ice cream, tomato sauce, fizzy drink, commercial sugar, fruit juice, sauces, candy, baked items, lollies.
[j] Includes added salt, food high in salt, chips.
[k] Includes takeaways/fast food, processed meat, 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, mushroom, pepper, adult snacks, drinks other than water or breast milk or infant formula or milk.
[o] Avoiding a food due to infant food allergy.

3.6. Prevalence of infant food allergies, and the diagnostic tool used to identify the allergy

The prevalence of parent-reported infant food allergies and the diagnostic tool used to identify the food allergy are reported in Table 5. A total of 12.6% of infants were reported to have a food allergy, with cow's milk allergy the most common (51.9%), followed by egg (46.8%).

Table 5
Parent-reported infant food allergies and their diagnostic identification tool (n = 625).

Prevalence n (%)		Diagnostic Tool[a,b]			
Total[c]	79 (12.6)	Symptom[d]	Health Professional[e]	Blood Test	Skin Prick Test
Food Allergy					
Wheat[f]	4 (5.1)	4	0	1	1
Cow's milk[g]	41 (51.9)	40	18	1	4
Egg[h]	37 (46.8)	34	12	2	5
Soy	9 (11.4)	9	7	0	1
Peanut	12 (15.2)	9	6	1	5
Tree nuts	4 (5.1)	4	1	1	1
Fish and shellfish[i]	3 (3.8)	3	0	0	0
Other[j]	11 (13.9)	11	5	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, oat, rice, apple.

A symptomatic response after exposure to the food was the diagnostic tool most commonly reported by parents for infant allergies to wheat, soy, tree nuts, fish and shellfish, and other foods. Half (n = 61/121, 50%) of the individual reported food allergies were determined by parental symptom report only and not confirmed by diagnosis from a health professional or allergy testing (blood or skin prick). Of the major food allergens diagnosed by a health professional, cow's milk allergy was the most common, followed by egg.

4. Discussion

This secondary analysis reports that most infants in the FFNZ study (aged 7–10 months) had not been offered all major food allergens during the early complementary feeding period (only 17% of infants by 9–10 months), with some parents planning to avoid major food allergens in their infant's first year of life. Interestingly, the complementary feeding approach chosen (TSF and BLW) was associated with whether major food allergens: egg, peanut, tree nuts, sesame, soy and seafood, were offered to the infant. Similarly, frequent baby food pouch use was associated with a lower likelihood of offering major food allergens of egg and peanut. In this study, 12.6% of infants had a parent-reported food allergy, with a symptomatic response after exposure being the most common diagnostic tool and only half of these symptomatic allergies were formally diagnosed.

In this study, parental offering of dairy, wheat, egg and soy between 7 and 10 months of age was more common (78.6%, 78.2%, 76.2%, and 75.8%, respectively) than offering peanut, seafood, sesame and tree nuts (55.8%, 55.5%, 30.1% and 20.3%, respectively). Importantly, only 17% of infants were introduced to all major food allergens by 9–10 months of age. By contrast, it was found that nearly all infants were introduced to major food allergens by 12 months in Australia, with text message reminders to include peanut, egg and wheat in their infant's diet not influencing introduction (Netting et al., 2022a). In Australian infants, the introduction of peanut is reported to be between 86% and 94% by 12 months of age (Netting et al., 2022b; O'Sullivan et al., 2020; Soriano et al., 2019). This is higher than our present study findings of 67% of infants offered peanut by 9–10 months, although this may be in part due to our infants being younger than 12 months old. Despite this, it suggests that Australian infants are introduced to major food allergens, particularly peanut, earlier than New Zealand infants, highlighting potentially improved communication and adherence to the guidelines for allergy prevention in Australia. This better adherence may be due to the development of programs in Australia, such as SmartStartAllergy, for use in the primary care setting to help promote and monitor the uptake of allergy prevention guidelines (Vale et al., 2022, 2023). Similar programmes are not currently available in New Zealand, where, parents predominantly receive support on introducing solids and complementary feeding as part of their free 'Well Child' health visits ('Well Child / Tamariki Ora') (Health New Zealand, 2024). However, it is not currently known whether all 'Well Child' providers in New Zealand educate families on introducing common allergen foods as per the guidelines (Ministry of Health, 2021).

A significant association was found in this study between the complementary feeding approach (TSF, partial BLW and BLW) and the offering of egg, peanut, tree nuts, sesame, soy and seafood. A study in the United Kingdom (UK) by Rowan and Brown (2023) between 2015 and 2018 also found a significant association between the complementary feeding approach and the offering of egg ($p < 0.001$), but no other major food allergens were investigated. Infants who were fed via BLW were twice as likely to be offered egg at 6–8 months and were offered egg and egg dishes more frequently than those following TSF. These findings are comparable to our results, where 62% of BLW infants were offered egg compared to 30% of TSF infants by 7–8 months of age. Therefore, BLW may be an approach which improves the offering these allergen foods in age appropriate forms (e.g., strips of omelette, thin spread of peanut butter on a toast strip).

We also found significant associations between offering egg and peanut and the frequency of baby food pouch use. Overall, 44% and 35% of 'frequent-pouch users' were offered egg and peanut, respectively, compared to 56% and 53% of 'less-frequent pouch users'. These differences highlight that the consumption of baby food pouches may impact on the offering of major allergen foods to infants. Parents may be unknowingly avoiding offering major allergens if they are frequently using baby food pouches as many do not contain major food allergens. Alternatively, parents may be choosing to use baby food pouches if their infant has a known food allergy, or is considered to be at increased risk of allergy, as a safe food for their baby. In this study, major food allergens egg and peanut were assessed to determine associations with baby food pouch use, this was due to the strong evidence for early introduction of these particular food allergens in reducing the risk of allergy (Scarpone et al., 2023). A recent Swedish study by Fredriksson et al. (2023) found no association between fruit pouch consumption and the development of food allergies. However, the aim of their study was to explore whether high consumption of specifically baby fruit pouches damages the lining of the gastrointestinal tract and if this increased food allergy development. Therefore, further studies are required to determine whether the use of baby food pouches is associated with food allergies in infants.

In the current study, 57% of 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%). This finding was somewhat expected as the Ministry of Health "Healthy Eating Guidelines for New Zealand Babies and Toddlers (0–2 years old)" advise to avoid honey in the first year of life, for food safety rather than allergy reasons (Ministry of Health, 2021). Cow's milk was the most common major food allergen being avoided (19%). It is likely this has captured both parents who are avoiding offering cow's milk as a drink (New Zealand guidelines recommend avoiding cow's milk as a main drink in the first

year of life (Ministry of Health, 2021)), but also those avoiding cow's milk because it is a major allergen (due to concern of an adverse reaction occurring). Parental concern around food allergies has been reported in a Norwegian study by Fagerlund et al. (2019), where 34% of parents feared allergy or hypersensitivity, resulting in avoidance of introduction of some foods to their infant. 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 some 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. Parents identifying as New Zealand Euopean were more likely to plan to avoid offering a food in the infants first year of life, whereas parents identifying as Māori, Pacific or Asian were more likely to plan to not avoid offering a food in the infants first year of life. Varying cultural practices may influence the introduction of foods into the infant's diet, and it is possible that certain ethnic groups may be more aware of recommendations for early introduction of allergen foods. Future studies should investigate this further to support targeted advice, where appropriate.

In this study, the prevalence of parent-reported infant food allergies was 12.6%. This figure is considerably lower than that reported previously where it was found that the prevalence of adverse reactions to foods was 40% in 0-5-year-olds in New Zealand (Crooks et al., 2010). However, the study by Crooks et al. (2010) included a wide age range of young children (0–5 years). The method of classifying food allergies also differs to adverse food reactions and therefore assessing adverse reactions to foods may not be as accurate as specifying food allergies. A New Zealand study by Speakman et al. (2018) investigated food induced anaphylaxis (FIA) hospital presentations over a 10 year period in infants and children aged 0–14 years. That study found an overall 2.8 fold increase in the annualised rate of FIA child hospital admissions, with the highest annualised rate among infants aged 0–2 years (50.5/100 000 children). These data were based on FIA hospital admissions which does not reflect all food allergy cases in New Zealand infants, as mild reactions may not result in a hospital admission. Thus, the current study adds additional data regarding the overall prevalence of food allergies in New Zealand infants.

Our findings are broadly comparable to those reported in Australia, where more than 10% of infants had a challenge-proven food allergy (Osborne et al., 2011). As our study was not challenge-proven, direct comparisons 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. In our study we found that cow's milk (including dairy products) and egg allergies were the most common food allergies. This is consistent with the Australian study by O'Sullivan et al. (2020), reporting that egg and dairy were the most common food allergens causing adverse food reactions. 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 that food allergy prevalence can be compared and monitored over time.

In the current study, 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 shellfish, and other foods. Additionally, some of the symptoms cited by parents were unspecific to allergy and subjective. By contrast, fewer parents reported the completion of a skin prick test or blood test. These findings highlight that advice to see a healthcare professional, followed by evidence-based testing (skin prick test and/or blood test) if an allergy is suspected, is not followed by all parents (ASCIA, 2022). However, some infants in the current study were only 7 months of age; therefore, if they only had one recent exposure to a major food allergen followed by symptoms, they may not have had an opportunity to be followed up by a healthcare professional before their participation in the current study.

The prevalence of use of each individual diagnostic tool could not be determined from the study, as some infants had multiple food allergies with differing diagnostic tools reported. However, the large number of parents reporting a symptomatic response compared to the number who received a diagnosis from a healthcare professional is similar to an earlier New Zealand study of children aged 0–5 years (Crooks et al., 2010). Crooks et al. (2010) reported that of the young children with parent-reported adverse reaction to a food, 91% were not investigated by a healthcare professional. This is of concern because if food allergies are not appropriately investigated, it is unlikely that accurate advice for management will be provided, which may increase the risk of future adverse reactions occurring. There is also an increased risk of nutrient deficiencies occurring with unnecessary food restrictions. It is important that if major food allergens are excluded from the infant's diet that parents are informed of appropriate substitutions to ensure the replacement of nutrients for the prevention of 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 healthcare 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's or child's age or the reliability of the tests affecting healthcare professionals' decisions (Foong & Santos, 2021).

4.1. Strengths and limitations

A strength of this study was the substantial sample size of 625 participants who represented diverse ethnic backgrounds and household 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, which is important for determining whether further advice is required for parents in this critical period of allergy prevention.

A limitation of this study was the cross-sectional study design, which investigated infants at ages 7–10 months, therefore it is unknown the extent of offering common allergens between the 10–12 month period. The nature of parent-reported data in this study may have resulted in misinterpretation. Some questions, including that around the introduction of major food allergens offered to the infant, 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. Therefore, other adverse reactions to foods were included within the prevalence of food allergies. As these findings relate to New Zealand parents, they may not be generalizable to other countries, although it is possible that infant feeding patterns in New Zealand are similar to other high income countries.

This study was unable to investigate the ongoing frequency of offering major food allergens to infants. Therefore, future work should investigate the full early complementary feeding period (6–12 months) and continued exposure to allergen foods in early infancy, in line with national recommendations, among all young New Zealand children.

5. Conclusion

Most infants are not offered all major food allergens during early

complementary feeding in New Zealand. In fact, only 17% of infants by 9–10 months of age had been offered all major food allergens, with some parents actively avoiding major food allergens in the first year of life. In total, 12.6% of infants had a parent-reported food allergy. A symptomatic response after exposure was the most common diagnostic tool reported and only half of these were confirmed by diagnosis (health professional or allergy testing). Thus, this research highlights the need for more targeted strategies to communicate the current food allergy prevention guidelines to parents during the early complementary feeding period.

CRediT authorship contribution statement

Jade M. Medemblik: Writing – review & editing, Writing – original draft, Investigation, Formal analysis. **Cathryn A. Conlon:** Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization. **Jillian J. Haszard:** Writing – review & editing, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Anne-Louise M. Heath:** Writing – review & editing, Methodology, Investigation, Funding acquisition, Conceptualization. **Rachael W. Taylor:** Writing – review & editing, Methodology, Investigation, Funding acquisition, Conceptualization. **Pamela von Hurst:** Writing – review & editing, Methodology, Investigation, Funding acquisition, Conceptualization. **Kathryn L. Beck:** Writing – review & editing, Methodology, Investigation, Funding acquisition, Conceptualization. **Lisa Te Morenga:** Writing – review & editing, Methodology, Investigation, Funding acquisition, Conceptualization. **Lisa Daniels:** Writing – review & editing, Supervision, Methodology, Investigation, Conceptualization.

Data sharing

The data used in the present study are not publicly available due to ethical restrictions related to the consent provided by participants. An ethically compliant dataset may be made available by the corresponding author upon reasonable request and upon approval by the Health and Disability Ethics Committees New Zealand.

Ethical statement

Written informed consent was obtained at the first study visit before participation. Ethical approval was obtained from the Health and Disability Ethics Committees New Zealand (19/STH/151) and the study was registered with the Australian New Zealand Clinical Trials Registry (registration number: ACTRN12620000459921).

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Declaration of competing interest

The authors declare no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2024.107709.

Data availability

Data will be made available on request.

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