


Household food insecurity and novel complementary feeding methods in New Zealand families

Ioanna Katiforis¹ | Claire Smith¹ | Jillian J. Haszard² | Sara E. Styles¹ |
 Claudia Leong³ | Rachael W. Taylor⁴ | Cathryn A. Conlon⁵ | Kathryn L. Beck⁵ |
 Pamela R. von Hurst⁵ | Lisa A. Te Morenga⁶ | Lisa Daniels⁴ |
 Kimberley J. Brown⁵ | Madeleine Rowan¹ | Maria Casale⁵ | Neve H. McLean¹ |
 Alice M. Cox⁴ | Emily A. Jones⁵ | Bailey R. Bruckner¹ | Rosario Jupiterwala⁵ |
 Andrea Wei⁵ | Anne-Louise M. Heath¹ 

¹Department of Human Nutrition, University of Otago, Dunedin, New Zealand

²Biostatistics Centre, University of Otago, Dunedin, New Zealand

³Department of Applied Science and Social Practice, Ara Institute of Canterbury, Christchurch, New Zealand

⁴Department of Medicine, University of Otago, Dunedin, New Zealand

⁵School of Sport, Exercise and Nutrition, Massey University, Auckland, New Zealand

⁶Research Centre for Hauora and Health, Massey University, Wellington, New Zealand

Correspondence

Claire Smith, Department of Human Nutrition, University of Otago, Dunedin 9054, New Zealand.

Email: claire.smith@otago.ac.nz

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Abstract

Optimal nutrition during infancy is critical given its influence on lifelong health and wellbeing. Two novel methods of infant complementary feeding, commercial baby food pouch use and baby-led weaning (BLW), are becoming increasingly popular worldwide. Household food insecurity may influence complementary feeding practices adopted by families, but no studies have investigated the use of BLW and baby food pouches in families experiencing food insecurity. The First Foods New Zealand study was a multicentre, observational study in infants 7.0–9.9 months of age. Households ($n = 604$) were classified into one of three categories of food insecurity (severely food insecure, moderately food insecure, and food secure). The use of complementary feeding practices was assessed via a self-administered questionnaire, both at the current age (mean 8.4 months) and retrospectively at 6 months. Mothers experiencing severe food insecurity had 5.70 times the odds of currently using commercial baby food pouches frequently (≥ 5 times/week) compared to food secure mothers (95% CI [1.54, 21.01]), reporting that pouches were 'easy to use' (89%) and made it 'easy to get fruits and vegetables in' (64%). In contrast, no evidence of a difference in the prevalence of current BLW was observed among mothers experiencing moderate food insecurity (adjusted OR; 1.28, 95% CI [0.73, 2.24]) or severe food insecurity (adjusted OR; 1.03, 95% CI [0.44, 2.43]) compared to food secure mothers. The high prevalence of frequent commercial baby food pouch use in food insecure households underscores the need for research to determine whether frequent pouch use impacts infant health.

KEYWORDS

baby-led weaning, commercial baby food pouches, complementary feeding, families, household food insecurity, infants, New Zealand

Rachael W. Taylor and Anne-Louise M. Heath are joint principal investigators.

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1 | INTRODUCTION

Household food insecurity is defined as a 'limited or uncertain availability of nutritionally adequate and safe foods or limited ability to acquire acceptable foods in a socially acceptable way' (Anderson, 1990). It is a serious public health problem with potential wide-ranging impacts on children including poorer diet quality (Hanson & Connor, 2014; Hutchinson & Tarasuk, 2022), delays in child development, behavioural and emotional problems, and negative impacts on academic performance (Gallegos et al., 2021; Rose-Jacobs et al., 2008; Shankar et al., 2017). In 2015/16, 17% of New Zealand young children from 0 to 4 years of age lived in moderately to severely food insecure households (Ministry of Health, 2019), while other high-income countries, including the United Kingdom (UK) (20%) (The Food Foundation, 2024) and the United States of America (US) (17%) (USDA, 2023) also experience concerning levels of food insecurity in households with children. The global economic crisis triggered by the COVID-19 pandemic (World Bank, 2022) means that the prevalence of food insecurity in households with young children may now be even higher in New Zealand.

Infants living in food insecure households are of particular concern because adequate nutrition during infancy is critical to support the rapid growth and development taking place during this period (Schwarzenberg et al., 2018; WHO, 2023). Complementary feeding is the process of introducing solid foods to complement the infant's milk-based diet, beginning at approximately 6 months of age (Ministry of Health, 2021; WHO, 2023). Complementary foods packaged in single-use, squeezable pouches with plastic nozzles were introduced to the commercial infant food market only a decade ago, but have since become the predominant format for commercial infant foods in many countries (Beauregard et al., 2019; Garcia et al., 2020; Katiforis et al., 2021; Moumin et al., 2020). Although commercial infant foods have been available for many years, the use of baby food pouches in particular is controversial, with concerns expressed by expert groups and health professionals (Crawley & Westwood, 2017; Koletzko et al., 2019; Sundborn et al., 2017) about potential impacts on infant nutrition and health, including their low iron and high sugars content (Brunacci et al., 2023; Katiforis et al., 2021).

With a long shelf-life, ready-to-eat food spanning a variety of flavours, and lightweight packaging that is easily transportable outside the home (Crawley & Westwood, 2019; Theurich, 2018), pouches have several features that could be particularly attractive to families experiencing food insecurity. However, no studies have investigated the use of commercial baby food pouches in food insecure households.

Another increasingly popular method of complementary feeding in high-income countries is baby-led weaning (BLW) (Brown et al., 2017; Fu et al., 2018). This approach encourages infants to select and feed themselves age-appropriate finger

Key messages

- Commercial baby food pouches are a popular method of complementary feeding among food insecure households, with almost two-thirds of mothers who were experiencing food insecurity using pouches frequently.
- Mothers in food insecure households who used pouches frequently reported using pouches primarily for reasons of convenience and because they considered them to be nutritious.
- Research investigating the impact of frequent pouch use on infant nutrient intake and health is needed to inform advice given to families by health professionals.

foods, in place of the traditional method of adult spoon feeding of puréed foods (Rapley, 2011). Although BLW has some purported benefits (Cox et al., 2024), it is not yet recommended as an alternative complementary feeding approach for New Zealand infants, due to potential safety concerns (Ministry of Health, 2021). Certainly, the nutritional impacts of BLW in low-income households may depend on the nutritional quality of the family diet. The use of BLW in food insecure households has not been investigated to date; however, observational studies have reported associations with higher levels of maternal education and higher socioeconomic status (Brown & Lee, 2011; Pérez-Ríos et al., 2020), which suggests that food insecurity may be inversely associated with BLW.

With the increasing popularity of pouches and BLW, alongside growing concerns about their use, it is important to investigate the use of these practices in families experiencing food insecurity. Therefore, the aim of this study was to investigate associations between household food insecurity and both commercial baby food pouch use and BLW.

2 | METHODS

2.1 | Study design

Data for this study were obtained from the First Foods New Zealand (FFNZ) study, for which this analysis was a secondary outcome. The FFNZ study was a cross-sectional study investigating infant feeding, nutrition and health in 625 infants from 7.0 to 9.9 months of age in New Zealand. The sample size was based on the number of participants required for the primary outcomes of the FFNZ study (Taylor et al., 2021). Ethical approval for FFNZ was granted by the Health and Disability Ethics Committees New Zealand (19/STH/151). The study is registered with the Australian New Zealand Clinical Trials Registry (registration number:

ACTRN12620000459921). Detailed methods for the FFNZ study are available in a protocol paper (Taylor et al., 2021), therefore, only methods relevant to this study are described here.

2.2 | Participant recruitment and eligibility

Caregiver-infant dyads were recruited between July 2020 and February 2022. Recruitment was done via word-of-mouth, advertisements on social media, and posters and flyers distributed to community hubs commonly frequented by families with infants. Recruitment materials did not refer to specific complementary feeding methods or food insecurity. To recruit a similar proportion of families from high socioeconomic deprivation areas to that in the New Zealand population (Daniels et al., 2023), recruitment drives via community centres and regular advertising were undertaken in these areas.

To be eligible to participate, caregivers were required to be at least 16 years of age, live in the Auckland or Dunedin regions (main cities in the North and South Islands of New Zealand), and the infant needed to be 7.0–9.9 months of age at the time of the first appointment. In addition, the infant was not eligible if they had recently taken part in a nutrition intervention study that involved changes to how the infant was fed, and caregivers needed to be able to communicate in English. The recruitment period coincided with intermittent COVID-19-related public health orders. Participants attended 3–5 appointments over a 2-week period following recruitment and received a NZD\$150 supermarket gift voucher for taking part in the study.

Written informed consent was obtained from all adult participants (for themselves and the infant) at the first appointment.

2.3 | Data collection

REDCap electronic data capture tools hosted at the University of Otago were used to collect and manage study data (Harris et al., 2009, 2019). All data reported in this study were collected at the first appointment, which was usually held in the participant's home. Data were collected via self-administered (for demographic and infant feeding characteristics, and complementary feeding practices) and interviewer-administered (for household food insecurity) questionnaires.

2.3.1 | Demographic and infant feeding characteristics

For the infant, the following data were collected: age, sex, ethnicity and gestational status. If participants identified themselves, or their infant, as having two or more ethnicities, ethnicity was categorised into one ethnic group using the following order aligned with New Zealand Census categories: Māori, Pacific,

Asian, New Zealand and other European, Other (Statistics New Zealand, 2018b).

For the adult caregiver, the following demographic data were collected: age, relation to infant, ethnicity (as above), highest level of education, employment status and maternal parity (if the adult participant was the mother of the infant).

To describe participants' households, the following data were collected: childcare outside the home (yes/no) and number of adults and children in the household. Socioeconomic deprivation was determined using the participant's home address and described using the New Zealand Index of Deprivation 2018 deciles (Atkinson et al., 2019). The index combines nine variables from the 2018 New Zealand Census to generate an area-level socioeconomic deprivation score which reflects the extent of material and social deprivation in the area, and is used to construct deciles from 1 (low deprivation) to 10 (high deprivation) (Atkinson et al., 2019).

Duration of exclusive breastfeeding was determined using questions with monthly response option categories to assess the age at which a food or drink other than breast milk was introduced. Exclusive breastfeeding to 'around 6 months of age' (Ministry of Health, 2021) was defined as 'Yes' if the duration of exclusive breastfeeding was ≥ 5 months of age, and 'No' if the duration was < 5 months of age, or ≥ 7 months of age. The age of introduction to complementary foods was assessed via a single question with monthly response option categories.

2.3.2 | Household food insecurity

Household food security status was measured using the interviewer-administered 'food security measurement tool for New Zealand households' (Parnell & Gray, 2014). The tool comprises eight New Zealand food insecurity indicator statements reflecting experiences of household financial constraint over the past 12 months and is a validated measure of household food insecurity in the New Zealand population (Parnell & Gray, 2014). Households were classified into one of three categories of food insecurity (severely food insecure, moderately food insecure, food secure) based on a total scoring method (Supporting Information S1: Appendix A). The total scoring method is a more nuanced approach than a previously published scoring method using the same food insecurity measurement tool (Smith et al., 2013), in that it separates participant reports of 'often' experiencing an indicator statement, from reports of 'sometimes' experiencing it. As this is the first study to use this approach for interpreting the indicator statements, the validation of the total scoring method is also included (Supporting Information S1: Appendix B). An acceptable construct validity for the total scoring method was demonstrated (Supporting Information S1: Appendix B).

2.3.3 | Commercial baby food pouch use

Frequency of commercial baby food pouch use was assessed at two time points: (i) retrospectively for when the infant was 'around 6 months

of age' and (ii) at the infant's 'current' age (i.e. at the time of study participation). Participants whose infant had ever eaten food from a baby food pouch were asked to indicate how often their infant had consumed food from a commercial baby food pouch at both time points.

Participants who indicated their infant consumed food from a commercial baby food pouch 'more than once a day', 'once a day', or '5–6 times a week' were defined as 'frequent pouch users'. This captured the top 28% of participants in terms of the current frequency of pouch use and was considered to reflect a frequency of pouch use that could potentially impact nutrition or health. Participants who selected '2–4 times per week' to 'once a month' were defined as 'nonfrequent pouch users'. Participants who selected 'less than once a month' or 'never' were defined as 'nonpouch users'.

Reasons for using baby food pouches were collected via the question: "Why do you use baby food pouches?" The question did not specify 'commercial baby food pouches' or 'home-filled pouches' (pouches that can be refilled and used on multiple occasions). However, it is likely that most responses referred to commercial baby food pouches, given that only 9% of the sample were currently using home-filled pouches frequently (defined as: at least 5 times per week in the past month). Participants could select one or more reasons from 17 prespecified checkbox options. There was also a free-text option but these are only reported where they could appropriately be recoded to one of the checkbox options, so that everyone had an equal opportunity to choose each reason.

2.3.4 | BLW status

BLW status was also assessed at two time points: (i) at 'around 6 months of age' and (ii) at the 'current' age. Given the absence of a validated definition of BLW within published literature, definitions were based on our previous published work (Taylor et al., 2017).

Participants were asked to specify how their infant was fed at both time points. Infants who were 'spoon-fed by an adult' or 'mostly spoon-fed by an adult, some baby feeding themselves', were classified as following 'traditional spoon-feeding'. Infants who were 'about half spoon-fed by an adult and half baby feeding themselves' were classified as following 'partial BLW'. Infants who were 'mostly baby feeding themselves, some spoon feeding by an adult' or 'baby feeding themselves' were classified as following 'full BLW'.

2.4 | Statistical analysis

All statistical analyses were undertaken using Stata SE version 17.0 (StataCorp) statistical software. Probability values of <0.05 were considered to indicate statistical significance.

Proportions of households at different levels of household food insecurity were calculated, and then statistically weighted for ethnicity and area-based socioeconomic deprivation (Daniels et al., 2023) to give an estimated prevalence (with 95% CI) of food insecurity in households with infants in the New Zealand population.

Demographic characteristics of the overall sample and by household food security status were summarised using descriptive statistics. To generate p-values for associations between demographic characteristics and household food security status, one-way analysis of variance (ANOVA) F-tests (for continuous variables), or chi-squared tests or Fisher's exact tests (for categorical variables) were used.

The use of commercial baby food pouches and BLW by household food security status was summarised using descriptive statistics, and comparisons were assessed using chi-squared tests.

Logistic regression models were used to assess the odds of commercial baby food pouch use and full or partial BLW in caregivers experiencing food insecurity (moderate or severe) compared to food secure caregivers. Estimates were adjusted for caregiver age, caregiver education, caregiver ethnicity and number of children in the household (selected a priori). A reliable logistic regression analysis could not be performed for complementary feeding practices assessed retrospectively at 6 months, due to the small number of values.

2.5 | Ethics statement

The First Foods New Zealand study was approved by the Health and Disability Ethics Committees New Zealand (grant number: 19/STH/151). The study is registered with the Australian New Zealand Clinical Trials Registry (registration number: ACTRN12620000459921).

3 | RESULTS

3.1 | Participant characteristics

A participant flow diagram detailing the recruitment of the final sample of 604 participants is shown in Supporting Information S1: Appendix C. Of the 625 participants in the full FFNZ study, 604 (97%) provided complete answers to the food security questionnaire so could be classified into a household food security status, and therefore included in this study.

Participant demographic characteristics are summarised in Table 1. Overall, infants had a mean (SD) age of 8.4 (0.8) months. The sample consisted of slightly more male (54%) than female infants (46%). The infants' ethnicities reflected the diversity of ethnicity in New Zealand, with 21% of infants identified by their caregiver as Māori, 15% as Asian, 7% as Pacific, and 56% as New Zealand and other European.

The caregivers' mean age was 32.7 years. As almost all caregivers were the 'mother' of the infant in the sample (99%), the term 'mother' is used for the remainder of the manuscript. For half of mothers, the child was their first child (48%). Most mothers were of New Zealand and other European ethnicity (66%), followed by almost equal proportions of Asian (14%) and Māori (13%) mothers. Two-thirds of mothers had a university education (65%). One-third of mothers reported being currently employed either part-time or full-time (33%), and a similar proportion reported being unemployed (i.e. not in work or not on leave from work) (30%). Most infants lived in a two-adult

TABLE 1 Demographic characteristics for all participants and by household food security status (n = 604).

Characteristic	Full sample 604 (100.0%)	Household food security status ^a			p-value
		Food secure 453 (75.0%)	Moderately food insecure 105 (17.3%)	Severely food insecure 46 (7.6%)	
Infant characteristics					
Age (months), mean (SD)	8.4 (0.8)	8.4 (0.8)	8.3 (0.8)	8.3 (1.0)	0.241
Sex ^b					0.570
Male	326 (54.0)	244 (53.8)	60 (57.1)	22 (47.8)	
Female	277 (45.9)	208 (45.9)	45 (42.9)	24 (52.2)	
Rather not say	1 (0.2)	1 (0.2)	0 (0.0)	0 (0.0)	
Ethnicity					<0.001
Māori	124 (20.5)	69 (15.2)	33 (31.4)	22 (47.8)	
Pacific	41 (6.8)	25 (5.5)	9 (8.6)	7 (15.2)	
Asian	88 (14.6)	76 (16.8)	10 (9.5)	2 (4.4)	
Other ^c	16 (2.7)	11 (2.4)	3 (2.9)	2 (4.4)	
New Zealand and other European ^d	335 (55.5)	272 (60.0)	50 (47.6)	13 (28.3)	
Gestational status ^e					0.032
Preterm (<37 weeks)	44 (7.3)	30 (6.6)	6 (5.7)	8 (17.8)	
Term (≥37 weeks)	559 (92.7)	423 (93.4)	99 (94.3)	37 (82.2)	
Infant feeding characteristics					
Exclusively breastfed to around 6 months of age ^f	230 (38.1)	183 (40.4)	36 (34.3)	11 (23.9)	0.061
Age introduced to complementary foods, months [mean (SD)]	5.2 (0.9)	5.2 (0.8)	5.2 (0.9)	4.8 (1.4)	<0.001
Caregiver characteristics					
Age (years), mean (SD) ^g	32.7 (4.8)	33.4 (4.3)	31.2 (5.6)	30.1 (6.4)	<0.001
Age group (years) ^h					<0.001
<25	46 (7.6)	14 (3.1)	20 (19.1)	12 (26.1)	
25 to <35	359 (59.6)	281 (62.3)	57 (54.3)	21 (45.7)	
≥35	197 (32.7)	156 (34.6)	28 (26.7)	13 (28.3)	
Relation to infant					.i
Mother	596 (98.7)	447 (98.7)	104 (99.1)	45 (97.8)	
Maternal parity ^{i,k}					<0.001
One	289 (48.0)	233 (51.4)	47 (45.2)	9 (19.6)	
Two	187 (31.0)	142 (31.4)	31 (29.8)	14 (30.4)	
Three	85 (14.1)	59 (13.0)	16 (15.4)	10 (21.7)	
Four or more	42 (7.0)	19 (4.2)	10 (9.6)	13 (28.3)	

(Continues)

TABLE 1 (Continued)

Characteristic	Full sample ⁶⁰⁴ (100.0%)	Household food security status ^a			p-value
		Food secure ⁴⁵³ (75.0%)	Moderately food insecure ¹⁰⁵ (17.3%)	Severely food insecure ⁴⁶ (7.6%)	
Ethnicity					<0.001
Māori	80 (13.3)	46 (10.2)	19 (18.1)	15 (32.6)	
Pacific	30 (5.0)	18 (4.0)	5 (4.8)	7 (15.2)	
Asian	83 (13.7)	71 (15.7)	12 (11.4)	0 (0.0)	
Other	15 (2.5)	10 (2.2)	4 (3.8)	1 (2.2)	
New Zealand and other European ^d	396 (65.6)	308 (68.0)	65 (61.9)	23 (50.0)	
Highest level of education ^l					<0.001
School (primary or secondary)	92 (15.3)	52 (11.5)	23 (21.9)	17 (37.8)	
Polytechnic or similar tertiary institution ^m	121 (20.1)	69 (15.2)	34 (32.4)	18 (40.0)	
University	390 (64.7)	332 (73.3)	48 (45.7)	10 (22.2)	
Current employment status					<0.001
Not employed	183 (30.3)	111 (24.5)	38 (36.2)	34 (73.9)	
Employed part-time	131 (21.7)	101 (22.3)	25 (23.8)	5 (10.9)	
Employed full-time	70 (11.6)	53 (11.7)	14 (13.3)	3 (6.5)	
Paid parental leave	58 (9.6)	48 (10.6)	9 (8.6)	1 (2.2)	
Unpaid parental leave	162 (26.8)	140 (30.9)	19 (18.1)	3 (6.5)	
Household characteristics					
Childcare outside the home ⁿ					0.105
No	498 (82.5)	375 (82.8)	81 (77.1)	42 (91.3)	
Yes	106 (17.6)	78 (17.2)	24 (22.9)	4 (8.7)	
Number of children in household ^{o,p}					<0.001
One	272 (45.1)	223 (49.3)	41 (39.1)	8 (17.4)	
Two	194 (32.2)	147 (32.5)	34 (32.4)	13 (28.3)	
Three	92 (15.3)	63 (13.9)	18 (17.1)	11 (23.9)	
Four or more	45 (7.5)	19 (4.2)	12 (11.4)	14 (30.4)	
Number of adults in household ^q					<0.001
One	23 (3.8)	9 (2.0)	4 (3.8)	10 (21.7)	
Two	502 (83.1)	385 (85.0)	89 (84.8)	28 (60.9)	
Three	40 (6.6)	29 (6.4)	7 (6.7)	4 (8.7)	
Four or more	39 (6.5)	30 (6.6)	5 (4.8)	4 (8.7)	

TABLE 1 (Continued)

Characteristic	Full sample 604 (100.0%)	Household food security status ^a			p-value
		Food secure 453 (75.0%)	Moderately food insecure 105 (17.3%)	Severely food insecure 46 (7.6%)	
Socioeconomic deprivation decile					<0.001
1–3 (Low)	173 (28.6)	147 (32.5)	18 (17.1)	8 (17.4)	
4–7	271 (44.9)	207 (45.7)	46 (43.8)	18 (39.1)	
8–10 (High)	160 (26.5)	99 (21.9)	41 (39.1)	20 (43.5)	

Note: Bold text indicates a statistically significant difference ($p < 0.05$).

Abbreviation: SD, standard deviation.

^aPercentages of the full sample and household food security status are reported vertically (i.e. by column). Percentages may not total to 100 due to rounding.

^b'Rather not say' excluded from statistical test.

^c'Other' comprises Aboriginal and Torres Strait Islander peoples, African, Native American, South American and West Asian.

^d'European' comprises American, Australian, Canadian, European, New Zealand European and South African European.

^e $n = 1$ missing datum.

^fExclusive breastfeeding to around 6 months of age is defined as: No (exclusively breastfed to < 5 months of age) or Yes (exclusively breastfed to ≥ 5 months of age).

^g $n = 2$ missing data.

^h $n = 2$ missing data.

ⁱUnable to perform statistical test due to small numbers in cells.

^jParity of the infant's mother, who may not be the participant in the sample.

^k $n = 1$ missing datum.

^l $n = 1$ missing datum.

^m'Polytechnic' may include bachelor's degrees.

ⁿDefined as the infant being 'regularly looked after by someone other' than the participant. Includes early childhood centre or home-based care.

^oNumber of children who 'usually (at least half the time)' live in the household. Age of 'child' not defined, therefore may include adult children.

^p $n = 1$ missing datum.

^qNumber of adults who 'usually live' in the household. Age of 'adult' not defined.

household (83%). The levels of socioeconomic deprivation reflected those in the New Zealand population with 27% of infants living in areas of high socioeconomic deprivation (deciles 8–10), compared with 28% of New Zealand households with young children (Daniels et al., 2023).

In terms of infant feeding characteristics, mothers experiencing severe food insecurity were less likely to exclusively breastfeed to around 6 months of age than food secure mothers (24% vs 40%). Mothers experiencing severe food insecurity introduced complementary foods approximately a third of a month earlier than those experiencing moderate food insecurity or those who were food secure (4.8 months compared to 5.2 months).

3.2 | Prevalence of household food insecurity

The distributions of responses for the food insecurity indicator statements are presented in Figure 1.

One-quarter (25.0%) of households were classified as food insecure: 17.4% were moderately food insecure and 7.6% were severely food insecure. The estimated prevalence of household food

insecurity was slightly lower (22.0%, 95% CI [19.0, 25.7]), when it was statistically weighted for ethnicity and area-level socioeconomic deprivation to more closely represent the New Zealand population of households with infants (Daniels et al., 2023).

Associations between demographic characteristics and household food security status are reported in Table 1. There were several demographic differences between participants who were experiencing food insecurity and those who were food secure. In particular, compared with mothers living in food secure households, mothers living in severely food insecure households were significantly ($p < 0.05$) more likely to be of a younger age, not to have completed a university education, to be of Māori or Pacific ethnicity, or to have more children in the household.

3.3 | Complementary feeding practices

At 6 months of age, mothers experiencing severe food insecurity were significantly ($p > 0.05$) more likely to use commercial baby food pouches frequently for complementary feeding, with almost half (41.3%, $n = 19/46$) using pouches frequently, compared to much

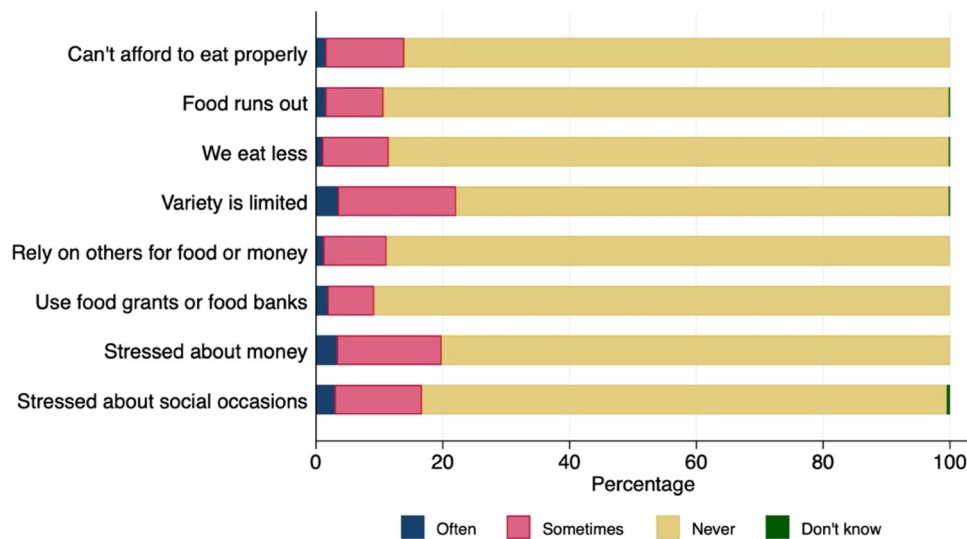


FIGURE 1 Stacked bar chart representing responses to the eight items used to determine household food security status, for all households combined ($n = 610$ households)^{abc}. ^aAll indicator statements refer to 'in the past year'. ^bSample comprises $n = 610$ households because households with 'Don't know' responses are included ($n = 6$). ^cThe wording of the indicator statement was "We can afford to eat properly" and the response options were: Never, Sometimes, Always. The scoring is reversed, so the wording has been reversed here to make the figure easier to understand ("We can't afford to eat properly"). This means that $n = 9$ participants responded 'never' to this indicator statement in the form it was administered ("We can afford to eat properly") but are recorded above as 'often' not being able to afford to eat properly.

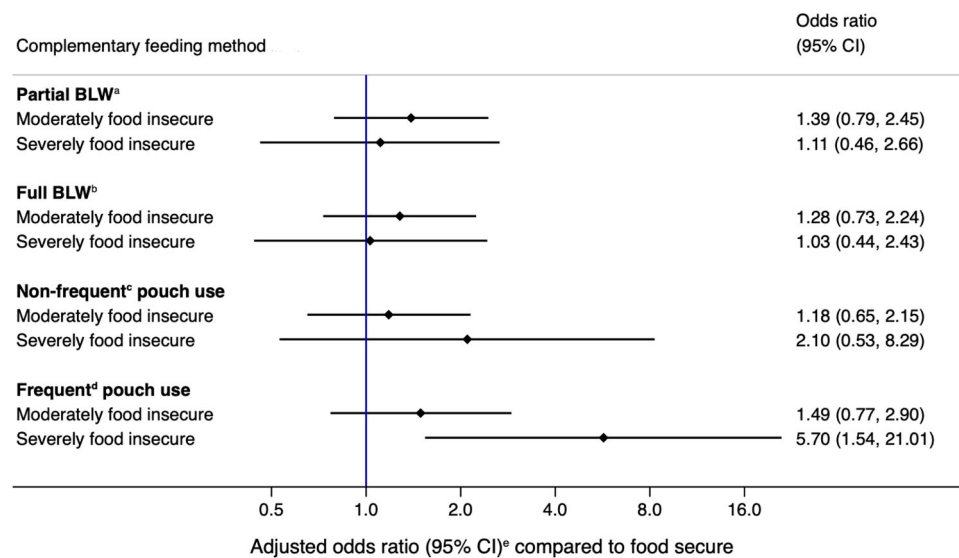


FIGURE 2 Forest plot of the adjusted odds ratios for baby-led weaning and commercial baby food pouch use at current^f age by household food security status. BLW, baby-led weaning; CI, confidence interval. ^aPartial baby-led weaning: About half were spoon-fed by an adult and half were infants feeding themselves. ^bFull baby-led weaning: Always or mostly infant feeding themselves. ^cNonfrequent: At least once but fewer than 5 times per week in the past month. ^dFrequent: At least 5 times per week in the past month. ^eOdds ratios adjusted for caregiver age, caregiver education, caregiver ethnicity and number of children in the household. ^fCurrent complementary feeding approach and commercial baby food pouch use measured when infants were aged between 7.0 and 9.9 months (mean age: 8.4 months).

lower proportions for mothers experiencing moderate food insecurity and food secure mothers (26.7%, $n = 28/105$ and 14.1%, $n = 64/453$, respectively). At the current age, almost two-thirds (60.9%, $n = 28/46$) of mothers experiencing severe food insecurity used pouches frequently. In fact, only 6.5% ($n = 3/46$) of mothers experiencing severe food insecurity did not use pouches, compared to more than

one-quarter (28.3%, $n = 128/453$) of food secure mothers. The odds of current frequent pouch use in mothers experiencing severe food insecurity were more than five times those of food secure mothers (adjusted OR; 5.70, 95% CI [1.54, 21.01]) (Figure 2).

Also at 6 months of age, mothers experiencing severe food insecurity were significantly ($p < 0.05$) less likely to use the full

BLW feeding approach than mothers experiencing moderate food insecurity and food secure mothers (2.2%, $n = 1/46$ vs. 15.2%, $n = 16/105$ and 13.5%, $n = 61/453$, respectively), but were more likely to use partial BLW (Table 2). Thus, the proportions following traditional spoon-feeding were similar in the three groups, ranging from 71.4% to 77.5%. By the 'current' infant age (mean age 8.4 months), the use of full BLW had increased in all groups and there were no longer any statistically significant differences in complementary feeding approaches between the groups. There was no evidence of an association between household food security status and either current partial (e.g., severely food insecure: adjusted OR; 1.11, 95% CI [0.46, 2.66]) or full (e.g., severely food insecure: adjusted OR; 1.03, 95% CI [0.44, 2.43]) BLW in the adjusted models (Figure 2).

3.4 | Reasons for using baby food pouches

The reasons for using baby food pouches most commonly reported by mothers experiencing severe food insecurity who were current frequent users related to 'convenience', followed by 'baby enjoys' and 'nutrition' (Table 3). Notably, reasons of 'convenience' were also the most frequently reported among food secure mothers. Almost all (89%, $n = 25/28$) mothers experiencing severe food insecurity reported that pouches were 'easy to use', and more than half considered that feeding with pouches 'takes less time' (61%, $n = 17/28$). Compared with food secure mothers who were frequently using pouches, substantially higher proportions of mothers experiencing severe food insecurity used pouches because they generated 'less mess' (46%, $n = 13/28$ vs 25%, $n = 25/102$) and were a 'hands free' method of complementary feeding (36% vs. 13%).

TABLE 2 Infant feeding practices by household food security status ($n = 604$ mothers).

Infant feeding practice	Household food security status ^a			p-value
	Food secure ($n = 453$)	Moderately food insecure ($n = 105$)	Severely food insecure ($n = 46$)	
Complementary feeding approach ^b —at around 6 months				0.007
Traditional spoon-feeding	351 (77.5)	75 (71.4)	34 (73.9)	
Partial baby-led weaning	41 (9.1)	14 (13.3)	11 (23.9)	
Full baby-led weaning	61 (13.5)	16 (15.2)	1 (2.2)	
Complementary feeding approach ^c —current ^d				0.916
Traditional spoon-feeding	223 (49.3)	47 (44.8)	24 (52.2)	
Partial baby-led weaning	107 (23.7)	27 (25.7)	10 (21.7)	
Full baby-led weaning	122 (27.0)	31 (29.5)	12 (26.1)	
Frequency of pouch use ^e —at around 6 months				<0.001
Nonpouch user (not used at around 6 months)	253 (55.9)	52 (49.5)	16 (34.8)	
Nonfrequent pouch user (≥ 1 time and < 5 times/week)	136 (30.0)	25 (23.8)	11 (23.9)	
Frequent pouch user (≥ 5 times/week)	64 (14.1)	28 (26.7)	19 (41.3)	
Frequency of pouch use ^f —current ^d				<0.001
Nonpouch user (never given or not used in past month)	128 (28.3)	21 (20.0)	3 (6.5)	
Nonfrequent pouch user (≥ 1 time and < 5 times/week in past month)	223 (49.2)	48 (45.7)	15 (32.6)	
Frequent pouch user (≥ 5 times/week in past month)	102 (22.5)	36 (34.3)	28 (60.9)	

Note: Bold text indicates a statistically significant difference ($p < 0.05$).

^aData presented as n (%) unless otherwise indicated. Percentages may not total to 100 due to rounding.

^bDefined based on the method of feeding: partial baby-led weaning (about half spoon-fed by an adult and half infant feeding themselves); full baby-led weaning (always or mostly infants feeding themselves); traditional spoon-feeding (always or mostly spoon-fed by an adult).

^c $n = 1$ missing datum.

^dCurrent complementary feeding approach and commercial baby food pouch use measured when infants were aged between 7.0 and 9.9 months (mean age: 8.4 months).

^eDefined as follows: Nonpouch user: Pouches not used at around 6 months; non-frequent pouch user: pouches used at least once but fewer than 5 times per week; frequent pouch user: pouches used at least 5 times per week.

^fDefined as follows: Nonpouch user: Never given or not given in the past month; nonfrequent pouch user: at least once but fewer than 5 times per week in the past month; frequent pouch user: at least 5 times per week in the past month.

TABLE 3 Reasons for using baby food pouches reported by current frequent pouch users, by household food security status ($n = 166$).^{a,b}

Reason ^c	Household food security status		
	Food secure	Moderately food insecure	Severely food insecure
n (%) of all participants who were current frequent pouch users	102 (22.5)	36 (34.3)	28 (60.9)
Convenience			
Easy to use	79 (77)	27 (75)	25 (89)
Takes less time	57 (56)	15 (42)	17 (61)
Practical	59 (58)	21 (58)	15 (54)
Less mess	25 (25)	9 (25)	13 (46)
Hands free	13 (13)	6 (17)	10 (36)
Health			
Nutrition			
Easy to get fruit and vegetables in	37 (36)	11 (31)	18 (64)
Easy to get meat in	29 (28)	11 (31)	11 (39)
Food is good for baby	14 (14)	5 (14)	9 (32)
Healthier than foods family eats	5 (5)	3 (8)	5 (18)
Organic	20 (20)	6 (17)	10 (36)
Safety	4 (4)	3 (8)	5 (18)
Baby enjoys	60 (59)	26 (72)	21 (75)
Variety	37 (36)	13 (36)	12 (43)
Less waste	22 (22)	13 (36)	10 (36)
Freshness	19 (19)	6 (17)	8 (29)
Cost less	9 (9)	3 (8)	4 (14)
Reputation	4 (4)	3 (8)	3 (11)

^a'Baby food pouch' may be a commercial baby food pouch or a home-filled pouch, therefore reasons may relate to either commercial infant pouch foods, pouches filled with home-prepared foods, or both.

^bParticipants were able to select more than one option.

^cAll reasons with n (%) were pre-specified checkbox options or free-text responses coded to one of the checkbox options. Responses are categorised as per the categorisations applied in McLean (2023). (%) is the percent of current frequent pouch users reporting the reason, by household food security status. For example, (89) means that 89% of current frequent pouch users who were experiencing severe food insecurity reported that pouches were 'easy to use'.

In addition, three-quarters (75%) of mothers experiencing severe food insecurity used pouches because they reported 'baby enjoys' pouch foods. Pouches were also considered to provide nutritious food; compared with food secure mothers, almost twice as many mothers who were experiencing severe food insecurity reported that feeding with pouches was an 'easy way to get fruit and vegetables in' (64%, $n = 18/28$ vs. 36%, $n = 37/102$), and more than one-third (39%, $n = 11/28$) considered that it was 'easy to get meat in' using pouches frequently. The perception that pouch foods were 'good for baby' was more commonly observed in mothers experiencing severe food insecurity who were currently using them frequently, than in food secure mothers (32%, $n = 9/28$ vs. 14%, $n = 14/102$).

Only 14% ($n = 4/28$) of mothers experiencing severe food insecurity reported that they used pouches because they cost

less—a similar proportion to that for food secure frequent users (9%).

4 | DISCUSSION

To our knowledge, this is the first investigation worldwide comparing the use of commercial baby food pouches and BLW, by household food security status. We found that mothers experiencing severe food insecurity had more than five times the odds of using commercial baby food pouches frequently compared to food secure mothers, despite adjustment for the caregiver (i.e. mother) age, education, ethnicity and number of children in the household. Most mothers experiencing severe food insecurity reported frequent use of pouches, so were feeding their

infant food from a pouch almost every day or every day. Only 7% of those experiencing severe food insecurity never offered pouches. Although mothers experiencing severe food insecurity were significantly less likely to follow full BLW at 6 months of age, this difference was brief and was no longer apparent by the current age (mean 8.4 months).

The high odds of pouch use in families experiencing severe food insecurity were striking. Almost all (89%) severely food insecure mothers who were currently using pouches frequently indicated that pouches were 'easy to use', and over half (61%) that feeding with pouches 'takes less time'. The value placed upon 'convenience' is consistent with Rowan et al.'s (2022) analysis of public parenting forum discussions which established that 'convenience' was a key determinant of pouch use for parents. The appeal of commercial baby food pouches as a convenient infant feeding option is evident; pouches contain ready-to-eat complementary foods, the flexible packaging allows for food to be easily squeezed out through the nozzle, and pouch labels with messages such as 'on the go', suggest that less time and effort is required for infant feeding when they are used, compared with traditional seated spoon-fed approaches. Certainly, almost three times the proportion of mothers experiencing severe food insecurity who were using pouches frequently reported using them because they could have their 'hands free' compared to food secure mothers (36% vs. 13%). Due to potential time constraints such as living in single-parent households or working multiple jobs (Arlinghaus & Laska, 2021), and the extensive effort involved in seeking food charity or money for food (ThinkPlace & Auckland City Mission, 2014), mothers experiencing food insecurity may value such efficient and convenient infant feeding methods that do not require preparing food 'from scratch'.

Three-quarters (75%) of mothers experiencing severe food insecurity used pouches frequently because their infant enjoyed them, suggesting that pouches provided greater certainty in the infant's acceptance of the food. A recent study from the UK of parents' perceptions of complementary food introduction found that 'packaged' baby food purées were perceived to be more cost-effective, despite being more expensive than the equivalent fresh ingredients because only the amount in the package would be wasted rather than an entire homemade batch if the infant were to reject the purée (Isaacs et al., 2022). Potential food waste is an important factor for low-income families when considering food affordability (Daniel, 2020) since wasted food translates to wasted money. In the context of food insecurity, the mess resulting from young children exploring and playing with food (as is usual in infants learning to eat solid foods) may be seen as waste, and strategies might be employed in households to minimise such waste (Baxter et al., 2024). Indeed, in this study, a larger proportion of mothers experiencing severe food insecurity who were frequent users reported 'less waste' as a reason for using baby food pouches compared to food secure mothers (35% vs 22%).

While stretching food dollars by buying fresh foods in bulk may reduce the cost of food per serve of homemade complementary

foods, it also requires that households have adequate storage, cooking facilities and kitchen supplies. A larger amount of kitchen equipment (e.g., a refrigerator and freezer, a hotplate and utensils) has been associated with a greater frequency of homecooked meals in low-income urban households with children in the US (Appelhans et al., 2014). An exploration of food access in rural Māori (indigenous peoples of New Zealand) mothers of young children revealed that cooking opportunity was limited for those who lived in unstable, shared, or emergency housing with communal kitchen facilities (Urlich et al., 2023). The living circumstances of mothers were not investigated in this study, but mothers experiencing food insecurity may have had inadequate cooking facilities or kitchen equipment to prepare homecooked infant meals from fresh foods. In contrast, baby food pouches containing puréed fruit, vegetables and meat do not require preparation and have much longer shelf-lives compared to their fresh counterparts. Perceptions of food affordability in low-income families may be influenced by a longer shelf-life of food (Daniel, 2020).

Mothers experiencing severe food insecurity who currently used pouches frequently also perceived them to be nutritious; specifically because they made it 'easy to get fruit and vegetables in' (64%), and 'easy to get meat in' (39%). Although pouches are not rich sources of iron and vitamin B12 (Katiforis et al., 2021), they may be an important source of vitamin C owing to their high fruit and vegetable content (Beauregard et al., 2019; Katiforis et al., 2021). A recent analysis of data from the overall FFNZ study shows that pouches contributed more than 30% of the intake of fibre, vitamin A and vitamin C from complementary foods for infants who consumed pouches (Haszard et al., 2024). However, they also provided 47% (7 g) of the total sugars from complementary foods. One of the concerns expressed about the nutritional value of baby food pouches is that the manufacturing of fruit purées may release more sugars from plant cell walls than does home preparation (WHO Regional Office for Europe, 2022), however, evidence does not suggest there is a difference (Huss et al., 2023).

In contrast, although mothers experiencing severe food insecurity were much less likely to follow full BLW at 6 months of age than moderately food insecure or food secure mothers, there was no evidence of a difference in the use of full BLW observed by the infants' current age (mean 8.4 months). The encouragement to touch and explore food that is characteristic of BLW means that more food falls to the ground than does with traditional spoon-feeding (Brown & Lee, 2011). Concerns about mess were raised by mothers following the baby-led approach in the UK, although concerns diminished over time as infants developed their oral motor skills and consumed more of the food offered to them (Brown & Lee, 2011). Perceptions that adopting BLW may increase feeding time could also underlie the significantly lower proportion of severely food insecure mothers following full BLW in early complementary feeding. BLW could plausibly demand a greater time commitment for supervised feeding than traditional spoon-feeding, considering that self-feeding means that infants decide how much of the food to eat and the speed at

which they will eat it, as opposed to the adult (Rapley, 2011). Time scarcity has been identified as a structural constraint influencing child-feeding decisions in low-income parents in the US (Schuster et al., 2019) and Australia (Pescud & Pettigrew, 2014). If BLW is shown to be associated with health benefits in future studies, it would be interesting to explore why BLW may be less popular in families experiencing severe food insecurity, especially when infants are early in their complementary feeding journey. The similar proportions of food secure mothers and food insecure mothers following full BLW at the current age are not surprising given that by 8 months, infants are closer to the 12-month developmental milestone of being able to feed themselves, thus requiring less spoon-feeding (Ministry of Health, 2021).

This study has multiple strengths. It is novel, providing the first data on the use of commercial baby food pouches and BLW in food insecure households. The timing of the research is also a strength; it was undertaken when the child was an infant and mothers were engaged in complementary feeding, which minimised the likelihood of recall error. Moreover, the large sample size allowed for an investigation of complementary feeding practices at two levels of severity of household food insecurity (moderate and severe), which offers a more nuanced understanding of their relationships with food insecurity. The mean age of the mothers in the sample was 32.7 years; similar to the typical age at infant birth of New Zealand mothers of 31.2 years (Statistics New Zealand, 2023). The sample also reflected the rich diversity of ethnicity in the general New Zealand population, comprising mothers of Māori (13%), Pacific (7%), Asian (15%), New Zealand and other European (78%), and Other (3%) ethnicities when ethnicity was determined using 'total response'. Although the proportions were similar to those in the population (Statistics New Zealand, 2018a), participants in this study were more educated than the general population, with 65% holding a university degree compared with 35% of the New Zealand adult population (Education Counts, 2022).

The limitations include the convenience sampling method used to recruit participants, which likely introduced selection bias towards mothers with higher levels of education than in the general New Zealand population and towards mothers who had a particular interest in infant nutrition and health. Additionally, only mothers who were fluent in English and had a literacy level high enough to complete the questionnaires were able to participate, which is not representative of all New Zealand households with infants. Finally, we investigated the frequency of commercial baby food pouch use but did not include the quantity of food consumed from pouches in our analyses. For example, these data do not differentiate between eating occasions in which part of a pouch was consumed, and those when food from more than one pouch was consumed. As it is unclear whether frequent baby food pouch use is nutritionally harmful or may be beneficial in this population (Hurley & Black, 2010), future observational research should investigate the impact of a high pouch food diet on food and nutrient intake and health, and the contribution of pouches to fruit and vegetable intakes, in infants of low-income groups. Additionally, further qualitative research exploring why

pouches are used by families experiencing food insecurity would offer valuable insights into their frequent use in this context.

5 | CONCLUSIONS

Our findings suggest that in the context of food insecurity, the use of commercial baby food pouches may be a convenient means of providing infants with 'ready-to-eat' complementary food that is regarded as nutritious and less likely to be wasted. Although pouches may be a strategy used to ensure that infants consume fruit, vegetables and meat, the low iron and vitamin B12 content of commercial baby food pouches sold in New Zealand is of concern. The popularity of commercial baby food pouches, evidenced by their almost-daily use in many families experiencing severe food insecurity, underscores the need to improve the nutritional value of pouch foods and to determine the nutrition and health impacts of pouch use. Should it be determined that pouches have no adverse impacts, it is recommended that they be included in food bank parcels for families with infants in the early stages of complementary feeding, given their frequent use for complementary feeding in food insecure households. Finally, forthcoming evidence from the FFNZ study assessing the impact of pouch use on infant iron status will be critical to inform advice offered by health professionals to families with infants.

AUTHOR CONTRIBUTIONS

Anne-Louise M. Heath, Rachael W. Taylor, Jillian J. Haszard, Cathryn A. Conlon, Kathryn L. Beck, Pamela R. von Hurst, Lisa A. Te Morenga and Lisa Daniels designed the study. Ioanna Katiforis, Kimberley J. Brown, Madeleine Rowan, Maria Casale, Neve H. McLean, Alice M. Cox, Emily A. Jones, Bailey R. Bruckner, Rosario Jupiterwala and Andrea Wei undertook data collection. Ioanna Katiforis and Jillian J. Haszard analysed the data. Ioanna Katiforis prepared the first draft of the paper. Claire Smith, Anne-Louise M. Heath, and Jillian J. Haszard had primary responsibility for the final content. All authors have read and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

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

ORCID

Anne-Louise M. Heath  <http://orcid.org/0000-0003-2856-0782>

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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