The oral feeding skills,

feeding behaviours and choking prevalence of

New Zealand infants

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Declaration

I declare that no part of this thesis has been submitted for a degree at Massey University or any other tertiary institution. This thesis describes original research conducted by the candidate, Emily Amy Jones under the supervision of primary supervisor Professor Cathryn Conlon and Professor Emerita Pamela von Hurst.

Abstract

Background: Oral feeding skills (OFS) are essential for infants and children to accept foods suitable for their age. Limited evidence indicates that, even without obvious medical issues, some healthy infants may experience subtle difficulties or delays in developing OFS, which can result in restricted food acceptance during infancy and later childhood. Distinguishing between normal developmental variation and a difficulty or delay in OFS has been challenging for health professionals. Early identification of OFS issues can help prevent problematic feeding behaviours, nutritional problems, and parental stress later in childhood.

The complementary feeding period represents a crucial milestone and a vulnerable window for early feeding development. During this transition, parents often report challenging behaviours as infants encounter new tastes and textures, frequently without recognising potential underlying OFS difficulties. This developmental stage also aligns with an increased risk of choking. Food-related choking (FRC) poses a significant public health concern, particularly in infants under 12 months, whose developing anatomy and emerging OFS create physiological vulnerability. Complementary feeding practices may also be associated with FRC occurrence due to the varied approaches in introducing solid food textures and developing OFS. Baby-led weaning (BLW) encourages infants to self-feed whole foods. In contrast, traditional spoon-feeding (TSF) and partial baby-led weaning (partial BLW) practices typically involve a parent-led approach that begins with purees. Despite being largely preventable, choking episodes persist in causing parental distress and morbidity globally.

Aim: The aim of this thesis was to describe the oral feeding skills of 7 to 10 month old New Zealand infants and their associations with early life factors and feeding behaviours. Additionally, this thesis examined food-related choking in this population.

Methods: For this cross-sectional study, infants aged 7 to 10 months and their primary caregivers were recruited from two cities in Aotearoa, New Zealand (Tāmaki Makaurau/Auckland, North Island

and Ōtepoti/Dunedin, South Island). Oral feeding skills (OFS) were described using the Child Oral and Motor Proficiency Scale (ChOMPS), concerns with OFS identified, and associations with sociodemographic characteristics and early feeding practices explored. Feeding behaviours were described using the Pediatric Eating Assessment Tool (Pedi-EAT), concerns about problematic feeding behaviours were identified, and their associations with sociodemographic characteristics and early feeding practices were explored. Both tools are patient-reported outcome measures. Within the study population, the prevalence of FRC and the number of FRC episodes were calculated, and implicated foods characterised. Comparisons of FRC episodes were conducted between parent-led complementary feeding practices (TSF and partial BLW) and BLW approaches. Additionally, weighted estimated prevalence was applied using the data from the study population and weighting for the distribution of ethnicity and area-level deprivation.

Results: The analysis included 625 eligible infant-parent dyads. Most infants 96% (*n* = 527) were classified with typical OFS based on their Total Score from the ChOMPS tool. Older infants (9 to < 10 months) were more likely to be associated with “concern” on the ChOMPS compared to the younger infants (7 to < 8 and 8 to < 9 months) ($p < .001$). Infants born to primiparous mothers were associated with “no concern” compared to those born to multiparous mothers ($p = .019$). Based on the Pedi-EAT normative reference values, 83% of participants (*n* = 463) were classified as having no problematic feeding behaviours. Infants born to primiparous mothers were more likely to be associated with "concern" on the Pedi-EAT ($p = .009$). Of the 625 infants, (*n* = 120, 19.2%) were reported to have experienced FRC. Among the 108 serious FRC episodes analysed, 45.5% involved whole foods (*n* = 49) consumed during self-feeding, occurring in 62% of events (*n* = 67), with the highest frequency (*n* = 46, 42.6%) in infants aged 8 to < 9 months. Fruits represented 24.3% of FRC episodes (*n* = 26) and vegetables 20.6% (*n* = 22), making them the most frequently implicated food categories. Infants aged 7 to < 8 months following a BLW complementary feeding practice demonstrated significantly higher rates of FRC compared to same-age peers using a TSF approach (90% versus 44.4%), ($p = .015$) when self-feeding. When weighted for national proportions of

ethnicity and area-level deprivation, the estimated prevalence of FRC was 18.2% (95% CI [15.3, 21.5]).

Conclusions: This study offers new insights into OFS development and feeding behaviours during the second half of infancy, establishing baseline data for healthy developmental variation, and identifying factors that may serve as early indicators of feeding difficulties. This is the first study, to our knowledge, to describe OFS and feeding behaviours in a New Zealand infant study population using validated patient-reported outcome measures. Identifying OFS and problematic feeding behaviours within the study population, with increasing age and primiparity emerging as associated risk factors, provides valuable information for early recognition of feeding development concerns during complementary feeding. Whole fruits and vegetables were the most commonly involved foods in FRC episodes, and BLW practices were significantly associated with FRC risk among the youngest infants. This suggests that parents may require clearer guidance on how to safely introduce whole foods in age-appropriate forms for infants. Additionally, guidelines may benefit from more explicit instruction on transitioning from modified textures to whole foods as infants develop appropriate OFS. These findings highlight an important tension in infant feeding: the foods parents are most likely to select as nutritious choices (fruits and vegetables) present the highest choking risk during complementary feeding.

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will benefit many families to come. I am especially grateful to the parents who granted permission for me to use their children's images in my thesis.

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Abbreviations

ACC	Accident Compensation Claims
BFP	Baby food pouch
BLW	Baby-led weaning
BPFAS	Behavioral Pediatric Feeding Assessment Scale
CFQ	Child Feeding Questionnaire
ChOMPS	The Oral and Motor Oral Proficiency Scale
CNS	Central nervous system
CPG	Central pattern generator
DST	Dynamic Systems Theory
FOP	Food oral processing
FTD	Feeding tube dependency
GOR	Gastroesophageal reflux
GORD	Gastroesophageal reflux disease
ICD	International classification of diseases
MCH-FS	Montreal Children's Hospital-Feeding Scale
MOH	Ministry of Health, New Zealand
NIQS	NZ Injury Query System
NNS	Non-nutritive sucking
NZ	New Zealand
OFS	Oral feeding skills
OMD	Oral-motor dysfunction
OMS	Oral-motor skill(s)
Partial BLW	Partial baby-led weaning (mixed or hybrid approach)
Pedi-EAT	The Pediatric Eating Assessment Tool
PEDS: DM	Parent's Evaluation of Developmental Status: Developmental Milestones
PFD	P(a)ediatric Feeding Disorder
PROM	Patient-reported outcome measure
SOMA	Schedule of Oral-Motor Assessment
TSF	Traditional spoon feeding
WHO	World Health Organization

Glossary

AOTEAROA

The Te Reo Māori name for New Zealand. In this thesis Aotearoa may be used with alongside New Zealand or referred to as “Aotearoa New Zealand”.

ASPIRATION

The entry of food or fluids into the airway below the level of the vocal folds. It can be silent (no outward signs) or overt (with coughing or choking).

BABY FOOD POUCHES

These are commercial or homemade infant or toddler food that are packaged in plastic pouches with a plastic nozzle. Contents can be squeezed directly onto a bowl or spoon, or the child can squeeze directly into their mouth.

BABY-LED WEANING

A complementary feeding practice where infants self-feed appropriate finger foods from the beginning of solid food introduction (around 6 months), with no spoon-feeding or purees. Babies participate in family meals, choosing what, how much, and at what pace to eat from foods offered, while continuing milk feeds.

COMPLEMENTARY FEEDING

The process of introducing solid foods and liquids to an infant's diet alongside continued breastfeeding or formula feeding when breast milk or formula alone is no longer sufficient to meet nutritional requirements, typically beginning around 6 months of age.

COMPLEMENTARY FEEDING PRACTICE

The specific feeding methods, foods, food preparation, and strategies used by parents when introducing and providing complementary foods to infants.

DYSPHAGIA

Difficulty swallowing affecting any stage of the swallowing process (oral preparatory, oral pharyngeal, or oesophageal phases), which may result from neurological, structural, or physiological disorders and can lead to nutritional deficits, aspiration, or other complications.

FEEDING

A broad term that can refer to the anticipatory responses in preparation for receiving food/fluid, method of feeding practice, placement of food and its management, chewing/mastication, and the transfer of the food bolus to the pharynx ready for swallowing.

FIRST FOODS NEW ZEALAND

A Health Research Council NZ funded observational cross-sectional study of 625 infants from Auckland and Dunedin aged 7 to 10 months.

FOOD-RELATED CHOKING

Foreign body aspiration/inhalation of food items.

INFANCY

The developmental period from birth to 12 months of age

MINISTRY OF HEALTH NZ/MANATU HAUORA

The government department in New Zealand responsible for the health system, including public health, disability, and mental health services. It also advises the NZ government on health policy.

ORAL FEEDING SKILLS/EATING SKILLS

Oral-motor and oral sensory skills that help to prepare fluids and food for swallowing.

ORAL-MOTOR DELAY

A developmental lag in the acquisition of age-appropriate oral-motor skills necessary for feeding, swallowing, and speech, characterised by immature oral movement patterns and delays in reaching typical developmental milestones for oral functions. These pair with oral sensory skills.

ORAL-MOTOR DYSFUNCTION

Reduced capacity or inability of the facial muscles and muscles in the oral cavity to perform the movements required for efficient feeding, characterised by inadequate strength, range of motion, coordination, or control of the oral structures, which may be due to neurological, structural, or functional factors.

ORAL-MOTOR SKILLS

Observable motor movements that refer to the mechanisms in the oral cavity that manipulate, break down and control liquids and foods so they are ready to be swallowed.

ORAL SENSORY SKILLS

The ability to receive, interpret, and respond appropriately to tactile, temperature, taste, and proprioceptive input within the oral cavity. These skills include tolerating various food textures,

temperatures, and flavours; discriminating between different oral sensations; and modulating responses to oral stimuli. Oral sensory skills work in conjunction with oral-motor skills to support the development of successful feeding, eating, and speech.

ŌTEPOTI

The Māori language word for Dunedin, a town in the South Island of New Zealand.

P(A)EDIATRIC FEEDING DISORDER (PFD)

PFD is described as age- inappropriate oral intake persisting for at least two weeks, accompanied by dysfunction in one or more domains including medical, nutritional, feeding skills, or psychosocial factors. This multi-domain definition underscores the necessity for comprehensive, interdisciplinary assessment and intervention approaches.

Preface

*As a **speech and language therapist**, I have seen firsthand the profound impact that feeding difficulties have on children's development and family wellbeing. Despite the abundance of research on disordered feeding, there is a lack of evidence detailing the expected trajectory of oral feeding skills in typically developing infants. This knowledge gap can lead to child and parental anxiety, delayed intervention and social isolation.*

Recognising this gap, I was motivated to explore the developmental patterns of oral feeding in healthy infants. A clearer understanding of typical feeding development will help clinicians distinguish between normal variation and early indicators of feeding challenges. This research aims to bridge the gap between clinical practice and research, ensuring that feeding advice provided to parents is evidence-based and reflects the natural progression of feeding skills.

This thesis represents not only years of formal study but also the culmination of countless clinical interactions that have shaped my understanding and approach. To the many families who have shared their feeding journeys with me over the years, this work is, at its heart, for you.

Chapter 1 – Introduction

This chapter provides the introduction and justification for the thesis, followed by the aims and objectives, the thesis structure, and the researchers' contributions. This chapter marks the beginning of my thesis journey, which commenced in 2018 when I introduced the Feeding Flock Assessments (The Child Oral Proficiency Scale and the Pediatric Eating Assessment Tool) into my clinical practice. I found that these patient-reported outcome measures enhanced my assessment process for children with feeding challenges, and I thought they could be used to help identify oral feeding skill difficulties on a broader scale.

These clinical insights evolved into a formal research study, which was accepted as part of a larger research initiative. This opportunity allowed me to contribute my clinical expertise to a multidisciplinary research team, with a focus on oral feeding skills for older infants. Through this research, I aim to bridge the gap between clinical practice and empirical evidence in an area where evidence-based practice remains limited despite its critical importance for child development.

Chapter 1

Introduction & justification for the study

The development of infant feeding skills constitutes a critical yet under-recognised determinant of child health trajectories. Infants progress from reflexive suckling to the complex oral-motor coordination required for varied food textures during complementary feeding. This transition period presents significant developmental opportunities alongside potential vulnerabilities that warrant greater attention in both research and clinical practice.

The complementary feeding period can be a vulnerable time for developing feeding skills, where subtle markers of oral-motor delay, oral-sensory processing differences may be recognised as problematic feeding behaviours on the one hand or dismissed as 'something they will grow out of' on the other. This is particularly evident, when the infant is considered healthy or typically developing, as missed early indicators can have profound consequences, including nutritional inadequacies, delayed oral feeding development, and learned maladaptive feeding behaviours that persist into later childhood.

Oral feeding skills (OFS) refer to the mechanisms in the oral cavity that manipulate, break down and control liquids and foods so they are ready to be swallowed. They start with reflexive sucking, then early chewing and biting skills as the infant progresses Chewing skills undergo significant changes, between 6 and 10 months, but only if the infant is exposed to textured foods (Gisel, 1991). In particular, the development of tongue lateralisation (side to side movement) requires texture exposure to develop; otherwise, infants will continue to use the pattern of least effort (Gisel, 1991; Harris & Mason, 2017). Hence, it is a critical period during which exposure to food texture is vital for early chewing and masticatory development. Delayed introduction to textured foods can result in difficulties with later food acceptance (Demonteil et al., 2018; Tournier et al., 2019; van Dijk et al., 2012).

Feeding difficulties often begin at the time of complementary feeding yet parents and caregivers might not seek advice until their child is around 2 years of age (Gisel, 1991; Levy et al., 2009; Pados, Park, et al., 2018; Ramos et al., 2017). Late parental reporting of feeding difficulties is often prompted by their child's problematic feeding behaviours, impacted growth and nutritional concerns. Behaviours could include avoiding or refusing foods, having a limited variety of accepted foods at mealtimes, or learned food aversions, all causing stress to families (Goday et al., 2019; Marshall et al., 2016). Therefore, early identification of OFS difficulties may support infants and families by reducing adverse behaviours, as well as the associated nutritional concerns and parenting stress.

Ongoing OFS difficulties don't just affect the mechanical process of eating and drinking and food acceptance. Rather they contribute to developmental disruption with potential long term effects on health, dietary intake and social functioning (Cohen & Dilfer, 2023; Goday et al. 2019). These limitations can continue even when underlying medical risk has improved, as children may remain reliant on modified food textures, specialised strategies or prolonged mealtimes. Restricting independence and reinforcing atypical feeding patterns over time. Long- term, this can impair children's ability to participate fully in normal eating contexts such as family meals, early childhood education and school environments, and community activities that involve eating. This impact extends beyond the individual child, affecting their family's ability to engage in social and community life (Cohen & Dilfer, 2022). Additionally, children with persistent feeding difficulties often have lower intakes of fruits, vegetables, fibre, iron, zinc, and key vitamins (A, D and B group), with these patterns often extending into adolescence and adulthood. Although prolonged poor diet quality and variety may not result in acute malnutrition, overtime these patterns may have broader consequences for physical resilience, immune function, neurodevelopment, and emotional regulation (Pjetraj et al., 2025). This difficulty in identifying OFS delay in infants and children is particularly pronounced in those who do not have a health or developmental cause explaining their feeding and swallowing difficulties, and/or are typically developing. There is increasing evidence that oral feeding skill (OFS)

difficulties are often under-recognised, as they rarely manifest as overt or dramatic events such as choking during meals. Rather, most OFS difficulties present more subtly, including challenges with spoon feeding, progression to more complex food textures, and limited acceptance of foods during infancy and continuing into later childhood (Kerwin, 1999; Manno et al., 2005; Pados, Park, et al., 2018; Wilken et al., 2021).

Speech-language pathologists assess, diagnose and implement strategies for feeding difficulties in infants and children. In addition to clinical assessment, best practice also relies on parent reporting that has often not been robustly reported, or undervalued in the assessment process (Marshall et al., 2023). Furthermore, existing tools have not been sensitive enough to identify or discern between variation in typical feeding development and a feeding disorder (Pados et al., 2019).

> 'Differentiating the child with feeding difficulty that falls within the range of typical development from the child with a paediatric feeding disorder is a significant challenge for the paediatric primary care providers.' **Pados et al., 2019, pg. 233.**

Most clinicians will rely on their knowledge of typical feeding development and observational skills to guide their assessments (Delaney & Arvedson, 2008). However, another challenge clinicians face is variability in OFS development. Therefore, incorporating validated parent-report assessments provides clinicians with valuable perspectives on a child's OFS and feeding behaviours, complementing clinical observations.

Purpose of the study

The overall aim of this thesis was to describe the OFS of healthy infants aged 7 to 10 months and their association with early life factors and feeding behaviours. Additionally, the prevalence of and risk factors for choking were explored. To our knowledge, this is the first time this has been done in New Zealand. The findings of this study will contribute valuable information on OFS of older

infants, which is currently lacking in contemporary literature both internationally and within Aotearoa New Zealand (Delaney & Arvedson, 2008; Delaney et al., 2021; Estrem et al., 2022). What is clear from past research is that OFS and identification of the delayed development of these skills continue to be overlooked for older infants and children. Therefore, the focus of this study is on OFS as a key aspect of the feeding process, and the findings presented in this thesis will aid in the early identification of delayed OFS at a critical developmental period. In addition to the descriptive information on OFS, early life factors that can affect OFS were explored through a parent questionnaire (such as early milk feeding practices, the age at which complementary feeding was introduced, and underlying health conditions). This knowledge could inform future guidelines on early and complementary feeding practices that better support OFS development, while also revealing whether certain practices chosen by parents are more strongly associated with OFS development than others.

In addition, OFS status was explored alongside feeding behaviours. That is, what the infants *have the skills to eat* (OFS) compared to what they are *willing to eat*, as OFS are highly related but distinct from symptoms of problematic feeding (Pados, Park, et al., 2018). Lastly, information was collected on the prevalence of food-related choking (FRC) in the study population. Risk factors that contribute to FRC episodes, and whether parental feeding practices (parent-led or baby-led practices) are associated with the occurrence of these episodes.

Research scope

To obtain data on OFS, feeding behaviours and choking of NZ infants, an observational cross-sectional study of infants aged 7 to 10 months was conducted in two cities in Aotearoa New Zealand (Tāmaki Makaurau/Auckland, North Island and Ōtepoti/Dunedin, South Island). Currently, there are no descriptive studies of the OFS of infants in NZ (7 to 10 months), so we focused on collecting observational data from an ethnically and socio-economically diverse population within NZ, which contributes to the limited international research (Delaney et al., 2021; Estrem et al., 2022). This

allows for a deeper understanding of OFS development and aids in the identification of important developmental time points for infants (Serel-Arslan et al., 2023). Data captured during infancy between 7 to 10 months of age reflects the rapid dietary change infants experience during complementary feeding, when feeding difficulties often first become apparent to parents (Estrem et al., 2022; Levy et al., 2009; Ramos et al., 2017; Sanchez & Morgan, 2018; Taylor et al., 2021). Furthermore, the findings of this study could potentially contribute to health policies and promote screening assessments at Well Child checks and primary healthcare consultations.

This study prioritises the exploration of OFS in infants due to the lack of evidence in the paediatric feeding literature for this developmental stage, particularly among typically developing populations (Delaney et al., 2021; Estrem et al., 2022). Lastly, given that OFS difficulties can be the earliest signs of more global developmental issues, the benefits of identifying these infants early will ideally be used to inform a prompter referral system for providing appropriate and timely support (Motion et al., 2001; Sanchez & Morgan, 2018).

Additionally, the use of the patient-reported outcome measure for OFS status is novel and the first of its kind to demonstrate reliability and content validity. However, it has not been used on a large study population since it was validated (Cohen & Dilfer, 2022; Marshall et al., 2023; Pados, Park, et al., 2018; Sanchez & Morgan, 2018).

First Foods New Zealand Study

This research was part of The First Foods New Zealand Study (FFNZ). This was a multicentre study conducted in Auckland and Dunedin, running from July 2020 to February 2022. 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, OFS and choking risk of New Zealand infants in general and those who are using baby food pouches or BLW compared with those who are not (Taylor et al., 2021). The aim of this thesis was to describe the OFS, feeding behaviours and choking prevalence of 7 to 10 month old New Zealand infants. The structure of the thesis is with

publication, with three chapters of the thesis written in manuscript format each with its own specific aims and objectives described below.

To describe the oral feeding skills of NZ infants aged 7 to 10 months and their associations with early life factors.

1. To describe the oral feeding skills of 7 to 10 month old infants.
2. To identify oral feeding skill difficulty or delay in the study population, using the Child Oral and Motor Proficiency Scale, a validated patient-reported outcome measure.
3. To explore associations between oral feeding skills, sociodemographic characteristics and early feeding practices.

To describe the feeding behaviours of NZ infants aged 7 to 10 months and their associations with early life factors. Explore the relationship between oral feeding skills and feeding behaviours.

1. To describe the feeding behaviours of 7 to 10 month old infants.
2. To identity problematic feeding behaviours in the study population, using the Pediatric Eating Assessment Tool, a validated patient-reported outcome measure.
3. To explore the associations between feeding behaviours, sociodemographic characteristics and early feeding practices.
4. To investigate the relationship between oral feeding skills and feeding behaviours.

To describe the prevalence of food-related choking and determine the predictors of food-related choking in the study population.

1. To determine the prevalence of food-related choking in the study population.
2. To explore the risk factors of food-related choking through a parent-reported questionnaire.
3. To compare food-related choking and complementary feeding practices (parent-led versus baby-led practices).
4. To determine the weighted estimated prevalence of food-related choking and liquid choking.

Thesis structure

This is a thesis with publications. Following this introductory chapter, Chapter Two provides a comprehensive review of the literature, providing the background to the three aims of the thesis. Chapters Three to Five present individual manuscripts aligned with each aim. Chapter Three reports on the first study, which utilised the Child Oral and Motor Proficiency Scale to describe the OFS of infants participating in the First Foods New Zealand Study. Chapter Four builds on these findings by describing infant feeding behaviours using the Pediatric Eating Assessment Tool and examining the relationship between OFS and feeding behaviours using both validated patient-reported outcome measures. Chapter Five presents the final study, which investigates the prevalence of FRC and examines associated risk factors, including complementary feeding practices and specific foods that have been implicated in choking events.

The thesis concludes with Chapter Six, which synthesises the findings across all three previous chapters, discusses their implications in the context of the existing literature, and offers recommendations for clinical practice and future research.

Researchers' contributions

Researcher	**Contribution**
Emily Jones *PhD Candidate*	Chapters 3 and 4: Conceptualisation and design. The candidate determined the use of the patient-reported outcome measures for the study. In addition, the recruitment, participant management, data collection, data checking and cleaning, data analysis planning, and writing of all aspects of the thesis, including manuscripts. Responsible for writing the thesis and manuscripts: design, literature search, and submission.
Professor Cathryn Conlon *Primary Supervisor* *Associate Investigator*	Study conceptualisation and design. Review of thesis and manuscripts.
Professor Emerita Pamela von Hurst *Secondary Supervisor* *Associate Investigator*	Study conceptualisation and design. Review of thesis and manuscripts.
Associate Professor Jillian Haszard *Biostatistician* *Associate Investigator*	Review of the statistical analysis plans. Curated statistical analysis.
The First Foods New Zealand Study received funding through a Health Research Council of New Zealand grant. The research project was led by principal co-investigators Professors Anne-Louise Heath and Rachael Taylor, with Professor Cathryn Conlon, Professor Kathryn Beck, Professor Emerita Pamela von Hurst, Associate Professor Jillian Haszard, Professor Lisa Te Morenga serving as associate investigators on the FFNZ study.	

Chapter 2 – Literature Review

This literature review has been far more than an academic exercise—it has been a transformative journey through which I've tried to find my voice in this field. Having a professional interest and investment in these topics, this review has enabled further engagement and commitment to critique and synthesise current and past knowledge to justify this study design and its implementation.

As I sifted through decades of research on oral feeding development and skills, problematic feeding behaviours and food-related choking, I often found myself staying up late, surrounded by journal articles, questioning terminology that I had previously accepted without hesitation. I've sometimes felt frustrated by gaps that seemed obvious to me from clinical practice but remained unaddressed in the research.

My professional life has been dedicated to helping families navigate feeding challenges, making this review deeply personal. Each study I analysed brought memories of specific children I've worked with—children with subtle oral-motor and sensory differences, overlooked until feeding behaviours became problematic, or those whose parents were terrified of choking after a frightening episode.

This review has strengthened my professional identity, helping me to grow from a clinician who consumes research to a researcher who questions, challenges, and ultimately contributes to the evidence base.

Chapter 2 – Literature Review

This chapter presents a comprehensive literature review of oral feeding skills (OFS) and their development, with a particular focus on the associations with early life factors. The review further examines feeding behaviours and their relationship with OFS and explores food-related choking as a related concern. Drawing on diverse fields, including paediatrics, public health, speech-language pathology, psychology, food science, infant and child nutrition, and preventive medicine, this review synthesises the current understanding of OFS. The literature search methodology involved five major databases of peer-reviewed publications, with detailed search terms and strategies presented in **Tables**. **2.1 to 2.3**.

The review is structured into three main sections. Section one examines OFS development from embryogenesis through childhood, addressing developmental variability through a theoretical framework, and explores early life factors and feeding behaviours that shape OFS. Section two focuses on problematic feeding behaviours, highlighting the diagnostic challenges stemming from inconsistent terminology used across healthcare disciplines and early life experiences. This section introduces the consensus-based Paediatric Feeding Disorder (PFD) (Goday et al., 2019). The PFD diagnostic framework was created to focus on the functional impact of feeding and swallowing difficulties, regardless of the diagnosis or its absence. Despite this framework, there are still areas under- researched, particularly for OFS. Additionally, this section evaluates existing assessment tools and the patient-reported outcome measures (PROMs) that have been developed to assess OFS and feeding behaviours from the parent/caregiver perspective. Section three addresses food-related choking (FRC), examining causes across infancy and childhood with particular emphasis on risk factors for infants under 12 months. The section concludes with a review of FRC and complementary feeding practices, specifically comparing baby-led feeding to parent-led feeding practices.

Search strategy

MEDLINE®/PubMED, Scopus, Google Scholar® and EBSCOhost were searched between October 2019 to February 2025. Search strategies aligned with the study objectives: 1) Oral feeding skill development, complementary feeding practices, and early life factors; 2) Problematic feeding and feeding behaviour; early life factors and associations with OFS; 3) Foreign body asphyxiation and FRC, prevalence, risk factors and associations with complementary feeding practices. **Tables 2.1, 2.2 and 2.3** present the concepts, key words and Medical Search Headings (MeSH), and free text terms used to find relevant articles, as well as search strategies that returned useful results. Additional publications were identified through a manual search of the reference lists of key papers and links to related articles. Public health guidelines were found via targeted website searches. Only articles published or translated to English were included.

Table 2.1

Concepts, keywords, MeSH terms and search strategies for the first aim and objectives

Concept	Keywords	MeSH terms
Oral feeding skills	Oral-motor skill*" OR "oral-motor" OR oromotor OR "oral processing" OR "feeding skill*" OR (oral* OR mouth OR eating OR feed*)) AND sensorimotor", oral processing, motor development, texture acceptance, oral feeding skills, oral sensory skills, food oral processing.	Eating, mastication, sucking behaviour, infant deglutition.
Infant	Infant*, baby*, newborn, neonate, p*ediatric.	Infant*, newborn*, baby, neonate*, Child.
Development	Prenatal OR fetal OR fetus OR antenatal OR antepartum OR perinatal OR in utero" OR infan* OR baby OR babies OR paediatric OR pediatric* OR newborn* OR neonat*.	Health, infant health, child development.
Complementary feeding practices	Complementary feeding, baby-Led Weaning, complementary foods, traditional spoon-feeding transitional foods, "baby- led weaning", pouch feeding OR "pouches* in feeding", "traditional spoon feeding".	Complementary feeding Weaning Mastication* Infant food
Early life factors	"Breastfeeding, bottle feeding, feeding difficulties, prematu*, introduction of solid food, weaning, weaning period, dysphagia, developmental readiness, deglutition disorders, growth, lumpy solids, texture exposure, Congenital heart defect, oral motor deficiency, oral motor delay, dysphagia, (motor skills OR motor skills disorders).	Infant health, feeding and eating disorders of childhood. Feeding methods Demography* Demography* - Health status; Family Characteristics Sociological Factors Health correlates
Assessment, early identification	Assess*, parent report* assessment*, questionnaire, survey.	Assessment.

Search Strategies

OMS AND development AND age Filters: English , Infant: birth-23 months , Infant 1-23 months.

"Oral motor skill*" OR "oral-motor" OR masticat* OR feeding skill* AND develop* AND newborn* NOT prematur*.

(oral motor development) OR (oromotor development) OR (mastication) OR (chewing development) OR (oral facial) AND (infants) NOT premat* NOT speech AND feeding NOT breastfeeding.

"Oral motor skills" OR" Oral skills", OR "oral feeding skills" "complementary feeding" OR transitional foods, "baby- led weaning", pouch feeding OR "pouches* in feeding", "traditional spoon feeding", infants OR babies*.

(Infants) AND "mastication"[Mesh] texture.

Feeding practices OR milk feeds OR age solids started OR parental demographics OR health OR disability.

Food oral processing OR Eating behaviours.

Oral motor skill* AND assessment OR survey AND infan* Or baby OR child*.

Filter: English, age 1 month- 23 months, not premature

Table 2.2

Concepts, keywords, MeSH terms and search strategies for the second aim and objectives

Concept	Keywords	MeSH terms
Feeding behaviour	Food refusal, problematic feeding, feeding behaviour, feeding disorder, fussy feeding, picky eating, aversive, acceptance, feeding problem.	Feeding behaviour (under Psychiatry and Psychology), Feeding and Eating Disorders of Childhood / diagnosis* Feeding and Eating Disorders of Childhood / aetiology* Feeding and Eating Disorders of Childhood / therapy
Early life factors	Breastfeeding, bottle feeding, feeding difficulties, prematu*, weaning, weaning period, dysphagia, developmental readiness, deglutition disorders, growth.	Infant health, feeding and eating disorders of childhood. Feeding methods Demography* Demography* - Health status; Family Characteristics Sociological Factors Health Correlates
Oral Feeding skills	Oral-motor skill*" OR "oral motor" OR oromotor OR "oral processing" OR "feeding skill*" OR (oral* OR mouth OR eating OR feed*) AND sensorimotor", oral processing, motor development, texture acceptance, oral feeding skills, oral sensory skills.	Eating Mastication, Sucking behavior, Infant deglutition
Assessment, early identification	Assess*, parent report* assessment*, questionnaire, survey.	Assessment.

Search Strategies

Oral motor OR feeding development, behavior, feeding, feeding behaviours, eating behavior, feeding related behaviors, feeding patterns NOT prem*.

Feeding behavio* OR milk feeds OR age solids started OR parental demographics OR health OR disability.

Feeding behavio* AND problems AND age.

Feeding behavio* AND problems AND OMS AND age.

Feeding behavio* AND assessment AND OMS AND age.

Feed* OR food OR eat* OR "early feeding" OR fussy* OR picky OR pickiness OR disordered OR "food acceptance" OR selective feeding OR avoidant OR aversive feeding behaviour.

("Feeding behavior"[Mesh]) AND oral-motor development.

Filters: English, age 1 month- 23 months, not premature

Table 2.3

Concepts, keywords, MeSH terms and search strategies for the third aim and objectives

Concepts	**Key words**	**MeSH terms**
Foreign body aspiration Food-related choking	Foreign object asphyxiation, food-related choking, food related aspiration, food related asphyxiation, choking.	Airway Obstruction Respiratory Aspiration Accidental Aspiration Foreign Body
Infants	Toddler* or babies or baby or infant*). Infant*, baby*, newborn, not neonate, p*ediatric.	Infant*, newborn*, baby, neonate*, Child.
Prevalence	Prevalence, population.	Prevalence Incidence Epidemiologic studies Population surveillance Disease burden Health surveys
Risk factors	Risk, feeding behavio*r.	Risk factor Feeding behavior Population at risk Health correlates Foreign bodies
Complementary feeding method	Complementary feeding, Baby-Led weaning, complementary foods, Traditional spoon-feeding transitional foods, “baby-led weaning”, pouch feeding OR “pouches* in feeding”, “traditional spoon feeding”.	Complementary feeding Weaning Mastication* Infant food
Search Strategies Food-related choking AND age AND prevalence. Choking AND age AND risks. Choking prevention AND guidelines. Choking*, “complementary feeding” OR “transitional feeding” OR “transitional foods*” OR “complementary foods”, high risk foods*, infants OR babies*. **Filters: English, age 1 month-23 months, child**		

Section 1- Oral feeding skills

Overview of feeding and swallowing development

Healthy infants born at term possess the innate ability to milk feed. Still, they must develop and master new oral-motor skills to successfully progress to varied textures and tastes throughout childhood (van Dijk et al., 2012). *Oral-motor skills* are observable motor movements that refer to the mechanisms in the oral cavity that manipulate, break down and control liquids and foods so they are ready to be swallowed (Delaney, 2010). Oral-motor skills start with reflexive patterns of movement (rooting and suckling) to elicit milk feeds (breast milk and formula) to sustain life. This progression to early chewing and biting skills as the infant develops is often referred to as *eating skills*. Oral-motor skills, as well as being responsible for the ingestion of fluids and food throughout development, also play a role in communication skills across the lifespan through vocalisation and spoken words. However, this thesis will only focus on skills related to feeding and swallowing.

Oral sensory skills, often referred to as *sensorimotor skills* or *oral sensory motor skills*, are the responses to tactile, temperature, taste and proprioceptive input in the oral facial region and oral cavity (Goday et al., 2019). These oral sensory skills emerge and align with the development of oral-motor skills to support feeding skills (van den Engel-Hoek et al., 2014). These represent the intricate integration of sensory processing and motor execution within the oral cavity, encompassing the precise coordination of neural pathways, muscle groups, and sensory receptors that facilitate feeding skills.

Feeding encompasses more than just oral sensory and motor skills. It can refer to the caregiver-child relationship (Delaney & Arvedson, 2008), as well as the anticipatory responses in preparation for receiving food/fluid, method of feeding practice, placement of food and its management, chewing/mastication, and the transfer of the food bolus to the pharynx ready for swallowing.

Different professions have used different terms to apply their own diagnostic lens to define feeding skills and their difficulties (Goday et al., 2019). This has led to a plethora of descriptions, but a lack of umbrella terms to benchmark typically developing skills and identify the prevalence of feeding difficulties in the research. In 2019, Paediatric Feeding Disorder (PFD) was established as a distinct diagnosis in the International Classification of Diseases (ICD) rather than a symptom. This consensus definition acknowledges that feeding difficulties arise from interactions between physiological, developmental, behavioural, and relational factors, necessitating interdisciplinary assessment and management. This framework aims to improve identification, referrals, and comprehensive treatment planning for children with feeding difficulties (Goday et al., 2019).

As part of its definition, PFD has four domains, including Feeding skill, in addition to Medical, Nutritional, and Psychosocial domains. In the Feeding Skill domain, oral-motor skills and oral sensory skills are classified as *oral feeding skills (OFS)* or *eating skills*, in addition to *pharyngeal sensory* and *motor function* (swallowing) (Goday et al., 2019). OFS are distinct from swallowing as they are predominantly an oral phase function that prepares the food and liquid bolus for safe swallowing (Delaney & Arvedson, 2008). In this thesis, the term *oral feeding skills (OFS)* is the predominant term used by the candidate to describe oral-motor and oral sensory skills, (although reported studies in this review may use oral-motor skills or oral sensory skills separately) to ensure consistency when documenting healthy feeding development and identifying feeding difficulties in the future.

Embryonic (prenatal) development of structures involved in swallowing (1-8 weeks)

The anatomical structures responsible for oral feeding develop early in embryogenesis. The pharyngeal arches, the structures responsible for most of the oral structures, develop approximately four weeks post conception (Delaney & Arvedson, 2008; Dodrill, 2021c; Pearson Jnr & Gosa, 2019). Most anatomy and cranial nerves involved in feeding and swallowing, except for the tongue, arise from these five pharyngeal arches, including the oral facial muscles that aid lip seal and bolus

formation, and those involved in supporting the swallow reflex (soft palate, pharyngeal and laryngeal structures). The tongue develops from occipital somites, which migrate into the pharynx to develop the tongue with the hypoglossal nerve, a motor-only nerve (CNXII) (Pearson Jnr & Gosa, 2019). Therefore, the tongue operates semi-independently in terms of motor function, but sensory feedback (touch and taste) arises from the pharyngeal arches. The pharyngeal arches and tongue develop concurrently with the skull and mandible (jaw) to form the respiratory, vocal, and digestive areas (Pearson Jnr & Gosa, 2019). By week 8, the embryo has a human appearance with the foundations of the main organ systems established (Arvedson & Lefton-Greif, 2020).

Foetal oral-motor movement and swallowing (week nine to birth)

The time of foetal development sees significant developmental progression of swallowing, sucking and oral sensorimotor function, due to the neurological development of the foetus (Delaney & Arvedson, 2008). Non-nutritive sucking movement and swallowing have been observed by ultrasound between 10 to 15 weeks in utero, demonstrated by thumb sucking and the foetus absorbing amniotic fluid post swallow (Delaney & Arvedson, 2008; Miller et al., 2003; Pearson Jnr & Gosa, 2019). This foetal swallowing occurs in parallel with the genesis and development of the brainstem, the control centre of swallowing and respiratory coordination.

Myelination (formation of the myelin sheath around the nerve to aid conduction) is part of the neurological maturation phase that begins in foetal development and continues to early childhood. The myelination of the cranial nerves involved with feeding and swallowing occurs at approximately 20-24 weeks (Delaney & Arvedson, 2008; Miller et al., 2003), and appear to coincide with early oral movement patterns, such as the opening and closing of the jaw, anterior tongue movements and suckling (reflexive sucking movements).

Oral feeding skill development (0 to 12 months)

Although the act of feeding for newborns is a highly intricate task involving 26 muscles and five cranial nerves (Trigeminal V, Facial VII, Glossopharyngeal IX, Vagus X, and Hypoglossal XII)

(Barlow, 2009), typical suckling patterns are usually observed soon after birth in healthy term infants. These patterns are characterised by loose lip approximation around the nipple or teat, efficient intra-oral seal made by the tongue and hard palate compressing the nipple or teat, while the bilateral fat pads (cheeks) and alveolar ridge (the curved bony prominence along the upper jaw that contains the dental sockets and supports the teeth, located where the gum tissue meets the beginning of the hard palate) stabilise the nipple. At the same time, wide jaw movements (mandibular excursions) and tongue blade extrusion work to draw the milk into the oral cavity, with the infant neurologically and physiologically only able to safely manage a liquid diet (Barlow, 2009; Pearson Jnr & Gosa, 2019). Researchers and experts in the field often describe this early suckling pattern, along with the oral structures involved, as a “box” that moves as a “total unit” during the first 6 months of life (Carruth & Skinner, 2002; Cichero, 2016). This is because infant anatomy is designed for self-protection, with infants being preferential nose breathers due to the close positioning of the epiglottis and soft palate during the first 6 months of life. The tongue fills the oral cavity and moves in a straight plane of movement, delivering milk to the posterior of the oral cavity from the nipple or teat (da Costa et al., 2010).

Infant OFS and behaviours are described as reflexive, as they occur when prompted by an external stimulus, such as a touch to the face, and by intrinsic cues, such as hunger. The rooting reflex, characterised by directional head movement in response to perioral tactile stimulation (such as contact with a finger, nipple, or bottle teat), and the subsequent suckling behaviour initiated upon oral insertion of the feeding utensil, constitute fundamental neurologically mediated feeding behaviours in early infancy (**Table 2.4**). However, in terms of the overall organisation of early oral-motor movements and behaviour, these are aided by central pattern generators (CPGs), located in the brainstem (the swallowing and respiratory control centre) (Barlow, 2009; Hadders-Algra, 2018).

Table 2.4

Primitive newborn reflexes involved in feeding

Reflex	Time of emergence	Age it diminishes
Suckling	Early third trimester	3 to 6 months
Gag	Third trimester	Retained through adulthood
Phasic bite	Late third trimester	9 to 12 months
Rooting	Third trimester	3 to 6 months
Tongue Protrusion	Late third trimester	3 to 6 months
Tongue Lateralisation	Late third trimester	6 to 9 months

Adapted from Dodrill (2021)

Central pattern generators

CPGs are made up of adaptive networks of interneurons that actuate groups of motor neurons to generate task-specific motor patterns. For example, healthy term infants can switch between a non-nutritive sucking pattern (the pattern used with a pacifier, where no fluid is drawn and swallowed) and a nutritive sucking pattern when milk feeds are offered. This means that these CPG networks demonstrate experience-dependent or task specific plasticity (Barlow, 2009; Delaney & Arvedson, 2008; Hadders-Algra, 2018). Two studies demonstrate this concept; an older longitudinal study by Shepherd and Mysark (1984) looked at the interplay between infantile reflexes and early chewing (voluntary movement). They found that their healthy term infant participants, from one week of age, displayed the appropriate jaw and tongue movement components needed to move a food bolus (a small cube of banana) from the lateral to the medial position in the oral cavity. Although the later developing chewing movement does not appear until later infancy. However, this demonstrated that the infant was able to display a different oral feeding pattern, depending on the stimulus (Sheppard & Mysak, 1984).

A later study altered pacifier stiffness for premature infants. The researchers demonstrated that changing the stiffness of the pacifier resulted in shorter non-nutritive sucking bursts. This in turn reduced the number of non-nutritive sucking bursts and altered their suck cycle, demonstrating the sensitivity of the suck CPG to respond to changes in the infant's environment or stimulus (Zimmerman & Barlow, 2008). Although oral feeding is reflexive, infants can adapt their skills to the environment or stimulus. This leads to the coordination of suck-swallow-breathe in infants.

For infants, still in the suckling phase (under 6 months of age), they should exhibit one suckle, one swallow and one breath per second 1:1:1. Cessation of breathing or swallow apnoea consistently occurs in nutritive sucking and non-nutritive sucking patterns of both healthy term and premature infants (Kelly et al., 2007a). In their longitudinal study, Kelly and colleagues found that infants achieved an 'adult type' pattern of post-swallow expiration, with two major shifts in the precise patterns occurring. The first shift occurred after one week of postnatal feeding and the second between 6 to 12 months, caused by changes both neurologically and anatomically (Kelly et al., 2007b). Their study, the longest longitudinal study, analysed over 15,000 infant swallows. It found that the infant's neurological and anatomical maturation appeared only to govern swallow-breathe coordination and not milk feeding practices (breast versus bottle feeding) (Kelly et al., 2007b). In contrast, other studies found that milk feeding practices did affect suckling patterns (da Costa et al., 2010; Qureshi et al., 2002). However, they only followed the infants for 4-10 weeks post birth, compared to one year post birth (Kelly et al., 2007b).

At approximately 5 to 6 months the early suckling pattern of movement develops into the more mature, learned pattern of sucking. This more mature pattern of movement exhibits more precise oral feeding movements, such as a tighter lip seal, compared to the lip seal seen in suckling. Healthy infants may use two or three sucks per one swallow, and one breath 2:1:1 (Pearson Jnr & Gosa, 2019). This progression to sucking is reflective of cortical maturation in which the infant achieves an adult-like pattern of expiration post swallow and transitions from being a preferential nose breather to a predominant oral breather. Coinciding with the anatomical changes of the oral cavity expanding and the epiglottis and soft palate no longer approximating (Kelly et al., 2007b; Pearson Jnr & Gosa, 2019).

Oral feeding skills at complementary feeding age

At this time of transition to a more mature sucking pattern another critical transition occurs, with the introduction of solid foods. At this time, the infant is exposed to new food textures and tastes and must learn and become proficient in these new OFS (van Dijk et al., 2012). The oral cavity expands, and the oral structures start to move more independently. The epiglottis and soft palate move apart as the pharynx lengthens, causing the posterior third of the tongue to descend with it. The spaces created allow the oral structures to move more independently rather than as one unit. The tongue starts to move vertically, helping the infant transition to a volitional sucking pattern for milk feeds and readiness to accept runny puree, which the infant can transport from the anterior to the posterior of the oral cavity. All these changes are preparing the infant to accept more textured solids, which require chewing or mastication. The next section addresses descriptive, observational, and longitudinal studies of OFS development for solids from a typically developing perspective at the complementary feeding age.

Chewing/mastication in the first 12 months

Chewing, or mastication, is an important developmental process for OFS that continues to evolve and refine throughout childhood. It is a protracted process that is shaped by anatomical development/growth, dentition, gross and fine motor development and texture progression (Carruth, Betty Ruth. et al., 2004; Gisel, 1991; Simione et al., 2018). To progress to more complex textures, repeated practice and consistent acceptance are required (da Costa et al., 2017; van den Engel-Hoek et al., 2014).

Earlier studies focused on OFS development have mainly relied on video or live observations to document mastery of food textures and skills by certain ages. Morris (1982) followed six children from birth to 2 years and reported 63 feeding skills. Levels of mastery were then developed when four out of six children demonstrated each particular skill. Interestingly, the emergence of these skills varied by as much as 26 months across the six children (Morris, 1982).

The levels developed by Morris were used by Telles & Macedo (2008) with a larger cohort (*n* = 42) to explore the relationship between OFS and motor development. They reported that variability was observed between infants between 4 and 9 months. However, by 6 months, most oral movements occurred without dissociation; that is, the oral structures continued to move as one, as infants transitioned from reflexive to volitional feeding. By 9 months, dissociation began to occur, with jaw movements increasing in complexity compared to the tongue and lips. Then by 12 months the jaw started to move diagonally. However, the researchers concluded that infants needed to have mastered independent seating for adequate development of oral control and OFS acquisition by 9 months (Telles & Macedo, 2008).

Oral feeding skills and motor development

There is a close relationship between motor development and oral-feeding ability (Delaney & Arvedson, 2008). Gross and fine motor skills need to be codeveloping to support self-feeding, with typically developing children acquiring self-feeding skills in the first 2 years of life (Carruth & Skinner, 2002; Carruth, Betty Ruth. et al., 2004; Delaney & Arvedson, 2008).

Curruth & Skinner (2002) found, in their longitudinal observational study, that infants who sat independently reached for a spoon at around 6 months could transfer food and toys between hands at around 7 months. The mothers (n = 98) of healthy children were interviewed when their child was between 2 and 24 months old. The authors found that most of the cohort were similar in age when their motor development and feeding skills developed, yet for some, there was a wide range of variability. They observed that some parents would benefit from education about the variability that occurs with healthy children, and others may require more encouragement to allow their children to be more autonomous in the feeding process (Carruth & Skinner, 2002). A later study by Carruth and colleagues found that children who developed self-feeding skills with spoon-feeding at an earlier age had better nutrient intakes than those who did not. However, this had evened out by 15 to 18 months (Carruth, Betty Ruth. et al., 2004).

Exposure to food textures

In addition to motor skills, OFS development depends on the infant's exposure to varying food textures. Older studies found oral movement patterns such as lateral tongue and jaw movements are texture dependent in infants 7 to 8 months of age (Reilly et al., 1995; Wilson et al., 2012).

Gisel (1991), in the largest longitudinal study at the time (*n* = 143), found that infants between 6 and 8 months typically achieved OFS maturity for purees and soft solids. However, for harder textures (such as dry cereal pieces), OFS proficiency was not achieved for some infants until after 24 months of age. At 6 months, the strategies used by the infants varied. Some would hold the food in their mouths, allowing saliva to dissolve it, and then initiate a sucking pattern to swallow. Others attempted to 'munch', displaying an early chewing pattern, meaning that the lower jaw moved in a vertical pattern to break down food pieces. In contrast, tongue lateralisation was elicited by the solid and viscous textures, but not for puree (Gisel, 1991). In these 2 months, chewing cycles start to appear, moving from an early munching pattern to a chewing cycle, "one-down-and-up movement of the mandible" pg. 71 (Gisel, 1991). As infants aged, fewer chewing cycles were needed to chew a standard bite size of food. For example, with a Cheerio® (meltable solid), chewing cycles decreased significantly from 10 to 12 months and 12 to 18 months.

Recently, a French study agreed with Gisel's results, finding that chewing skills emerged at 8 months and were established by 10 months (Demonteil et al., 2019). Their study also included foods not previously explored, such as raw vegetables and sticky foods (fork-mashed banana, half-slice of banana and soft cheese (Brie). Chewing continued to develop until 18 months for hard foods, such as raw carrots, baby biscuits, and crusty bread. The authors reported that infants accepted some textures at an earlier age compared with when their parents introduced them (Demonteil et al., 2019).

In addition to food texture, Gisel (1991) observed that the size of the food pieces made a significant difference in the number of chewing cycles as children aged. This was most clearly seen with viscous (slippery) foods (orange gelatine). At 6 months, there was no difference in time or chewing cycles for small or large pieces. The infants used a 50% sucking and 50% munching pattern. By 8 months, there was a significant difference between the time taken for small pieces (5 x 4 x 4mm) and large pieces (10 x 4 x 4mm), with infants taking longer to eat the larger pieces. Although small pieces continued to require fewer chewing cycles as the infants aged, larger pieces consistently took longer than small pieces to chew after 8 months (Gisel, 1991).

Similarly, a well-designed intervention study reported small but significant evidence that infants' exposure to larger and harder pieces of food at 8 months can improve their chewing skills for pieces of food but not for mashed foods. The group given the larger and harder pieces of food at 8 months was found to have a higher chewing capability for cooked carrot, cooked potato and banana pieces four weeks post-introduction. They concluded that exposure to textures can influence early chewing ability (da Costa et al., 2017).

In addition to texture exposure and bite sizes, consistent practice is also important for developing OFS. A study looking at infants acquiring the skill of spoon feeding found that infants between 4 and 8 months needed approximately 5.7 to 8 weeks to acquire the skill (van den Engel-Hoek et al., 2014). The authors concluded that the start of spoon feeding or the moment in time the skill is acquired is less important than the period in weeks to acquire the skill. This suggests that exposure and practice is most effective for developing OFS rather than the age it starts; and that the associated OFS (opening and closing the lips, tongue movement to transport the bolus to initiate swallowing) became more precise with experience, particularly, daily experience (van den Engel-Hoek et al., 2014). Although these studies reported skill for the textures given, the volumes of food texture infants will tolerate through typical mealtimes has not been examined until recently.

Volume of food textures tolerated

A cross-sectional study of typically developing infants aged 8 to 12 months found that by 8 months of age, infants had transitioned to pureed solids, and nearly half of their energy requirements were met through this texture, with the rest met by milk feeds. By 10 months, infants were consuming a range of purees and regular solids, with an equal distribution of energy intake between purees and solid foods. By 12 months, there was a significant transition to a more mature feeding schedule with fewer daily feedings (about five to six compared to seven at younger ages), less reliance on liquid-only feedings, and solids contributing an equal proportion of energy intake as liquids (Delaney et al., 2021). There were limitations to this study, as the cohort was small and homogeneous, and not ethnically diverse (all but one participant was Caucasian and all from higher socioeconomic backgrounds). In addition, the developmental and feeding questionnaires used were not validated. However, the authors made an important suggestion for future assessment as a result of this study. They suggested that the proportion of texture infants were consuming as well as OFS should be assessed together, to give a clearer picture of feeding development than just on texture consumption alone.

The researchers also recommended that future research include larger, more diverse cohorts of children with standardised texture categories and definitions that align with OFS development. Furthermore, comprehensive assessment criteria are needed to establish age-appropriate texture intake patterns as clinical reference points. These patterns could be used to identify children at risk of Paediatric Feeding Disorder (PFD) based on delays in texture advancement (Delaney et al., 2021). The table below summarises OFS development and the appropriate food textures in their first 12 months of life, as summarised by various sources (**Table 2.5**).

Table 2.5

Oral feeding skills, oral structures and food examples of typically developing children 0-12 months

Age	Oral Feeding skills	Oral structures	Food examples
Birth to 6 months	Nutritive and non-nutritive sucking (suckling) – all reflexive	Lips, tongue, jaw. The oral cavity works as one unit	Milk feeds only
4 to 6 months	Nutritive sucking transitioning to volitional control (sucking). Biting and chewing skills not developed	Tongue starts to move vertically	Milk feeds, smooth, runny purees
6 to 9 months Central incisors start emerging	Early tongue lateralisation. Vertical chewing Munch in response to dissolvable solids Mixed response to viscous textures (gelatine) (50% sucking, 50% munching) Beginning of chewing-like movements	Dental eruption commences (central incisors) The tongue moves laterally (sideways)	Smooth and lumpy purees Minced and moist foods in sauce. Dissolvable solids Soft foods
9 to 12 months Premolar phase Lateral incisors start emerging Major transition point in oral-motor development (10 months)	Not biting through foods. Munching becomes more frequent than suckling for gelatine Puree is eaten in a mature manner from this point on Mature chewing patterns continue to develop Vertical shifting to diagonal jaw movements but not biting through foods	Lateral incisors Tongue lateralisation improving	Chopped foods, finger foods, teething rusks, soft pieces of solids Stick shapes to encourage tongue lateralisation

*Individual variations in development rate. Adapted from Cichero, (2019); Delaney & Arvedson (2008); Gisel (1991); Morris, (1982) Carruth et al., (2002); Dodrill (2021) ; Simione et al., (2018)

Oral feeding skills continuing into childhood

The development of OFS, particularly the skill of chewing solids, continues into childhood, driven by dentition (particularly the development of molars), increasing bite force and greater jaw movement. Early chewing development has been proposed to go through two phases: The Premolar and the Molar phases (Simione et al., 2018). Infants and children in the Premolar phase have the basic motor patterns for chewing, but their mandibular (jaw) control and coordination are lacking, as well as bite force (Simione et al., 2018). Simione and colleagues found that, although 9 month olds (their youngest participants) had similar chewing rates to older children (22 months), their jaw movements exhibited decreased bite force and greater jaw displacement compared to those of older

children. As they continue to develop, children will refine their OFS, enabling them to tolerate an adult diet. However, the age at which OFS plateau is undecided in the literature (Delaney & Arvedson, 2008). A theoretical framework to help explain this variability in motor and oral feeding development is discussed next, through the lens of Dynamic Systems Theory.

Dynamic Systems Theory: A framework to understand oral feeding skill development in the first 12 months of life

Dynamic Systems Theory is a theoretical framework that stemmed from mathematics and chaos theory, and views development and motor skills as a complex, self-organising process rather than a predetermined sequence (Thompson et al., 2023). It was through Esther Thelen's research examining the stepping reflex in infants that three elements emerged to explain motor learning according to the Dynamic Systems Theory framework: Development depends on the dynamic interplay between *person factors* (individual capabilities, neural status, muscle strength, motivation), *task factors (*specific movement demands, complexity, goals*)*, and *environmental factors* (context, tools, support, constraints), rather than being controlled by any single factor (Zimmerman et al., 2020). Dynamic Systems Theory also emphasises the importance of the parent-child relationship, parental voice, and family context in feeding development (Thompson et al., 2023). Dynamic Systems Theory, described by Esther Thelan, comprises three core principles that describe motor developmental processes. These will be discussed in terms of oral feeding development when starting solids. This framework can also be applied to infants learning to eat solids as their early chewing skills are developing, illustrating that development emerges from interactions rather than fixed milestones.

The first principle, **multidetermined development**, proposes that motor behaviour results from interactions between multiple factors, not single causes (Zimmerman et al., 2020). A child's feeding development results from a complex network of interacting components, including the structure and function of the oral structures, milk feeding practices (breast or bottle feeding), gross

and fine motor development, and underlying health conditions, all contributing to feeding development (van Dijk, 2021).

The second principle, **softly assembled** development, emphasises that motor patterns are flexibly organised based on the task and environmental context. Thelen's research revealed that the same motor pattern—stepping—could appear and disappear based purely on environmental conditions, such as water submersion or treadmill support, but not in normal contexts (Zimmerman et al., 2020). These can relate to parental choices around foods given and the environment the child is exposed to, for example, involvement in family meals and adequate seating provision.

The final principle, **nonlinear development**, recognises that motor systems undergo periods of instability and reorganisation rather than smooth, linear progression when a new developmental skill is emerging (van Dijk, 2021; Zimmerman et al., 2020). In Thelen's research, when infants were placed on a treadmill (with assistance), it was found that in their first month of life, they produced few steps on the treadmill, but there was an increase at 3 months of age. Yet this change in stepping occurred at different times for each infant (Thelen & Ulrich, 1991). This nonlinearity is particularly relevant to feeding development, where variability is recognised not as error or immaturity, but as an indicator of system exploration and potential for change (Zimmerman et al., 2020).

Similar to other motor skills, such as walking, oral feeding development is a dynamic developmental process in which a typical sequence is usually followed. For example, when learning to walk, most infants follow a typical developmental sequence, such as crawling on their stomach, then on their knees, hands, and feet, followed by standing and walking. However, some may follow a less typical sequence, such as crawling on the stomach, then standing and walking, which still results in a successful outcome (Thelen, 1985; Thompson et al., 2023; Zimmerman et al., 2020).

Likewise, during development transitions (introducing solids), development becomes particularly non-linear and unpredictable, with instability necessary for determining solutions (Zimmerman et al., 2020). Often, high variability is observed in early feeding tasks before stabilisation, and decreased variability occurs as feeding skills develop (van Dijk, 2021).

Most children follow a typical sequence of oral skill development, such as sucking from the breast or bottle, taking pureed solids from a spoon, and then eating chewable foods (Carruth, Betty Ruth et al., 2004; Pados, Park, et al., 2018). However, other children may follow a different sequence of skill development that also allows for the achievement of complex OFS. Different complementary feeding practices, in which chewable foods are offered first, instead of pureed texture or taking larger volumes of pureed solids for longer, may still result in age-appropriate OFS. Using Dynamic Systems Theory as a potential framework for considering OFS development may be helpful in explaining variability in typically developing children.

Both age and consistency-related effects are evident in the development of masticatory timing. Changes in food texture affect measures of masticatory timing in infants as young as 7 months. While some aspects of chewing development are established early in ontogeny, others are protracted beyond 35 months of age (Wilson et al., 2012). This differential timing across various aspects of masticatory development illustrates the non-linear, dynamic nature of oral feeding skill acquisition.

Consistent with Dynamic Systems Theory, this complexity manifests as significant individual variability in developmental pathways. This variability in OFS acquisition among healthy infants is well-documented, with the American Academy of Paediatrics reporting that some children do not develop the skills to tolerate an adult diet until 4 years of age (AAP, 2010). Such variation reflects the self-organising nature of feeding development, where individual differences in timing and progression emerge from complex interactions between child, task, and environmental factors. Interestingly, although there is variability, OFS, like other motor tasks, rely on experience and/or environmental stimuli to aid development.

Complementary feeding and oral feeding skills

Complementary feeding refers to the introduction of solid foods alongside continued breastfeeding or formula feeding. From a nutritional perspective, complementary feeding should

start when exclusive breastfeeding can no longer provide enough energy and nutrients for the infant's growth and development. It is also the time infants display cues to indicate their readiness for solids (reaching and looking at foods) (Zakarija-Grković et al., 2020). Complementary feeding represents a critical developmental window not only for nutrition but for OFS acquisition. The onset of complementary feeding coincides with the cortical maturation of the infant, as reflexive feeding ceases. As infants transition from a milk-exclusive diet to a varied diet with different textures, they simultaneously develop the complex OFS essential for mature eating patterns, both for immediate feeding success and long-term development.

The New Zealand Ministry of Health recommends starting complementary feeding at around 6 months of age using a developmental approach (Ministry of Health, 2021). These guidelines also align with the World Health Organization's Guideline for complementary feeding of infants and young children 6-23 months of age (World Health Organization, 2023). A developmental approach to complementary feeding involves providing food textures that complement the development of OFS. After only having milk feeds, purees can help an infant learn to swallow a thicker texture comfortably and expose them to different flavours before progressing through the texture continuum (Ripton & Potock, 2016). A smooth puree is initially given by spoon by the caregiver, followed by lumpier purees, then mashed, chopped, and finger foods, and finally, progressing to family foods by 12 months of age. This swift texture progression is important to support developing OFS (early biting, chewing and oro-sensory awareness) and the gradual expansion of the oral cavity. This approach is described as traditional spoon feeding (TSF) in this thesis.

Baby-led weaning

In contrast, baby-led weaning (BLW) is an approach to complementary feeding whereby infants are presented with foods in whole form (finger foods) rather than purees and feed themselves rather than being offered food by spoon. BLW was first described by Gill Rapley, a health visitor and midwife in the United Kingdom. Rapley believed that by 6 months of age, the infant is

developmentally ready to feed themselves with finger foods, such as soft-cooked vegetables, fruit, strips of meat and toast fingers. The idea being that infants at 6 months are better equipped in terms of their oral-motor and fine motor abilities to handle food themselves, and will learn to accept new tastes and textures readily if exposed to them (Rapley, 2005).

Rapley reported from her own experiences as a health visitor that TSF was concerning for the infant's development in two ways. Firstly, it gave too much control to the feeder and presented difficulties for the infant as they progressed to more mashed solids. She observed that TSF made mealtimes less messy, but the infant could be at risk of overfeeding by the parent or caregiver. Secondly, she found that TSF infants had an increased tendency of gagging and spitting out lumps when they progressed to lumpier and mashed textures. Rapley, from her observations, reported that "the infant allowed to handle their food and bite off pieces themselves appear to cope with lumps more effectively and at a younger age than those who are either prevented from tackling them or have them offered on a spoon" (Rapley, 2005, p. 285).

In 2022, Adapted Baby-Lead weaning© was published as an approach for infants and children with developmental difficulties, coauthored by Gill Rapley and speech-language pathologist, Jill Rabin (Rabin, 2022). There are no studies examining the relationship between BLW and oral feeding development; however, some randomised control trials have looked at the textures of foods consumed and the risk of choking (Dogan et al., 2018; Fangupo et al., 2016; Morison et al., 2016). These will be discussed later in section three.

Modified baby-led weaning

BLISS (Baby-Led Introduction to SolidS) is a modified approach to BLW, pioneered through the University of Otago, that maintains the self-feeding approach but includes specific nutritional guidance to provide caregivers with information to reduce choking risk and promote nutrient sufficiency (iron and energy intake) (Daniels, Taylor, Williams, Gibson, Fleming, et al., 2018; Daniels, Taylor, Williams, Gibson, Samman, et al., 2018; Williams Erickson et al., 2018). A randomised

controlled trial (RCT) was conducted comparing nutritional differences between infants who were encouraged to feed themselves from the start of complementary feeding using the BLISS practice with those introduced to complementary feeding by TSF (Williams Erickson et al., 2018) (Daniels, Taylor, Williams, Gibson, Fleming, et al., 2018; Daniels, Taylor, Williams, Gibson, Samman, et al., 2018). Although BMI and choking (Fangupo et al., 2016) were examined between the groups, OFS were not examined specifically.

Traditional spoon feeding versus baby-led weaning

Most studies comparing BLW to TSF have primarily looked at nutrient outcomes (Daniels, Taylor, Williams, Gibson, Fleming, et al., 2018; Fangupo et al., 2016; Williams Erickson et al., 2018). Previous concerns regarding BLW have been about infants' iron status due to not receiving fortified cereals, and choking (D'Auria et al., 2018). Currently, BLW is not recommended by the Ministry of Health, New Zealand. Despite increasing in popularity, evidence to support the safety and nutritional outcomes of BLW is limited (Fu et al., 2018). In terms of OFS development, two studies, (Białek-Dratwa et al., 2022; Wright et al., 2011) suggest a positive influence associated with longer breastfeeding duration and the introduction of solids when infants are sitting independently and reaching for foods.

A recent cross-sectional study from Poland found that breastfeeding rates and the timing of solid introduction were significantly different between groups (TSF versus BLW). They found that infants who were mainly fed via BLW accepted more lumpy textures and were more independent at sitting. Breastfeeding rates were significantly higher in the BLW group and lowest in those whose mothers were not familiar with the BLW approach. However, only 29% were exclusively BLW, while the remaining group classified as BLW were receiving a mixed approach (Białek-Dratwa et al., 2022).

Wright et al. (2011) found that BLW was effective for most infants but may not be suitable for those with developmental delays, who might struggle with nutritional intake. Some infants in

their study were still not reaching for food at 8 months, suggesting that a flexible approach combining both BLW and TSF may be best for some children (Wright et al., 2011).

Baby food pouches

Over the past few years, baby food pouches (BFPs) have gained popularity. These pouches are made of compressible plastic filled with pureed food with a plastic nozzle. Although convenient and more sustainable for the environment (Koletzko et al., 2019; Sieti et al., 2019), concerns have been raised regarding their high sugar and energy content, in addition to concerns regarding the feeding method to infants. Originally, BFPs were designed to be directly squeezed onto the spoon. However, there are concerns that parents and caregivers may skip this step and feed their infant directly from the nozzle or allow older infants and children to feed themselves directly from the BFP. These concerns are valid, as OFS need to develop into a vertical chewing or munching pattern to support biting and chewing skills, rather than encouraging an early sucking pattern of movement. It also means that parents may not be introducing more textured solids to their infants and may let them remain on smooth purees.

An internal study conducted by Gerber Baby Foods in the United States revealed that children offered commercial purées in BFPs demonstrated 31% higher willingness to sample or consume the contents compared to identical offerings presented in conventional open bowls. Parental feedback indicated that two key factors contributed to this enhanced acceptance: the opacity of the pouch, which concealed the food's colour from the child's view, and the self-feeding autonomy the pouch design facilitated. These findings were interpreted as promising indicators for future infant nutritional product development and delivery systems (Smith-Simpson, 2018). However, in this industry-funded study, the participants were children with picky eating habits and established low vegetable consumption, rather than infants at complementary feeding age.

To our knowledge, no empirical studies have examined the relationship between OFS and the use of BFPs. A qualitative study on parental perceptions revealed concerns that BFPs might limit

exposure to diverse textures and flavours, with some participants (parents) refusing to allow direct consumption from BFPs due to potential adverse effects on OFS acquisition and dental development (Rowan et al., 2019). Nevertheless, a recent New Zealand study using the FFNZ data reported that only 5% of 7 to 10 month old infants (*n* = 30/625) were fed directly from pouch nozzles (McLean et al., 2024). Despite limited research, many infant feeding experts advise against BFP use (Cichero, 2017; Koletzko et al., 2019).

Early life factors contributing to oral feeding skill status

This section reports on the early life factors that contribute to OFS. The delayed introduction of complementary feeding and insufficient exposure to texture progression have been identified as primary factors affecting typical OFS development. Although these constitute the most critical influences on feeding skill acquisition, other early life factors also contribute to oral feeding development.

Late/delayed introduction of solids/complementary feeding

Introducing solids after 9 months, potentially signalling delayed oral feeding development, correlates with subsequent food acceptance difficulties in childhood. The first researchers to propose the concept of a critical or sensitive period for introducing solids were Illingworth and Lister (1964). They cautioned that if infants were not exposed to solid foods at six to 7 months, it would lead to refusal, failure to chew, and vomiting later in childhood. The authors based these findings on 9 children in a residential institution with developmental delays or health issues (Illingworth & Lister, 1964). Despite the limitations of the research, in recent years many robust studies have found that late introduction of solids, particularly the prolonged use of pureed textures, caused difficulties with later progression and acceptance of foods into childhood (Coulthard et al., 2009; Emmett et al., 2018; Fewtrell et al., 2017; Harris & Coulthard, 2016; Northstone et al., 2001), supporting Illingworth and Lister's findings.

Northstone et al. (2001) found that the late introduction of 'lumpy' solids (after 10 months) resulted in fewer family foods being accepted by 15 months. In a follow-up study, Coulthard et al. (2009) sought to determine whether the age of solid food introduction affected the child's diet at the age of 7. Again, the children offered 'lumpy' solids after 9 months ate fewer food groups at 7 years, including all 10 categories of fruit and vegetables, than the group introduced to solids before 9 months (Coulthard et al., 2009). In Brazil, although the introduction of pureed solids occurred at the recommended time by their national guidelines, transitioning to harder solid foods happened later than recommended (an average of 16 months) for children with feeding difficulties. Whether parents delayed harder foods due to their infant's feeding difficulties is unclear. However, their sample of infants 0 to 12 months was small (n = 11), and from a convenience sample, so it may not reflect the general population (Ramos et al., 2017). Moreover, the cohort ranged in age from 0 to 10 years, with parents of older children recalling their past feeding history over a prolonged period. Nevertheless, the risk of prolonged and exclusive use of pureed foods beyond 9 months of age appears to compromise acceptance of age-appropriate foods in later childhood.

Past and current milk feeding practices (breast & bottle feeding)

The choice of milk feeding practice (breast, bottle feeding, or mixed) that parents chose to use from birth and alongside complementary feeding may impact OFS. However, there is limited evidence. Most literature has reported that the types of food and textures offered impacted OFS rather than the method of milk feeding (Harris & Coulthard, 2016; Hübl et al., 2020). Harris & Coulthard (2016) concluded that breastfeeding offers some advantages by exposing the infant to a wider range of flavours in their diet. However, it is not a prequel to wider food tolerance; rather, it is the timing and frequent exposure to varied food textures and tastes that are. Formula-fed infants can still develop a preference for varied foods through timely introduction to a range of foods (Harris & Coulthard, 2016).

Recently, a scoping review found inconsistent evidence for associations between the duration of breastfeeding and atypical feeding behaviours in young children (Bąbik et al., 2021). However, most studies in the review did not examine OFS and were conducted on infants and older children. Although one study found a positive association between exclusive breastfeeding and OFS development for sucking performance at 9 months, there was no association between OFS and chewing or spoon feeding (Bąbik et al., 2021). Interestingly, some studies suggest that if breastfeeding was successful, parents will not report feeding difficulties originating from the introduction of solid food, delaying identification of feeding difficulties until later in childhood (Bąbik et al., 2021; Fuls et al., 2020).

Guimaraes et al. (2023) conducted a 12 month cohort study comparing oral motor dysfunction (OMD) and the introduction of food consistencies between preterm and full-term infants. OMD is an older term referring to functional alterations in oral skills that affect feeding abilities, including difficulties with sucking, swallowing, and chewing. The study followed 87 at-risk infants (46 preterm, 41 full-term) through five evaluations from hospital discharge to 12 months of age. OMD was initially observed in 30 infants (15 in each group) during the first assessment with liquid consistencies. However, most cases resolved over time, with only 5 infants demonstrating persistent OMD at the final assessment when solid consistencies were evaluated.

Contrary to expectations, the researchers found no significant differences between preterm and full-term infants in the timing of introducing different food consistencies during complementary feeding. The study found that bottle feeding at hospital discharge increased the likelihood of developing OMD by approximately seven times (OR = 7.55). Regarding breastfeeding practices, full-term infants demonstrated higher initial breastfeeding rates; however, both groups had shorter exclusive breastfeeding durations than the recommended guidelines (4 months versus 6 months). (Guimares et al., 2023). Hübl et al. (2020) further explored feeding skill development in healthy premature infants, demonstrating that the length of chewing experience was significantly associated with feeding skills at 9 and 12 months ($p < .001$), rather than sucking patterns (Hübl et al., 2020).

Overall, the evidence regarding the impact of milk feeding practices on OFS remains mixed and limited. Whilst some studies suggest breastfeeding may offer advantages through flavour exposure (Harris & Coulthard, 2016) the consensus indicates that texture progression and timing of solid food introduction are more influential factors than the method of milk feeding itself. The identification of bottle feeding as a significant risk factor for oral motor dysfunction (Guimares et al., 2023) warrants further investigation, particularly given the inconsistent findings regarding breastfeeding duration and feeding behaviours (Bąbik et al., 2021). Importantly, successful early feeding experiences may mask later difficulties, highlighting the need for continued monitoring beyond the initial feeding period.

Early introduction of solids

Early solid introduction (before 6 months) correlates with diminished diet quality and altered eating frequency by age 3, compared to introduction at or after 6 months (Hollis et al., 2016). Limited evidence exists regarding its impact on OFS relative to late introduction (after 9 months). Maternal youth, multiparity, lower educational attainment, and smoking status were predictors of early solid introduction (Hollis et al., 2016).

Similarly, a review on early solid introduction suggested that it may have a detrimental effect on oral feeding development; however, the results were inconclusive as only lower-level quality studies were included (Brisque Neiva et al., 2003). More recently, a South African longitudinal study found that early solid introduction was associated with lower fine motor skill outcomes, impacting texture exposure and progression due to self-feeding difficulties (Eales et al., 2020).

Developmental delay & disability

Children with existing diagnoses of neurological impairment and developmental delay, such as Down syndrome and cerebral palsy, have a high prevalence of OFS difficulty and dysfunction (Field et al., 2003). Lefton-Grief & Arvedson (2007) reported that the prevalence of *feeding difficulties* (including dysphagia) in children with developmental delay or other diagnoses was approximately 85-

90% (Lefton-Greif & Arvedson, 2007). More recently, a nationwide prevalence study in the United States, also looking at general *feeding difficulties* of children between 7 months to 17 years (*n* = 39 674) between 2010 to 2017, found that enteral (tube) feeding was the most associated diagnosis, followed by OFS difficulty and congenital anomalies (Edwards et al., 2022).

Health conditions

Health conditions may disrupt OFS, leading to delays or dysfunction. However, most published studies examined persistent or severe feeding difficulties rather than OFS specifically. Common risk factors associated with feeding difficulties include lower birth weight, prematurity, congenital heart conditions, early enteral feeding, and gastroesophageal reflux (Douglas & Bryon, 1996; Mason et al., 2005; Motion et al., 2001; Pados, 2019; Pados et al., 2021; Ramsay et al., 2011; Rommel et al., 2003; Sanchez et al., 2016). A large clinical study by Rommel et al. (2003) found that nearly half of participants with feeding difficulties also had an underlying medical condition.

Gastroesophageal reflux (GOR) and gastroesophageal reflux disease (GORD) have long been known to cause discomfort for infants during feeding, impacting oral intake (Douglas & Bryon, 1996). However, studies focused on their impact on OFS are scarce. A small but well-controlled study examining the effect of GOR on OFS found that nearly all the infants (16/20) were diagnosed with moderate to severe OMD, compared to non-GOR infants. The presence of GOR impacted their fine motor skills (holding a spoon and the ability to self-feed) as well as their capability to display readiness cues or skills needed to transition to solids. Only infants with no other health or developmental condition were included in the study (Mathisen et al., 1999). Similarly, Field and colleagues found that half of the children in their study with GORD had OFS delays (Field et al., 2003), and children diagnosed with OMD also had a history of GOR and GORD. In contrast, those without OMD had a history of constipation and faltering growth (Dailey, 2009).

Other factors associated with oral feeding skill difficulties

Earlier studies examining demographics and parental factors associated with feeding difficulties (which encompassed feeding behaviours and dysphagia beyond OFS alone) found that child-related factors, such as birth weight and growth patterns, showed stronger associations than demographic or parental characteristics factors (Douglas & Bryon, 1996; Motion et al., 2001; Reilly et al., 1999)

In Reilly et al. (1999), although the associations were not statistically significant, they found that children with OMD tended to be shorter, have a slightly smaller head circumference, slightly lower birthweights and tended to weigh less in the first 6 months of life compared to those without OMD (Reilly et al., 1999). Additionally, these infants with OMD exhibited subtle neurological signs, including hypotonicity and tactile defensiveness. The researchers speculated that perhaps a soft/subtle neurological impairment emerges around the introduction of solid foods that was not identified during reflexive feeding (Reilly et al., 1999). Furthermore, although the authors found that these infants were also less adaptive at mealtimes, the infants' behaviour did not seem to be an issue for caregivers. Although not dysphagic (impaired swallow ability), they were left on purees and semisolids for a longer time, as they had greater difficulty with these textures (Reilly et al., 1999).

In addition, Mathiesen and colleagues found that OFS difficulties were seldom identified in infants from lower socioeconomic communities with faltering growth. Due to the feeding behaviours between the mother/child dyad being more pronounced. These feeding behaviours were decreased maternal responsiveness to infant feeding cues and limited mealtime interaction (Mathisen et al., 1989). The authors concluded that the infants' OFS difficulties would not have been identified through routine primary care screening due to the problems observed in the parent-child feeding relationship (Mathisen et al., 1989).

Late parental reporting of OFS difficulty

The risk for infants not identified with OFS difficulty or OMD is that their growth and feeding development can be impacted later when learned behaviours have become apparent, as the child refuses the foods, they find challenging. Two international studies support this.

The first study by Marshall et al. (2016) compared the clinical characteristics between children with Autistic Spectrum Disorder (ASD) and those who were non-medically complex, that is, they had no diagnosis or developmental delay but had a feeding disorder (aged 2 to 6 years). The researchers found that children with ASD were significantly heavier and taller compared to the non-medically complex group. They considered two possibilities for this. Firstly, the difference may be explained by parents in the ASD group seeking help and referral earlier, before growth was compromised. Whereas the parents of the non-medically complex group may have waited longer to seek help, and only when their child's feeding difficulties impacted growth. Secondly, parents may have waited because they perceived their child as typically developing and/or were advised by healthcare professionals that improvement would occur over time. Interestingly, the majority of children in both the ASD and non-medically complex groups were identified with oral feeding delays during their study (Marshall et al., 2016).

Likewise, Levy and colleagues found significantly more food and utensil refusal behaviours and anticipatory and mealtime gagging in a group of children who had the same initial onset of feeding difficulties (when solids were introduced or at the start of complementary feeding). The difference between the groups was the timing of seeking support. One group sought support at 12 months due to discovering their infant had an underlying health condition. However, symptoms were alike across groups (vomiting, poor growth and limited oral intake) (Levy et al., 2009). Similar to the previous study reported, caregivers reported feeding difficulties at a late stage, around 2 years of age, most likely due to their child's health and developmental status.

Concerningly, most parents will report and seek advice for their child's feeding difficulty when their child is around 2 years of age, but state that the difficulties often began at the time of

complementary feeding, when OFS are developing, and they are navigating more advanced food textures (Delaney, 2010; Levy et al., 2009). However, it is challenging for health professionals to advise parents or provide education due to a lack of knowledge regarding age-appropriate feeding behaviours, which delays the early identification of oral feeding difficulties. Feeding refusal behaviours in healthy infants are most likely related to OFS development but can be a red flag for OFS dysfunction or more global developmental issues. The earlier difficulties are detected, the easier they are to treat, particularly for healthy children (Delaney et al., 2024).

Oral feeding skill development and acceptance behaviours at mealtimes

Currently, there is limited knowledge regarding age-appropriate signposts for feeding acceptance patterns that impact the early identification of feeding difficulties in healthy infants. Delaney et al. (2024) explored the food acceptance and feeding behaviours of typically developing infants aged 8 to 12 months. The authors examined several key metrics: acceptance rates, acceptance duration, and feeding behaviours. For acceptance rates, they found high levels of bite acceptance, with rates of 80% or greater across all age groups, although texture-specific differences emerged. Smooth puree and easily dissolvable solids had significantly higher acceptance rates than lumpy puree and soft solids. Regarding acceptance duration, there was a significant effect for texture (p = .009) but not age. Both lumpy puree and soft solids took longer to accept (averaging 3.1 seconds and 3.2 seconds, respectively) compared to easily dissolvable solids (2.4 seconds), indicating that children were more hesitant with these textures. For feeding behaviours, the authors categorised their observations into four types: passive behaviours, disruptive movements, expulsion, and feeding concerns (Delaney et al., 2024).

In terms of behaviours, the authors reported that as OFS improved with age, the nature of feeding behaviours changed. Feeding concerns, indicating skill difficulty (gagging, coughing, choking, hard effortful swallows, food loss, facial grimacing, persistent bolus manipulation and repeated swallows) decreased from 8 to 12 months of age. That is, most feeding concerns were observed at 8

months and then fewer at 12 months. For younger infants, this may reflect their OFS progression to tolerating more complex textures (Delaney et al., 2024).

Disruptive behaviour increased with infant age in the study, but not to significance. The authors concluded that what is considered negative behaviour in older children may be developmentally appropriate feeding concerns in younger children, and that immature and disordered OFS development should be considered first rather than problematic behaviour. Delaney and colleagues noted that feeding refusal in typically developing infants was most likely related to the lack of OFS coordination during development. However, it can also be an early sign of feeding skill difficulty or dysfunction (Delaney et al., 2024). Similarly, children with developmental delays, disability, or chronic health issues may lack OFS coordination, leading to reduced acceptance rather than feeding refusal based only on behaviour (Delaney et al., 2024). Limitations of this study included the homogeneity of the infants and the cross-sectional design, as researchers were unable to follow the infants to determine if disruptive behaviours continued to increase into toddlerhood. In addition, the standardised research setting rather than the naturalistic home setting may have affected the behaviours observed by the infants as they were in an unfamiliar environment (Delaney et al., 2024).

In his doctoral thesis examining OFS in children with food refusal, Dailey (2009) applied the principles of applied behaviour analysis, which involves exploring variables such as antecedents (environmental stimuli or events that occur immediately before a behaviour) and the consequences of the behaviour during mealtimes. In his study of children (*n* = 44), aged 11 to 71 months (mean age 28 months), Dailey hypothesised that those children classified as having a *texture sensitivity* (*n* = 17) (those that refuse particular textures only, for example they accept purees and liquids but refuse harder solids) would have OMD. Those classified as having *type sensitivity* (*n* = 24) (accepts particular type(s) of food and often refuse whole food groups, such as, yoghurt, bread, crackers but refuse all fruit and vegetables), would not have OMD; because they eat a variety but limit the types of food

they will eat. Interestingly, he found that children in both groups had OMD with no significant differences between the groups.

Dailey assessed the children using the Schedule of Oral-Motor Assessment (SOMA) (Skuse et al., 1995), a validated clinical assessment commonly used by speech-language pathologists. Children with *type sensitivity* were not expected to have OMD; however, upon reflection, post-results, he surmised that perhaps for these children, the effort required to eat a particular texture of food may be the same as that of children without OMD. The effort required to eat a preferred solid was less than the effort required to eat a less preferred solid, resulting in the child eating certain solids even if it required greater effort than less textured foods, such as purees. For example, a child may have chewing difficulties but prefers the taste of pasta and sauce, so they will eat that and refuse other foods

Another interesting finding was that children with *texture sensitivity* were not found to have OMD, but they were still found to have OFS difficulties on the SOMA. However, food and fluid refusal behaviours during the assessment may have skewed the assessment score. He concluded that all children with *feeding difficulties* should be assessed for OFS, as the feeding behaviours exhibited did not indicate the presence or absence of OFS difficulty (Dailey, 2009).

Additionally, two recent studies by psychologists demonstrate how the feeding behaviours of children overshadowed their primary OFS difficulty. Wilken and colleagues in Germany assessed children with a diagnosed feeding disorder and feeding tube dependency but no dysphagia (impaired swallowing) and found not only behavioural but also OFS difficulties. They concluded that OFS difficulties were frequent and interfered with the transition to oral feeding. Therefore, to classify feeding disorder and feeding tube dependency as only behavioural issues was misleading (Wilken et al., 2021).

Similarly, a retrospective chart review of children from Australia and New Zealand (n = 42) who received applied behavioural analysis treatment for feeding difficulties found that OFS difficulties and OMD such as lengthy chewing periods, overstuffing the mouth, gagging, coughing,

and nibbling were observed in 86% of cases. Others demonstrated difficulty lateralising their tongue to move foods in the oral cavity and achieve lip closure on a spoon. The authors concluded that although these children were referred for behavioural intervention, their underlying OFS difficulty was their primary issue (Taylor & Taylor, 2021). On a cautious note, the studies presented in this section are of children over 12 months of age, with the majority being over two, when learned behaviours have become established. Feeding behaviours and symptoms of problematic feeding will be discussed next.

Section 2 – Problematic feeding behaviours

This section examines problematic feeding behaviours in infants and their contributing factors. The diagnostic criteria of Paediatric Feeding Disorder (PFD) are described in more detail to aid in identifying infants and children with feeding and swallowing difficulties. This section also evaluates assessment tools used to identify OFS difficulties and symptoms of problematic feeding behaviours (Goday et al., 2019).

Definition of problematic feeding behaviours

Problematic feeding behaviours can occur from birth through to late adolescence; however, the highest rates of reported feeding difficulties is between 6 months and 4 years (Aldridge et al., 2010; Estrem et al., 2016; Levy et al., 2009). They occur when an infant or child is unable or unwilling to safely eat and drink enough variety or volume orally, despite having food available (Pados, Thoyre, et al., 2018). Problematic feeding is often persistent and can shape health outcomes. Usually developing during certain developmental stages of infancy and early childhood, specifically related to stages of adaptation in feeding style and dietary intake. These include complementary feeding, self-feeding and mobilisation stages (Birch, 1999). They often present as food refusal, gagging before or during mealtimes, avoidance of specific food or textures and specific food presentation insistence (Estrem et al., 2016).

A plethora of definitions

In the past, feeding difficulties were often defined as *organic* or *non-organic*. For example, an infant or child may have an organic feeding difficulty because of health or developmental diagnoses (such as gastroesophageal reflux or neurological impairment). In contrast, feeding difficulties caused by a disruptive environment or underlying emotional and behavioural issues, including disrupted parent-child feeding relationships, or an unknown cause, were defined as *non-organic*. The challenge for health professionals has been that previous research has not accurately captured the true extent of this issue's prevalence, resulting in gaps in services for children and

families who require additional support. In addition, OFS development was not recognised, unless it existed with an organic diagnosis. Moreover, different terms were used by single professions. Medicine, nutrition/dietetics, speech-language pathology, occupational therapy, and psychology applied their own diagnostic lenses to define these feeding difficulties. Less recognition of the associated functional limitations was given to help manage and plan treatment and improve quality of life (Goday et al., 2019). This next section addresses the issues most associated with problematic feeding behaviours in the literature.

Factors associated with problematic feeding behaviours

Several factors contribute to problematic feeding behaviours in infants and children, including physiological conditions, difficulties with early milk feeding, maladaptive feeding practices, and birth status. These are presented below.

Physiological factors

Physiological symptoms are often the earliest indicators of problematic feeding behaviours, with gastrointestinal issues most reported in the literature (gastroesophageal reflux (GOR), constipation, and allergies) (Park, Pados, Thoyre, & Gregas, 2019). Park and colleagues examined changes in problematic feeding behaviours over 6 months in children seen in an outpatient feeding clinic. They found, from their sample of parents (n = 58) of children aged 6 months to 7 years, that constipation had a stronger and more consistent association with problematic feeding behaviours. However, in younger infants, one or more of these physiological symptoms or health issues may prolong the period during which the willingness or ability to feed orally occurs more frequently.

Difficulties with early milk feeding

In addition to physiological factors, parents have reported problematic feeding behaviours associated with difficulties with early milk feeding. A reported history of early milk feeding difficulty (breast and bottle feeding) was significantly associated with “high concern” on the Pediatric Eating Assessment Tool (Pedi-EAT). The Pedi-EAT, a validated patient-reported outcome measure (PROM),

compared symptoms of problematic feeding behaviours in infants and children with a history of congenital heart disease with those of healthy peers. The authors concluded that, regardless of health status, infants who experienced difficulties with early milk feeding were likely to face feeding challenges in later childhood (Pados, 2019). A qualitative study also identified difficulties with early milk feeding as a major theme in ongoing negative feeding interactions, which contribute to maladaptive feeding patterns and disruption of the parent-child feeding relationship (Estrem et al., 2016).

Maladaptive feeding patterns and practices

Maladaptive feeding patterns and practices can arise from multiple factors beyond previous negative feeding experiences, including inadequate feeding environments and parental misinterpretation of infant feeding cues. Two cross-sectional studies examining children with diagnosed feeding difficulties found that inadequate feeding environments, characterised by inconsistent feeding site or inappropriate seating were significant contributing factors (Benjasuwantep et al., 2013; Ramos et al., 2017).

In Thailand, children with feeding difficulties were more likely to lack a designated feeding space compared to those without difficulties (42.6% versus 31%) (Benjasuwantep et al., 2013). Similarly, the Brazilian study found that 55.2% of children were fed in inadequate environments, contributing to their maladaptive feeding behaviours, though this association did not reach statistical significance (Ramos et al., 2017). Both studies also identified prolonged mealtimes (> 30 minutes) and inconsistent feeding schedules as contributing factors.

While both studies predominantly included older children, Ramos et al. (2017) observed a distinct pattern among infants under 12 months: their feeding difficulties were primarily skill-based rather than behavioural, often resulting from parental misinterpretation of feeding cues. However, this finding should be interpreted cautiously given the small sample size (n = 11).

Interestingly, for infants under 12 months, particularly those who are healthy, OFS difficulties appear more frequently in studies examining feeding difficulties and behaviours. Instead of attributing OFS difficulty to the condition itself, these studies often point to parental feeding practices as the cause. Rommel and colleagues considered that feeding disorders in children less than 2 years old may be related to oral feeding dysfunction. They believed that negative or disrupted parent–child interactions were often considered to cause the feeding problem, when it may be the consequence of poor OFS (Rommel et al., 2003).

This point is further demonstrated in a focused study on healthy infants (n = 144) with a mean age of 8.5 months (Eales et al., 2020). The researchers found correlations between motor difficulties and specific feeding behaviours: fine motor issues with food refusal (p = .013), gross motor problems with acting up (p = .001) and specific oral feeding difficulties, such as pocketing (holding food in the oral cavity), gagging, spitting, and vomiting (p = .038). Despite these correlations, the authors attributed feeding problems to maladaptive parent-child feeding practices rather than to delayed OFS development.

The authors' conclusion appeared to be shaped by assessment discrepancies: while few infants (< 5%) failed the validated feeding skills screener, many more (n = 47, 40.3%) failed the developmental milestone assessment, both of which are parent-reported measures. This inconsistency may reflect parents' inability to recognise early oral feeding difficulties, as well as gross and fine motor delays, leading to a misinterpretation of feeding cues.

Primiparity

In addition to misinterpreting feeding cues, primiparous mothers (those with only one child) were more likely to report problematic feeding behaviours than multiparous mothers (those with multiple children), according to several studies. Hines et al. (2022) found that first time parents perceived more problematic breastfeeding behaviours in their infants than multipara, even though there were no differences in sucking patterns (Hines et al., 2022).

In addition, two large prevalence studies found significant associations between primiparous mothers and reports of problematic feeding behaviours in typically developing children (Benjasuwantep et al., 2013; Sdravou, Fotoulaki, et al., 2021). Additionally, in Denmark, a high risk of feeding and eating disorders was associated with primiparity (1.33, 95% CI [1.19-1.50]) from a nationwide cohort of *n* = 901,277 infants followed until 48 months of age (Hvelplund et al., 2016). Conversely, two validation studies of parent-report assessments showed no such associations. However, their clinical non-medical samples contained predominantly primipara parents whose children were referred for feeding difficulties without an organic cause (Crist & Napier-Phillips, 2001; Ramsay et al., 2011).

Oral feeding skills and problematic feeding behaviours

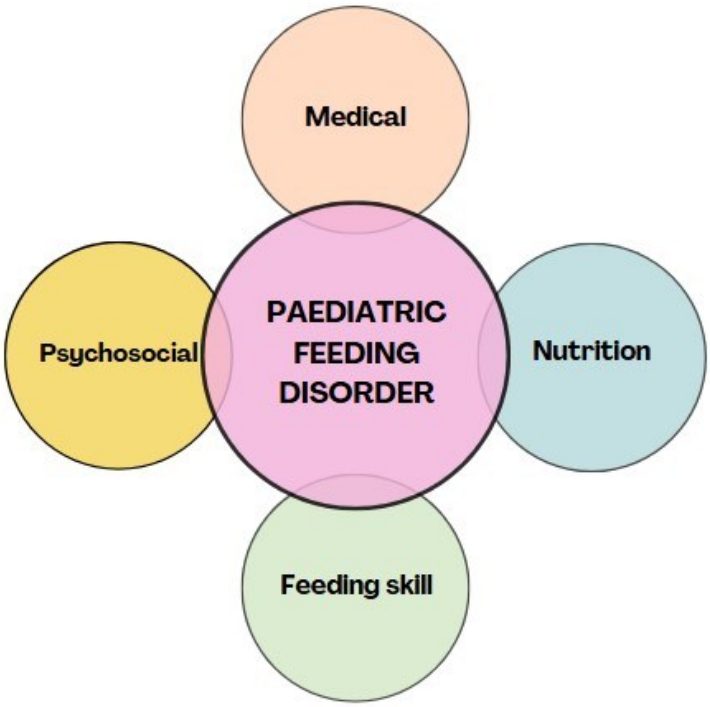
Researchers across health disciplines recommend comprehensive OFS assessments for children referred with feeding difficulties, even when the primary concerns appear unrelated to feeding skills, such as poor growth or mealtime food refusal (Dailey, 2009; Marshall et al., 2016; Wilken et al., 2021). Speech-language pathologists are called upon to determine if a feeding disorder is related to OFS deficiencies that interfere with texture advancement. This is challenging due to the gap in the research for OFS development, lack of normative data and the natural variability in OFS development (Delaney, 2010; Delaney & Arvedson, 2008; Delaney et al., 2021). Although in 2019, a consensus paper proposed universal criteria for identifying impaired oral intake across all infant and child populations, regardless of developmental status, to establish a universally accepted definition across health disciplines called Paediatric Feeding Disorder (PFD) (Goday et al., 2019).

Paediatric Feeding Disorder

The definition of Paediatric Feeding Disorder (PFD) is impaired oral intake that is not age-appropriate, lasting at least two weeks and is associated with medical, nutritional, feeding skill and psychosocial dysfunction. It is not attributable to eating disorder pathology, food scarcity, or culturally normative feeding practices (Goday et al., 2019). The definition of PFD uses the World

Health Organizations' (WHO) International Classification of Functioning, Disability, and Health (ICF) Framework, which focuses on how feeding difficulties impact a child's functioning rather than the cause. This is important, as PFD was created through an expert, multidisciplinary consensus, signifying a shift in viewing feeding difficulties and disorders from single-profession perspectives and recognising the different elements that contribute to feeding difficulties and dysfunction. PFD is now a stand-alone diagnosis as part of the International Classification of Diseases (ICD-11) (World Health Organization, 2022) (**Figure 2.1**).

Figure 2.1
Paediatric Feeding Disorder



Adapted from Goday et al., 2019

A recent study estimated the prevalence of PFD in the United States, finding that PFD is more common than previously recognised, affecting a significant number of children under 5 years of age (Kovacic et al., 2021). The authors analysed insurance claims from three databases (2009-2014) using clinical diagnostic codes (ICD codes) from medical coding systems used by health and medical professionals for their estimation. Overall, they found that 1 in 23 children had PFD based on public insurance in one state only and 1 in 37, from nationwide private insurance claims. Children with

chronic health conditions had a much higher prevalence of 1 in 5. The prevalence study was limited to persons with private health insurance and those with public insurance in only two states. Therefore, it may not represent all United States based children, especially those without insurance in other states. However, the authors noted that PFD prevalence demonstrated comparable prevalence to other recognised conditions, for example, eating disorders and Autism Spectrum Disorder, which are well established in terms of public awareness and clinical practice. Suggesting that PFD is an under -recognised health issue requiring similar recognition and attention. (Kovacic et al., 2021). **Table 2.6** displays the criteria for diagnosing PFD for each domain and the functional impact it can cause, adapted from Goday et al., 2019.

Table 2.6

Paediatric Feeding Disorder criteria

Primary Criteria: The infant or child experiences a disturbance in oral intake, inappropriate for their age, lasting at least 2 weeks and is associated with one or more of the following difficulties:	
Medical[a]	Respiratory compromise or distress during feeding Documented aspiration events or aspiration pneumonia Cardiorespiratory instability associated with oral intake
Nutrition[a]	Evidence of malnutrition or growth faltering Deficiencies in specific nutrients or restricted dietary variety limiting nutritional adequacy Requires supplemental nutrition via enteral feeding or oral supplements.
Feeding skill[a]	Requires food or fluids to be modified Requires adaptive feeding equipment or positioning strategies Requires techniques/strategies for feeding.
Psychosocial[a]	Exhibits feeding-related avoidance or resistance behaviours Caregiver demonstrates maladaptive feeding management approaches Impaired social engagement during feeding situations Strained caregiver-child interactions specific to feeding contexts
Exclusionary criteria: Not attributable to eating disorder pathology, food scarcity, or culturally normative feeding practices.	

[a] The following domains use the International Classification of Functioning, Disability and Health (ICF) categories to describe dysfunction to body systems and or limitations in activities/participation related to feeding. Adapted from Goday et al., (2019) pg. 125 and supplementary tables 1-4

The Feeding Skill Domain

The Feeding Skill Domain of PFD encompasses OFS, which speech-language pathologists and occupational therapists primarily diagnose. This domain highlights how impairments and difficulties disrupt development and impact a child's ability to eat safely, efficiently, and in an age-appropriate

manner. The main elements of the Feeding Skill Domain are summarised with impairment types, descriptions and clinical examples below (**Table 2.7**).

Table 2.7

Impairments, descriptions and clinical characteristics in the Feeding Skill Domain of Paediatric Feeding Disorder

Impairment Type	Description	Clinical examples
Oral Sensory Functioning (Under-response/Hyposensitivity)	Reduced awareness and response to oral stimuli	• Lack of awareness of food in mouth • Forms a poor food bolus • Anterior food loss from mouth • Increased bolus size • Seeking intense flavours/textures
Oral Sensory Functioning (Over-response/Hypersensitivity)	Heightened sensitivity to oral stimuli	• Gagging with specific textures • prolonged chewing • Preference for bland flavours • Preference for small bites • Preference for room-temperature foods
Oral-Motor Functioning	Impaired control, manipulation, and transit of food/liquid	• Inefficient intake • Messy eating • Poor control of liquids/foods • Slow/ineffective bolus formation • Gagging during bolus formation
Pharyngeal Sensory Functioning	Impaired sensation affecting airway protection and swallowing efficiency	• Poorly timed swallowing • Poor awareness of bolus location • Pharyngeal residue post-swallow • Silent aspiration • Gulping or audible swallows
Pharyngeal Motor Functioning	Reduced strength/coordination of pharyngeal movements	• Multiple effortful swallows per bolus • Throat clearing • Chronic nasal congestion • Inability to clear residue • Poor airway protection

Adapted from the Feeding Skill Domain supplementary table from Goday et al., (2019)

When impairments occur in the Feeding Skill Domain, they lead to one or more functional difficulties. These functional impacts on the infant and child in relation to feeding and swallowing are described below and summarised (**Table 2.8**).

Table 2.8

Implications of dysfunction in the Feeding Skill Domain

Dysfunction Type	Key Characteristics	Functional Implications
Unsafe Feeding	• Choking • Aspiration • Adverse cardio-respiratory events • Gagging/vomiting • Fatigue/refusal	• Reduced ability to safely meet nutritional needs orally due to impaired swallowing/breathing coordination and muscle weakness. • Affects sensory-motor skills during swallowing. • Often requires enteral nutrition (tube feeding). • Needs a focused feeding plan to reduce health risks.
Delayed Feeding Skills	• Inability to manage age-appropriate textures • Requires modified foods • Delayed self-feeding skills • Continued reliance on breast/formula feeds • Needs specialised feeding strategies/equipment	• May be early indicators of global developmental issues. • Problems are often identified during the transition to complementary feeding. • Requires specialised strategies for skill development. • May need specific seating and feeding utensils.
Inefficient Oral Feeding	• Prolonged mealtimes (>30 minutes) • Inadequate oral intake • Requires texture modification • Needs nutritional supplementation	• May indicate underlying oral-motor difficulties. • Requires specific strategies to improve feeding efficiency. • Often needs modified food textures, such as, meltable textures, grated or thinly sliced foods). • May require supplemental nutrition.

Adapted from (Cohen & Dilfer, 2022; Delaney, 2019; Dodrill, 2021b; Goday et al.,2019; McGlothlin & Rowel, 2015; Motion et al.,2001; Pados et al., 2018b)

Feeding is unsafe

When feeding is unsafe, it is primarily due to medical complications involving the respiratory or neuromuscular systems of the body. These, in turn, affect the interplay between sensory and motor skills during the oral and pharyngeal phases of swallowing. Unsafe feeding may present as choking, aspiration (food/fluid entering the airway), adverse cardio-respiratory events (apnoea, bradycardia) during oral feeds, or other unpleasant mealtime events such as gagging, vomiting, fatigue and refusal (Delaney, 2019; Goday et al., 2019). If feeding is unsafe, a feeding plan is advised to reduce risk to the child's health status. Often, enteral nutrition (tube feeding) is recommended practice.

Feeding skills are delayed

This refers to infants or children who cannot manage age-appropriate food textures and/or who require modifications. They may need foods altered to easier textures, such as purees or naturally smooth foods that would typically be considered inappropriate for their age. Many may

continue to rely heavily on breast milk or formula for nutrition when they should be transitioning to solid foods. Their feeding challenges frequently necessitate specialised strategies to develop fundamental chewing and biting skills, along with adaptive seating arrangements and customised feeding utensils to support their developmental needs (Cohen & Dilfer, 2022; Dodrill, 2021a; Goday et al., 2019). On a cautious note, these difficulties can be the earliest clinical signs of more global developmental issues, (Motion et al., 2001; Sanchez & Morgan, 2018) or oral feeding patterns that have not progressed the child to age-appropriate feeding at the time of complementary feeding (Pados, Park, et al., 2018).

Oral feeding is inefficient

This may appear as prolonged mealtimes (mealtimes should not exceed 30 minutes) or inadequate oral intake (Delaney, 2019). This may be demonstrated by an infant or child requiring texture modification to aid in addressing OFS delay or difficulty. For example, instead of a raw apple piece, the fruit is modified to a meltable texture, grated, or cut into thin slices to aid chewing skills (Rowell & McGlothlin, 2015). They also may require nutritional supplementation (Cohen & Dilfer, 2022; Dodrill, 2021b; Goday et al., 2019).

The Psychosocial Domain

Goday et al. (2019) explain that PFD often creates problematic feeding patterns affecting both children and their families. These problems typically manifest in several ways. Children may develop learned feeding aversions, where they actively avoid eating situations that have become negative experiences; both children and caregivers often experience significant mealtime stress. Children may also exhibit disruptive behaviours such as pushing food away or refusing to self-feed, become overly selective eaters despite having the ability to eat a wider range of foods, or develop "grazing" patterns characterised by frequent small intakes that reduce overall intake. Additionally, parents may adopt strategies that seem helpful but are actually counterproductive, such as feeding children who can feed themselves, force-feeding, using bottles beyond the appropriate age, or

offering only preferred foods (Aldridge et al., 2010; Berlin et al., 2010; Chatoor & Ganiban, 2003). The Psychological Domain is described in more detail previously (**Table 2.6**).

Previous research has often focused on these psychosocial aspects and the importance of identifying psychosocial risk signs, due to the disruptive behaviours and nutritional challenges they cause (Aldridge et al., 2010). However, as reported previously, psychosocial or problematic feeding behaviours are often a result of an underlying feeding skill delay or dysfunction (Delaney et al., 2021; Pados, Park, et al., 2018). Early identification of difficulties in the Feeding Skill Domain could potentially prevent an effect on other PFD domains, particularly the Nutrition and Psychosocial Domains.

Early identification

Despite the established PFD consensus definition, research gaps remain significant. A recent scoping review revealed that few studies have examined PFD prevalence or feeding problems using population-based samples (Estrem et al., 2022). Most published research focuses on either children aged less than 1 month or between 2 and 9 years of age, leaving the time between 1 month and 2 years relatively under-researched. The review also identified research imbalances across PFD Domains, with Nutrition and Feeding Skills receiving less attention than Medical and Psychosocial Domains (Estrem et al., 2022). This finding aligns with earlier research highlighting that OFS development in the second half of infancy is understudied (Delaney & Arvedson, 2008; Delaney et al., 2021).

To assess feeding and identify difficulties in the Feeding Skill Domain, health professionals commonly use a combination of clinical observations, interviews and questionnaires (Marshall et al., 2023; Sdravou, Fotoulaki, et al., 2021). Whereas for the Medical and Nutrition Domains, there are objective biomarkers to support diagnosis (medical diagnosis, micronutrient deficiency) (Marshall et al., 2023). Perhaps the difficulty in identifying dysfunction in the Feeding Skill Domain for infants and children, including underrepresentation in research, are due to the challenges of capturing both the

skilled observations by the clinician and the parent/caregiver perspective. According to Marshall et al. (2023), the value of parental input has often been overlooked or captured informally during the assessment process (Marshall et al., 2023).

Assessment using a Dynamic Systems Theory framework

When assessing an infant, it is beneficial to use a Dynamic Systems Theory framework to separate feeding constructs and identify the underlying issue affecting feeding appropriately. That is, to determine what an infant and child can eat (OFS) and what they are willing to eat (feeding behaviours) (Pados et al., 2019). Both constructs need to be assessed as both are related but contribute distinctively to oral feeding success (Pados et al., 2019; Park, Pados, Thoyre, McComish, et al., 2019).

Consistent with the Dynamic Systems Theory tenet of soft assembly, an infant's feeding should be observed in their natural environment (Thompson et al., 2023). Conducting feeding assessments during typical mealtimes in the child's natural environment, rather than in clinical settings, achieves this. For example, soft assembly demonstrates that “problems” do not exist in any other moment than the one in which they are occurring (Thompson et al., 2023). That is, there is something about the individual, task, or environmental constraints that result in a “feeding problem” (van Dijk, 2021). For example, there could be a gastrointestinal component (individual), no opportunity for the infant to reach for finger foods, the parent may spoon-feed them due to seating restraints (task), or uncertainty in reading readiness cues (environment). Van Dijk (2021) commented that moment-to-moment interactions and patterns are important to observe and to consider variability as important diagnostic information (van Dijk, 2021).

Parent- report assessments that examine these different concepts are a means to achieve a realistic view. Validated questionnaires and PROMs are convenient tools for identifying symptoms of OFS difficulty and problematic feeding behaviours. In addition, they are also useful tools to collect

data on OFS and feeding behaviours in a healthy population. Furthermore, they can aid in the estimation of prevalence on a larger scale (Sdravou, Fotoulaki, et al., 2021; Serel-Arslan et al., 2023).

Patient-reported outcome measures and parent questionnaires investigating oral feeding skills and problematic feeding behaviours in infants

Cross-sectional studies that used validated PROMS and parent questionnaires to identify feeding difficulties in healthy infants and children will now be presented (Eales et al., 2020; Fuls et al., 2020; Sdravou, Fotoulaki, et al., 2021; Serel-Arslan et al., 2023). Two of the four studies used the Behavioral Pediatric Feeding Assessment Scale (BPFAS) (Crist & Napier-Phillips, 2001) and the Montreal Children's Hospital Feeding Scale (MCH-FS) (Ramsay et al., 2011). The BPFAS was developed in 2001 and was found to be the most robust parent-report measure in terms of psychometric properties and application for assessing feeding difficulties in pre-school children (Sanchez et al., 2015). A limitation of the BPFAS in terms of OFS and infants is that it is valid from 9 months onwards, making it unsuitable for assessing those infants just starting solids and more commonly used with pre-school and school-aged children. Two prevalence studies used validated country-specific versions of the BPFAS (Greece and Turkey) on healthy children aged 2 to 7 years. They found parents reported concerns for food selectivity, limited appetite, chewing dysfunction and even signs of dysphagia (disordered swallowing) in their samples (Sdravou, Fotoulaki, et al., 2021; Serel-Arslan et al., 2023).

Alternatively, the Montreal Children's Hospital Feeding Scale (MCH-FS) (Ramsay et al., 2011) offers a practical alternative with only 14 items, enabling quick administration in clinical settings. This instrument demonstrates robust psychometric properties and has been validated across multiple languages for assessing parental perceptions of infant feeding challenges. Its comprehensive approach encompasses various feeding constructs, including oral-motor skills, appetite, parental concerns, and mealtime behaviours. However, it should be noted that the MCH-FS functions solely as a screening tool and cannot serve as a post-discharge or post-intervention outcome measure. Furthermore, when used in isolation, it may provide an incomplete picture of feeding difficulties.

The feeding skills of 200 healthy infants aged between 6 and 12 months were evaluated using the (MCH-FS) (Fuls et al., 2020). Thirteen infants were identified with feeding difficulties, and from those, 11 had oral-motor dysfunction (OMD) when followed with a clinical feeding assessment, the Schedule of Oral-Motor Assessment (SOMA) (Skuse et al., 1995). Those found with OMD were 6 and 10 months of age, with infants experiencing difficulties with new pureed textures at 6 months, then foods with more complex textures requiring more feeding skill at 10 months (Fuls et al., 2020).

In a related study of 144 healthy infants, fewer than 5% failed the MCH-FS. However, researchers found significant correlations between fine motor difficulties and initial food refusal (p = .013), gross motor challenges and behavioural issues (p = .001), and specific oral feeding problems including food pocketing, gagging, spitting, and vomiting (p = .038). As noted earlier, this study revealed that parent questionnaires failed to adequately identify OFS issues, as caregivers often missed early warning signs of feeding difficulties, including oral-motor problems and developmental delays in gross and fine motor skills, leading to misinterpretation of infant feeding cues (Eales et al., 2020). These findings underscore the importance of using both PROMS that can track changes over time and clinical assessments to identify skill deficiencies, particularly in seemingly healthy children or those without a diagnosis.

Although the BPFAS is still highly regarded and used in clinical practice and research, a recent clinimetric review found the Feeding Flock's® Child Oral and Motor Proficiency Scale (ChOMPS) and Pediatric Eating Assessment Tool (Pedi-EAT) as the more robust PROMs to measure feeding skills and identify difficulties in the Feeding Skill Domain of PFD (Marshall et al., 2023). This is due to the quality assessment undertaken in the review, which was completed using the Consensus-based Standards for the Selection of Health Measurement Instruments (COSMIN) methodology (published after the BPFAS). The COSMIN methodology revealed the BPFAS had limitations, particularly in content validity (Marshall et al., 2023).

The Feeding Flock© developed, the ChOMPS and the Pedi-EAT from a Dynamic Systems Theory perspective, emphasising the parents' understanding of their infant's skills across time and

environments (Thompson et al., 2023; Thoyre et al., 2018). Both assessments are validated and have age-based reference values for infants and children aged from 6 months to 7 years (Pados, Park, et al., 2018; Pados, Thoyre, et al., 2018). The ChOMPS and Pedi-EAT are further discussed in the following section.

The Child Oral and Motor Proficiency Scale

The ChOMPS is designed to assess oral feeding and gross and fine motor skill proficiency, and to identify oral feeding and motor skill delays, which are not currently addressed by any other PROM. Although not a diagnostic tool, health and medical professionals can use the ChOMPS to identify oral feeding difficulty and delay, and augment clinical assessment by providing the parental perspective, as they are most familiar with their infant's skills (Sanchez & Morgan, 2018). For research, the ChOMPS can be used to estimate the prevalence of OFS difficulty in a population, with age reference values on a sample of healthy, full-term born infants already published (Pados, Park, et al., 2018; Pados et al., 2019; Park, Pados, Thoyre, McComish, et al., 2019). Furthermore, the ChOMPS demonstrates adequate content validity, structural validity, internal consistency, reliability, and hypothesis-testing validity in accordance with COSMIN criteria (Pados et al., 2019; Park, Pados, Thoyre, McComish, et al., 2019). Content validity was established through expert review using content validity indices (scale-level CVI ≥ 0.90 for relevance and ≥ 0.96 for clarity) and cognitive interviews with parents, supporting the relevance, comprehensiveness, and comprehensibility of items (Pados et al., 2019). Structural validity was supported through principal component analysis conducted with 364 parents, identifying a four-factor structure that explained 58.45% of the total variance, with satisfactory factor loadings across subscales (Park, Pados, Thoyre, McComish, et al., 2019). Internal consistency was rated as sufficient, with Cronbach's α of 0.97 for the total scale and 0.74–0.97 across subscales (Park, Pados, Thoyre, McComish, et al., 2019). Test–retest reliability demonstrated high stability over a two- to three-week interval (r = 0.80–0.98, p < .001) (Park, Pados, Thoyre, McComish, et al., 2019). Hypothesis-testing validity was supported through known-groups

comparisons, with significantly lower ChOMPS scores observed in children with feeding problems compared to typically developing children (t = 6.84, $p < .001$), consistent with a priori hypotheses (Park, Pados, Thoyre, McComish, et al., 2019; Pados, Park et al., 2018). However, it does not have evidence of cross-cultural validity (Marshall et al., 2023; Pados et al., 2019).

Previously, the CHOMPS has been used to identify OFS difficulties in infants with congenital heart defects (Pados & Harrison, 2023), and those born before 34 weeks gestation (Pados et al., 2024). It has also been used in a prospective longitudinal study of full- term infants, Westemeyer et al. (2024) examining the relationship between non-nutritive sucking measures at 3 months and OFS status at 12 months. Several statistically significant, though small to moderate, associations were identified. At 12 months, caregiver-reported ChOMPS scores demonstrated several statistically significant associations with non-nutritive suck (NNS) parameters measured at 3 months. Longer NNS burst duration was associated with a lower ChOMPS Total Score ($r = −0.31$, $p = .011$) and lower Oral–Motor Coordination scores ($r = −0.28$, $p = .021$). Greater numbers of NNS bursts ($r = −0.26$, $p = .036$), cycles per burst ($r = −0.30$, $p = .016$), and cycles per minute ($r = −0.31$, $p = .012$) were also associated with a lower ChOMPS Total Score. Additionally, higher cycles per minute were related to a lower Complex Movement Pattern score ($r = −0.24$, $p = .048$). No significant associations were identified between NNS amplitude and any ChOMPS outcome (Westemeyer et al., 2024). However, there are no studies to date that use ChOMPS to identify OFS delay in healthy infants who are at complementary feeding age, except when validated.

The ChOMPS tool contains four sub-scores: Basic Movement Patterns, Oral-Motor Coordination, Fundamental Oral-Motor Skills, and Complex Movement Patterns. The Basic Movement Patterns sub- score contains questions regarding foundational motor skills, for example, bringing hands to mouth and sitting. Oral-Motor Coordination encompasses skills such as drinking liquids without gagging, coughing, or choking, and moving food around the mouth with the tongue. The Fundamental Oral-Motor Skills sub-score contains questions regarding tongue lateralisation (side to side movement) and opening the mouth wide enough to accept a spoon.

Finally, the Complex Movement Patterns sub-score covers questions regarding more developed movements, such as drinking from a straw and using utensils to bring food to the mouth and is therefore only applicable to infants aged 9 to 12 months and older. Parents are asked to indicate their child's ability to perform each skill on a 3-point Likert scale. Options are "Yes" (skill is established, score = 2), "Sometimes" (skill emerging, score = 1), and "Not Yet" (skill not yet emerging, score = 0). Scores for each sub-score are then calculated as the sum of all item scores and higher scores on each sub-score indicate more developed skills.

The ChOMPS age-based normative reference study was assessed on infants and children consuming solid food from 6 months to 7 years. They aimed for a sample size of n = 100 for each age group. Authors found that OFS and motor skills developed with age but there was variability in skills across sub-scores in the 6 to 9 and 9 to 12 month age groups. At particular ages, for each sub-score, most children could demonstrate all or most of the skills. By 24 months, 95% of children could perform all Basic Movement Patterns sub-score skills. At 4 years, more than 95% could perform all Fundamental Oral-Motor sub-score Skills. By 5 years, 90% could perform all Oral-Motor Coordination sub-score skills. By 6 and 7 years, 95% received a score of 44 of 46 on Complex Movement Patterns. Scores below the 5th percentile indicated that the infant or child's score is lower than 95% of children their age, classifying the score as "highly concerning", deserving further investigation. Those scores between the 5th and the 10th percentile were classified as "concerning", also deserving of further investigation and/or review. The creators of the ChOMPS noted limitations with their homogeneous normative sample, which consisted mainly of white, two-parent families who were tertiary educated. To increase its utility, they recommended the ChOMPS to be tested in more diverse populations in other countries (Pados, Park, et al., 2018). In addition, over-identification was cautioned due to its current normative reference values, which were based on infants and children with no feeding difficulties. The exclusion of children with feeding difficulties, as well as those diagnosed with conditions commonly associated with such challenges, may result in normative data that

disproportionately represent children with fewer developmental impairments (Sanchez & Morgan, 2018).

Mapping the Child and Oral-Motor Proficiency Scale to Paediatric Feeding Disorder

The recent clinimetric review by Marshall and colleagues found the ChOMPS covered all three components of the Feeding Skills Domain of PFD (3a, 3b, and 3c) (**Tables 2.6 and 2.9**) as well as one component of the Medical Domain, making it a comprehensive PROM for assessing OFS (Marshall et al, 2023). However, the ChOMPS does not map to the Nutrition or Psychosocial domains of PFD (**Table 2.9**).

Table 2.9

Mapping the Child Oral and Motor Proficiency Scale (ChOMPS) to the Medical and Feeding Skill Domains of Paediatric Feeding Disorder

Paediatric Feeding Disorder Domains	Impairment and functional components that map to the Child Oral Proficiency Scale (ChOMPS)
Medical Domain	
1b: Aspiration or recurrent aspiration pneumonitis	Impairment: Compromised airway protection mechanisms Functional impact: Limited ability to safely consume thin liquids or certain food textures
Feeding Skills Domain	
3a: Need for texture modification	Impairment: Reduced oral-motor skills, delayed chewing development, oral-sensory processing difficulties Functional impact: Inability to manage age-appropriate food textures, limited dietary variety
3b: Use of modified position or equipment	Impairment: Poor postural stability, oral-motor weakness. Functional impact: Inability to maintain appropriate feeding position independently, need for specialised seating or utensils
3c: Use of modified feeding strategies	Impairment: Difficulty with self-feeding, oral-sensory aversions, impaired oral-motor coordination Functional Impact: Extended mealtimes, reliance on specific feeding techniques, limited feeding independence

Information adapted from Goday et al., (2019) and Marshall et al., (2023).

The Pediatric Eating Assessment Tool

The Pedi-EAT, assesses the symptoms of problematic feeding (Thoyre et al., 2018). The populations already examined by the Pedi-EAT include premature infants (Park, Pados, Thoyre, & Gregas, 2019), premature infants at 4 years of age (Kwon et al., 2020), infants and children admitted to a tertiary feeding clinic (Park et al., 2018), infants with congenital heart defects (Pados, 2019; Pados & Harrison, 2023), and older infants born before 34 weeks gestation (Pados et al., 2024). The Pedi-EAT demonstrates strong psychometric properties. Content validity was established though expert review using content validity indices, with scale-level CVI values (S-CVI ≥ .90), and supported by cognitive interviews with caregivers, demonstrating that items are relevant, clear and appropriate (Thoyre et al., 2014). A stable four-factor structure has been identified, with high internal consistency (Cronbach's α = .83–.95), and strong test–retest reliability (r = .87) (Thoyre et al., 2018). Convergent

validity was (r = .77) and known-groups validity was demonstrated by significantly lower scores in children with feeding difficulties compared to typically developing peers (Thoyre et al., 2018). Age-based norm-reference values for children aged 6 months to 7 years are available (Pados, Thoyre et al., 2018). However, diagnostic accuracy, criterion validity, and responsiveness to intervention have not yet been established (Pados, Thoyre et al., 2018; Thoyre et al., 2018).

The Pedi-EAT has a holistic view of feeding difficulties and can be mapped to three domains of PFD. It covers two aspects of the Feeding Skills Domain (3a and 3c) but does not address 3b (Use of modified positioning or equipment). It also captures elements from both the Medical Domain (1a, 1b) and the Psychosocial Domain (4a, 4c), making it a relatively comprehensive assessment tool (Marshall et al., 2023). The Pedi-EAT does not capture information from the Nutrition Domain of PFD (**Tables 2.6 and 2.10**.)

Table 2.10

Mapping The Pediatric Eating Assessment Tool (Pedi-EAT) to the Medical, Feeding Skill and Psychosocial Domains of Paediatric Feeding Disorder

Paediatric Feeding Disorders Domains	**Impairment and functional components that map to the Pediatric Eating Assessment Tool (Pedi-EAT)**
Medical Domain	
1a: Cardiorespiratory compromise	Impairment: Reduced cardiorespiratory function, poor endurance. Functional impact: Limited ability to sustain feeding for adequate nutrition.
1b: Aspiration	Impairment: Compromised airway protection mechanisms. Functional impact: Inability to safely manage certain food consistencies.
Feeding Skills Domain	
3a: Need for texture modification	Impairment: Reduced oral-motor skills, delayed chewing development, oral-sensory processing difficulties. Functional Impact**:** Inability to manage age-appropriate food textures, limited dietary variety.
3c: Use of modified feeding strategies	Impairment: Difficulty with self-feeding, oral-sensory aversions, impaired oral-motor coordination. Functional impact: Extended mealtimes, reliance on specific feeding techniques, limited feeding independence.
Psychosocial Domain	
4a: Active or passive avoidance behaviours	Impairment: Anxiety, sensory defensiveness, learned aversions. Functional impact: Food refusal, behavioural resistance during mealtimes.
4c: Disruption of social functioning	Impairment: Stress responses decrease the enjoyment of meals. Functional impact: Limited participation in social eating contexts, family mealtime disruption.

Adapted from Goday et al., (2019) and Marshall et al., (2023)

The Pedi-EAT contains four sub-scores: Physiological Symptoms, Problematic Mealtime Behaviours, Selective/Restrictive Eating, and Oral Processing. The Physiological Symptoms sub-score assesses symptoms and behaviours associated with dysphagia (impaired swallowing) and oral feeding difficulty, including coughing and gagging. In addition to difficulties maintaining physiological stability or coordinating eating and breathing (such as fatiguing, sweating, and/or increased work of breathing), there are symptoms of gastrointestinal issues (including arching, vomiting, and difficulty defecating). The Problematic Mealtime Behaviours sub-score focuses on food acceptance, avoidance and refusal behaviours. For example, “opens mouth when food is offered”, “plays to avoid eating”, “throws food way”, and “stops eating after a few bites”.

The Selective/Restrictive Eating sub-score assesses the child's food texture and temperature preferences. The final Oral Processing sub-score assesses symptoms of OFS difficulty, including prolonged chewing, food pocketing in the cheeks, a preference for strong flavours, and the need for fingers to manipulate food in the mouth. Parents are required to rate each item on a 6-point Likert scale (0 = never, 1 = almost never, 2 = sometimes, 3 = often, 4 = almost always and 5 = always). Higher scores on the Pedi-EAT indicate more symptoms of problematic feeding behaviour. The Pedi-EAT is validated (Thoyre et al., 2018; Thoyre et al., 2014), and normative reference values based on a sample of full -term infants and healthy children have been published (Pados, Thoyre, et al., 2018). The Pedi-EAT has been used on a healthy infant cohort, when compared to same-aged peers with congenital heart disease (Pados, 2019) and those born prematurely (Park, Pados, Thoyre, & Gregas, 2019). Although these studies focused on infants and children with medical conditions, the researchers also identified symptoms of problematic feeding in healthy infants and children.

Pados et al. (2019) identified associations with symptoms of problematic feeding behaviours for healthy infants who experienced difficulties with early milk feeds (breast and bottle), as well as those with congenital heart disease (Pados, 2019). In addition, Park and colleagues reported that full-term healthy infants (*n* = 979) and those born preterm (*n* = 256) (6 to 15 months) were both found to have symptoms of problematic feeding. However, their symptoms differed from those of the older age groups (15 months to 2.5 years and 2.5 to 7 years). The younger cohort had higher scores on the sub-scores relating to Physiological Symptoms, Selective/Restrictive Eating, and Oral Processing than their older peers. Whereas, for the Problematic Mealtime Behaviour sub-score, the younger cohort had lower scores compared to the older children (Park et al., 2019).

These findings were similar to the age-related normative reference study results and previous literature that found that the behaviours described in the Problematic Mealtime Behaviour sub-score were few in infants under 12 months but did increase during the toddler years (Carruth, Betty Ruth et al., 2004; Mascola et al., 2010; Pados, Thoyre, et al., 2018).

The ChOMPS and Pedi-EAT have been used together to describe the OFS and feeding behaviours of infants with congenital heart disease (Pados & Harrison, 2023) and more recently for infants aged 8 to 24 months, born prematurely (Pados et al., 2024). However, to our knowledge, neither PROMS has been used together to describe OFS and feeding behaviours for healthy infants. To date no studies have explored the associations between OFS status and feeding behaviours on NZ infants.

Section 3 – Food-related choking in infants

Choking, or foreign body aspiration, is a common injury in infants and young children, with similar occurrence rates across genders (Saccomanno et al., 2023). It occurs when food, liquids or non-food items occlude the airway and is never considered normal at any age. Whilst choking is preventable, its occurrence is greater in children under 4 years, with food-related choking (FRC) peaking for infants under 12 months (Altmann & Ozanne-Smith, 1997; Gregori et al., 2012; Sidell et al., 2013). Choking in young children is attributed to their oral exploration of their environment, inability to distinguish between edible and inedible items, and tendency to engage in activities like playing while eating (Rodríguez et al., 2012). Furthermore, the cough reflex is less effective in expelling food and non-food items, and small objects can block the small diameter of the airway (Ministry of Health, 2020).

Infants are at greater risk of FRC, as the size of their oral cavity is smaller, with the tongue taking up more space than in older children (Saccomanno et al., 2023). Their developing OFS may not be sufficient to break down hard foods (Delaney, 2010) and the lack of second molars can impact their ability to successfully grind food before swallowing (AAP, 2010; Ministry of Health, 2020).

The airways of infants and children are shorter and narrower in diameter than those of adults, and even mild obstruction can further reduce the diameter, leading to respiratory difficulties (Ministry of Health, 2020). This anatomical vulnerability is compounded by infants heightened metabolic demands, with oxygen consumption rates approximately double those of adults. Consequently, choking episodes present a particularly acute threat to infants, as their elevated metabolic oxygen demands and limited respiratory reserves provide minimal tolerance for interruption before the onset of hypoxia (Saccomanno et al., 2023).

Consequences of food-related choking

FRC is a significant public health concern across industrialised nations. In the United States, it is a leading cause of death in children under three, with one child dying approximately every five

days (AAP, 2010). In France, FRC was the primary cause of infant mortality for children under 12 months in 2012 (Boulanger & Vernet, 2018). New Zealand reported nine FRC deaths in children under 6 years between 2002-2009, caused by processed meats, peanuts, apple pieces, and whole grapes (Child and Youth Mortality Review Committee, 2013). Unpublished Accident Compensation Claims (ACC) data reported that 411 children had a choking accident between 2017 and 2019, resulting in a claim to ACC. The most common food found to cause choking accidents in children under 12 months of age was apple (ACC, 2019).

Prevalence of food-related choking

Comparing international FRC prevalence in infants under 12 months is challenging due to the inconsistent research methods used. Most studies are retrospective analyses of hospital admissions over extended periods, with infants forming part of broader paediatric samples (Brkić & Umihanić, 2007; Harris et al., 1984; Ling et al., 2022; Reid et al., 2020; Sidell et al., 2013; Wu et al., 2018). The lack of standardised definitions and reporting systems for FRC and foreign body aspiration complicates cross-country comparisons (Edwards & Martin, 2011; Foltran et al., 2012; Gregori et al., 2012). Additionally, hospital-based data excludes choking episodes resolved without medical intervention, creating significant knowledge gaps in population-level prevalence.

Surveillance data

The Susy Safe Project, established by the European Union, represents the first comprehensive multinational surveillance database documenting foreign body aspiration episodes, including FRC. This registry facilitates reporting from parents, educators, and healthcare providers across 26 countries. After 4 years of operation, the database documented 16,878 foreign body injuries in children aged 0 to 14 years. Infants under 12 months accounted for 25% of cases, while FRC constituted 26% of all reported incidents (Gregori, 2006; Gregori et al., 2012). Recent data from Susy Safe administrators (personal communication, November 2022) identified 254 foreign body aspiration cases in infants aged 0-12 months, all of which involved food. Nearly half of these

incidents (*n* = 112, 44%) occurred during the complementary feeding period between 7 and 9 months of age (SusySafe, 2022).

Prevalence of food-related choking in complementary feeding studies

Studies on complementary feeding practices provide insights into the prevalence of FRC among infants starting solids. Research has compared various complementary feeding practices, including parent-led approaches, such as traditional spoon-feeding (TSF), baby-led approaches emphasising infant self-feeding (BLW), and mixed or hybrid practices/partial baby-led weaning (partial BLW). However, it is not easy to compare studies due to their study design. Cross-sectional studies report prevalence, that is, the proportion of infants who have experienced choking at a specific point in time or during a specific period. Whereas randomised control trials (RCTs) report incidence, that is, the rate of new choking cases occurring within a defined timeframe. Although helpful in contributing knowledge to the burden of choking, these epidemiological measures cannot be directly compared numerically.

Studies reporting the prevalence of FRC across different complementary feeding practices, all cross-sectional in methodology, are presented in **Table 2.11**. They differ in participant age ranges, but all studies have used a parent-report questionnaire to collect data. All the studies reported prevalence in their populations with the largest reported by Susmarini et al. (2021) (66.1%).

Table 2.11

Prevalence of food-related choking in complementary feeding practice studies

Study	Design	*n*	Age Range	Prevalence of Food-Related Choking *n* (%)
Bialek Dratwa et al. (2022) (Poland)	Cross-sectional	*n* = 646	6 to 36 mo	35/646, 5.4% FRC with TSF[a,b] 31/447, 6.94% FRC with BLW[a,b]
Brown (2018) (UK)	Cross-Sectional	*n* = 1151	4 to 12 mo	*n* = 155, 13.6% FRC overall
Cameron et al. (2013) (NZ)	Cross-sectional Internet survey	*n* = 199	6 to 12 mo	32.6% FRC overall 71.4% FRC on whole foods
Fu et al. (2018) (NZ)	Cross-sectional Internet survey	*n* = 628	6 to 36 mo	*n* = 1 BLW/partial BLW[d]
Kharaman et al. (2020) (Turkey)	Cross-sectional	*n* = 485	6 to 24 mo	*n* = 100, 20.6% FRC overall *n* = 29, 21.2% BLW group *n* = 19, 18.6% TSF group *n* = 52, 21.1% partial BLW group
Susmarini et al. (2021) (Indonesia)	Cross-sectional	*n* = 286	6 to 12 mo	*n* = 189, 66.1% FRC overall

[a]Results are presented as proportion with percentage *p* (x%), showing both the actual count and its percentage relative to the total.

[b]Participants could choose both TSF and BLW

[c] Percentage reported only.

[d]Only one infant experienced an FRC episode requiring medical assistance

FRC- food-related choking

Partial BLW – partial baby-led weaning/hybrid approach

BLW- baby-led weaning

TSP- traditional spoon feeding

However, no studies have reported weighted estimated prevalence for FRC, which matches proportions of ethnicity and deprivation to provide more nationally representative data to give a more accurate picture of FRC burden. Helping to inform future public health guidelines and resources.

RCT studies presenting incidence of FRC are presented (**Table 2.12**). All but one study reported incidence of FRC using the BLISS method (modified baby-led weaning) and TSF, with the one study reporting incidence of FRC in infants fed by BLW and TSF (Arslan et al., 2023).

Table 2.12

Incidence of food-related choking in complementary feeding studies

Study	Design	*n*	Age Range	Incidence of Food-Related Choking
Arslan et al. (2023) Turkey	RCT	*n* = 52	4 to 12 mo	6 months: FRC with BLW (*n* = 1, 3.8%) FRC with TSF (*n* = 4, 15.4%) 12 months: FRC with BLW (n =0, 0% FRC with TSF (n = 1, 3.8%)
Dogan et al. (2018) (Turkey)	RCT	*n* = 280	5 to 6 mo	FRC with BLISS (*n* = 2) FRC with TSF (*n* = 3)
Fangupo et al. (2016) (NZ)	RCT	*n* = 206	6 to 8 mo	35% FRC at least once between 6-8 months 6 months: FRC with BLISS 16.3% FRC with TSF 25.3%
De Paiva et al. (2023) (Brazil)	RCT	*n* = 130	6 to 12 mo	FRC overall (*n* = 34, 26.2%) FRC with TSF (*n* = 13, 30.2%) FRC with BLISS (*n* = 10, 22.2%) FRC with partial BLW (*n* = 11, 26.2%)

FRC- food-related choking
BLW-baby-led weaning
TSF- traditional spoon-feeding
BLISS- Baby led introduction to solids (modified baby-led weaning)
Partial BLW- partial baby-led weaning (hybrid approach)

Risk factors associated with food-related choking

Risk factors associated with FRC for infants under 12 months highlighted round, spherical and hard textured foods as well as feeder-related risk factors, such as reduced supervision, offering age-inappropriate foods and self-feeding (Na'ara et al., 2020; Özyüksel et al., 2019; van As et al., 2012; Wu et al., 2018). These factors are discussed in more detail in the next section.

Food characteristics

The Susy Safe project reported that children under 3 years most commonly choke on spherical, three-dimensional, rigid and semi-rigid foods which lodge in the airway (trachea, bronchi, lungs) or pharynx and larynx (van As et al., 2012). Spherical foods are round items with a uniform diameter that may occlude the airway by forming a tight seal. Examples of these foods described include nuts, seeds, peas and fruit stones. Three-dimensional food items have depth and volume, allowing them to lodge within the airway or aerodigestive tract rather than passing flatly through it. Examples include nuts, beans and seeds, all of which have measurable volume and were commonly

retrieved from the pharynx, larynx, and lower airways (van As et al., 2012). Rigid foods retain their shape under pressure and are less likely to deform during chewing or swallowing increasing the risk of obstruction or tissue injury. Examples include bones (particularly fish and chicken bones), nuts and fruit stones. Semi-rigid foods have limited compressibility and may partially deform while still maintaining enough structure to obstruct the airway. Examples of these are nuts, seeds, peas and some sweets. Nuts are across all categories of spherical, three dimensional and rigid foods (van As et al., 2012). Across diverse cultures and countries, nuts and seeds are the primary choking hazards for children under 3 years, including those under 12 months (Brkić & Umihanić, 2007; Reid et al., 2020; SusySafe, 2022; World Health Organization, 2023; Wu et al., 2018). However, New Zealand data showed apples and carrots as the most common foods causing FRC for infants under 12 months (ACC, 2019). Studies comparing complementary feeding practices similarly found that whole fruits and vegetables caused most choking episodes in this age group (Cameron et al., 2013; Fangupo et al., 2016).

Feeder related/supervision

Beyond food characteristics, feeder-related factors also contribute to the risk of choking. The Susy Safe project reported that foreign body aspiration in children aged 0 to 4 years resulted from a lack of adult supervision (40%) and the offering of inappropriate or improperly prepared foods (60%) (van As et al., 2012). Two studies examining FRC events in the Middle Eastern involving nuts and seeds found contrasting results. A Turkish study by Özyüksel et al. (2019) reported 80% of infants (mean age 9 months) choked while self-feeding versus 14% during caregiver-assisted feeding, concluding BLW was unsafe for infants under 12 months. However, they acknowledged the foods were age-inappropriate and supervision may have been inadequate (Özyüksel et al., 2019). Conversely, an Israeli study by Na'ara et al. (2020) identified caregiver feeding of inappropriate foods as the primary factor rather than supervision. Cultural practices of offering nuts and seeds at social

gatherings were noted as contributing factors (Na'ara et al., 2020). Both studies emphasised the need for improved parental education about choking hazards.

Guidelines for prevention

A summary of national public health guidelines for parents, childcare providers, and food manufacturers aimed at preventing FRC has been published (Lorenzoni et al., 2022). These policies share similarities in their preventative strategies, food preparation recommendations, educational approaches, and resuscitation protocols. However, these guidelines are exclusively published in English and originate from developed nations, including New Zealand. Since Lorenzoni et al.'s (2022) publication, New Zealand's Ministry of Health has implemented new guidelines for early childhood providers specifically addressing FRC reduction (Ministry of Health, 2020) and updated its "Healthy eating guidelines for 0 to 2 years" (Ministry of Health, 2021). Both guidelines provide information on high-risk foods, with guidelines for early childhood providers prohibiting nuts and seeds from being offered at centres.

Complementary feeding practices and food-related choking

Due to the increased risk of FRC to infants, the choice of complementary feeding practice is an important consideration. Studies evaluating complementary feeding practices and FRC prevalence, specifically parent-led (TSF) versus baby-led, including BLW and modified baby-led weaning (BLISS), are presented. All the studies found were cross-sectional or RCTs, that compared complementary feeding practices, and most found no statistically significant difference between complementary feeding practice and FRC episodes. Moreover, they all included parent questionnaires and retrospective interviews; therefore, recall bias cannot be ruled out.

A recent systematic review focused on choking and complementary feeding practices concluded that choking episodes were more closely related to specific foods and textures rather than the complementary feeding practice itself. Raw fruits and vegetables (particularly apples and carrots)

posed the highest risks, but unexpectedly, "safer seeming" foods like bananas, melons, and avocados also caused choking due to their slippery and complex texture (Correia et al., 2024).

The review reported methodological limitations, including inconsistent definitions across studies, potential recall bias in parental reporting, and difficulties distinguishing between genuine choking and protective gagging reflexes. Many studies relied on parent reported episodes without medical verification. The authors concluded that healthcare providers should focus less on which complementary feeding practice parents choose and more on providing clear, practical guidance on food modification across all practices (Correia et al., 2024).

A significant association between BLW and increased FRC episodes was reported in only one study, where infants following BLW experienced more frequent FRC compared to those following TSF (p = .014) (Susmarini et al., 2021). Interestingly, this study was not included in the systematic review just mentioned. This may be due to the fact that it was not published at the time of the review's search, or the methods did not meet the systematic review's inclusion criteria. In contrast, other studies found no significant differences between complementary feeding practices (Białek-Dratwa et al., 2022; Correia et al., 2024; Kahraman et al., 2020; Morison et al., 2016). On a different note, from a Polish study, infants in the BLW group had significantly higher prevalences of gagging, spitting out food and vomit reflex initiation compared to those in the TSF group, but not for FRC (Białek-Dratwa et al., 2022).

Rapley (2005),who first described BLW, hypothesised, based on personal reflection, that infants who are predominantly spoon fed (TSF) may be at increased risk of FRC because they have fewer opportunities to practise chewing and biting skills. This limited early experience with textured foods may delay the development of the OFS required to manage more complex textures later in infancy. Two studies provide support for Rapley's hypothesis. Although no significant associations between complementary feeding practices (TSF & BLW) and FRC, infants who experienced FRC were more likely to be following TSF and had significantly more choking episodes on finger foods (p = .014) and lumpy puree (p = .002) compared to infants following BLW (Brown, 2018). Similarly, no

statistically significant differences were found in a large retrospective study from Turkey (Kahraman et al., 2020). Although most parents followed a partial BLW practice, there was an extensive age range of participants (6 to 24 months). Subsequently, due to this age range, researchers relied on mothers' prolonged recall regarding their child's complementary feeding practices and foods consumed.

Three RCTs examining the BLISS method and TSF found no significant difference in FRC episodes between infants following either practice (de Paiva et al., 2023; Dogan et al., 2018; Fangupo et al., 2016). Although the BLISS group participants received educational materials identifying high-risk foods to avoid as part of their protocol, these same high-risk foods were subsequently implicated in choking episodes, despite parental access to preventative guidance. The daily calendar used in Fangupo et al. (2016) had comparability with a weighed food record, indicating recall accuracy (Correia et al., 2024; Fangupo et al., 2016).

Only one RCT compared BLW with TSF and found no significant difference in choking risk between the two feeding practices (Arslan et al., 2023). The study provided training modules to both parent groups on age-appropriate complementary feeding education with guide booklets. The BLW groups received additional information about the BLW approach. However, the safety-focused training that characterises BLISS approaches would not have been included.

Complementary feeding is a time of substantial developmental change for the infant, particularly for their OFS. Only one study found BLW had a significant association with FRC prevalence (p = .014) compared to those TSF (Susmarini et al., 2021). While Brown (2018) found no overall statistical significance between complementary feeding practices, the study revealed that infants who choked on finger foods and lumpy purees were those who were TSF (Brown, 2018).

This section focused on FRC in later infancy, examining its prevalence, associated risk factors, comparison with complementary feeding practices, and FRC episodes. Assessing prevalence remains challenging due to heterogeneity in methodological approaches employed across various studies and surveillance systems, and the absence of weighted estimated prevalence to provide a more accurate

estimate of the true population burden. Globally, nuts and seeds are identified as the most common foods implicated in FRC; however, in NZ, fruits and vegetables predominantly correlate with FRC in infants under 12 months (Ministry of Health, 2020). When comparing FRC episodes between complementary feeding practices, only one study reported a statistically significant association between BLW and FRC compared to TSF. Despite the utilisation of parent-reported questionnaires across complementary feeding studies, variability in the time lag between the child's age at the time of complementary feeding and parental reporting introduces the potential for recall bias.

Summary

This literature review examined three key areas: OFS, feeding behaviours, and FRC in older infants. These areas will be further explored in subsequent chapters. Knowledge regarding typical developmental trajectories for OFS and feeding behaviours remains limited, particularly for healthy infants under 12 months of age. Whilst the new diagnostic consensus for Paediatric Feeding Disorder (PFD) represents significant progress, early identification of feeding skill difficulty or delay continues to be delayed due to assessment challenges. Historically, feeding behaviours have been the more obvious symptoms prompting parents to seek help. In contrast, OFS have often not been recognised as a primary underlying cause, particularly in infants and children who are considered healthy or typically developing. This emphasis on behaviours over skills is reflected in the research literature, where investigation into the Feeding Skill Domain of PFD has been deficient compared to other PFD domains.

Capturing FRC prevalence has proven challenging due to varying study designs across the literature. The time lag between data collection and publication may not accurately reflect current national guidelines, evolving complementary feeding practices, or the development and availability of various food products. Additionally, studies focused on FRC, and complementary feeding practices have not used weighted estimated prevalence to provide a more accurate estimate of the true population burden in the latter part infancy.

Chapter 3 – The oral feeding skills of 7 to 10 month old infants in New Zealand: A cross-sectional study

As I immersed myself in the existing research, I realised something was missing: a comprehensive picture of the oral feeding skills of healthy New Zealand infants. When I began this investigation, I felt both excitement and a sense of responsibility. This work represents the first time anyone has systematically documented oral feeding skills in our healthy infant population using a validated measurement tool that captures parents' observations. I am grateful for the busy parents who completed the Child Oral Proficiency Scale (ChOMPS), a tool I use frequently in my clinical practice, and for their responses, which will finally fill a critical gap in our understanding of typical feeding development in New Zealand children.

Chapter 3

Abstract

Background: Identifying oral feeding skill difficulty early can help reduce problematic feeding behaviours, nutritional concerns, and parental stress later in childhood. The Child Oral and Motor Proficiency Scale (ChOMPS) is a validated 70-item patient-reported outcome measure (PROM) of eating, drinking and related feeding skills that can be used for children who are taking some solid food from 6 months to 7 years. Currently, there are no studies that use this tool to report the oral feeding skills (OFS) of a large study population of healthy infants at complementary feeding age, except when the normative reference values for ChOMPS were established.

Objectives: To describe the oral feeding skills (OFS) of NZ infants aged 7 to 10 months and identify those classified as of "concern" using the Child Oral and Motor Proficiency Scale (ChOMPS) indicating difficulty or delay in OFS. To explore associations between OFS, sociodemographic characteristics and early feeding practices.

Methods: Our observational study examined 562 term infants. We collected data on OFS using the ChOMPS, as well as sociodemographic characteristics and early feeding practices. We explored the associations between OFS and sociodemographic characteristics (age, sex, and diagnosed health conditions), as well as early feeding practices (current milk feeding practices, age at introduction of solid foods, and complementary feeding practices). These complementary feeding practices included traditional spoon-feeding (TSF), baby-led weaning (BLW), partial baby-led weaning (PBLW), and frequent use of baby food pouches (BFP). Using univariate analysis, we investigated associations between infants classified as of "concern" on the ChOMPS (those scoring below the 10th percentile) and these factors.

Results: Utilising the normative reference values for the ChOMPS Total Score, most infants (*n* = 527, 96%) were classified as having "no concern" (> 10th percentile) with their OFS, whilst *n* = 22, 4% were classified as "concern". The ChOMPS sub-score with the highest number of infants (*n* = 38, 27.3%)

classified as “concern” was the Basic Movement Patterns, specifically in older infants in the 9 to 12 month age group. The Fundamental Oral-Motor Skills sub-score had the lowest number of infants classified in the “concern” category (n = 17, 3%). We calculated the 5th and 10th percentile cut-off scores using our study population. Significant associations were found for infants born to primiparous mothers, as well as older infants, on the Total Score (p < .001).

Conclusion: The frequency of OFS difficulty was relatively low in this population of healthy New Zealand infants. The ChOMPS demonstrated utility as a parent-reported assessment tool for early identification of OFS difficulties. However, current normative reference value cut-off points for the ChOMPS to identify possible delays may require more nuance.

Introduction

Feeding difficulties are common in young children, with approximately 25% of typically developing children experiencing problematic feeding (Carruth et al., 2004; Wright et al., 2007). These challenges are affected by OFS, which encompass the movement patterns necessary for safe, coordinated eating and drinking, as well as sensory responses within the oral cavity, including reactions to tactile stimulation, temperature, taste, and proprioceptive input.

These skills begin with suckling (a reflexive sucking pattern) and then develop into early masticatory skills, enabling the management of solid food during complementary feeding. For example, opening the mouth to accept spooned foods, and lateral tongue movements to move food around the oral cavity. However, evidence supporting OFS as the primary or underlying concern for problematic feeding behaviours remains limited, particularly in the second half of infancy (Delaney, 2010; Delaney & Arvedson, 2008; Delaney et al., 2021; Estrem et al., 2022).

Difficulties with OFS may be under-recognised (Delaney & Arvedson, 2008) as they often present subtly, with spoon-feeding difficulties, delayed food texture advancement, and/or having limited food acceptance in infancy and later childhood (Manno et al., 2005; Pados, Park, et al., 2018). Certain health conditions, including prematurity (Sanchez et al., 2016), congenital heart defects

(Pados & Harrison, 2023), and gastroesophageal reflux (Field et al., 2003; Mathisen et al., 1999; Wilken et al., 2021) have been associated with OFS difficulty. Health conditions often impact feeding during infancy, but evidence remains limited regarding whether specific milk feeding practices (breast versus bottle feeding) are associated with OFS proficiency and/or OFS difficulties (Bąbik et al., 2021; Harris & Coulthard, 2016; Hübl et al., 2020).

A critical and complex transition for OFS occurs around the age of 5 to 6 months when the infant transitions from milk feeds to solid foods (Gisel, 1991). This developmental milestone represents a fundamental shift in oral-motor skills and sensory processing. As infants progress from a coordinated sucking pattern for milk feeding to the skills required for processing varied textures, they must develop new oral-motor patterns involving the tongue, lips, and jaw (Carruth, Betty Ruth. et al., 2004). This transition coincides with the development of improved head and trunk control and the emergence of self-feeding skills (Simione et al., 2018).

Oral movement patterns, such as tongue and jaw movement, are texture dependent and exposure to different food textures is essential for OFS development (Gisel, 1991; Reilly et al., 1995; Wilson et al., 2012). Studies have reported on the textures infants can accept and tolerate during complementary feeding (da Costa et al., 2017; Delaney et al., 2024; Delaney et al., 2021; Demonteil et al., 2019). Yet studies on the relationship between OFS and different complementary feeding practices, such as TSF, BLW, or feeding infants directly from BFPs, are limited.

Due to safety and nutritional concerns BLW is currently not recommended by the Ministry of Health NZ (Ministry of Health, 2021). Concerns have also been raised about the use of BFPs for infants, particularly if they are sucking food directly from the pouch. Sucking directly from a BFP encourages an early sucking movement pattern. In contrast, OFS need to develop a vertical chewing or munching pattern to support biting and chewing skills during complementary feeding. Frequent usage of BFPs may limit the introduction of more textured solids to a child, causing them to remain on smooth puree (Taylor et al., 2021).

While complementary feeding should begin around 6 months of age, with a gradual transition to family foods by 12 to 24 months, parents frequently delay seeking professional support for feeding difficulties until around 2 years of age, despite indicating that concerns first arose during the complementary feeding phase (Gisel, 1991; Levy et al., 2009; Ramos et al., 2017; Sanchez et al., 2016).

Most research on OFS in infants and children has focused on disordered feeding, particularly among infants under 1 month of age and children over 2 years with underlying health issues and/or disabilities (Bhattacharyya, 2015; Estrem et al., 2022; Lefton-Greif & Arvedson, 2007). The limited studies that have explored the prevalence of feeding difficulties in healthy children over 2 years of age, have used patient-reported outcome measures (PROMS) (Kamińska-Sobczak et al., 2023; Lindberg et al., 1991; Sdravou, Fotoulaki, et al., 2021; Serel-Arslan et al., 2023). These are convenient tools to collect data on healthy populations and aid in the estimation of prevalence on a larger scale (Sdravou, Fotoulaki, et al., 2021).

The ChOMPS is the only validated PROM to identify OFS delay and co-developing gross and fine motor skills together from 6 months to 7 years (Sanchez & Morgan, 2018). This is important as there is a close relationship between motor development and oral-feeding ability in terms of self-feeding skills and food texture acceptance (Carruth, Betty Ruth. et al., 2004; Delaney & Arvedson, 2008). The ChOMPS has been used to identify OFS concerns in infants with congenital heart defects (Pados & Harrison, 2023) and infants aged 8 to 24 months born less than 34 weeks gestation (Pados et al., 2024). In addition, the ChOMPS has been used to investigate the relationship between non-nutritive sucking skills at 3 months of age and later oral feeding skill and general motor development at 12 months in full term infants (Westemeyer et al., 2024). Yet there are no studies to date that use the ChOMPS to identify OFS concern in healthy infants at complementary feeding age, other than when normative reference values were established for the tool (Pados, Park, et al., 2018).

The normative reference values for the ChOMPS were established through a comprehensive observational study involving 1,057 healthy, typically developing children aged 6 months to 7 years.

Parents completed the 63-item assessment, evaluating OFS across four subscales: Basic Movement Patterns, Fundamental Oral-Motor Skills, Oral-Motor Coordination, and Complex Movement Patterns. For each age group and subscale, the researchers calculated median scores, score ranges, and critical percentile cut-offs (5^{th} percentile indicating "high concern" and 10^{th} percentile indicating "concern"). Creating normative reference values in a healthy population enables clinicians to identify children whose feeding skills fall below typical developmental expectations (Pados, Park, et al., 2018). Although the ChOMPS is not a diagnostic tool, health and medical professionals can use the PROM to identify oral feeding concerns and augment clinical assessment by providing the parents' or caregivers' perspective, as they are most familiar with their child's feeding skills.

Paediatric Feeding Disorder (PFD) is defined as impaired oral intake that is not age-appropriate and is associated with medical, nutritional, feeding skill, and psychosocial dysfunction (Goday et al., 2019). It was officially recognised as a diagnostic category in 2019, when it was included in the International Classification of Diseases, 10^{th} Revision, Clinical Modification (ICD-10-CM) (Goday et al., 2019) (Centers for Disease Control and Prevention, 2019). A large retrospective cohort study using US insurance claims data revealed significant variation in PFD prevalence among children under 5 years: 1 in 23 for publicly insured children and 1 in 37 for privately insured children. Prevalence rose dramatically to 1 in 5 among children with chronic conditions (Kovacic et al., 2021). Studies identifying the Feeding Skill Domain of PFD, including OFS, are minimal compared to those focused on the Medical and Psychosocial Domains (Estrem et al., 2022). The ChOMPS has been recently identified as a robust PROM to measure OFS and identify difficulties in the Feeding Skill Domain of PFD (Marshall et al., 2023). This can indicate to health professionals if further assessment is required to identify potential OFS difficulties and PFD early.

The study aimed to describe the OFS of NZ infants aged 7 to 10 months old and identify infants classified with "concern" on the ChOMPS, indicating OFS difficulty or delay. Additionally, the study examined associations between OFS, sociodemographic characteristics and early feeding practices.

Methods

Study design

This analysis was conducted as part of the First Foods New Zealand (FFNZ) study- an observational, cross-sectional, multi-centre study exploring the dietary intake and feeding practices of NZ infants. The primary objective of the FFNZ study was to assess iron status among infants following different complementary feeding practices (BLW versus TSF) (Taylor et al., 2021). Detailed methods for the study have previously been published by Taylor et al., (2021), therefore, only relevant information is included here. The study has ethical approval from the Health and Disability Committees New Zealand (19/STH/151) and is registered with the Australian New Zealand Clinical Trials Registry (ACTRN12620000459921).

Participants

Altogether, 625 parent/caregivers were recruited from two cities in New Zealand (Auckland, North Island and Dunedin, South Island) to participate in the study when their infant was between 7 to 10 months of age. A sample size of 625 was estimated to provide 80% power ($\alpha = .05$) to detect a 5.0 µg/L mean difference in plasma ferritin concentration (SD = 16.8 µg/L; assuming 70% complete biochemical data (Daniels, Taylor, Williams, Gibson, Samman, et al., 2018) in infants following BLW, compared to those following TSF (assuming 28.3% BLW) (Fu et al., 2018), which was the primary objective of the FFNZ study (Taylor et al., 2021).

Recruitment occurred between July 2020 and February 2022 via word of mouth and advertising across social media platforms such as Facebook groups. Exclusion criteria included infants older than 10 months, mothers under 16 years of age, infant-mother dyads residing outside of Dunedin and Auckland, and those who had participated in a research study involving a dietary intervention. The research team took care to minimise recruitment bias by targeting all infants and not those only using a specific complementary feeding practice (BLW or TSF), and targeted strategies were taken to recruit a diverse range of ethnic and socioeconomic groups. For each participant, data

collection spanned approximately three weeks and was conducted in the participants' homes, at the university research rooms, and online.

Measures

Online questionnaires were administered through the Research Electronic Capture (REDCap) platform hosted at the University of Otago, NZ, to collect sociodemographic information, diagnosed health conditions, early and current milk feeding practices, age of solid food introduction, and complementary feeding practices. The sociodemographic information included infant and parent/caregiver age, sex, parent/caregiver employment status, highest educational level, maternal parity, household composition, use of childcare and infant ethnicity (categorised using the New Zealand census categories) was collected (Statistics New Zealand, 2018). Participants could identify with more than one ethnic group, and these were prioritised to: Māori (the Indigenous population of New Zealand), Pacific, Asian, Others, and NZ European. As a proxy for determining socioeconomic status, area level deprivation was determined using the New Zealand Index of Deprivation (NZDep) based on the participant's home address (Atkinson et al., 2019).

Complementary feeding practices were assessed at the time of completing the study and retrospectively at "around 6 months of age". Parent/caregivers were asked to describe infant feeding using one of the following categories: "spoon-fed by an adult", "mostly spoon-fed by an adult", "some infant feeding themselves", "about half spoon-feeding by an adult", and "half infant feeding themselves". The first three options were categorised as TSF. The remaining options were classified as partial BLW. Those who reported "mostly infant feeding themselves", "some adult spoon-feeding", or "infant feeding themselves" were classified as full BLW. The frequency of BFP use was assessed by questionnaire. Infants were defined as frequent BFP users if their parent/caregiver indicated that they were given food from a BFP "5 to 6 times a week", "once a day", or "more than once a day".

The Child Oral and Motor Proficiency Scale

Participants were sent an electronic link to complete a second questionnaire after their final appointment, which included the Child Oral and Motor Proficiency Scale (ChOMPS) (Pados, Park, et al., 2018). The ChOMPS contains four sub-scores: Basic Movement Patterns, Oral-Motor Coordination, Fundamental Oral- Motor Skills, and Complex Movement Patterns. The Basic Movement Patterns sub-score contained questions regarding foundational motor skills, for example, bringing hands to mouth and sitting. Oral-Motor Coordination covered skills including drinking liquids without gagging, coughing, or choking and moving food with the tongue around the mouth. The Fundamental Oral-Motor Skills sub-score contained questions regarding tongue lateralisation (side to side movement) and opening the mouth wide enough to accept a spoon. Finally, the Complex Movement Patterns contained questions about more developed movements, such as drinking from a straw and using utensils to bring food to the mouth. The Complex Movement Patterns sub-score was only applicable to infants aged 9 to 12 months. During these questions, parents/caregivers were asked to indicate their child's ability to perform each skill on a 3-point Likert scale. Options were "Yes" (skill is established, score = 2), "Sometimes" (skill emerging, score = 1), and "Not Yet" (skill not yet emerging, score = 0). The Total Score was calculated as the sum of all sub-scores, with a higher score indicating more developed skills. Low scores on the ChOMPS indicate difficulty with OFS. ChOMPS has established construct validity, internal consistency and test-retest reliability (Pados et al., 2019; Park, Pados, Thoyre, McComish, et al., 2019) and normative reference values based on the 5th and 10th percentiles of a healthy population have been published (Pados, Park, et al., 2018).

Statistical analysis

R statistical software was used for all statistical analyses (R Core Team, 2025). Descriptive statistics were used for the parent/caregiver and infant sociodemographic and early life factors. We classified the infants' ChOMPS Total Score and sub-scores using two approaches. First, we applied the established normative reference values from Pados et al. (2018), which define "concern" as scores at

or below the 10th percentile and "high concern" as scores at or below the 5th percentile and grouped infants into broader age ranges (6 to < 9 months and ≥ 9 to 12 months). Due to our large study population and using the methods by Pados et al. (2018) we calculated the median scores, score ranges, and the 5th and 10th percentile cut-off scores using the same age ranges (6 to < 9 months and ≥ 9 to 12 months) to allow comparison with the original normative reference values. Additionally, we created more precise age-specific reference values by dividing our larger study population into narrower monthly age bands: 7 to < 8 months, 8 to < 9 months, and 9 to < 10 months. Again, we employed the same methods as Pados et al. (2018) for each of these more specific age groups, calculating the median scores, score ranges, and the 5th and 10th percentile cut-offs to facilitate comparison with the original normative reference values, while providing greater age specificity. Missing data were imputed as the mean of all other items in the sub-score, provided that at least 80% of the items in the sub-score were non-missing.

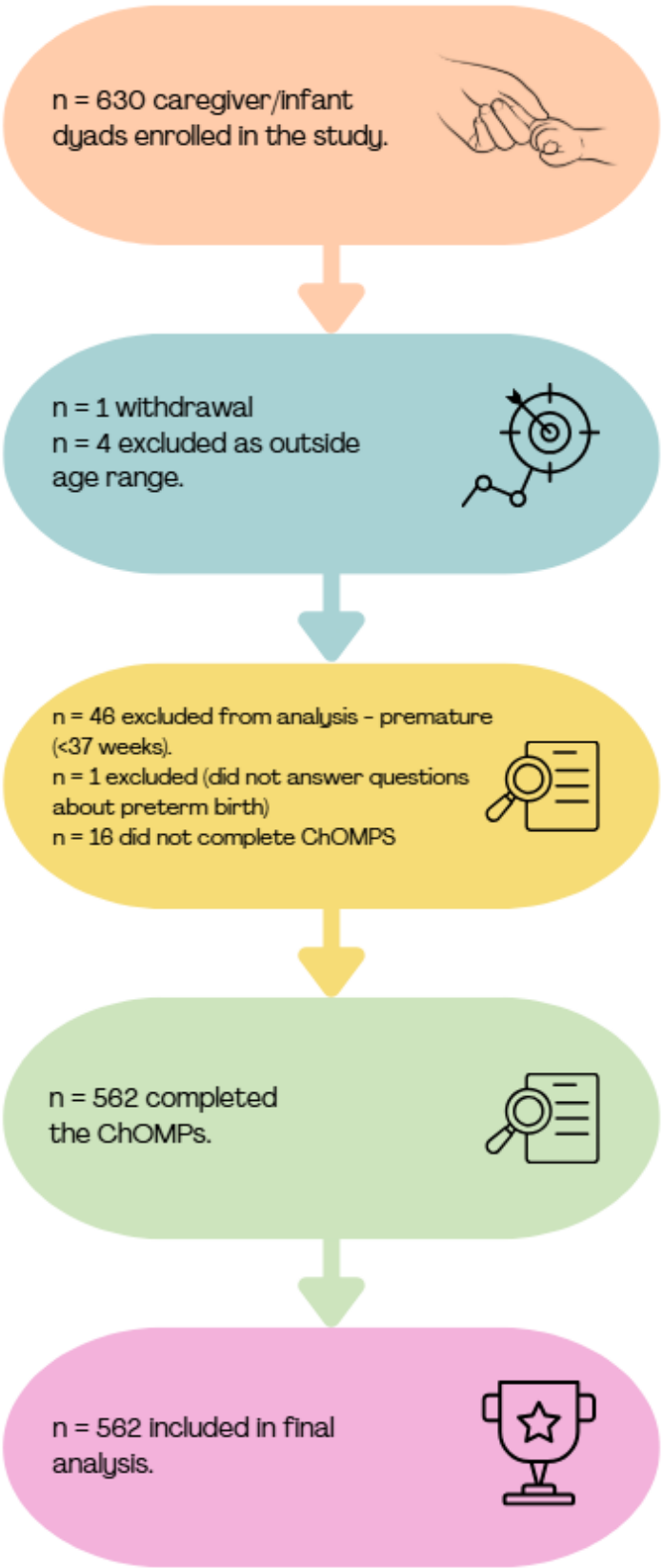
Univariate analysis was used to examine the associations between sociodemographic characteristics and early feeding practices, including complementary feeding practices (TSF, BLW, partial BLW, and BFP), and those who scored < 10th percentile on the ChOMPS, indicating “concern” for OFS. T-tests were used to compare continuous variables (infant and caregiver age) by categories of “no concern” and “concern” (combining “concern” and “high concern”). Chi Square and Fisher’s exact tests were used to compare categories of “no concern” and “concern” for all other categorical variables. If a demographic category contained less than 2% of the sample, it was not included in the Fisher’s exact test, although descriptive results were still reported. $P < .05$ was considered to indicate statistical significance.

Results

Of the 630 parent/infant dyads enrolled in the study, 562 were included in the final analysis (**Figure 3.1**).

Figure 3.1

Participant recruitment and selection flowchart



The mean age of the study population was 8.4 (SD = .8) months, with slightly more males than females (*n* = 298, 53%). Participants were predominantly from higher-deprivation areas, with a small number of infants identified as having a diagnosed health condition (*n* = 48, 8.5%) and reflux (*n* = 44, 7.8%) (**Table 3.1**). In terms of respondent characteristics, most were mothers (*n* = 555, 98.8%), primiparous (*n* = 281, 50.1%), and university educated (*n* = 373, 66.5%).

The milk and complementary feeding practices of the infants in this study are also presented (**Table 3.1**). At data collection, most were current consumers of formula (*n* = 300, 77%), with (*n* = 382, 68%) still breastfeeding. In terms of complementary feeding, the majority were introduced to solids at 5.2 (.9) months, using TSF practice at 6 months of age. At data collection, the majority of infants continued to be TSF (47.4%), with 25% partial BLW, and 17.6% fully BLW. Also, at around 6 months of age, 18% of infants were frequent BFP users, which increased to 26.2% by data collection time.

Table 3.1

Sociodemographic characteristics of the participants

n	562
Infant age (mo)	
Mean (SD)	8.4 (.8)
Range (min, max)	6.9, 10.1
Sex[a] *n* (%)	
Male	298 (53)
Female	263 (47)
Age group (FFNZ) *n* %	
7 to <8 mo	212 (38)
8 to <9 mo	211 (37)
9 to <10 mo	139 (25)
Ethnicity[b] *n* (%)	
Māori	113 (20)
Pacific	37 (6.6)
Asian	84 (15)
NZ European	315(56)
Other	13 (2.3)
Area level deprivation[c,] *n* %	
1-3	167 (30)
4-6	190 (34)
7-10	205 (36)
Number of children in household[d] *n* %	
One	265 (47.2)
Two	183 (32.6)
Three	83 (14.8)
Four or more	30 (5.4)
Diagnosed health conditions[e] *n* (%)	
Health Conditions (not reflux)	48 (8.5)
Reflux	44 (7.8)
Milk feeding practice[f], *n* (%)	
Currently breastfeeding	382 (68)
Current consumer of infant formula	300 (77)
Age solids started, (mo)	
Mean (SD)	5.2 (.9)
Complementary feeding practices (at 6 months), *n* (%)	
Baby-led weaning (BLW)	78 (13.9)
Partial baby-led weaning (partial BLW)	57 (10.1)
Traditional spoon-feeding (TSF)	427 (76)
Complementary feeding practice (currently), *n* (%)	
Baby-led weaning (BLW)	155 (27.6)
Partial baby-led weaning (partial BLW)	140 (25)
Traditional spoon-feeding (TSF)	266 (47.4)
Frequent baby food pouch (BFP) use at around 6 months of age	101 (18)
Current frequent baby food pouch use (BFP)	147 (26.2)

[a d e] Missing data (*n* = 1)

[b] Ethnicity measured using New Zealand Census categories. Participants who reported two or more ethnic groups were assigned to a single group using a prioritisation system, with the following order of priority (from highest to lowest): Māori, Pacific, Asian, Others, European).

[c] Area level deprivation, as a proxy for determining socioeconomic status, was determined using the New Zealand Index of Deprivation (NZDep) based on the participant's home address: 1-3 = Low, 4-6 = Medium/middle, 7-10 = High (Atkinson et al., 2019).

[e] Diagnosed health conditions excluded reflux, and included: eczema, food allergy, congenital heart defect, gastrointestinal issues, renal, respiratory difficulties, hypospadias, torticollis, benign familial seizures, epilepsy, haemangioma, osteomyelitis, kyphosis, faltering growth, club foot, and tongue tie.

[f] Participants can choose more than one milk feeding practice.

Infants classified as of “concern” using the normative reference values from the Child Oral and Motor Proficiency Scale

Infants classified as “no concern”, “concern”, and “high concern” using the ChOMPS normative values (Pados, Park, et al., 2018) are presented in **Table 3.2**. The majority of infants (*n* = 527, 96%) were classified as “no concern’’ on the Total Score. The highest proportion of infants classified as “concern” and “high concern’’ (under the 10th and 5th percentile respectively) occurred for older infants (≥ 9 months) across the Total Score and sub-scores. The sub-score with the highest number of infants classified with “concern” was the Basic Movement Patterns, particularly the older infants (n = 38, 27.3%). The Fundamental Oral-Motor Skills sub-score had the lowest number of infants classified in the “concern” category (**Table 3.2**). The median, range, 5th, and 10th percentile cut-off scores from the normative reference values are presented in **Table 3.3**.

Table 3.2

Infants classified as "no concern", "concern" and "high concern" using the normative reference values of the Child Oral and Motor Proficiency Scale

ChOMPS Total score and sub-scores			***FFNZ study population***
Age ranges	***Infant 6 to <9 months of age***	***Infants ≥ 9 to 12 months of age***	**All infants**
n	**423**	**139****	**562**
Total ChOMPS score*			
No concern, *n* (%)	419 (99.1)	108 (85.7)	527 (96)
Concern, *n* (%)	3 (.7)	12 (9.5)	15 (2.7)
High concern, *n* (%)	1 (.2)	6 (4.8)	7 (1.3)
Basic movement patterns sub-score			
No concern, *n* (%)	406 (96)	101 (72.7)	507 (90.2)
Concern, *n* (%)	6 (1.4)	22 (15.8)	28 (5)
High concern, *n* (%)	11 (2.6)	16 (11.5)	27 (4.8)
Fundamental oral-motor skills sub-score			
No concern, *n* (%)	417 (98.6)	128 (92.1)	545 (97)
Concern, *n* (%)	3 (.7)	5 (3.6)	8 (1.4)
High concern, *n* (%)	3 (.7)	6 (4.3)	9 (1.6)
Oral-motor coordination sub-score			
No concern, *n* (%)	420 (99.3)	131 (94.2)	551 (98.0)
Concern, *n* (%)	2 (.5)	3 (2.1)	5 (.9)
High concern, *n* (%)	1 (.2)	5 (3.6)	6 (1.1)
Complex movement patterns[a] sub-score			
No concern, *n* (%)		110 (87.3)	110 (87.3)
Concern, *n* (%)		9 (7.1)	9 (7.1)
High concern, *n* (%)		7 (5.5)	7 (5.5)

Note*Total score missing *n* = 13 who did not complete complex movement patterns (*n* = 549)

[a]The Complex Movement Patterns sub-score was only applicable to infants 9 to 12 months of age, and only 126 participants completed this sub-score Missing (*n* = 13)

A comparison table summarising the reference values from Pados et al. (2018) and the FFNZ study population is presented (**Table 3.3**). There were higher cut-off scores for the FFNZ in the 6 to < 9 month age range compared to the normative reference scores for the Total score. Generally, lower cut-off scores were found for sub-scores for early skills (Basic Movement Patterns, Fundamental Oral-Motor Skills), and higher cut-offs for sub-scores representing more complex skills compared to the normative reference values for the ≥ 9 to 12 month age range. The 10th & 5th percentile cut-off

scores were higher for the 7 to < 8 and 8 to < 9 month groups for the Total score and all sub-scores, compared to the ChOMPS normative reference values. The Basic Movement Patterns cut-off scores were lower for all monthly age groups than the normative reference values (**Table 3.3**).

Table 3.3

Total and sub-scores from Child Oral and Motor Proficiency Scale with infants categorised by different age ranges

The Child Oral Proficiency Scale (ChOMPS) Reference values		**Reference data. *Normative Reference Scores (median and range) and Normative Reference Values (5th and 10th percentile scores) for ChOMPS (Pados et al., 2018)*[a]**		**Infants classified 6 to < 9 and ≥ 9 to 12 months[b]**		**Infants classified by monthly age[c]**		
		6 to < 9 mo	≥ 9 to 12 mo	6 to < 9 mo	≥ 9 to 12 mo	7 to < 8 mo	8 to < 9 mo	9 to < 10 mo
n		94	92	423*	139†	212	211	139†
Total score of ChOMPS	Median Score (range)	60 (23-80)*	84.5 (42-126)	63.8 (37-80)	76 (30-106)	65 (37-80)	71 (48-80)	85 (30-106)
	10th percentile Score	44.5	73.3	56	72.5	54	60	72
	5th percentile Score	38.5	69	52.1	70	51	57	70
Basic Movement Patterns	Median (range)	33 (13-40)	40 (32-40)	31 (19-40)	39 (17-40)	32 (19-40)	37 (19-40)	39 (17-40)
	10th percentile	25	36	28	32	27	29	32
	5th percentile	23.8	32	26	32	25	28	32
Fundamental Oral-motor skills	Median (range)	10.5 (3-12)	12 (4-12)	11 (3-12)	12 (3-12)	12 (3-12)	12 (3-12)	12 (3-12)
	10th percentile	6.5	9.3	10	10	9	10	10
	5th percentile	6	8	9	9	8	9	9
Oral-Motor Coordination	Median (range)	16 (4-28)	25 (9-28)	20 (6-28)	26 (8-28)	22 (6-28)	24 (13-28)	25 (8-28)
	10th percentile	7.5	20.3	14	22	14	17	22
	5th percentile	6.8	17.3	11	20	11	16	20
Complex Oral Movement Patterns	Median (range)		10 (0-46)		9 (1-27)			9 (1-27)
	10th percentile		3		3			3
	5th percentile		1.7		2.25			2

Note: *Total score missing *n* = 13 who did not complete complex movement patterns (*n* = 549)

†The complex movement patterns scale was only applicable to infants 9 to 12 months of age, and only 126 participants completed this scale, Missing data (*n* = 13)

[a] Normative reference values from Pados et al. (2018)

[b] FFNZ cut-off scores using 6 to < 9 and ≥ 9 to 12 month age ranges

[c] FFNZ cut-off scores using monthly age groups

Using the ChOMPS Total Score and normative reference values (Pados, Park, et al., 2018), older infants were more likely to be classified as "concern" compared to "no concern" ($p < .001$) **(Table 3.4)**. There was a negative trend for infants using TSF at around 6 months to be classified as "concern", compared to infants using a BLW practice ($p = .053$) and infants born to primiparous mothers were less likely to be classified as "concern" on the CHOMPS ($p = .019$) (**Table 3.4**).

Table 3.4

Associations of sociodemographic characteristics and early feeding practices with classification of "concern" and "no concern" using the normative reference values

	Overall	**No concern**	**Concern**	***p*-value[a]**
n	***n* = 549[b]**	***n* = 527**	***n* = 22**	
Infant characteristics				
Age, mean (SD) months	8.4 (.8)	8.3 (.8)	9.0 (1.0)	< .001
Sex *n* (%)				.53
Male	288 (53)	275 (52)	13 (59)	
Female	260 (47)	251 (48)	9 (41)	
Ethnicity *n* (%)				.97
Māori	107 (19)	103(20)	4 (18)	
Pacific Island	36 (6.6)	34 (6.5)	2 (9.1)	
Asia	81 (15)	78 (15)	3 (14)	
New Zealand European	313 (57)	300 (57)	13 (59)	
Other	12 (2.2)	12 (2.3)	0 (0)	
NZ Deprivation Score *n* (%)				.64
1-3	164 (30)	155 (29)	9 (41)	
4-6	185 (34)	181 (34)	4 (18)	
7-10	200 (36)	191 (36)	9 (41)	
Diagnosed health conditions *n* (%)				
Health conditions	48 (8.7)	44 (8.3)	4 (18)	.12
Gastroesophageal Reflux (GOR)	43 (7.8)	41 (7.8)	2 (9.1)	.69
Maternal Primiparity *n* (%)	274 (50)	266 (51)	8 (36)	.019
Early feeding practices *n* (%)				
Currently breastfeeding	378 (69)	363 (69)	15 (68)	.94
Current consumer of infant formula	291 (77)	281 (77)	10 (77)	>.99
Age solids started, mean (SD) months	5.2 (.9)	5.1 (.9)	5.5 (.7)	.071
Complementary feeding practices at 6 months *n* (%)				.053
Baby-led weaning (BLW)	35 (6.4)	35 (6.6)	0 (0)	
Partial Baby-led weaning (partial BLW)	257 (47)	251 (48)	6 (27)	
Traditional spoon feeding (TSF)	257 (47)	241 (46)	16 (73)	
Current complementary feeding practices *n* (%)				.62
Baby-led weaning (BLW)	42 (7.7)	40 (7.6)	2 (9.5)	
Partial baby-led weaning (partial BLW)	445 (81)	429 (81)	16 (76)	
Traditional spoon feeding (TSF)	61 (11)	58 (11)	3 (14)	

[a]*p* values-Pearson's chi-squared test; Fisher's exact test; [b]*n* = 549 due to *n* = 13 not included in Total Score due to incompletion of Complex Movements sub-score.
Missing *n* = 1

When we stratified the infants by the 5th and 10th percentile from our study population, more associations were found between infants in the lowest 10th percentile of the study population and feeding practices. Infants in the lowest 10th percentile of the study population showed stronger associations with the following feeding practices on the ChOMPS Total Score: Introduced to solids closer to 6 months, rather than earlier (p = .001), were TSF at 6 months (p = .001) and currently (p < .001) (**Table 3.5**). Fewer infants in the lowest 10th percentile range were likely born to primiparous mothers (p = .011) (**Table 3.5**).

Table 3.5

Associated sociodemographic characteristics and early feeding practices with classification of "concern" and "no concern" on the ChOMPS Total Score using the FFNZ 5th and 10th percentile cut-off scores

	Overall	**No concern**	**Concern**	***p*-value[a]**
n	***n* = 549[b]**	***n* = 486**	***n* = 63**	
Infant characteristics				
Age, mean (SD) years	8.4 (.8)	8.3 (.8)	8.2 (.9)	.060
Sex *n* (%)				.065
Male	288 (53)	248 (51)	40 (63)	
Female	260 (47)	237 (49)	23 (37)	
Ethnicity *n* (%)				.81
Māori	107 (19)	96(20)	11 (17)	
Pacific Island	36 (6.6)	33 (6.8)	3 (4.8)	
Asia	81 (15)	71 (15)	10 (16)	
New Zealand European	313 (57)	274 (56)	39 (62)	
Other	12 (2.2)	12 (2.5)	0 (0)	
NZ Deprivation Score *n* %				.19
1-3	164 (30)	146 (30)	18 (29)	
4-6	185 (34)	169 (35)	16 (25)	
7-10	200 (36)	171 (35)	29 (46)	
Diagnosed health conditions *n* (%)				
Health conditions	48 (8.7)	41 (8.4)	7 (11)	.48
Gastroesophageal reflux	43 (7.8)	35 (7.2)	8 (13)	.13
Maternal primiparity *n* (%)	274 (50)	252 (52)	22 (35)	.011
Early feeding practices *n* (%)				
Currently breastfeeding	378 (69)	337 (69)	41 (65)	.49
Current consumer of infant formula	291 (77)	260 (76)	31 (84)	.29
Age solids started, mean (SD) months	5.2 (.9)	5.1 (.8)	5.5 (.8)	.001
Complementary feeding practices at 6 months, *n* (%)				.001
Baby-led weaning (BLW)	35 (6.4)	32 (6.6)	3 (4.8)	
Partial baby-led weaning (partial BLW)	257 (47)	240 (49)	17 (27)	
Traditional spoon feeding (TSF)	257 (47)	214 (44)	43 (68)	
Current complementary feeding practices, *n* (%)				< .001
Baby-led weaning (BLW)	42 (7.7)	36 (7.4)	6 (9.7)	
Partial baby-led weaning (partial BLW)	445 (81)	405 (83)	40 (65)	
Traditional spoon feeding (TSF)	61 (11)	45 (9.3)	16 (26)	

[a] p values-Pearson's chi-squared test; Fisher's exact test.

[b] n = 549 due to n = 13 not included in Total Score due to incompletion of Complex Movements sub-score. Missing n = 1

When the 5th and 10th percentile scores for the monthly age ranges (7 to < 8, 8 to < 9, 9 to < 10) were utilised to identify infants of concern different associations were identified (**Table 3.6**). We found associations for infants classified in the lowest 10th percentile of the study population, compared to those > 10th percentile on the ChOMPS Total Score. Infants in the lowest 10th percentile of the study population showed stronger associations with the following feeding practices on the ChOMPS Total Score: Currently formula feeding (p = .042), introduced to solids closer to 6 months, rather than earlier (p = .003), TSF at 6 months (p = .005) and currently (p < .001). Fewer infants in the lowest 10th percentile of the study population were likely born to primiparous mothers (p = .038) (**Table 3.6**).

Table 3.6

Associated sociodemographic characteristics and early feeding practices using the ChOMPS Total Score and the 5th, 10th and < 10th percentile FFNZ cut-off scores and monthly age groups

	Overall	No concern	Concern	High concern	*p*-value[a]
n	***n* = 549[b]**	***n* = 486**	***n* = 63**	***n* = 30**	
Infant characteristics					
Age, mean (SD) years	8.4 (.8)	8.4 (.8)	8.1 (.8)	8.2 (.9)	.14
Sex[c] *n* (%)					.11
Male	288 (53)	248 (51)	21 (70)	19 (58)	
Female	260 (47)	237 (49)	9 (30)	14 (42)	
Ethnicity *n* (%)					.94
Māori	107 (19)	96(20)	7 (23)	4 (12)	
Pacific Island	36 (6.6)	33 (6.8)	2 (6.7)	1 (3.0)	
Asian	81 (15)	71 (15)	4(13)	6 (18)	
New Zealand European	313 (57)	274 (56)	17 (57)	22 (67)	
Other	12 (2.2)	12 (2.5)	0 (0)	0 (0)	
NZ Deprivation Score *n* (%)					.39
1-3	164 (30)	146 (30)	7 (23)	11 (33)	
4-6	185 (34)	169 (35)	8 (27)	8 (24)	
7-10	200 (36)	171 (35)	15 (50)	14 (42)	
Diagnosed health conditions *n* (%)					
Health conditions	48 (8.7)	41 (8.4)	2 (6.7)	5 (15)	.41
Gastroesophageal reflux (GOR)	43 (7.8)	35 (7.2)	4 (12)	4 (12)	.26
Maternal primiparity *n* (%)	274 (50)	252 (52)	10 (33)	12 (36)	.038
Early feeding practices *n* (%)					
Currently breastfeeding	378 (69)	337 (69)	18 (60)	23 (70)	.56
Current consumer of infant formula	291 (77)	260 (76)	16 (100)	15 (71)	.042
Age solids started, mean (SD) years	5.2 (.9)	5.1 (.8)	5.4 (.9)	5.6 (.7)	.003
Complementary feeding practices at 6 months *n* (%)					.005
Baby-led weaning (BLW)	35 (6.4)	32 (3.3)	1 (6.1)	2 (6.1)	
Partial baby-led weaning (partial BLW)	257 (47)	240 (49)	10 (33)	7 (21)	
Traditional spoon feeding (TSF)	257 (47)	214 (44)	19 (63)	24 (73)	
Current complementary feeding practices *n* (%)					< .001
Baby-led weaning (BLW)	42 (7.7)	36 (7.4)	3 (10)	3 (9.4)	
Partial baby-led weaning (partial BLW)	445 (81)	405 (83)	23 (77)	17 (53)	
Traditional spoon feeding (TSF)	61 (11)	45 (9.3)	4 (13)	12 (38)	

[a] *p*-values-Pearson's chi-squared test; Fisher's exact test

[b] *n* = 549 due to *n* = 13 not included in Total Score due to incompletion of Complex Movements sub-score.

[c] Missing data *n* = 1

Discussion

This study presents a comprehensive analysis of the OFS of infants using data from a large study population of 562 healthy infants. We used the ChOMPS, a validated patient-reported outcome measure (PROM). The ChOMPS Total Score and sub-scores measured different domains of OFS, to describe these skills and identify those infants classified as of "concern" using the normative reference values.

Leveraging our substantial sample size, we established new clinical reference points by creating 5th and 10th percentile cut-off scores for age groupings on the ChOMPS (6 to < 9 months and ≥ 9 to 12 months). Additionally, we established cut-off scores for monthly age groups (7 to < 8, 8 to < 9, and 9 to < 10). This was to provide more nuanced information about the rapid change in feeding development that occurs in the second half of infancy.

Describing oral feeding skills and identifying infants classified as "concern" using the normative reference values of the Child Oral and Motor Proficiency Scale

Using the normative reference values of the ChOMPS, the majority of infants (*n* = 527, 96%) aged between 7 to 10 months were classified as having no concerns regarding their OFS. Most infants meeting the "concern" classification were older infants (≥ 9 months) on the Total Score and Basic Movement Patterns sub-score.

This finding is similar to the only other study using the ChOMPS to identify concerning OFS, which found that 32% of infants met the criteria for "concern" at 8 months and 67% at 10 months, before decreasing to 30% at 12 months (Pados & Harrison, 2023). Although these infants had congenital heart disease, they were followed longitudinally, with a higher rate of skill difficulty found at 10 months compared to the younger and older time points. Similarly, Fuls and colleagues found that feeding skill difficulties were mostly identified via a parent screener at 6 and 10 months, when the infants were experiencing new food textures (Fuls et al., 2020). This South African study differed from ours in terms of its smaller cohort (*n* = 200), larger infant age range (6 to 12 months), and the

assessment tools used. However, despite these differences results were similar, with more than 90% of participants not identified with feeding difficulties in both their cohort and our study population.

Oral feeding skills and their associations with early life factors

Using the normative reference values, most infants classified as "concern" fell within the older 9 to < 10 month old group, as indicated by both the Total Score and across all sub-scores. Increasing age was significantly associated with "concern" ($p < .001$) (**Table 3.5**.). This is likely due to the cut-off points developed for each sub-score were for ≥ 9 to 12 month old infants, and our oldest infants (9 to < 10 months) represent the youngest portion of this age category. Those who might be expected to have a lower skill level than the wider group of ≥ 9 to 12 month old infants.

A negative trend was observed for infants who were TSF at 6 months, as indicated by the Total Score, compared to those following BLW ($p = .053$), as shown in **Table 3.5**. Most infants in the study population were TSF, exposing them to purees and likely some more textured (lumpy) spooned solids. Just under half of the study population ($n = 266$, 47.4%) continued TSF at the time of data collection, with a minority of those taking solids via BLW or partial BLW.

Infants born to primiparous mothers were less likely to be classified with "concern" on the Total Score of the ChOMPS tool, ($p = .19$). This was an interesting finding, as primiparous mothers have reported concerns regarding their children's feeding behaviours in previous studies (Benjasuwantep et al., 2013; Hines et al., 2022; Sdravou, Fotoulaki, et al., 2021). Hines et al. (2022) found that first time mothers perceived more problematic breastfeeding behaviours in their infants than multiparous mothers, even though there were no differences in sucking patterns (Hines et al., 2022). Moreover, two large prevalence studies found significant associations between primipara mothers and reports of problematic feeding behaviours in typically developing children (Benjasuwantep et al., 2013; Sdravou, Fotoulaki, et al., 2021). However, these studies reported on the mother's perception of their child's feeding behaviour, rather than their child's feeding skills.

This point is demonstrated in Eales et al. (2020) in their study of 44 healthy infants (mean age 8.5 months). While researchers found significant correlations between motor difficulties and feeding skill difficulties such as fine motor issues with food refusal (p = .013), gross motor with acting up (p = .001), and oral-motor delays with specific feeding difficulties (p = .038), they still attributed these difficulties to parent-child interactions rather than feeding skill difficulties. However, only 4.9% of infants failed the feeding screening (MCH-FS), while 40.3% were identified with developmental concerns (Parent's Evaluation of Developmental Status: Developmental Milestones -PEDS-DM), both of which are parent-reported questionnaires (Eales et al., 2020). This inconsistency in assessment scores revealed the parents' inability to recognise developmental feeding readiness cues and oral feeding difficulties, causing them to misinterpret these OFS difficulties as behavioural feeding problems.

A recent scoping review of PFD research identified significant gaps in demographic data reporting (Estrem et al., 2022). Our finding with infant birth status contradicts some existing literature. Given both this inconsistency and the identified research gaps, future studies should further investigate the relationship between infant birth status and their OFS.

First Foods New Zealand reference (cut-off) scores

The ChOMPS has not been used on a healthy population since its normative reference values were created. The cohort of 6 to 12 month-old infants, used to establish the normative reference values, was small (n = 186), with no diagnosed health conditions, mostly White/Caucasian, from two-parent families, with tertiary-educated parents (57%), mainly residing in the United States (Pados, Park, et al., 2018; Sanchez & Morgan, 2018). Our study population was larger (n = 562), more ethnically and socioeconomically diverse with diagnosed health conditions not excluded. Most infants were classified as having "no concern" with OFS.

The authors of the ChOMPS recommended that testing of the specificity and sensitivity of the assessment's cut-off scores was needed due to the risk of over-identification, as their normative

reference sample was typically developing with no underlying health conditions. They also suggested that testing on a more diverse sample was needed to help enhance their normative reference values (Pados, Park, et al., 2018; Sanchez & Morgan, 2018). Sensitivity and specificity analyses were not conducted within our study, as the study design involved normative sampling of typically developing infants rather than comparison with a clinically diagnosed feeding disorder cohort. However, our study contributes to the psychometric evidence base for the ChOMPS by providing age-specific normative data within a culturally and socioeconomically diverse infant sample. Using the methods applied by Pados et al. (2018), we calculated 10th and 5th cut-off scores using our larger study population. Our cut-off scores were higher for the 6 to < 9 month age group compared to the normative reference values. This is likely due to having older infants in the younger age range (7 months and older). Whereas our cut-off scores for the ≥ 9 to 12 month age group were lower or the same for the Total Score and sub-scores for the 10th percentile (with a slight increase for the Fundamental Oral-Motor Skills sub-score), compared to the ChOMPS normative reference values (**Table 3.3**).This suggests that there is a need for cut-off scores for each *month of age*, to identify infants at risk of OFS delay during this period of rapid development. Indeed, the FFNZ 10th percentile cut-off scores for 9 to < 10 month old infants were lower on for the Total Score and Basic Movement sub-score (**Tables 3.3**), compared to the cut-off scores from the normative reference data, and may represent a more appropriate point at which to define "concern" for this age group of 9 to < 10 month old infants. Having cut-off scores defined for a three-month age range may mean that more infants at the younger end of these age ranges are inappropriately identified as having "concerning" OFS. For example, a 6-month-old who is just starting purees and an 8.9 month old who is exploring finger foods will both technically fit within the 6 to < 9 month age range yet are at very different stages of development.

Due to the changing nature of OFS in the second half of infancy at the time of complementary feeding, it could be argued that the normative reference scores of the ChOMPS may be too broad. This is due to the differences between the age and when solid textures are introduced,

which increase skill acquisition and the co-development of gross and fine motor skills. With consideration, we divided the ages monthly (7 to < 8, 8 to < 9 and 9 to < 10 months) to gather more information to add to the ChOMPS normative reference data (**Table 3.2**). Our study population had higher cut-off scores for 5th and 10th percentiles for the younger age groups (7 to < 8, 8 to < 9 months) across the Total Score and sub-scores compared to normative reference values of the ChOMPS. However, the cut-off scores for the older group, 9 to > 10 months, varied across sub-scores. This is reflective of the ages and larger size of the study population and adds alternative cut-off score options to the ChOMPS for future research and clinical purposes.

When we applied the monthly FFNZ cut-off scores, fewer infants were in the lowest 10th percentile for the Total Score and Basic Movement Patterns sub-score compared to the normative reference values (**Tables 3.2 and 3.3**). In particular, for the older infants (9 to < 10 months). More infants were in the lowest 10th percentile for the oral- motor sub-scores (Oral-Motor Coordination and Fundamental Oral-Motor Skills) compared to the normative reference values. However, these numbers decreased in the older age group (9 to < 10 months), indicating OFS development.

Transitioning to more advanced textures can be a vulnerable time for infants because the acquisition of the sensory and motor skills necessary for the intake of these advanced textures requires increasingly complex oral-motor control. (Delaney, 2010) and (Gisel, 1991) reported that infants between 6 to 8 months have achieved oral-motor skill maturity for puree and soft solids. However, for harder textures such as dry cereal pieces, proficiency was not achieved for some infants until after 24 months of age (Delaney, 2010; Gisel, 1991). Furthermore, oral movement patterns, in particular tongue lateralisation (side to side movement and precursor to chewing), require food texture exposure to develop (Harris & Mason, 2017).

Associations with oral feeding skills and early life factors using the First Foods NZ reference scores

The older infants (≥ 9 months) were more likely to be classified as "concern" on the ChOMPS when normative reference values were used (**Table 3.4**), most likely because they represented the

younger end of the ≥ 9-12 month age range. This age effect disappeared when FFNZ cut-off scores were applied (**Tables 3.5 and 3.6**). Using the FFNZ percentile cut-offs revealed that early feeding practices, (current formula feeding, timing of solid food introduction, and TSF practice) had stronger associations with placement in the lowest 10th percentile on the ChOMPS Total Score.

Infants currently formula feeding were more likely to be in the lowest 10th percentile of the study population for the Total Score of the ChOMPS, compared to those currently breastfeeding. This was an interesting finding, as most literature reports that the types of food and textures offered affect OFS rather than the method of milk feeding (Harris & Coulthard, 2016; Hübl et al., 2020). Harris and Coulthard (2016) concluded that while breastfeeding offers advantages by exposing infants to a wider variety of flavours, it is not the main determinant of wider food tolerance. Rather, the timing and frequent exposure to diverse food textures and tastes play the crucial role. Formula-fed infants can equally develop food acceptance when introduced to varied foods at appropriate times (Harris & Coulthard, 2016). Similarly, Hubl et al. (2020) reported that the length of chewing experience was significantly associated (p < .001) with chewing abilities at 9 and 12 months for healthy pre-term and term infants rather than sucking patterns (Hübl et al., 2020). Further investigation into early and current milk feeding practices in relation to OFS is recommended in future studies.

Our study found that infants introduced to solids closer to 6 months of age were more likely to fall within in the lowest 10th percentile on the ChOMPS Total Score, compared to those infants who started solids earlier. This was noteworthy as the early introduction of solids was associated with poorer effects on OFS in two large cross-sectional studies (Eales et al., 2020; Hollis et al., 2016).

The apparent discrepancy between these earlier findings and our study's may reflect differences in the outcomes measure or the timing of skill acquisition assessed. While early solid introduction has been linked to fine motor challenges(p = .015 (Eales et al., 2020). The present findings suggest that delaying solids until closer to 6 months may also be associated with poorer OFS, as captured by the ChOMPS. This supports earlier reviews suggesting that timing of solid

introduction may influence OFS development, although evidence has historically been inconclusive die to methodological limitations (Brisque Neiva et al., 2003). Notably, in our study, the association between later introduction of solids and lower ChOMPS Total Score reached statistical significant when using the monthly FFNZ cut-offs (p = .003) and showed a trend when the normative reference values were applied (p = .071). This suggests that the relationship between the timing of solid introduction and OFS development may be context-dependent and warrants further investigation using longitudinal designs and standardised OFS outcome measures(Brisque Neiva et al., 2003; Hollis et al., 2016).

We found that infants who were TSF at 6 months and currently were more likely to be in the lowest 10th percentile of the study population for the Total Score of the ChOMPS, compared to those who were BLW. This pattern was consistent with analyses using normative reference values, where a negative trend was also observed for infants who were TSF at 6 months of age (p = .053) (**Table 3.5**). Together, these findings suggest an association between prolonged TSF and less mature OFS, although the direction of the relationship remains unclear.

It is plausible that delays in OFS influence caregivers' choice to continue TSF if their infants do not appear developmentally ready to self-feed. Conversely, continued reliance on TSF may limit infants' opportunities to practise key skills such as biting, chewing, and manipulation textured foods, thereby contributing to delayed OFS development. This potential bidirectional relationship is consistent with broader feeding literature indicating that exposure and practice are critical for the development of feeding skills.

While TSF allows caregivers to introduce a range of tastes and texture, particularly more lumpy or textured purees, previous research has shown that delayed introduction of lumpy and textured foods beyond 10 months of age is associated with feeding difficulties in toddlerhood and later childhood (Harris & Mason, 2017). However, observational data suggests that many infants may be capable of managing more challenging textures earlier than they are routinely offered. For example, Demonteil et al. (2019) reported that cooked pieces of food were highly accepted by

infants at 8 months, and that acceptance often preceded parental introduction (Demonteil et al., 2019).

In contrast, Delaney et al. (2021) reported that at 8 months of age, infants primarily consumed liquids and purees, with purees accounting for nearly half of their total energy intake. Then, by 10 months, infants began incorporating more regular solid foods (Delaney et al., 2021). When considered alongside the present findings, this discrepancy highlights the role of complementary feeding practices in shaping infants' feeding experiences and opportunities for skill development. Further longitudinal research is needed to determine whether prolonged TSF contributes to delayed OFS, or whether early feeding skill differences drive continued use of TSF.

Infants born to primiparous mothers were less likely to be in the lowest 10th percentile of the study population for the Total Score of the ChOMPS, compared to those born to multiparous mothers. This finding was similar to the normative reference value analysis, where it reached significance (p = .011) (**Table 3.5**). Further research is recommended regarding the association between birth status and the development of OFS and PFD.

In terms of the limitations of our study, the convenience sampling method used for recruitment would most likely have introduced selection bias towards parents and caregivers with higher education levels than the general population of NZ, as well as those who have a greater interest in their infants' OFS development. Moreover, those parents/caregivers who have sufficient English and literacy skills to complete the ChOMPS were able to participate. Interpretation of the findings must be considered within the context of the PROMs. Although parent report offers a valuable and ecologically valid perspective on infant feeding skills as they occur in everyday contexts, it is subject to caregiver perceptions, experiences, and reporting bias. As such, the findings represent the caregiver-reported observations of their infant's OFS rather than direct observational assessment by a speech-language pathologist. Further investigation is warranted to explore the significant associations found between early feeding practices, primiparity, and OFS in the second half of infancy.

Conclusion

To our knowledge, this is the first study to describe the OFS of infants aged 7–10 months in Aotearoa New Zealand and to identify skill-based feeding difficulties during the complementary feeding period using a validated PROM. By addressing our objectives to describe OFS, identify OFS difficulty or delay using the ChOMPS and explore associations with sociodemographic characteristics and early feeding practices, this study adds important developmental context to the limited literature on feeding skill acquisition in the second half of infancy. The large and socioeconomically and ethnically diverse sample drawn from two urban centres further strengthens the relevance of these findings to contemporary infant feeding practices in New Zealand.

The use of the ChOMPS enabled evaluation of OFS from a caregiver perspective, contributing to the small but growing body of research applying this PROM in infants under 12 months of age. The derivation of age-specific 5^{th}, 10^{th}, and $>10^{th}$ percentile cut-off scores for infants aged 7 to < 8, 8 to < 9, and 9 to < 10 months provides additional nuance to existing normative reference values and has potential utility for both future research and clinical screening. Together, these findings support the ChOMPS as a useful tool for identifying variation in OFS development during a critical transitional feeding period.

However, further work is required to refine and validate normative reference values for the ChOMPS. Future research combining individual participant data across similar studies would allow the development of robust, internationally representative norms, as well as the establishment of sensitivity and specificity through comparison with independent clinical assessments, particularly within clinically referred populations. In addition, the observed associations between OFS, early feeding practices, and primiparity warrant further investigation to better understand how feeding environments and caregiver experience interact with OFS development during complementary feeding. Such work may support more targeted, developmentally appropriate guidance to optimise feeding experiences and outcomes in early infancy. Moreover, establishing sensitivity and specificity

for the PROM remains an important direction for future research, particularly in studies incorporating clinically referred populations.

Chapter 4 – The feeding behaviours of 7 to 10 month old infants in New Zealand: A cross-sectional study

Throughout my years as a feeding specialist, I've observed countless children whose oral feeding abilities seemed intrinsically connected to their broader feeding behaviours—a relationship I knew existed but could not definitively explain. This chapter represents not just another section of research but a deeply personal turning point in my professional journey.

Here, I examined feeding behaviours with the same analytical process applied to oral feeding skills in Chapter 3. Still, I take a step further by exploring how these two domains intertwine during the study population's age range of 7 to 10 months. As I analysed the data, I found myself nodding in recognition—the numbers were confirming patterns I had intuited at children's highchairs for over 20 years.

When the statistical relationships emerged clearly on my screen, I felt a wave of validation. Those moments when I'd told parents and peers that ''refusal behaviours are reflecting the child's skills". "This gagging is not the child being naughty but real sensory responses, affecting their skill progression". "Food falling from mouths is not rejection of the food but demonstrating oral skill

weakness", were not just clinical hunches—they represented real, measurable connections that this research documents.

This chapter marks a pivotal moment, both in my doctoral journey and in my identity as a feeding specialist. After years of clinical observation without concrete evidence to support my integrated approach to feeding, I can now speak with confidence. The data is bridging the historically separate domains of feeding skills and feeding behaviours.

Chapter 4

Abstract

Background: Problematic feeding behaviours can occur in healthy term infants; however, parents often do not seek help until later childhood. The Pediatric Eating Assessment Tool (Pedi-EAT) is a 78 item validated patient-reported outcome measure (PROM) that evaluates symptoms of problematic feeding behaviours in infants and children aged 6 months to 7 years. Currently, there are limited studies describing feeding behaviours and identifying problematic feeding behaviours in healthy term infants at complementary feeding age, and their relationship with oral feeding skills (OFS).

Objectives*:* To describe the feeding behaviours of 7 to 10 month old infants, identify problematic feeding behaviours in the study population, using the Pedi-EAT. Explore associations between feeding behaviours, sociodemographic characteristics and early feeding practices, and investigate the relationship between feeding behaviours and OFS.

Methods: This observational study included 561 term infants. Data on sociodemographic and early life factors were collected. Feeding behaviours were assessed using the Pedi-EAT. Associations between feeding behaviours, sociodemographic characteristics and early life factors, including health conditions and feeding practices, were explored using univariate analysis. In addition, the relationship between feeding behaviours and OFS were investigated with parents of 548 infants completing both the Pedi-EAT and ChOMPS (Child Oral and Motor Proficiency Scale) and analysed by multiple linear regression.

Results*:* The majority of infants (n = 463, 83%) were categorised as having no concerns with feeding behaviours based on the Pedi-EAT normative reference values. Feeding behaviours of "concern" were associated with gastro-oesophageal reflux (GOR) diagnosis and maternal primipara status. The Pedi-EAT Total Score also showed a positive correlation with the ChOMPS Total Score, indicating an association between feeding behaviours and OFS. Notably, infant age exhibited the strongest positive relationship with the ChOMPS Total Score (p < .001), followed by primiparity (p = .001) and

the Pedi-EAT Total Score (p = .004). No association was observed between infant age and the Pedi-EAT Total Score.

Conclusions: The frequency of problematic feeding behaviours was relatively low in this study population of New Zealand infants. The Pedi-EAT demonstrated utility as a PROM tool for early identification of problematic feeding behaviours. However, age groupings may require greater nuance. While infant age was associated with OFS (ChOMPS Total Score), no comparable relationship was observed with feeding behaviours (Pedi-EAT Total Score). These observations suggest that age-related factors may have different relationships with OFS compared to feeding behaviours, which could be relevant for clinical assessment approaches.

Introduction

Problematic feeding behaviours can appear from birth to late adolescence. However, the highest rates of reported difficulties are between 6 months and 4 years (Dovey et al., 2010; Estrem et al., 2016; Levy et al., 2009). Symptoms of problematic feeding behaviours present as food refusal, gagging before or during mealtimes, a specific food or texture avoidance and insistence on specific food presentation (Estrem et al., 2016).

The aetiology of problematic feeding behaviours is multi-factorial. Health conditions are one of the main causes. Medical conditions, including gastrointestinal issues (such as, gastroesophageal reflux, constipation), food allergies, a history of tube feeding, congenital heart defects, and developmental delays, are key contributors to problematic feeding behaviours (Park et al., 2018). However, problematic feeding behaviours can also occur in healthy infants and children, particularly during critical developmental stages that require adaptation in feeding styles and dietary intake. Such as early milk feeding practices, the introduction of solid foods, self-feeding, and when children become increasingly mobile and independent (Birch, 1999). Feeding refusal behaviours in healthy infants are most likely related to delays in OFS development but can also be an early sign of developmental delay. Likewise, children with an underlying medical condition or developmental

delay may lack OFS coordination causing reduced acceptance of texture at the time of complementary feeding (Delaney et al., 2024).

Beyond an infant's OFS, several environmental and parental factors may contribute to problematic feeding behaviours. These include inadequate feeding environments, maladaptive feeding styles, parental lack of awareness of infant feeding cues, and birth status (Eales et al., 2020; Estrem et al., 2017; Hvelplund et al., 2016; Rommel et al., 2003). Research in a low-middle income country identified OFS difficulties and food refusal in healthy 8.5-month-old infants (*n* = 144), revealing a relationship between fine motor difficulties and mealtime food refusal (Eales et al., 2020). These infants exhibited specific oral feeding challenges including pocketing food, gagging, spitting, and vomiting. The authors suggested that caregivers' failure to recognise early feeding difficulties or misinterpret infant cues led to maladaptive practices such as force feeding and restricting infant autonomy during self-feeding (Eales et al., 2020).

Identification of problematic feeding behaviours during infancy is important to prevent the adverse health outcomes associated with these behaviours in childhood (Pados, Thoyre, et al., 2018).Negative mealtime experiences can lead to learned behaviours that are challenging to manage as the child grows, emphasising the importance of timely intervention. Moreover, early identification is needed to determine if the infant’s behaviours are reflective of a feeding skill-based difficulty or delay.

To assist early identification of problematic feeding behaviours validated PROMs can be used to identify symptoms of problematic feeding behaviour and OFS. The Pedi-EAT and the ChOMPS have been identified as the most robust and valid in terms of PROMs, particularly for identifying the Feeding Skill Domain of Paediatric Feeding Disorder (PFD) (Marshall et al., 2023). PFD is a relatively new disease classification created by an expert consensus in 2019, which is helping to classify children with feeding difficulties so support can be implemented sooner. PFD is defined as impaired oral intake in an infant or child, which is not age appropriate and is associated with medical, nutritional, feeding skill and psychosocial difficulties (Goday et al., 2019).

These PROMs have also been used to describe symptoms of problematic feeding behaviour and OFS in infants with congenital heart disease (Pados & Harrison, 2023) and infants aged 8 to 24 months born less than 34 weeks gestation (Pados et al., 2024). However, to our knowledge this is the first study to use the validated PROMs together to analyse symptoms of problematic feeding behaviours and OFS from a large study population of infants. Currently, there are no studies investigating the associations between OFS status and feeding behaviours in NZ infants.

The study aimed to describe the feeding behaviours of 7 to 10 month old infants, identify problematic feeding behaviours and their associations with sociodemographic characteristics and early feeding practices, and investigate the relationship between feeding behaviours and OFS.

Materials and methods

Study design

This analysis was conducted as part of the First Foods New Zealand (FFNZ) study. An observational, cross-sectional, multi-centre study exploring the dietary intake and feeding practices of NZ infants. The primary objective of the FFNZ study was to assess iron status among infants following different complementary feeding practices, such as baby-led weaning (BLW) versus traditional spoon-feeding (TSF) (Taylor et al., 2021). Detailed methods for the study are already published (Taylor et al., 2021) therefore, only relevant information is included here. The study had ethical approval from the Health and Disability Committees New Zealand (19/STH/151) and is registered with the Australian New Zealand Clinical Trials Registry (ACTRN12620000459921).

Participants

A total of 630 parent/caregivers were enrolled from two cities in New Zealand (Auckland, North Island and Dunedin, South Island) to participate in the study when their infant was between 7 to 10 months of age. A sample size of 625 was estimated to provide 80% power ($\alpha = .05$) to detect a 5.0 µg/L mean difference in plasma ferritin concentration (SD = 16.8 µg/L; assuming 70% complete

biochemical data (Daniels, Taylor, Williams, Gibson, Samman, et al., 2018) in infants following BLW, compared to those following TSF (assuming 28.3% BLW) (Fu et al., 2018).

Recruitment occurred between July 2020 and February 2022 via word of mouth and advertising across social media platforms such as Facebook groups. Exclusion criteria included infants older than 10 months, mothers less than 16 years of age, infant/mother dyads living outside of Dunedin and Auckland, and those who had taken part in a research study that had involved a dietary intervention. Premature infants were excluded as we could not calculate their corrected age when using the Pedi-EAT and ChOMPS. However, this was not the case with the rest of the FFNZ objectives. Care was taken to minimise recruitment bias by targeting all infants and not those only using a specific complementary feeding practice (BLW or TSF), and efforts were taken to recruit a diverse range of ethnic and socioeconomic groups. Data collection was also conducted in the participants' homes and/or the university research rooms over a three-week period, and online.

Online questionnaires were administered through the Research Electronic Capture platform (REDCap) hosted at the University of Otago to collect sociodemographic information. The sociodemographic information included parent and infant age, sex, and infant ethnicity measured using the New Zealand Census categories (Statistics New Zealand, 2018). Participants could identify with more than one ethnic group, and these were prioritised to: Māori (the Indigenous population of New Zealand), Pacific, Asian, Others, and NZ European. Area level deprivation, as a proxy for determining socioeconomic status, was determined using the New Zealand Index of Deprivation (NZDep) based on the participant's home address (Atkinson et al., 2019). Also, parent employment status, highest educational level, maternal parity, household composition, and use of childcare were collected. Information related to infant early life factors included diagnosed health conditions, early and current milk feeding practices, age of solid food introduction, and complementary feeding practices were collected.

Pediatric Eating Assessment Tool (Pedi-EAT)

Participants were sent an electronic link to complete a second questionnaire after their final appointment, which included the Pedi-EAT (Pados, Thoyre, et al., 2018) and the ChOMPS (Pados, Park, et al., 2018). The Pedi-EAT is a 78 item PROM of symptoms of problematic feeding related to at least some solid-food eating in infants and children aged 6 months to 7 years of age. This PROM assessed the infants' willingness to eat and their feeding behaviours from a parent perspective. The Pedi-EAT contains four sub-scores: Physiologic Symptoms, Problematic Mealtime Behaviours, Selective/Restrictive Eating, and Oral Processing. The Physiologic Symptoms sub-score contained 27 items regarding symptoms and behaviours of swallowing difficulties (coughing, gagging and wet voice quality), difficulties maintaining physiological stability or coordinating eating and breathing (fatiguing, sweating and/or increased work of breathing), and gastrointestinal issues (arching, vomiting and difficulty defecating). The Problematic Mealtime Behaviours sub-score has 23 items focused on food acceptance, avoidance and refusal behaviours. For example, "opens mouth when food is offered", "plays to avoid eating", "throws food way", and "stops eating after a few bites".

The Selective/Restrictive Eating sub-score has 15 items assessing food texture and temperature preferences of the infants. The final Oral Processing sub-score, made up of 13 items, looks at the infant's oral processing skills and symptoms of difficulty, such as, needing to chew food for a long time, pocketing food in their cheeks, preferring strong flavours and needing their fingers to move food in their mouths. Parents were asked to rate each item on a 6-point Likert scale (0 = never, 1 = almost never, 2 = sometimes, 3 = often, 4 = almost always and 5 = always). Five items on the Problematic Mealtime Behaviours sub-score, twelve items on the Selective/Restrictive Eating sub-score and six items on the Oral Processing sub-score were scored in reverse.

The scale for six items was modified to include an additional answer option to allow caregivers to answer the item appropriately if their infant had not yet been offered specific types of foods or textures (such as, crunchy or frozen foods). For example, for the Problematic Mealtime Behaviours item "My child prefers crunchy foods", the scale was modified to include an answer

option of “My child is not offered crunchy foods” in addition to the six existing Likert-scale ratings (from Never to Always). Where caregivers answered any of the six Pedi-EAT items using the additional answer option, the items were scored as follows: Four items in the Selective/Restrictive Eating sub-score were given a score of 0, as per instructions in the original Pedi-EAT questionnaire; and two items, one item in the Selective/Restrictive Eating sub-score, (“My child will eat mixed texture foods”), and one item in the Problematic Mealtime Behaviours sub-score, (“My child prefers crunchy foods”), were scored as missing (so the questions were not included in the sub-score score if the infant was not yet eating mixed texture foods or crunchy foods). In the Oral Processing sub-score four questions asked about chewable foods and (“My child has to be reminded to chew food”, “My child sucks on food to soften or moisten it, rather than chewing it”, “My child chews food but doesn’t swallow it”, “My child chews a bite of food for a long time , approximately 30 seconds or longer”) were also scored as missing if the parent answered “My child is not offered chewable food”. Sub-score responses for each item were combined to determine a total score for each sub-score. Higher scores on the Pedi-EAT indicate more symptoms of problematic feeding behaviours. The Pedi-EAT is validated (Thoyre et al., 2014; Thoyre et al., 2018) and normative reference values based on the 90th and 95th percentiles for a healthy population have been published (Pados, Thoyre, et al., 2018).

Child Oral and Motor Proficiency Scale

The ChOMPS, also sent via electronic link is a 63 item PROM, that measured the infants’ OFS. Similarly to the Pedi-EAT, the ChOMPS is validated on children from 6 months to 7 years who are eating some solid food. Unlike the Pedi-EAT, which asks parents to rate their child’s willingness to eat and their feeding behaviours, the ChOMPS asks parents to rate their infant’s ability to perform each OFS on a 3 point Likert scale, with the following options: “Yes” (skill is established; score = 2), “Sometimes” (skill emerging; score = 1), and “Not Yet” (i.e., skill not yet emerging ; score = 0). Scores for each sub-score were calculated as the sum of all item scores and higher scores on each sub-score indicated more developed skills.

The ChOMPS contains four sub-scores: Basic Movement Patterns, Oral-Motor Coordination, Fundamental Oral-Motor Skills, and Complex Movement Patterns. The Basic Movement Patterns sub-score contains items regarding foundational motor skills, for example, bringing hands to mouth and sitting. Oral-Motor Coordination covered skills including drinking liquids without gagging, coughing, or choking and moving food with the tongue around the mouth. The Fundamental Oral- Motor Skills sub-score contains items regarding tongue lateralisation (side to side movement) and opening the mouth wide enough to accept a spoon. Finally, the Complex Movement Patterns sub-score contains items about more developed movements, such as drinking from a straw and using utensils to bring food to the mouth.

The Complex Movement Patterns sub-score was only applicable to infants 9 to 12 months of age. Low scores on the ChOMPS indicate difficulty with OFS. Similar to the Pedi-EAT, ChOMPS has established construct validity, internal consistency and test-retest reliability (Pados et al., 2019; Park, Pados, Thoyre, McComish, et al., 2019) and normative reference values for the age ranges based on the 5th and 10th percentiles of a healthy population have been published (Pados, Park, et al., 2018).

Statistical analysis

IBM SPSS Statistics (Version 29) and R (R Core Team, 2025) were used for the statistical analyses. We classified the infants' Pedi-EAT Total Score and sub-scores using two approaches. First, we applied the established normative reference values from Pados et al. (2018), which define "concern" as scores at or above the 90th percentile and "high concern" as scores at or above the 95th percentile, using the broader age ranges (6 to < 9 months and ≥ 9 to 12 months). Due to our large study population and using the methods by Pados et al. (2018) we calculated the median, score ranges, mean (SD) and the 90th and 95th percentile cut-off scores, using the same age ranges (6 to < 9 months and ≥ 9 to 12 months), to allow comparison with the original normative reference values. Additionally, we created more precise age-specific reference values by dividing our larger study population into narrower monthly age bands: 7 to < 8 months, 8 to < 9 months, and 9 to < 10

months. Again, we employed the same methods as Pados et al. (2018) for each of these more specific age groups, calculating the median, score ranges, mean (SD), and 90th and 95th percentile cut-off scores to facilitate comparison with the original normative reference values, while providing greater age specificity. Missing data were imputed as the mean of all other items in the sub-score, provided that at least 80% of the items in the sub-score were non-missing.

Descriptive and frequency summary statistics were calculated for the parent and infant sociodemographic and early life factors. If a sociodemographic category contained less than 20% of the sample, it was not included in the Fisher's exact test. However, descriptive results were still reported, $p < .05$ was considered to indicate statistical significance. Univariate analysis was used to examine associations between the Pedi-EAT scores and early life factors (including sociodemographic characteristics, health conditions, GOR, and milk feeding complementary feeding practices) and the Pedi-EAT. T-tests were used to compare continuous variables (infant age) by categories of no "concern" and "concern" (combining "concern" and "high concern") using the Pedi-EAT Total Score only. Fisher's exact tests were used to compare categories of no "concern" and "concern" for all other categorical variables.

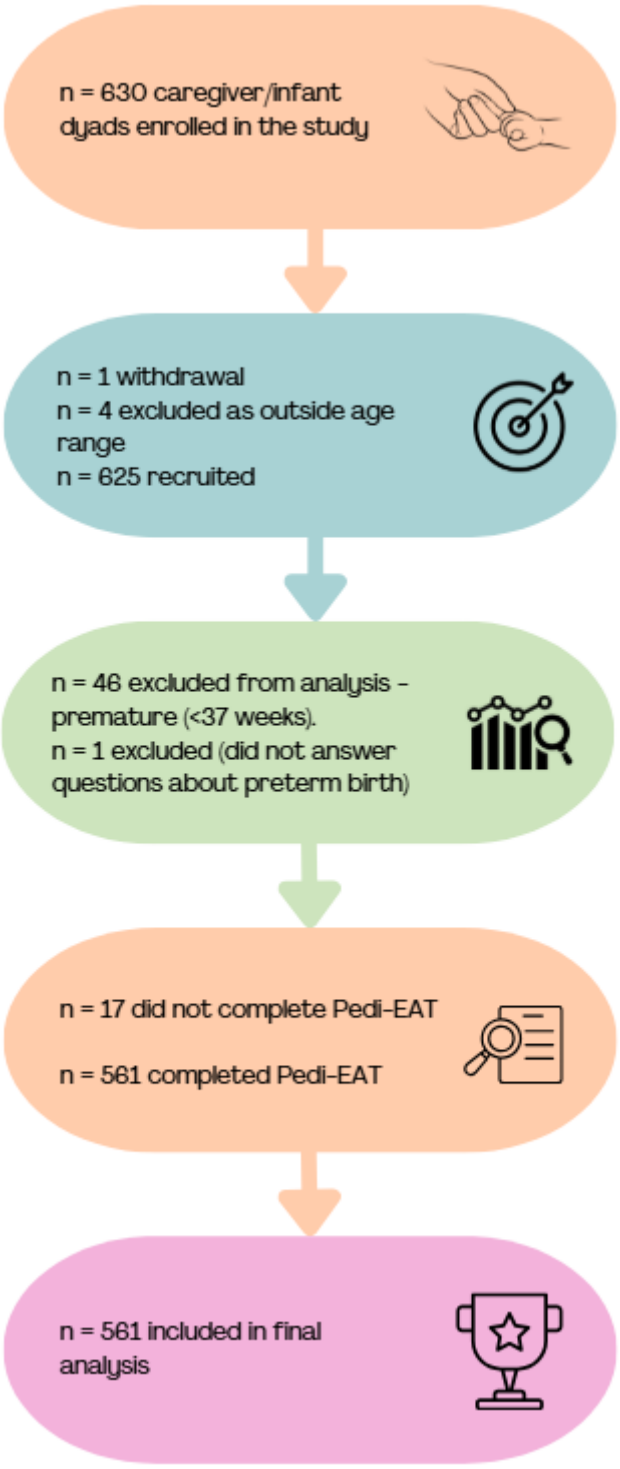
Multivariate linear regression was performed to ascertain a relationship between feeding behaviour (Pedi-EAT) and OFS (CHOMPS). The initial model including confounding items: age (months), sex, reflux (yes/no), primiparity (yes/no), New Zealand deprivation score, ethnicity (Māori, Pacific, Asian, Other and European). The final model removed insignificant confounders while retaining sex and age and included age, sex, and primiparity as confounders. Variables in the final regression model were checked for collinearity using the variance inflation factor. Residual statistics (residuals vs fitted; scale-location; residuals vs leverage (Cook's distance) was examined to ensure linearity, homogeneity, and any undue effect of individual cases on the final model. All tests came within acceptable parameters. Significance was defined as $p < .05$.

Results

In total, 630 parent/infant dyads consented to participate in the FFNZ study, *n* = 561 were included in the final Pedi-EAT analysis (**Figure 4.1**).

Figure 4.1

Participant recruitment and selection flowchart



The table below presents the sociodemographic characteristics of the infants whose parents completed the Pedi-EAT (*n* = 561). The mean (SD) age of the infants was 8.4 months (.8), with most identified as NZ European (*n* = 315, 53%), living in areas of higher deprivation (n = 204, 36%), and being primiparous (*n* = 281, 50%) (**Table 4.1**).

Table 4.1

Sociodemographic characteristics of the participants

n	561
Infant age (mo)	
Mean (SD)	8.4 (.8)
Range (min, max)	6.9, 10.1
Sex[a] *n* (%)	
Male	298 (53)
Female	262 (47)
Age group (FFNZ) *n* (%)	
7 to < 8 mo	212 (38)
8 to < 9 mo	210 (37)
9 to < 10 mo	139 (25)
Ethnicity[b] *n* (%)	
Māori	113 (20)
Pacific	37 (6.6)
Asian	83 (15)
NZ European	315 (56)
Other	13 (2.3)
Area level deprivation[c] *n* (%)	
1-3	167 (30)
4-6	190 (34)
7-10	204 (36)
Number of children in household[d] *n* (%)	
One child	265 (47.2)
Two children	183 (32.6)
Three children	82 (14.6)
Four or more children	31 (5.5)
Diagnosed health conditions *n* (%)	
Health conditions (not reflux)	48 (8.6)
Reflux	44 (7.8)
Milk feeding practice[e] *n* (%)	
Currently breastfeeding	382 (68)
Current consumer of infant formula	299 (77)
Complementary feeding practices at 6 months *n* (%)	
Baby-led weaning (BLW)	35 (6.2)
Partial baby-led weaning (partial BLW)	261 (47)
Traditional spoon feeding (TSF)	265 (47)
Complementary feeding practices (currently) *n* (%)	
Baby-led weaning (BLW)	42 (7.5)
Partial baby-led weaning (partial BLW	455 (81)
Traditional spoon feeding (TSF)	63 (11)

[a d] Missing data (*n* = 1)

[b] Participants can indicate multiple ethnicities

[c] Area level deprivation, as a proxy for determining socioeconomic status, was determined using the New Zealand Index of Deprivation (NZDep) based on the participant's home address: 1-3 = Low, 4-6 = Medium/middle, 7-10 = High (Atkinson et al., 2019).

[e] Participants could choose more than one milk feeding practice

The Total Score and sub-scores from the Pedi-EAT categorised using the normative reference values reported by Pados et al (2018) are presented in **Table 4.2**. The majority of infants (*n* = 463, 83%) were classified as having feeding behaviours of ''no concern" based on the Pedi-EAT Total Score. Infants classified as having feeding behaviours of "concern" and "high concern" on the Total Score were (*n* = 98, 17.4%). The Selective/Restrictive Eating sub-score reported the highest number of infants of "concern" and "high concern" (*n* = 162, 29%). The majority of infants classified as "concern", and "high concern" were the younger infants in the study population (7 to < 9 months) who were grouped into the 6 to < 9 month scoring category. The exception to this was for the Oral Processing sub-score, which had a low number of "concern" (*n* = 5, .9%) for the study population.

Table 4.2

The feeding behaviours of infants and those classified as "concern" using the normative reference values of the Pediatric Eating Assessment Tool

Pedi-EAT Total Score and sub-scores	**Age range**		**All infants**
Age ranges	**6 to < 9 mo[a]**	**≥ 9 to 12 mo[a]**	**All infants 7 to 10 mo**
n	422	139	561
Pedi-EAT Total Score			
No concern, *n* (%)	351 (83.2)	112 (80.6)	463 (83)
Concern, *n* (%)	45 (1.7)	18 (12.9)	63 (11)
High concern, *n* (%)	26 (6.1)	9 (6.5)	35 (6)
Physiological Symptoms sub-score			
No concern, *n* (%)	364 (86.2)	123 (88.5)	487 (87)
Concern, *n* (%)	22 (5.3)	7 (5.0)	29 (5)
High concern, *n* (%)	36 (8.5)	9 (6.5)	45 (8)
Problematic Feeding Behaviour sub-score			
No concern, *n* (%)	329 (78)	112 (80.6)	441 (79)
Concern, *n* (%)	47(11.5)	9 (6.5)	56 (10)
High concern, *n* (%)	45 (1.5)	18 (13.0)	63 (11)
Selective/Restrictive Eating sub-score			
No concern, *n* (%)	291 (68.9)	108 (77.6)	399 (71)
Concern, *n* (%)	21 (4.9)	19 (13.6)	40 (7)
High concern, *n* (%)	110 (26)	12 (8.6)	122 (22)
Oral Processing sub-score			
No concern, *n* (%)	421 (99.8)	135 (97.2)	556 (99)
Concern, *n* (%)	1 (.2)	3 (2.1)	4 (.7)
High concern, *n* (%)	0	1 (.7)	1 (.2)

Reference ranges are from reference data (Pados et al., 2018), where the "high concern" category was defined by scores at the 5th percentile and the "concern" category was defined by scores at the 5th to 10th percentiles. The median from this reference data is also presented. [a]Missing *n* = 1

Comparison of normative reference values and FFNZ reference scores

A comparison table summarising the reference values from Pados et al. (2018) and the FFNZ study population is presented (**Table 4.3**). Both the FFNZ age groups (6 to < 9 months and 9 to < 12 months) and the monthly age groups (7 to < 8 months, 8 to < 9 months and 9 to < 10 months) had higher cut-off scores for the 90th and 95th percentile scores for the Total Score and most sub-scores. Except for the Oral processing sub-score, which had lower cut-off scores compared to the normative reference values (**Table 4.3**).

Table 4.3

Comparison of Pedi-EAT reference data: Normative reference values, FFNZ three-month age-groups and monthly reference scores

The Pediatric Eating Assessment Tool (Pedi-EAT)		Reference data. Normative Reference scores (median and range) and Normative Reference Values (90th and 95th percentile scores) for Pedi-EAT (Pados et al., 2018)[a]		Infants classified 6 to < 9 and ≥ 9 to 12 months[b]		Infants classified by monthly age[c]		
		6 to < 9 mo	≥ 9 to 12 mo	6 to < 9 mo	≥ 9 to 12 mo	7 to < 8 mo	8 to < 9 mo	9 to < 10 mo
n		100	95	422	139	212	210	139
Total Score of Pedi-EAT	Median (range)	63.5 (17-141	57 (14-145)	79 (22-163)	73 (14-169)	78 (22.3-143.8)	80 (22.3-163.2)	73 (14.2-169)
	Mean (SD)	66.3 (27.2)	64 (27.3)	78.2 (24.6)	76.2 (28.4)	77.4 (22.9)	79.1 (26.4)	76.3 (28.5)
	90th percentile	100.9	102.2	111.0	116.0	107.9	113.0	115.6
	95th percentile	115.7	123.8	119.5	125.0	115.7	120.3	125.0
Physiological Symptoms	Median (range)	11 (0-37)	9 (0-41)	17 (0-59)	14 (1-55)	17 (0-59)	17 (0-48)	14 (1-55)
	Mean (SD)	12.6 (8.7)	11.4 (8.8)	17.5 (8.6)	15.2 (9.4)	17.8 (8.8)	17.4 (8.6)	15.2 (9.5)
	90th percentile	26.9	24.4	29	26.2	28.9	28.0	26.2
	95th percentile	31	31	33	34.1	33	32	34.1
Problematic Feeding Behaviour	Median (range)	14 (0-47)	15 (1-53)	19 (0-66)	19.8 (0-59)	18 (7-50)	20 (3-66.9)	19.9 (3-59.5)
	Mean (SD)	15.1 (11.1)	16.9 (10.6)	20.7 (12.0)	21.0 (13.2)	20.0 (11.1)	21.6 (13.0)	21.1 (13.3)
	90th percentile	30	32.2	36.4	41	35.5	38.7	39.4
	95th percentile	35.7	37.8	42.7	46	41.2	43.6	46
Selective/ Restrictive Eating	Median (range)	13.5 (2-36)	16 (2-36)	21 (3-39)	20 (3-38)	22 (7-50)	21 (3-39.6)	20 (3-38)
	Mean (SD)	14.6 (7.4)	17.3 (7.2)	21.1 (7.7)	19.8 (7.9)	21.7 (7.0)	21.7 (8.5)	19.8 (8.0)
	90th percentile	25.9	27	31	30	35.5	31	30
	95th percentile	27	31	34	34	41.2	35	33.1
Oral Processing	Median (range)	24 (5-44)	17 (1-45)	19 (3-40)	20 (4-39)	18 (3-35)	20 (7-40)	20 (4-39)
	Mean (SD)	24 (9.7)	18.5 (9.3)	18.7 (6.1)	20.1 (6.6)	18.1 (6.5)	19.4 (5.6)	20.1 (6.6)
	90th percentile	36.9	32.4	26	28	26	26	28.0
	95th percentile	42	37	28	31	28.0	27.5	31

[a]Normative reference values from Pados et al. (2018)

[b]FFNZ cut-off scores using 6 to < 9 and ≥ 9 to 12 month age ranges

[c] FFNZ cut-off scores using monthly age groups

Associated sociodemographic and early feeding practices associated with problematic feeding behaviours

When data were categorised using normative reference values (Pados et al., 2018), a significant positive association was found between maternal primiparity and "concern" classification (compared to " no concern") ($p < .009$) (**Table 4.4**).

Table 4.4

Infant sociodemographic characteristics and early feeding practices associated with "concern" and "no concern" using Total Score and normative reference values of the Pedi-EAT

	Overall	**No concern**	**Concern**	***p*-value[a]**
n	***n* = 561**	***n* = 463**	***n* = 98**	
Infant characteristics				
Age, mean (SD) months	8.4 (.8)	8.4 (.8)	8.5 (.8)	.13
Sex[b] *n* (%)				.97
Male	298 (53)	246 (54)	52 (53)	
Female	262 (47)	216 (46)	46 (47)	
Ethnicity *n* (%)				.24
Māori	113 (20)	92 (20)	21 (21)	
Pacific Island	37 (6.6)	33 (7.1)	4 (4.1)	
Asian	83 (15)	64 (14)	19 (19)	
New Zealand European	315 (56)	261 (56)	54 (55)	
Other	13 (2.3)	13 (2.8)	0 (0)	
Health conditions *n* (%)	48 (8.6)	38 (8.2)	10 (10)	.52
Gastroesophageal reflux (GOR) *n* (%)	44 (7.8%)	33 (7.1)	11 (11)	.11
Maternal primiparity *n* (%)	281 (50)	220 (48)	61 (62)	.009
Early feeding practices *n* (%)				
Currently breastfeeding	382 (68)	309 (67)	73 (74)	.13
Current consumer of infant formula	299 (77)	248 (78)	51 (73)	.38
Complementary feeding practices at 6 months *n* (%)				.49
Baby-led weaning (BLW)	35 (6.2)	33 (6.6)	2 (3.4)	
Partial baby-led weaning (partial BLW)	455 (81)	404 (80)	51 (89)	
Traditional spoon feeding (TSF)	265 (47)	240 (48)	25 (43)	
Current complementary feeding practices *n* (%)				.080
Baby-led weaning (BLW)	42 (7.5)	40 (8.6)	2 (2.1)	
Partial baby-led weaning (partial BLW)	455 (81)	371 (80)	84 (87)	
Traditional spoon feeding (TSF)	63 (11)	52 (11)	11 (11)	

[a]*p* values-Pearson's chi-squared test; Fisher's exact test
[b]Missing data (*n* = 1)

Using the FFNZ 90th and 95th percentile monthly cut-off scores, significant associations were found for infants in the 90th percentile range compared to those under the 90th percentile cut-off who had gastroesophageal reflux (GOR) (p = .035) and were born to primiparous mothers (p < .001) (**Table 4.5**).

Table 4.5

Infant sociodemographic and early feeding practices associated with "concern" and "no concern" using Total Score and 90th & 95th cut-off scores

	Overall	**No concern**	**Concern[a]**	***p*-value[b]**
n	***n* = 561**	***n* = 503**	***n* = 58**	
Infant characteristics				
Age, mean (SD) months	8.4 (.8)	8.4 (.8)	8.5 (.7)	.19
Sex[c] *n* %				.60
Male	298 (53)	269 (54)	29 (50)	
Female	262 (47)	233 (46)	29 (50)	
Ethnicity *n* (%)				.29
Māori	113 (20)	102 (20)	11 (19)	
Pacific Island	37 (6.6)	36 (7.2)	1 (1.7)	
Asian	83 (15)	70 (14)	13 (22)	
New Zealand European	315 (56)	282 (56)	33 (57)	
Other	13 (2.3)	13 (2.6)	0 (0)	
Health conditions *n* %	48	41 (8.2)	7 (12)	.32
Gastroesophageal reflux (GOR) *n* (%)	44 (7.8%)	35 (7.0)	9 (16)	.035
Maternal primiparity *n* %	281 (50)	240 (48)	41 (71)	< .001
Early feeding practices *n* %				
Currently breastfeeding	382 (68)	341 (68)	41 (71)	.65
Current consumer of infant formula	299 (77)	268 (77)	31 (74)	.62
Complementary feeding practices at 6 months *n* %				.49
Baby-led weaning (BLW)	35 (6.2)	33 (6.6)	2 (3.4)	
Partial baby-led weaning (partial BLW)	455 (81)	404 (80)	51 (89)	
Traditional spoon feeding (TSF)	265 (47)	240 (48)	25 (43)	
Complementary feeding practices, currently *n* %				.17
Baby-led weaning (BLW)	42 (7.5)	41 (8.2)	1 (1.8)	
Partial baby-led weaning (partial BLW)	261 (47)	404 (80)	51 (89)	
Traditional Spoon feeding (TSF)	265 (47)	58 (12)	5 (8.8)	

[a]"Concern" combines infants with scores identified in the "concern" or "High concern" categories from Table 3.5

[b]*p* values Pearson's chi-squared test; Fisher's exact test

[c] Missing data (*n* = 1)

The relationship between feeding behaviours and oral feeding skills

For this analysis, only participants who completed both the Pedi-EAT and the ChOMPS tools (*n* = 546) were included (**Table 4.6**). The multivariate linear regression model revealed a strong (but small) relationship between the CHOMPS Total Score (excluding complex movement) and the Pedi-EAT Total Score. As the behaviour increased by one score on the Pedi-EAT, the CHOMPS score increased by .04 (95% CI: .02, .06) (**Table 4.6**). Infant age was associated with the ChOMPS score, with a 1 month increase in age corresponding to a 4.2 to 5.7 point increase (95% confidence). Birth status was associated with the ChOMPS score, with firstborn infants scoring .62 and 2.99 points higher (95% confidence) than non-firstborn infants. The standardised beta coefficients were .49 for age, .12 for the Pedi-EAT and .11 for primiparity. **Figure 4.2** demonstrates the statistical model illustrating that the age of the infant has the most effect on the ChOMPS score, compared to other variables (Pedi-EAT score, primiparity and sex).

Table 4.6

Relationship between feeding behaviours oral feeding skills using multiple linear regression

Characteristic	Beta	95% CI[a]	Standardised beta	*p*-value
(Intercept)	3.165	23.711, 36.619		< .001
Pedi-EAT Total Score	-.04	-.06, -.02	-.12	< .001
Sex	-533	-1.707, .642	-.033	.373
Infant age (month)	4.93	4.22, 5.65	.49	< .001
Primiparity	1.80	.615, 2.985	.11	.003

[a] Confidence Interval

548 participants completed both CHOMPS and Pedi-EAT, (*n* = 13) who completed the Pedi-EAT did not complete the ChOMPS. (*n* = 1) who did complete the ChOMPS did not complete the Pedi-EAT. Other data points missing were sex (*n* = 1) and primiparity (*n* = 1) , therefore (*n* = 546) were included in the analysis.

This model explains 27% of the variance in the CHOMPS score (excluding complex movement) (Adjusted R^2 = .27).

Notes: The outcome is the CHOMPS score. The predicting variable is the Pedi-EAT score. Confounding variables are infants age, sex, ethnicity, reflux (yes/no), and parity. A higher CHOMPS score is favourable. A lower Pedi-EAT score is favourable. The CHOMPS score excludes the complex movement sub-score because it is only measured in infants older than 9 months.

Figure 4.2

Linear regression model of the relationship between oral feeding skills and feeding behaviours and infant age

Discussion

This chapter presents a comprehensive analysis of infant feeding behaviours using data from a robust study population of 561 infants. We used the Pedi-EAT, a validated PROM, to describe feeding behaviours and identify problematic feeding behaviours. Leveraging our substantial sample

size, we established new reference points using the 90th and 95th percentile cut-off scores. Through multiple linear regression analysis, we then explored the critical relationship between feeding behaviours and OFS.

The feeding behaviours of the study population

Using the Pedi-EAT normative reference values by Pados et al. (2018), the majority of infants were classified as having no concerns regarding their feeding behaviours (*n* = 463, 83%) . The sub-score with the most "concern" categorisation was the Selective /Restrictive Eating (*n* =162, 29%), followed by Problematic Feeding Behaviour (*n* = 119, 21%) with the Oral Processing sub-score having the lowest occurrence, (*n* = .9, 9%).

There were some similar findings in our study population to the Pedi-EAT age-based normative reference study (Pados, Thoyre, et al., 2018), particularly regarding the Selective/ Restrictive Eating sub-score. This sub-score focused on the infants' sensory experience of foods, including texture, taste, and temperature. In the Pedi-EAT normative reference study, there was an increase in the normative score at certain time points. The first when starting complementary feeding and when trying unfamiliar foods with different sensory properties around 9 to 12 months (Pados, Thoyre, et al., 2018).

Our results mostly differed from the normative reference study. Our findings showed that Selective/Restrictive Eating had the highest reported "concern" (*n* =162, 29%) and Oral Processing the lowest, (*n* = .9, 9%). Pados et al. (2018) found that the Oral Processing sub-score was highest for 6 to < 9 month olds. However, we found only a small number of infants (*n* = 4, .9%) classified as "concern". Incidentally, the overall number of infants classified as "concern" for problematic feeding behaviours on the Total Score was higher than expected for our study population (*n* = 98, 17.4%). Infants with health conditions were not excluded from our study, whereas the normative reference study excluded infants and children with diagnosed health conditions or disabilities.

Our study population (*n* = 561) was larger than the Pedi-EAT normative reference study (*n* = 195). Following author recommendations for additional normative sampling and using the methods applied by Pados et al. (2018) we calculated 90th and 95th percentile cut-off scores for both standard Pedi-EAT age bands (6 to < 9, ≥ 9 to 12 months) and monthly groups (7 to < 8, 8 to < 9, 9 to < 10 months).

The 90th and 95th percentile cut-off scores applied to the 6 to < 9 and ≥ 9 to 12-month age groups were higher compared to the normative reference data, except for the Oral Processing sub-score. We found that younger infants (6 to < 9 months of age) were more likely to fall in the 90th percentile of the study population for the Oral Processing sub-score. These results align with those of Pados et al. (2018), who found that 6 to < 9 month olds experienced the most difficulty with the Oral Processing sub-score.

Using monthly age groups, our cut-off scores were higher than the Total Score and sub-scores compared to the normative reference data, except for the Oral Processing sub-score. Younger infants were more likely to fall within the 90th percentile for the study population for the Oral Processing sub-score. While the older infants (9 to < 10 months) were less likely to fall into the 90th percentile of the study population across the Total Score and sub-scores. These results were also more consistent with those of Pados et al. (2018). Monthly cut-off scores may offer more nuanced insights during this period of rapid feeding development.

Associations between feeding behaviours and early life factors

Infants born to primiparous mothers were more likely to be classified with “concern” on the Pedi-EAT, using the normative reference values (p = .009). Previous literature has documented that primiparous mothers report more problematic feeding behaviour in their children, compared to multiparous mothers. Hines et al. (2022) found that first-time parents perceived more problematic breastfeeding behaviours in their infants than multiparous parents, even though there were no differences in sucking and feeding physiology (Hines et al., 2022). Two large prevalence studies of

parent-reported problematic feeding behaviours in infants and children taking solid foods in typical populations found significant associations between reporting of problematic feeding behaviours in primiparous parents compared to multiparous (Benjasuwantep et al., 2013; Sdravou, Fotoulaki, et al., 2021).

In contrast, two validation studies using parent-report assessments found no significant association between birth status and reported problematic feeding behaviours. However, it is important to note that in both studies, their clinical non-medical samples (children referred for feeding difficulties without any underlying organic diagnosis) contained a large proportion of primiparous parents (Crist & Napier-Phillips, 2001; Ramsay et al., 2011). This finding highlights the importance of supporting first-time parents, who may experience heightened anxiety about feeding behaviours or lack confidence in their feeding practices.

Only primiparity was found to be associated with infants classified as “concern” on the Pedi-EAT when the normative reference values were applied (p = .009). However, when using the FFNZ 90th and 95th percentile cut-off scores, infants in the highest 90th percentile of the study population showed stronger associations with both primiparity (p < .001) and GOR (p = .35). This difference likely occurred because the Pedi-EAT normative reference values over diagnosed infants as of “concern”, which diluted the ability to identify those with GOR. Specifically, using Pedi-EAT normative reference values, only 11/98 infants classified as "concern" had GOR, whereas 9/58 infants in the highest 90th percentile of the study population had GOR.

GOR has long been known to cause discomfort for infants during feeding, affecting oral intake in healthy infants and those with health and disability issues alike (Douglas & Bryon, 1996; Rommel et al., 2003; Sdravou, Emmanouilidou-Fotoulaki, et al., 2021). In addition, problematic feeding behaviours were examined by the Pedi-EAT related to GOR in infants with congenital heart disease (CHD) (Pados & Harrison, 2023). Authors reported the Pedi-EAT Total Score significantly correlated with GOR at 8 months (rho = .52, p = .002), and at 12 months (rho = .67, p = .001) (Pados

& Harrison, 2023). These findings underline the importance of month-by-month scoring, which offers greater nuance during this critical period of rapid feeding development.

Relationship between oral feeding skills and feeding behaviours

Early identification of feeding difficulties, especially at the time of complementary feeding, is advocated in the literature by clinicians and researchers across disciplines in paediatric feeding (Delaney et al., 2024; Delaney et al., 2021; Levy et al., 2009; Mudholkar et al., 2023; Park et al., 2018). Furthermore, for years, it has been difficult for clinicians to determine if a feeding difficulty is due to the infant's OFS or behavioural factors caused by their environment. Both are associated but are distinct factors that contribute to feeding difficulties and Paediatric Feeding Disorder (PFD) (Pados et al., 2019).

We sought to explore the relationship between OFS, as measured using the ChOMPS (a parent-reported OFS based PROM), and feeding behaviours as assessed by the Pedi-EAT, with particular attention to factors associated with the ChOMPS Total Score. Given the cross-sectional nature of the study, our findings represent a snapshot in time rather than developmental trajectories. Within this context, age emerged as the strongest predictor of the ChOMPS Total Score, followed by a higher Pedi-EAT Total Score and birth status. OFS improved with increasing age; however, age did not exert a direct effect on the Pedi-EAT Total Score. This suggests that improvements in OFS and changes in feeding behaviour may be associated.

Our findings align with recent evidence demonstrating that OFS maturation is linked to age and experience rather than behaviour alone. Devezeaux de Lavergne et al. (2024) reported declining refusal behaviours alongside increasing texture acceptance in a cohort of infants aged 4 to 36 months, with acceptance improving as exposure to a variety of textures increased. Notably, more complex textures (slippery, rubbery foods and foods with skin) were more likely to be rejected when introduced later in infancy (Devezeaux de Lavergne et al., 2024). The authors suggested that refusal is more strongly associated with delayed or limited exposure than with limitations in OFS. Taken

together, these findings support the concept that timely, progressive exposure to diverse textures during complementary feeding plays a key role in supporting OFS development and shaping later feeding responses.

Further supporting this interpretation, Delaney et al. (2024) observed that OFS related concerns, including gagging, coughing, hard swallows and prolonged bolus manipulation, were most prevalent at 8 months of age but decreased by 12 months in a healthy infant cohort, indicating rapid age-related improvement in OFS. Acceptance duration (time to accept the bite) also varied by food texture, with longer acceptance times observed for textures requiring more advanced OFS, such as lumpy purees and soft solids. Importantly, these acceptance durations decreased at 12 months, further indicating maturation of OFS (Delaney et al., 2024).

In contrast to these improvements in acceptance and OFS indicators, Delaney et al. (2024) reported an increase in disruptive feeding behaviours with age. Behaviours such as pushing food away, hitting the spoon, shaking the head and reaching toward the food presentation increased from 8 months (28%) to 10 months (37%) and remained similar at 12 months (35%). The authors proposed that, at 8 months of age, these behaviours were more reflective of immature OFS, whereas by 12 months they were more indicative of merging autonomy and the expression of food preferences. As such, these behaviours were interpreted as normative feature of OFS development rather than learned problematic feeding behaviours typically observed in older children (Delaney et al., 2024).

Interestingly, the Pedi-EAT normative reference study also found an increase in the Problematic Mealtime Behaviour sub-score in the toddler years (1 to 3 years) but not for healthy infants under 12 months (Pados, Thoyre, et al., 2018). This distinction is further supported by findings from the Pedi-EAT normative reference study, which demonstrated an increase in Problematic Mealtime Behaviour sub-scores during the toddler years (approximately 1–3 years of age), but not among healthy infants under 12 months (Pados et al., 2018). These findings reinforce the idea that feeding

behaviours may evolve independently of improvements in OFS and may reflect developmental changes in autonomy, experience, and preference rather than underlying feeding skill deficits(Delaney et al., 2024; Pados, Thoyre, et al., 2018). Comparisons of studies using the Pediatric Eating Assessment Tool and the Child Oral and Motor Proficiency Scale

Our findings regarding the associations between age, Pedi-EAT score, and birth status and OFS are consistent with those reported in two studies that used the ChOMPS and Pedi-EAT tools. However, these studies were longitudinal, aimed at assessing feeding outcomes, and conducted on smaller targeted samples of infants and children with health conditions. The first on infants with congenital heart disease (*n* = 33) (Pados & Harrison, 2023) and the other on infants born before 34 weeks gestation (*n* = 35) (Pados et al., 2024).

In the congenital heart disease study, the ChOMPS and Pedi-EAT Total Scores were significantly correlated at all time points (6, 8, 10 and 12 months), indicating that lower OFS was associated with more problematic feeding behaviours. They found that OFS improved with age, although not to the level of healthy peers (Pados & Harrison, 2023). Initially, problematic feeding behaviours were very prevalent, with 90% of infants meeting criteria for problematic feeding at 6 months of age. The frequency then generally decreased over time, with 62% at 8 months, dropping to 29% at 10 months, but then slightly increasing to 38% at 12 months (Pados & Harrison, 2023).

A recent study on 8–24 month old infants born before 34 weeks of gestation using the ChOMPS and Pedi-EAT found that the "concern" classification for OFS (ChOMPS) increased from (*n* = 7, 30%) at 8 months to (*n* = 15, 56%) at 12 months, then decreased by 24 months (*n* = 9, 24%). The Oral-Motor Coordination sub-score was the area with the most reported skill difficulty, assessing the adequate movement of oral structures and whether gagging, coughing, or choking occurs with food or liquids. Problematic feeding behaviours generally decreased over time and were less prevalent than OFS, dropping from 15 cases (63%) at 8 months to 9 cases (33%) at 12 months, and finally to 7 cases (24%) at 24 months. However, the sample sizes were small. Overall, they found that "concern"

classification for OFS occurred more frequently than for problematic feeding behaviours, indicating that OFS difficulty was the primary issue in this population during infancy and toddlerhood. Unlike problematic feeding behaviours, OFS difficulties initially increased with age before showing improvement in toddlerhood. This contrasts with our infant study population, where OFS improved consistently with age.

Early identification of feeding difficulties, (OFS and problematic feeding behaviours), is particularly important in populations of otherwise healthy infants, where feeding concerns may be subtle and easily overlooked. Evidence suggests that early feeding refusal behaviours are often related to immature or inefficient feeding skills rather than refusal and may therefore signal emerging OFS difficulties or developmental delay (Delaney et al., 2024). Within this context, identifying persistent concerns using validated PROMS such as the ChOMPS provides an opportunity for timely referral and assessment through primary health services before feeding challenges become more complex or entrenched. From a clinical perspective, ChOMPS classifications indicating ongoing OFS concern beyond expected developmental periods may offer a practical threshold for escalation of care within community and primary health settings. Similarly, Pedi-EAT sub-scores relating to Physiological Symptoms, Oral Processing, and Selective or Restrictive Eating appear particularly valuable as early indicators of OFS vulnerability. These sub-scores capture both physiological contributors to feeding difficulty and sensory-motor challenges associated with food acceptance, which are commonly implicated in early feeding problems across diverse populations.

Importantly, these findings align with international literature demonstrating that untreated feeding difficulties in infancy may persist and evolve into more established problematic feeding behaviours in later childhood (Sdravou, Fotoulaki, et al., 2021; Serel-Arslan et al., 2023). By extending this evidence to a younger, non-referred infant cohort, the present study highlights the importance of early, skill-focused identification as a means of preventing the progression of feeding difficulties. Understanding feeding behaviours within the context of OFS development allows clinicians to

distinguish developmentally appropriate behaviours from those warranting intervention, supporting more targeted, timely, and proportionate responses to feeding concerns in early life.

This study had limitations that should be considered. Firstly, the method of convenience sampling for recruitment would have introduced selection bias towards parents and caregivers with higher education levels than the general population of NZ, as well as those who have more interest in their infant's feeding behaviours. Additionally, only parents and caregivers with sufficient English and literacy skills were able to participate, as they were able to complete the Pedi-EAT and ChOMPS. In addition, the findings must be considered within the context of the PROMs. Although parent report offers a valuable and valid perspective on feeding behaviours as they occur in everyday contexts, it is subject to caregiver perceptions, experiences, and reporting bias. As such, the findings represent caregiver-reported feeding behaviours and OFS of their infant rather than direct observational assessment by a speech-language pathologist. There were missed questions, perhaps due to the length of the PROMs and by completing the PROMs electronically, on phones and/or computers, questions may have been missed or sections incomplete. Although our healthy population consisted largely of healthy infants, medical conditions diagnosed in these infants were not excluded. Only prematurity was excluded, which may have biased the results.

Conclusions

Our study provides new insight into feeding behaviours in infants aged 7 to 10 months by describing the feeding behaviours and identifying problematic feeding behaviours using the Pedi-EAT, a validated PROM. To our knowledge, it is the first study to apply the Pedi-EAT to this age group in both New Zealand and international contexts. In addition, the study examines the relationship between feeding behaviours and OFS in late infancy, using validated PROMs within a large sample drawn from an ethnically and socioeconomically diverse population across two urban centres in New Zealand.

The findings demonstrate that the Pedi-EAT is a useful tool for identifying problematic feeding behaviours in infants; however, they also indicate that further work is needed to establish robust normative reference values. Greater age stratification and larger infant samples are required to support interpretation of scores during this period of rapid developmental change. Consistent with best practice, the use of the Pedi-EAT alongside the ChOMPS is recommended to support differentiation between behavioural feeding concerns and underlying OFS difficulties. The Total Score on the ChOMPS typically improved with increasing age, reinforcing its usefulness for capturing developmental progression in OFS and supporting early identification of feeding skill difficulties.

Associations between feeding behaviours and caregiver factors were also evident, with primiparity showing a significant relationship with feeding behaviours in the second half of infancy. Moreover, GOR was also significantly associated with this healthy infant cohort, although most research has seen GOR associated with problematic feeding behaviours with clinical populations. These findings warrant further investigation.

Future longitudinal studies on healthy infants are recommended. In addition, further investigation is warranted to explore the significant associations found for primiparity and GOR with feeding behaviours in the second half of infancy.

Chapter 5 – Food-related choking in 7 to 10 month old New Zealand infants: Its prevalence, risk factors and associations with complementary feeding practices

In 2017, a little boy choked on an apple at his day care in Rotorua, suffering severe brain damage that forever changed his life and the lives of those around him. I remember feeling shaken when I first learned about this preventable tragedy—one that prompted New Zealand's Ministry of Health to develop guidelines aimed at reducing choking risks in early childhood centres. When these guidelines were published, I witnessed a surprising public reaction: parents and educators voiced strong opposition to the requirements for modifying high-risk foods, revealing the complex tensions between safety and typical feeding practices.

Just months ago, on March 31, 2025, my heart sank hearing about another young child, a 1 year old boy from Northland, who was rushed to Starship Hospital after his terrified parents found him struggling to breathe with chicken lodged in his airway.

As a speech-language therapist, I've sat with many parents who, having witnessed their child choking, remain haunted by the experience—many becoming anxious about continuing normal feeding progression. I've felt the weight of responsibility in these clinical moments, trying to balance

compassionate reassurance about typical feeding development while remaining alert to genuine safety concerns.

This research into food-related choking among healthy infants stems from these personal clinical experiences. I believe our profession brings crucial perspectives to multidisciplinary conversations about feeding practices. Perspectives that honour both developmental progression and safety. Each time I work with a family navigating these challenges, I'm reminded why this research matters so deeply.

Chapter 5

Abstract

Background: The introduction of complementary foods marks a critical period of choking risk for infants. Food-related choking represents a significant public health concern during this period, particularly for infants under 12 months who are physiologically vulnerable due to their developing anatomy and oral feeding skills (OFS). Despite being largely preventable, choking events continue to cause parental distress and morbidity globally, highlighting the need for careful evaluation of both feeding practices and food choices to minimise risk.

Objectives: To determine the prevalence of food-related choking (FRC) among New Zealand infants, identify associated risk factors, compare FRC episodes across different complementary feeding practices, and calculate a weighted prevalence estimate that reflects national proportions of ethnicity and deprivation, providing population-representative findings.

Methods*:* Parents of 625 infants provided data on sociodemographic characteristics and health status and completed a parent-reported questionnaire regarding FRC. Information on the foods and liquids responsible for FRC, as well as the parents' complementary feeding practice (baby-led weaning (BLW), traditional spoon-feeding (TSF), and partial baby-led weaning (partial BLW) were collected.

Results: FRC occurred in 120 infants (19.2%) with food and in96 infants (15.4%) with liquids. Most parents whose infant had a serious FRC episode (*n* = 108) reported they did so on whole foods (*n* = 49, 45.4%), via self-feeding (*n* = 67, 62.0%) and were 8 to < 9 months of age (*n* = 46, 42.6%). Fruit (*n* = 26, 24.3%) was the food that caused most FRC, followed by vegetables (*n* = 22, 20.4%). A significant association was found for infants aged 7 to < 8 months who followed a BLW complementary feeding practice and experienced choking while self-feeding (*p* = .015), compared to other infants of the

same age who were TSF. The weighted prevalence estimate of choking was 18.2%, 95% CI [15.3, 21.5] on food and 15.2%, 95% CI [12.5, 18.4] on liquids.

Conclusions: The prevalence of FRC in our study population was similar to that of other studies examining complementary feeding and choking, but higher than those that exclude health conditions. Fruit and vegetables caused most FRC for 8 to < 9 month-old infants who were self-feeding. BLW as a complementary feeding practice was significantly associated with FRC for the younger infants of the study population compared to those of the same age following TSF. To our knowledge, this is the first study to determine the weighted estimated prevalence of choking among infants in the second half of infancy. These findings provide a more accurate estimate of the true population burden in New Zealand.

Introduction

Choking, or foreign body aspiration/inhalation, occurs when food or non-food items occlude the airway, posing fatal risks, particularly to children under 4 years (Foltran et al., 2012; Gregori et al., 2008). Despite being preventable, choking risk rises in this age group as children explore orally, cannot distinguish edible from non-edible items, and become distracted while eating (Rodríguez et al., 2012). Varying developmental rates of OFS and the inability to gauge appropriate bite size further compound these risks (AAP, 2010; Delaney & Arvedson, 2008; Edwards & Martin, 2011)

Choking episodes in infants can be broadly categorised into two main types: food-related choking (FRC) and liquid choking. FRC refers specifically to choking caused by solid foods, including purees, finger foods and whole foods, introduced during complementary feeding. FRC represents the most common factor in choking episodes for infants (Altmann & Ozanne-Smith, 1997; Gregori et al., 2012; Sidell et al., 2013). Infants during complementary feeding face heightened vulnerability due to the following factors: They have developing OFS that are not yet mature to break down hard foods, second molars are absent for grinding, they have a less effective cough reflex, and narrower airways that can occlude more easily (AAP, 2010; Delaney, 2010; Ministry of Health, 2020). Liquid choking,

while also a concern during infancy, it represents a separate category of episodes. This chapter focuses specifically on FRC in 7 to 10 month old infants in NZ.

The multinational surveillance database, the Susy Safe Project (Gregori et al., 2012), registered FRC cases for under 12 months as *n* = 254 as of November 2021 (SusySafe, 2022). FRC occurred most frequently at 7 to 9 months of age, followed by 12 months, then 4 to 6 months with food located in the airway (trachea, bronchus, or lung). In New Zealand, 19 children had an FRC accident between 2008 and 2019, with most being under 12 months (ACC, 2019). FRC was the leading cause of death of infants under 12 months in France in 2012 (Boulanger & Vernet, 2018).

High risk foods for FRC in infants include round/spherical and hard textured items (Gregori et al., 2008; Harris et al., 1984; SusySafe, 2022; Wu et al., 2018), as well as semi-solid and solid consistencies (de Paiva et al., 2023; Foltran et al., 2012). Nuts and seeds are frequently reported in overseas studies for causing most FRC events (Altmann & Ozanne-Smith, 1997; Foltran et al., 2012; Reid et al., 2020; Wu et al., 2018). In New Zealand, apples and carrots are most commonly implicated (ACC, 2019). Feeder-related risk factors include reduced supervision, offering age-inappropriate foods, improper food preparation, and self-feeding (Na'ara et al., 2020; Özyüksel et al., 2019; van As et al., 2012).

Complementary feeding practices can contribute to FRC beyond just high-risk foods. The New Zealand Ministry of Health advocates for a developmental approach, aligning food textures with OFS. This spoon-fed practice (TSF) progresses systematically from caregiver-provided smooth purees to increasingly complex textures, ultimately reaching family foods by 12 months of age. This calibrated progression supports OFS development and oral cavity expansion (Ministry of Health, 2021).

BLW is a complementary feeding approach in which infants self-feed finger foods rather than being spoon-fed purees. Developed by UK health visitor and midwife Gill Rapley, this method is based on the premise that 6 month old infants can independently manage soft finger foods, including cooked vegetables, fruit, meat strips, and toast. The approach assumes that infants at this

developmental stage have adequate OFS for self-feeding and can better accept diverse tastes and textures through direct food exploration (Rapley, 2005).

Studies evaluating complementary feeding practices and FRC, specifically BLW and TSF found mixed results. A recent systematic review found that none of the included seven studies had statistically significant differences in FRC risk between complementary feeding practices (Correia et al., 2024). However, other studies were excluded because they did not meet the review's inclusion criteria.

The only study to date that found a significantly higher FRC rate among infants following BLW compared to those TSF (p = .014) (Susmarini et al., 2021) was excluded from the systematic review, likely because it did not report the specific food types or forms that caused the FRC events. Brown et al. (2018) also reported no significant association between complementary feeding practices (TSF & BLW) and FRC. However, the infants who experienced choking were those following a TSF practice and had more choking episodes on finger foods than those who were BLW (Brown, 2018).

One randomised control trial (RCT) that compared BLW to TSF reported more FRC episodes in those infants using a TSF approach at 6 months and 12 months, however, the difference was not statistically significant (Arslan et al., 2023). Three RCTs using the Baby-Led Introduction to Solids approach (BLISS) (modified BLW) found no difference in FRC frequency between infants following a TSF or the BLISS approach (de Paiva et al., 2023; Dogan et al., 2018; Fangupo et al., 2016). However, participants following the BLISS approach were provided with information on high-risk foods to avoid as part of their modified approach.

A recent cross-sectional study found that while infants following BLW had significantly higher episodes of gagging, spitting out food, and vomit reflex initiation compared to those following TSF, there was no difference in FRC between the groups (Białek-Dratwa et al., 2022). FRC is different from gagging. Gagging is a reflex that prevents food and non-food items from blocking the airway. Gagging is usually noisy with the infant vocalising, pushing the food out, often accompanied by excess saliva and vomiting (Fangupo et al., 2016). On the other hand, choking is silent, with the infant unable to

make a sound due to their airway being occluded (Morison et al., 2016). Due to the serious consequences of FRC, the NZ Ministry of Health developed food preparation and safety guidelines to minimise choking risk in early childcare centres (Ministry of Health, 2020). In addition to their Healthy Eating Guidelines for 0 to 2 years (Ministry of Health, 2021). This study aimed to determine the prevalence of FRC in NZ infants aged 7 to 10 months, describe associated risk factors, and compare FRC episodes across different complementary feeding practices. Weighted prevalence estimates were calculated for both food and liquid choking that reflect national proportions of ethnicity and deprivation, providing population-representative findings.

Methods

Study design

This analysis was conducted as part of the First Foods New Zealand (FFNZ) study—an observational, cross-sectional, multi-centre study exploring the dietary intake and feeding practices of NZ infants. The primary objective of the FFNZ study was to assess iron status among infants following different complementary feeding practices, such as BLW versus TSF (Taylor et al., 2021). Detailed methods for the study have already been published; therefore, only relevant information is included here. The study received ethical approval from the Health and Disability Committee of New Zealand (19/STH/151) and is registered with the Australian New Zealand Clinical Trials Registry (ACTRN12620000459921).

Participants

Altogether, 630 parents/caregivers were recruited from two cities in New Zealand (Auckland and Dunedin) to participate in the study when their infant was aged between 7 and 10 months. A sample size of 625 was estimated to provide 80% power (α = .05) to detect a 5.0 µg/L mean difference in plasma ferritin concentration (SD = 16.8 µg/L; assuming 70% complete biochemical data) (Daniels, Taylor, Williams, Gibson, Samman, et al., 2018) between infants following BLW and

those following TSF, (assuming 28.3% would follow BLW) (Fu et al., 2018). This was the primary objective of the FFNZ study (Taylor et al., 2021).

Recruitment took place between July 2020 and February 2022, primarily through word of mouth and advertising on social media platforms, including Facebook groups. Exclusion criteria included infants older than 10 months, mothers under 16 years of age, parent/infant dyads residing outside of Dunedin and Auckland, and those who had participated in a research study involving a dietary intervention. Care was taken to minimise recruitment bias by targeting all infants, rather than those using only a specific complementary feeding practice (BLW or TSF), and efforts were made to recruit a diverse range of ethnic and socioeconomic groups. Data collection took place both in person and online over a period of three weeks.

Measures

Online questionnaires were administered through the Research Electronic Data Capture platform (REDCap) hosted at the University of Otago, New Zealand, to collect sociodemographic information. The sociodemographic information included parent and infant age, sex, and infant ethnicity (measured using the New Zealand census categories) (Statistics New Zealand, 2018). Participants could identify with more than one ethnic group, and these were prioritised to: Māori (the indigenous population of New Zealand), Pacific, Asian, Others, and NZ European. Area level deprivation, as a proxy for determining socioeconomic status, was determined using the New Zealand Index of Deprivation (NZDep) (Atkinson et al., 2019) based on the participant's home address. Additionally, information was collected on parent employment status, highest educational level, maternal parity, household composition, and the use of childcare and complementary feeding practices.

Food-related choking

A parent-reported questionnaire, consisting of retrospective questions covering the period from birth to the present day, was administered at the initial appointment. The questionnaire

consisted of structured, closed-ended items assessing the frequency of choking and gagging events since birth. Parents who reported choking events were asked additional structured questions regarding the most serious choking episode, including symptoms, food type and texture, feeding practice, and resolution of the event. Responses generated quantitative counts and categorical data. The questionnaire was developed for the BLISS RCT, informed by prior work, existing literature, and national and international feeding safety guidelines, with expert input from paediatric speech-language pathologists. It was developed for the same age group as the FFNZ study population by Fangupo and colleagues and was found to have comparable results to choking data collected prospectively using a daily calendar (Correia et al., 2024; Fangupo et al., 2016). Choking was indicated if the parent reported that their infant "coughed", "gasped", or "went silent". Classification of serious choking episodes was based on parental definitions rather than clinically verified events (Appendix D, questions 67 to 69e) .

Complementary feeding practices

Complementary feeding practices were assessed currently as well as retrospectively at "around 6 months of age". Parent/caregivers were asked to describe infant feeding as either: "spoon-fed by an adult," "mostly spoon-fed by an adult," "some infant feeding themselves," "about half spoon-feeding by an adult," and "half infant feeding themselves." The first three categories were classified as TSF. Parents/caregivers who chose the latter two categories were classified as partial BLW. Those who reported "mostly infant feeding themselves," "some adult spoon-feeding," or "infant feeding themselves" were classified as full BLW.

Statistical analysis

Stata statistical software version 17.0 (StataCorp, Texas) was used for all statistical analyses. Descriptive and frequency summary statistics were calculated for the parent and infant sociodemographic and early life factors. Estimated prevalence of experiencing at least one serious choking event was calculated for the sample and with weighting for national proportions of ethnicity

and area-level deprivation. Descriptive statistics were used to summarise food types, with frequencies and percentages reported. Fisher's exact tests were conducted to compare choking prevalence between infants following BLW and those following TSF, with significance set at $p < .05$.

Results

In total, 630 parent/infant dyads consented to participate in the FFNZ study (**Figure 5.1**). Of these, one withdrew, and four were outside the target group age at the time of consent, leaving 625 participants with a mean age (SD) of 8.4 (.8) months, with just over half of the study population identifying as NZ European (**Table 5.1**).

Figure 5.1

Participant recruitment and selection flowchart

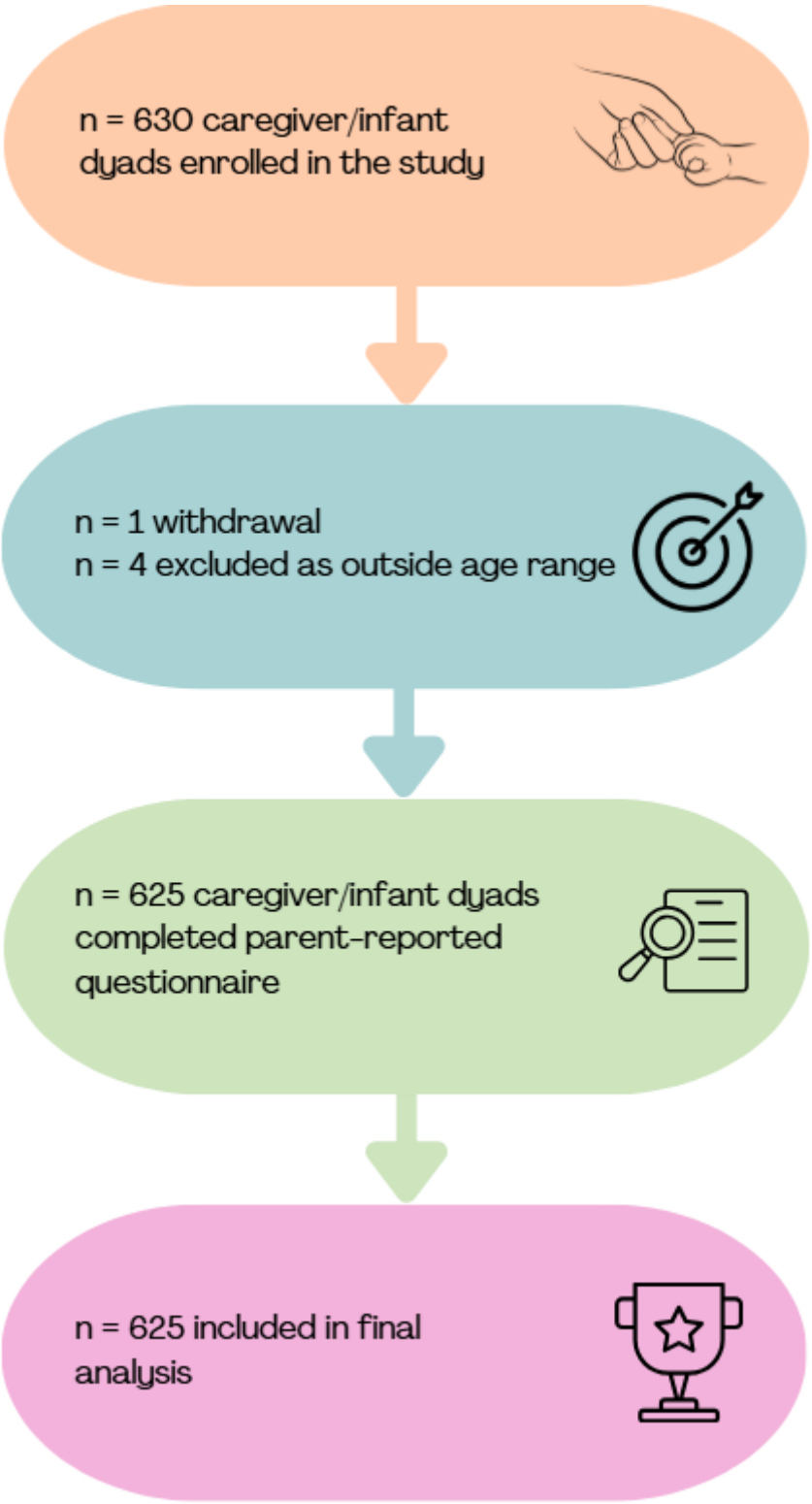


Table 5.1

Sociodemographic characteristics of infants and adult respondents

	n = 625
Infant age (mo), mean (SD)	8.4 (.8)
Infant female, *n* (%)[a]	289 (46.2)
Infant ethnicity, *n* (%)[b]	
Māori	131 (21.0)
Pacific	44 (7.0)
Asian	90 (14.4)
Others	16 (2.6)
European	344 (55.0)
Preterm *n* (%)[c]	46 (7.4)
Respondent age (years), mean (SD)[d]	32.7 (4.9)
Highest level of education of adult respondent, *n* (%)[e]	
School	94 (15.1)
Polytechnic or similar	125 (2.0)
University	405 (64.9)
Mother as respondent, *n* (%)	617 (98.7)
Primiparous, *n* (%)[f]	303 (48.6)
Respondent employment status, *n* (%)	
Employed full time	70 (11.2)
Employed part time	137 (21.9)
Other[e]	418 (66.9)
Childcare used, *n* (%)[g]	109 (17.4)
Socioeconomic deprivation, *n* (%)[h]	
1-3 (Low)	180 (28.8)
4-7	282 (45.1)
8-10 (High)	163 (26.1)

[a] *n* = 1 answered, 'I would rather not say' to the question "Is your baby a girl or a boy?"

[b] Ethnicity prioritised as listed.

[c, d, f] Data missing for *n* = 1[c], *n* = 2[d]

[e] Not employed or on parental leave.

[g] Childcare used includes early childcare centre or home-based care.

[h] Determined using the New Zealand Index of Deprivation 2018 (Atkinson et al, 2021) NZDep2018 combines 9 variables from the 2018 New Zealand national census to determine a deprivation score for each Statistical Area 1 (a geographic area defined by Statistics New Zealand containing ~100-200 people). The deprivation score estimates the relative material and social deprivation for the area where the participant lives, where decile 1 represents areas with the least deprivation and decile 10 represents areas with the most deprivation.

Of the 625 infants in the study population, 96 (15.4%) experienced at least one serious choking episode. Most serious choking episodes involved food (*n* = 108) rather than liquids. Among

FRC episodes, 49 (45.4%) involved whole foods, 67 (62.0%) occurred during self-feeding, and 46 (42.6%) occurred in infants aged 7 to < 8 months. Parents resolved most episodes themselves 68 (63%), with no infants requiring professional medical assistance or hospitalisation (**Table 5.2**). When weighted to reflect national demographics, the estimated population prevalence was 15.2% (95% CI: 12.5-18.4) for liquid choking and 18.2% (95% CI: 15.3-21.5) for FRC.

Table 5.2

Infant choking episodes

Choking items	Total sample	7 to < 8 mo	8 to < 9 mo	9 to < 10 mo
	***n* (%)**	***n* (%)**	***n* (%)**	***n* (%)**
n	624[a]	241	231	152
Ever choked on liquid	96 (15.4)	39 (16.2)	36 (15.6)	21 (13.8)
Choked on a liquid 3 or more times	63 (1.1)	25 (1.4)	24 (1.4)	14 (9.2)
Ever choked on food	120 (19.2)	31 (12.9)	53 (22.9)	36 (23.5)
Choked on a food 3 or more times	34 (28.6)	10 (32.3)	13 (24.5)	11 (31.4)
Ever choked[b], indicated by 'coughed', 'gasped', or 'went silent'	108 (17.3)	28 (11.6)	44 (19.1)	36 (25.5)
Resolution of most serious[c] choking episode on food (*n* = 108) (multiple answers allowed)				
Baby resolves it themselves	60 (55.6)	11 (39.3)	27 (61.4)	22 (61.1)
Parent resolves it	68 (63.0)	19 (67.9)	24 (54.6)	25 (69.4)
A health professional resolved it	0	0	0	0
Another person resolved it	1 (.9)	0	0	1 (2.8)
Form of food in most serious choking episode (*n* = 108)				
Thin liquid	0	0	0	0
Thick liquid	1 (.9)	0	0	1 (2.8)
Pureed	3 (2.8)	1 (3.6)	1 (2.8)	1 (2.8)
Mashed	12 (11.1)	2 (7.1)	5 (11.4)	5 (13.9)
Diced	7 (6.5)	3 (1.7)	2 (4.6)	2 (5.6)
Sliced	36 (33.3)	12 (42.9)	14 (31.8)	10 (27.8)
Whole	49 (45.4)	10 (35.7)	22 (5.0)	17 (47.2)
Who fed food in most serious choking episode (*n* = 108)				
Baby	67 (62.0)	20 (71.4)	26 (59.1)	21 (58.3)
Parent	33 (3.6)	8 (28.6)	13 (29.6)	12 (33.3)
Another adult	5 (4.6)	0	4 (9.1)	1 (2.8)
Brother or sister	3 (2.8)	0	1 (2.3)	2 (5.6)
Another child	0	0	0	0
Age at most serious choking episode (*n* = 108)				
< 4 months	0			
4 to 5 months	5 (4.6)			
6 months	27 (25.0)			
7 months	46 (42.6)			
8 months	24 (22.2)			
9 months and over	6 (5.6)			

Estimated prevalence calculated with weighting for national proportions of ethnicity and area-level deprivation

[a] Missing data *n* = 1 (1 did not answer choking questions)

[b] Responses included "Red face then pale, red around the eyes" and "face went red, saliva coming out of mouth"

[c] Classification of serious choking episodes was based on parental definitions captured through the parent-reported questionnaire representing parent-reported responses rather than clinically verified events.

The food items responsible for the most serious FRC episodes (*n* = 108) were: Fruit (*n* = 26, 24.3%), followed by vegetables (*n* = 22, 2.6%) (**Table 5.3**).

Table 5.3

Foods consumed in the most serious food-related choking episode

Food type[a]	**Total sample**
	n (%)
n	108
Meat	8 (7.5)
Fruit	26 (24.3)
Banana	9 (8.4)
Apple	8 (7.5)
Mandarin	3 (2.8)
Plum	2 (1.9)
Other fruit[b]	5 (4.5)
Vegetables	22 (2.6)
Carrot	7 (6.5)
Broccoli	7 (6.5)
Spinach	3 (2.8)
Mixed vegetables	2 (1.9)
Other vegetables[c]	3 (2.7)
Root vegetables	12 (11.2)
Potato	6 (5.6)
Kumara	6 (5.6)
Toast or bread	12 (11.2)
Cracker	5 (4.7)
Cheese	1 (.9)
Pasta	3 (2.8)
Rusk	3 (2.8)
Nuts[d]	2 (1.9)
Rice	1 (.9)
Puree	3 (2.8)
Biscuit	1 (.9)
Chip	1 (.9)
Unsure	9 (8.4)
Leaf	1 (.9)

[a] Free text response, some put more than one food

[b] Other fruit: pear (1), apricot (1), kiwifruit (1), Watermelon (1), Orange (1)

[c] Other vegetable: Asparagus (1), capsicum (1), mushroom (1).

[d] Peanut (1), almond (1)

The majority of infants were fed using traditional spoon feeding (TSF) (*n* = 304), while 167 infants followed BLW. For the 7 to < 8 month age group specifically, BLW infants experienced significantly more FRC during self-feeding compared to TSF infants (*p* = .015) (**Table 5.4**).

Table 5.4

Complementary feeding practice currently and choking episodes in the study population

Choking items	***n***	**Traditional spoon feeding**	**Partial baby-led weaning**	**Baby-led weaning**	***p*-value[c]**
		n (%)	**n (%)**	**n (%)**	
n		304	152	167	
Ever choked on liquid	623[b]	45 (14.8)	28 (18.4)	23 (13.8)	.786
Currently 7 to < 8 mo[a]	241	20/142 (14.1)	7/44 (15.9)	12/55 (21.8)	
Currently 8 to < 9 mo[a]	231	17/109 (15.6)	14/65 (21.5)	5/57 (8.8)	
Currently 9 to < 10 mo[a]	151	8/53 (15.1)	7/43 (16.3)	6/55 (1.9)	
Choked on liquid 3 or more times	623	25 (8.2)	21 (13.8)	17 (1.2)	.501
Currently 7 to < 8 mo[a]	241	9/142 (6.3)	6 (44 (13.6)	10/55 (18.2)	
Currently 8 to < 9 mo[a]	231	11/109 (1.1)	9/65 (13.9)	4/57 (7.0)	
Currently 9 to < 10 mo[a]	151	5/53 (9.4)	6/43 (14.0)	3/55 (5.5)	
Ever choked on food	623	52 (17.2)	38 (24.8)	30 (18.0)	.899
Currently 7 to < 8 mo[a]	240	11/141 (7.8)	10/44 (22.7)	10/55 (18.2)	
Currently 8 to < 9 mo[a]	231	26/109 (23.9)	19/65 (29.2)	8/57 (14.0)	
Currently 9 to < 10 mo[a]	152	15/53 (28.3)	9/44 (2.5)	12/55 (21.8)	
Choked on food 3 or more times	623	10 (3.3)	12 (7.8)	12 (7.2)	.068
Currently 7 to < 8 mo[a]	240	0/141	4/44 (9.1)	6/55 (1.9)	
Currently 8 to < 9 mo[a]	231	5/109 (4.6)	6/65 (9.2)	2/57 (3.5)	
Currently 9 to < 10 mo[a]	152	5/53 (9.4)	2/44 (4.6)	4/55 (7.3)	
Baby resolved most serious choking episode on food themselves[a]	108	27/44 (61.4)	18/35 (51.4)	15/29 (51.7)	.473
Currently 7 to < 8 mo	28	4/9 (44.4)	2/9 (22.2)	5/10 (5.0)	
Currently 8 to < 9 mo	44	13/20 (65.0)	10/17 (58.8)	4/7 (57.1)	
Currently 9 to < 10 mo	36	10/15 (66.7)	6/9 (66.7)	6/12 (5.0)	
Form of food in most serious choking episode (*n* = 108)		*n* = 44	*n* = 35	*n* = 29	.072
Thin liquid		0	0	0	
Thick liquid		1 (2.3)	0	0	
Pureed		2 (4.6)	0	1 (3.5)	
Mashed		8 (18.2)	4 (11.4)	0	

Choking items	*n*	Traditional spoon feeding	Partial baby-led weaning	Baby-led weaning	*p*-value[c]
		n (%)	n (%)	n (%)	
Diced		2 (4.6)	2 (5.7)	3 (1.3)	
Sliced		14 (31.8)	14 (4.0)	8 (27.6)	
Whole		17 (38.6)	15 (42.9)	17 (58.6)	
Who fed food in most serious choking episode (*n* = 108)		*n* = 44	*n* = 35	*n* = 29	.067
Baby		22 (50.0)	22 (62.9)	23 (79.3)	
Parent		18 (4.9)	10 (28.6)	5 (17.2)	
Another adult		3 (6.8)	1 (2.9)	1 (3.5)	
Brother or sister		1 (2.3)	2 (5.7)	0	
Baby fed food themselves in most serious choking episode[a]	108	22/44 (50.0)	22/35 (62.9)	23/29 (79.3)	.015
Currently 7 to < 8 mo	31	4/9 (44.4**)**	7/9 (77.8)	9/10 (90.0)	
Currently 8 to < 9 mo	44	11/20 (55.0)	11/17 (64.7)	4/7 (57.1)	
Currently 9 to < 10 mo	36	7/15 (46.7)	4/9 (44.4)	10/12 (83.3)	
Age at most serious choking episode (*n* = 120)		*n* = 44	*n* = 35	*n* = 29	.497
4-5 mo		2 (4.6)	2 (5.7)	1 (3.5)	
6 mo		10 (22.7)	6 (17.1)	11 (37.9)	
7 mo		20 (45.5)	16 (45.7)	10 (34.5)	
8 mo		11 (25.0)	8 (22.9)	5 (17.2)	
9 mo and over		1 (2.3)	3 (8.6)	2 (6.9)	

[a] Results are presented as proportion with percentage p (x%), showing both the actual count and its percentage relative to the total p (x%).

[b] Missing data *n* = 1

[c] *p*-value calculated from a Fisher's exact test between traditional spoon-feeding and baby-led weaning groups. Partial baby-led weaning was not included in the statistical test due to small numbers.

Discussion

Our study captured FRC in a study population of older infants with a mean age of 8.4 months, who experienced different complementary feeding practices and lived in two urban cities in New Zealand. While we characterised this as a broadly representative sample, we did not exclude infants born preterm (*n* = 46). Data collection utilised a parent-report questionnaire that has demonstrated previous accuracy and provided clear descriptions to help parents distinguish between FRC and gagging (Fangupo et al., 2016).

Prevalence of food-related choking

Regarding prevalence, comparisons with the international literature are challenging due to the variation in studies on FRC, due to different methodologies and surveillance reporting systems. This makes cross-country comparisons challenging and obscures population-level FRC prevalence (Edwards & Martin, 2011; Foltran et al., 2012; Gregori et al., 2012). This study can only be compared to other cross-sectional studies that examined FRC prevalence in infants at complementary feeding age using parental reporting tools. However, studies differ in sample size, participant age, study design, and aims (Białek-Dratwa et al., 2022) (Brown, 2018; Cameron et al., 2013; Fu et al., 2018; Kahraman et al., 2020; Susmarini et al., 2021). Moreover, these studies have not reported weighted estimated prevalence, so their results cannot be applied to the broader population of their countries.

Our study showed a higher prevalence of FRC than three studies that used similar parental questionnaires, including only healthy term infants. For example, Brown (2018) reported in her cross-sectional study that 13.6% (*n* = 155) experienced a choking episode, although some parents had a recall period of up to 6 months. Similarly, an earlier NZ study also found FRC prevalence to be low (2%) in a population of 876 healthy children aged 6 to 36 months. However, that study only counted FRC episodes that required immediate medical attention and documented by a health professional in the child's Well Child Book. Thus, episodes resolved by the parent or child were not recorded (Fu et al., 2018). No infants in our study required medical or healthcare professional assistance for their FRC episodes, as they were resolved mainly by a parent (*n* = 68, 63%) or the infant themselves (*n* = 60, 55.6%), with (*n* = 120, 19.2%) experiencing a FRC episode overall. A Polish study (*n* = 646) reported a lower prevalence of choking compared to our study and others. Although their study population size was similar to ours, they had a much wider participant age range (6 to 36 months), requiring some parents to recall early feeding history from up to 30 months prior (Białek-Dratwa et al., 2022).

In contrast, three studies reported a greater prevalence of FRC compared to our study, all of which used parental reporting questionnaires. In an online survey of parents (*n* = 199) of healthy full-term infants aged 6 to 12 months, an older New Zealand study found that 71.4% reported at least

one choking episode, with most occurring with whole foods (Cameron et al., 2013). Researchers provided parents with a written description to differentiate choking from gagging, yet the authors acknowledged that despite these descriptions, parents likely misidentified gagging as choking.

Additionally, Susmarini et al. (2021) reported much higher FRC rates of 66.1% (*n* = 189) in infants aged 6 to 12 months, as determined using an online questionnaire. They excluded infants with congenital or chronic diseases but did not indicate whether preterm infants were included. Meanwhile, parents of 485 children in Turkey, aged 6 to 24 months, reported FRC occurrence in 20.6% (*n* = 100) of the cases. However, this study only excluded incomplete questionnaires with no other documented inclusion or exclusion criteria. Moreover, parents had to recall early feeding history from a prolonged period, potentially affecting reporting accuracy (Kahraman et al., 2020).

Foods causing food-related choking

Previously reported characteristics of foods causing FRC in infants are solid and semi-solid foods (de Paiva et al., 2023; Foltran et al., 2012) that are round and hard in texture (Gregori et al., 2008). The foods causing the most FRC episodes in our study were whole foods, mostly fruit (24.3%, *n* = 26) followed by vegetables. Interestingly, bananas were the most commonly choked on food (*n* = 9), closely followed by apples (*n* = 8). This finding aligns with studies focused on infants under 12 months that examined complementary feeding practices, including modified BLW (BLISS), which may be attributed to the emphasis on nutrient-dense finger foods in these approaches.

Two RCT studies using the BLISS approach identified bananas as commonly involved in FRC events (de Paiva et al., 2023; Fangupo et al., 2016), a finding that was also reported in a large cross-sectional study (Brown, 2018). Bananas and other "slippery foods" such as melon and avocado are generally not considered high-risk foods (Correia et al., 2024), particularly when compared to apples, carrots, and other raw fruits and vegetables which are more frequently identified in other complementary feeding studies and surveillance data (ACC, 2019) (Brown, 2018; Cameron et al., 2013) (SusySafe, 2012).

Perhaps bananas were common household foods, already used in a mashed form and then presented in larger pieces to support self-feeding, which led to FRC. Banana, although not classified as a 'hard solid', requires young infants to adequately mash it with the tongue against the hard palate to break it down for safe swallowing. Infants use a predominant sucking pattern between 6 to 8 months, transitioning to soft pieces and chewing abilities between 8 to 10 months (Demonteil et al., 2019).Fruits and vegetables are among the earliest and most frequently offered foods in infancy, and their over-representation in choking data may therefore reflect opportunity for exposure rather than inherent food-related risk. This interpretation is consistent with previous literature indicating that choking risk is influenced more by food texture, preparation, and developmental readiness than by food group alone (Correia et al., 2024).

Gisel (1991) found that infants between 6 to 8 months are in a transitional phase of oral feeding skill acquisition, characterised by variable feeding strategies that alternate between sucking and early vertical munching, particularly when managing soft but cohesive textures (gelatine cubes). transitioning to more frequent munching by 10 months of age. However, time of day, alertness levels, and feeding skill also shaped the infant's approach, with infants using the pattern requiring the least effort (Gisel, 1991). This developmental profile provides a mechanistic explanation for the findings of the present study. The highest proportion of serious FRC episodes occurred among infants aged 8 to < 9 months, particularly during self-feeding of whole fruits and vegetables. These foods are soft yet cohesive and require effective vertical jaw movement and developing tongue control to fragment safely. As Gisel demonstrated, such textures place increased demands on OFS that are maturing during the transitional feeding period. Infants following a BLW approach may therefore encounter a developmental mismatch between the texture and form of foods offered and their current OFS level, increasing FRC risk during self-feeding.

In a more recent study on food texture and early chewing skills, Costa et al. (2017) extended this work by demonstrating that at 8 months, chewing capability was strongly texture dependent. Infants showing greater difficulty managing pieces of carrot and potato cofeeding period, significant

changes in oral feeding patterns occur between 6 and 12 months, with infants under 8 months frequently alternating between sucking and early vertical munching when managing small pieces of viscous texture. Although Costa et al. (2017) reported high chewing capability scores for banana pieces among 8-month-old infants, suggesting that banana is relatively easy to manage from a chewing perspective, the findings of the present study indicate that banana was the most frequently implicated food in serious FRC episodes. This apparent discrepancy highlights the distinction between chewing capability and safe bolus management in real-world feeding contexts. Banana is a soft yet highly cohesive and slippery food that can encourage early swallowing with minimal chewing effort. Consistent with Gisel's observations, infants in the transitional feeding period may adopt a least-effort strategy when managing such textures, relying on immature sucking–munching patterns rather than sustained bolus preparation. During self-feeding, this tendency may be exacerbated by reduced caregiver control over the bite size and pacing, increasing the risk of choking despite adequate chewing capability. However, younger infants in our study population may have lacked the mature OFS necessary to adequately break down banana and other fruit pieces, contributing to FRC episodes.

Conversely, our findings of fruit and vegetables, are different to international surveillance data (SusySafe, 2022), other recent international studies (Altmann & Ozanne-Smith, 1997; Foltran et al., 2012; Reid et al., 2020; Wu et al., 2018) and the World Health Organization (World Health Organization, 2023), that reported nuts and seeds as causing most FRC episodes in childhood. For infants under 12 months, two studies also found that nuts and seeds were the predominant foods causing FRC (Na'ara et al., 2020; Özyüksel et al., 2019). A Turkish retrospective study examined infants admitted to hospital for FRC who underwent bronchoscopy (an endoscopic procedure to investigate the airway and respiratory system) (Özyüksel et al., 2019). The researchers found that nuts and seeds were responsible for 80% of FRC occurrences in these infants (mean age, 9 months). Additionally, they reported that self-feeding accounted for 14% of FRC episodes. The authors concluded that self-feeding was a significant risk factor for FRC due to the infants' immature OFS.

However, it should be noted that the foods offered or made available were inappropriate for the infants' age and OFS development.

Unlike Özyüksel et al. (2019), who emphasised infant self-feeding as the primary cause of choking episodes, Na'ara et al. (2020) found in their study that caregivers actively providing inappropriate foods was the main factor leading to hospital admissions for FRC. Na'ara et al. (2020) highlighted how cultural factors and social events often contributed to infants experiencing FRC from nuts and seeds. While some episodes stemmed from inadequate adult supervision, allowing unintentional ingestion of age-inappropriate foods, others occurred when parents deliberately offered hazardous foods during social gatherings. This suggests that choking episodes were primarily linked to caregiver feeding decisions rather than the children's self-feeding behaviours (Na'ara et al., 2020). Only a small number of infants in our study population (n = 2, 1.9%) choked on nuts, and no seeds were reported. Unfortunately, we were unable to explore whether adult supervision during feeding or food preparation was adequate.

The difference in terms of the high-risk foods that caused FRC in NZ compared to overseas may be due to our national guidelines. New Zealand's Ministry of Health has published guidelines stating that nuts and seeds are high-risk choking foods in both its Healthy Eating Guidelines for 0 to 2 years and guidance for reducing FRC for babies and young children at early learning services. As part of the early learning services guidance, nuts and seeds are excluded from early childhood centres in NZ (Ministry of Health, 2020, 2021).

Complementary feeding practice and food-related choking

In terms of the association between complementary feeding practice and FRC, our study found a statistically significant relationship. BLW infants aged 7 to < 8 months had higher rates of FRC episodes compared to their TSF counterparts (p = .015).

These findings align with a previous, albeit smaller study (n = 286) conducted by Susmarini et al. (2021), which also demonstrated a significant association between FRC and infants following BLW

compared to TSF practices (p = .014). Their analysis indicated that infants following BLW were 1.98 times more susceptible to FRC than their counterparts following TSF. Methodologically, Susmarini et al. (2021) employed distinct approaches from this study: they provided explicit written descriptions to enable parental discrimination between FRC and gagging responses, along with clear operational definitions of complementary feeding practices (specifically BLW and TSF). Additionally, their classification protocol relied on parental self-identification for the complementary feeding practice, whereas our study classified complementary feeding practices based on parent responses.

A notable limitation of Susmarini's investigation was the absence of data regarding the specific food types or forms implicated in FRC episodes. This component has been addressed in our research. However, most studies found no statistically significant difference between complementary feeding practices and FRC (Białek-Dratwa et al., 2022; Cameron et al., 2013; Fu et al., 2018; Kahraman et al., 2020; Morison et al., 2016; Townsend & Pitchford, 2012). Although the research was similar to ours in terms of design (cross-sectional using a parent-report questionnaire), the differences may be due to the retrospective nature of the studies. That is, the focus and content of the parent-reporting tools relied on parents to recall their infant's feeding history over a prolonged period.

Townsend & Pitchford (2012) reported that 93.5% of their BLW group had never experienced a choking episode. However, there was no question in their methods that appeared to target FRC. They also reported foods via their categories (carbohydrates, fruit, or vegetables) but not the specific foods or textures. They also relied on parent recall over a prolonged period. However, FRC was not the primary outcome of their study (Townsend & Pitchford, 2012).

A cross-sectional study (n = 485) by Kharaman and colleagues, had a larger age range of children (6 to 24 months) and used the validated Child Feeding Questionnaire (CFQ) (Birch et al., 2001), which explores mothers' beliefs and perceptions of feeding. The CFQ results suggested that mothers using a TSF practice reported more controlling maternal feeding behaviours, higher concerns about their infant's weight , and increased pressure for their infants to eat compared to

mothers following BLW and partial BLW practices (Kharaman et al., 2020). Despite this, there was no validated questionnaire used for the FRC data, and no foods or forms described that caused FRC. It was also unclear how many questions were targeted at FRC, and if there were written descriptions to help mothers discern choking from gagging.

On a different note, Białek-Dratwa et al. (2022) found increased gagging, spitting out of food and vomiting reflex initiation in infants who were BLW compared to those TSF. Again, as previously reported, the age range of infants was larger than ours (6 to 36 months), relying on some mothers to recall early feeding history, despite a large time gap. Additionally, the authors reported that most parents preferred a mixed complementary feeding practice (partial BLW, 5.7%), with only 29% exclusively using BLW. Furthermore, food texture descriptions were reported generally, but not for FRC (Białek-Dratwa et al., 2022).

Three older but similar studies to ours in terms of method and age range of the infants reported no difference in FRC between complementary feeding groups. High risk foods were offered in all groups (BLW, partial BLW and TSF) and when the researchers analysed the daily weighed food records, they could not rule out increased odds of FRC with BLW as their confidence intervals were very wide (CI: 2.57, .63 to 1.44) (Morison et al., 2016).

The previously mentioned study by Brown (2018) examined foods introduced when complementary feeding began. She found that 67.5% choked between 4 and 7 months, but the rate was small (13%). Most infants fed by TSF had significantly more choking episodes on finger foods than those who were BLW (p = .002) (Brown, 2018). However, again, some parents had to rely on a six month recall to document early feeding information, and the author expressed caution over bias with mothers wanting BLW to come across as safe (Brown, 2018). Brown's findings agree with Rapley (2005), the author who first described BLW. Rapley hypothesised that TSF may put infants at greater risk of choking due to the infant's inexperience with biting off food (Rapley, 2005).

In contrast to RCTs that compared BLW to TSF including those that used the BLISS approach, our study also yielded different results. In the BLISS studies, the researchers consistently reported

that parents offered foods posing a high risk of FRC, despite the provision of resources intended to mitigate this risk (de Paiva et al., 2023; Dogan et al., 2018; Fangupo et al., 2016). The only RCT to compare TSF and BLW (not BLISS) by Arslan and colleagues, only reported the frequency of FRC and not the foods involved, which limits the practical safety insights we can draw from their study. However, significant differences were found for their BLW group in terms of earlier transition to solids at 6 to 8 months compared to the TSF group (p > .001) and self-feeding at 12 months (p = .005). Interestingly, though, the TSF group transitioned to eating regular family food earlier than the BLW group (p = .016) (Arslan et al., 2023).

The strengths of our study include our large, ethnically and socioeconomically diverse study population, as well as the implementation of our parent-reported questionnaire, which has demonstrated good recall accuracy (Correia et al., 2024; Fangupo et al., 2016). Complementary feeding practices were determined through detailed parent reports of infant self-feeding volumes and spoon-feeding proportions, with clear distinctions provided between FRC and gagging to ensure accurate classification. Importantly, this study employed weighted estimated prevalence calculations to provide a more precise estimate of the true population burden of choking in infants during complementary feeding. This epidemiological approach has not been utilised in previous research in this field.

Nevertheless, our study had limitations that require acknowledgement. First, the use of convenience sampling for recruitment may have introduced selection bias, with participating parents and caregivers more likely to have higher education levels than the general population of NZ. In addition, only parents and caregivers with sufficient English proficiency and literacy to complete the questionnaire were able to participate. Participants were recruited from two urban centres, and therefore the findings may not be representative of families living in rural areas or other regions. Furthermore, infants with diagnosed health conditions, including those born prematurely, were not excluded. Finally, choking events were identified through parent report and may therefore be subject to recall error or misclassification.

Conclusion

This study contributes novel population-level evidence on FRC and liquid choking in infancy by quantifying both unweighted and weighted prevalence estimates in community-dwelling infants under 12 months who were consuming solid foods and exposed to a range of complementary feeding practices. To our knowledge, this is the first study to report weighted prevalence estimates for FRC and liquid choking in this population, providing a more representative understanding of the burden of choking during the first year of life.

Within this cohort, FRC episodes were most commonly associated with fruit and vegetables, in infants who were self-feeding. This highlights the importance of food texture and preparation whilst infants are developing their OFS during complementary feeding. Analysis of caregiver-reported data also identified several factors associated with FRC, reflecting the multifactorial nature of choking risk in infancy. Notably, differences were observed according to complementary feeding approach, with infants following BLW at 7 to < 8 months experiencing a higher frequency of FRC episodes compared with those following TSF practices. These findings contribute to the growing body of literature examining how feeding practices intersect with developmental readiness and choking risk.

FRC represents a preventable adverse event, with infants under 12 months constituting a particularly vulnerable population due to their distinctive anatomical characteristics, developmental limitations in their OFS, and emerging cognitive capabilities. This study highlights the need for more thorough research on FRC across larger populations, particularly among infants under 12 months. Although fruits and vegetables, particularly bananas, were the most commonly reported foods involved in FRC events, this finding should be interpreted in light of their high frequency of exposure during complementary feeding. Fruits and vegetables are among the earliest and most frequently offered foods in infancy, and their over-representation in choking data may therefore reflect opportunity for exposure rather than inherent food-related risk. This interpretation is consistent with

previous literature indicating that choking risk is influenced more by food texture, preparation, and developmental readiness than by food group alone.

Furthermore, there is a need for evidence-based resources that focus on optimal food preparation instructions for caregivers implementing baby-led complementary feeding practices. The BLISS guidelines exemplify such resources, providing explicit protocols for food preparation that mitigate choking hazards by giving guidance on how to prepare foods for developing feeding skills, while simultaneously prioritising nutrient-dense offerings to ensure nutritional adequacy. The development and validation of similar interventional frameworks would represent a valuable contribution to public health initiatives aimed at reducing FRC episodes while supporting developmentally appropriate feeding skills.

Chapter 6 – Discussion and Conclusions

Working with families has reinforced my conviction that parents are the experts on their children's feeding skills. Their daily observations capture nuances that even the most comprehensive clinical assessment might miss. By prioritising parent reporting in this research, I have gathered rich data that reflects the authentic feeding experiences of infants in their natural environments.

The developmental progression of oral feeding skills revealed in this study affirms that these abilities typically improve with age, yet follow individual trajectories shaped by personal and environmental factors experienced during early life. This knowledge equips speech-language pathologists with crucial benchmarks to distinguish between typical variations and concerning patterns that may warrant intervention.

I hope that this research strengthens the collaborative relationship between clinicians and families, providing speech-language pathologists with evidence-based guidance while validating the essential role parents play in supporting healthy feeding development. I aspire for these findings to encourage more interprofessional research across disciplines, fostering collaboration that address the multifaceted nature of infant feeding development. Furthermore, I believe this work can inform future paediatric feeding guidelines and provide valuable support to Well Child services and primary health providers, who are often the first point of contact for families with feeding concerns. As we continue to advance our understanding in this field, I remain committed to approaches that honour

both clinical expertise and parental wisdom in nurturing safe and positive feeding experiences for infants and young children.

Introduction

The trajectory of oral feeding skills (OFS) development in healthy infants can vary depending on their experiences and exposure to solid food textures during the second half of infancy. Complementary feeding is a critical period in which exposure to varied food textures supports the development of chewing skills. Food- related choking (FRC) risk is influenced not by exposure itself, but by factors such as food size, texture, and preparation. yet presents inherent risks for food-related choking (FRC). Despite the recognised importance of OFS, they have received comparatively limited research attention, particularly in healthy infant populations both internationally and within New Zealand.

Health professionals face significant challenges distinguishing between typical developmental variations and problematic feeding patterns (Pados, Park, et al., 2018; Pados, Thoyre, et al., 2018). What parents often perceive as problematic feeding behaviours frequently signifies underlying OFS difficulties or delay (Delaney et al., 2024). The interrelationship between skill acquisition, behaviours, and choking risk creates a complex assessment landscape that requires nuanced evaluation.

FRC is a serious concern during child development. As infants transition to increasingly challenging textures, their OFS are constantly adapting, creating a window of vulnerability where choking episodes are more likely. Understanding how complementary feeding practices shape both skill development and choking risk is essential for developing and providing appropriate guidance. Therefore, this study aimed to comprehensively examine OFS in 7 to 10 month old New Zealand infants, exploring their associations with early life factors and feeding behaviours. Additionally, we investigated FRC episodes to expand the limited research base during this critical transitional period.

The first aim

The first aim was to describe the OFS of New Zealand infants and identify difficulties using the validated Child Oral and Motor Proficiency Scale (ChOMPS) (Pados, Park, et al., 2018) (as presented in Chapter Three of this thesis). Sociodemographic characteristics and early feeding practices were explored to determine associations with infants classified as "concern" versus "no concern" on the ChOMPS. The ChOMPS proved to be a valuable tool for assessing infants OFS from the parents' perspective, effectively complementing a Dynamic Systems Theoretical Framework by enabling assessment in the infant's natural environment. This approach leverages parents' intimate knowledge of their infants, allowing them to observe their infant's OFS across various settings and times of day—contexts that clinical assessments may not capture.

Beyond its utility for parent-reported assessment, the ChOMPS demonstrated notable clinical relevance as one of the higher-scoring tools capable of mapping to all three functional elements within the Feeding Skills Domain of Paediatric Feeding Disorder (PFD). Given that PFD diagnosis across the Feeding Skills Domain requires integration of both clinician and parent perspectives, the ChOMPS provides an important bridge between professional clinical evaluation and real-world parental observation, making it a valuable addition to comprehensive feeding assessments.

Most infants were not classified as showing 'concern' based on the normative reference values of the ChOMPS (Pados, Park, et al., 2018). However, older infants were disproportionately more likely to be classified as 'concern' compared to younger infants. This pattern appears to reflect the different cut-off scores applied to infants 9 months and older versus younger infants in the study population, rather than necessarily indicating genuine feeding difficulties in the older age group. The ChOMPS authors acknowledged this risk of over-identification and recommended further testing across different countries and settings to refine the PROM's age-based normative values (Pados, Park, et al., 2018; Sanchez & Morgan, 2018)

As we had a larger sample, we determined cut-off scores using the same methods as Pados et al. (2018), using the 5th and 10th percentiles and the 6 to < 9 and ≥ 9 to 12 month age ranges. We also calculated alternative monthly cut-off scores (7 to < 8, 8 to < 9 and 9 to < 10 months) at the 5th and 10th percentiles to add to the literature for the ChOMPS and provide more information at this rapidly developing stage. When we applied our cut-off scores, fewer infants overall would be considered "concern" for both the ChOMPS Total Score and Basic Movement Patterns sub-score compared to the normative reference values. More infants were in the lowest 10th percentile for the oral- motor sub-scores (Oral-Motor Coordination and Fundamental Oral-Motor Skills) compared to the normative reference values. However, these numbers decreased in the older age group (9 to < 10 months), indicating OFS development. These results better reflect the typical developmental trajectory of OFS, where infants' abilities improve with age. In contrast, the normative reference values classified older infants as having "concern," contradicting expected developmental patterns.

Between 6 to 12 months, the OFS development of infants goes through substantial changes (Delaney & Arvedson, 2008; Gisel, 1991). Month-by-month cut-off scores account for the rapid and non-linear progression of OFS during this critical period, providing more developmentally appropriate benchmarks than broader age ranges. Delaney et al. (2021) found that by 8 months, most infants were consuming large volumes of puree. Therefore, an infant at 8 months who still struggles with purees may warrant “concern”, even if they fall within a broader "6 to 9 month" category.

Month-specific benchmarks offer realistic expectations for parents regarding their infant's feeding development, potentially reducing anxiety associated with normal developmental variations. Additionally, these nuanced cut-off scores establish a methodological foundation for future studies investigating developmental trajectories. Using 5th and 10th percentile cut-offs from our larger study population (*n* = 562) supports the statistical reliability of these reference points compared to previous studies with smaller sample sizes.

More specific reference points enable earlier detection of subtle deviations from typical development, allowing for timely referral and assistance before feeding difficulties become entrenched. We found that by using monthly cut-off scores, the older infants were less likely to be classified as "concern" on the ChOMPS. This helps to reduce false positives and false negatives, particularly crucial during periods of accelerated developmental change. Thus, allowing health professionals to make more informed decisions about whether observed feeding patterns represent typical variations or warrant further assessment. We suggest combining data from similar studies using the CHOMPS to build a large dataset of individual participant data, thereby generating monthly normative reference values from 6 to 12 months, based on an internationally representative sample.

Summary

The ChOMPS is a valuable PROM to identify OFS and track a child's OFS development. However, further work is needed on its normative reference values to develop its efficacy further. Using month-by-month cut-off scores during the second half of infancy would offer several advantages when applying the ChOMPS to healthy infants. Ideally, we would have monthly reference values between 6 and 12 months of age to identify infants of concern, however, our study does provide valuable data for the 7 to 10 month age range.

The second aim

The second aim of this study, presented in Chapter Four, was to describe the feeding behaviours of NZ infants aged 7 to 10 months using a validated PROM, the Pediatric Eating Assessment Tool (Pedi-EAT) (Pados, Thoyre, et al., 2018). Feeding behaviours were classified as "concern" versus "no concern" using the Pedi-EAT, and associations with early life factors and OFS were explored.

The majority of infants were classified with "no concern" regarding their feeding behaviours based on using the normative reference values established by Pados et al. (2018). Similarly to

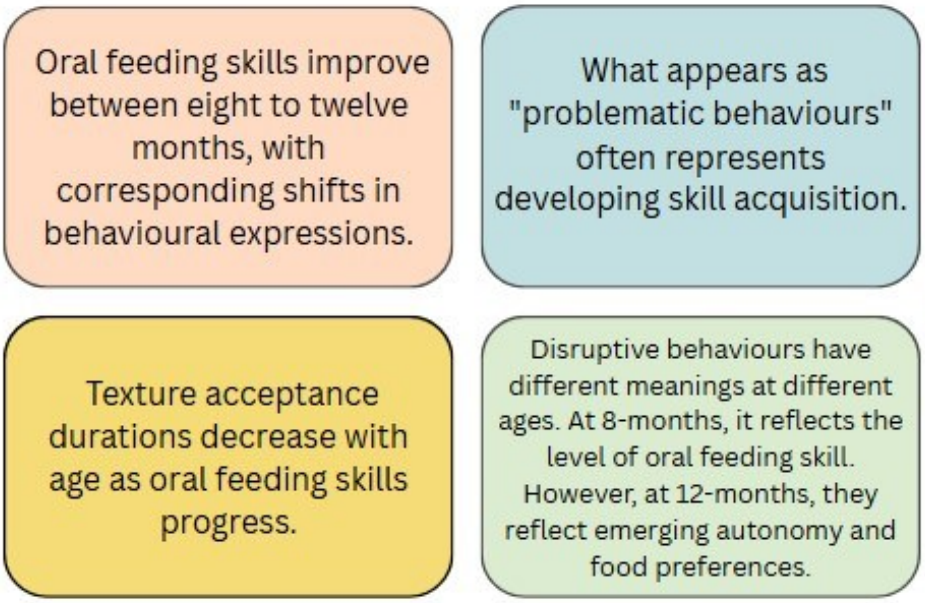
Chapter 3, we identified infants of concern and high concern using alternative 90th and 95th percentile cut-off scores using the 6 to < 9 and ≥ 9 to 12 month age ranges as well as monthly cut-off scores (7 to < 8, 8 to < 9, 9 to < 10 months) from our study population.

Our analysis demonstrated that assessment sensitivity varies significantly depending on the benchmarks applied. Using the Pedi-EAT normative reference values, only primiparity showed a significant association with infants classified as "concern". However, when applying our FFNZ 90th and 95th percentile cut-off points, both primiparity and gastroesophageal reflux emerged as significant associations with infants classified as "concern." This difference most likely occurred because the Pedi-EAT normative reference scores over diagnosed the infants as “concern”, which obscured the identification of infants with gastroesophageal reflux.

In addition, the analysis of the relationship between OFS (ChOMPS) and feeding behaviours (Pedi-EAT) using multivariate linear regression revealed that increasing age had the strongest positive relationship with ChOMPS scores, followed by decreasing (improving) Pedi-EAT scores, with primiparity also showing a positive relationship. The model, adjusted for sex and age, demonstrated that as OFS improve (higher ChOMPS score), feeding behaviours also improve (lower Pedi-EAT score). Our findings revealed that age was associated with OFS development, but no relationship was observed with feeding behaviours. Delaney et al. (2024) provided crucial context for interpreting these findings. Their research revealed a nuanced relationship between OFS and feeding behaviours for infants in the second half of infancy. They found that what might appear to parents as problematic feeding behaviours may actually reflect typical developmental stages in OFS acquisition, with the relationship between acceptance rates, the types of feeding behaviours demonstrated, and duration measures providing a more complete view of feeding development (**Figure 6.1**).

Figure 6.1

The relationship between oral feeding skills and feeding behaviours



(Delaney et al., 2024)

By applying these insights from Delaney and colleagues, as well as establishing monthly cut-off scores for our 7 to 10 month old infants, we can better inform our identification of feeding concerns during this period of rapid development. Without such specificity, we risk both over-diagnosing younger infants still mastering basic skills and missing genuine issues in older infants.

Furthermore, the findings contextualise feeding behaviours within a Dynamic Systems Theory Framework. That is, recognising that what might appear as problematic may represent typical developmental progression, with experiences of instability and non-linearity in OFS acquisition (Zimmerman et al., 2020).

An interesting finding was the contrasting association between primiparity for OFS and feeding behaviour. Primiparity was found to be associated with infants classified as “no concern” on the ChOMPS tool, and with improving OFS when our regression model was applied. However, primiparity was associated with infants classified as “concern” on the Pedi-EAT. Perhaps due to the lack of normative information on OFS available to parents, they do not have the knowledge to identify an OFS delay or difficulty. Or, to consider typical variability and times of instability during

developmental progressions. Therefore, parents label these as behaviour difficulties rather than recognising immature skills or a skill deficit.

Primiparity has been associated with greater parental concern about feeding behaviours, despite no corresponding concern regarding OFS on clinical assessment (Crist & Napier-Phillips, 2001; Hines et al., 2022; Ramsay et al., 2011). Furthermore, large prevalence studies have identified primiparity as an association with reported feeding difficulties in children (Benjasuwantep et al., 2013; Hvelplund et al., 2016; Sdravou, Fotoulaki, et al., 2021). Future studies focused on OFS development and Paediatric Feeding Disorder (PFD) and contributing sociodemographic characteristics should consider further research into the effect of birth status.

Summary

While the Pedi-EAT demonstrates value in detecting feeding difficulties among infants, establishing more robust normative data is recommended. This would require a further break down in age groups and larger infant samples. Optimal clinical practice should incorporate both the Pedi-EAT and ChOMPS to exclude OFS difficulties. The ChOMPS demonstrates age-related improvements in both the Total Score and sub-scores, supporting its utility for early identification purposes. Longitudinal research examining healthy infant populations would strengthen the evidence base. Additionally, the notable relationship between birth status and feeding behaviours during later infancy merits further exploration.

The third aim

The third aim, addressed in Chapter Five, determined the prevalence of FRC in the study population and identified associated risk factors. Using a parent-reported questionnaire, this study found an FRC prevalence of 19.2% (*n* = 120), consistent with findings from other cross-sectional studies of infants during the complementary feeding period.

Foods implicated in FRC episodes in our study differed from those most commonly highlighted in international guidance, where nuts and seeds are typically identified as primary choking hazards for infants under 12 months. In contrast, fruits and vegetables were most frequently reported as involved in FRC events in our cohort, with bananas accounting for the largest proportion of episodes. This finding should be interpreted in the context of exposure, as fruits—particularly bananas—are among the most commonly offered foods during early complementary feeding. Their frequent involvement in FRC events may therefore reflect the high number of eating occasions rather than an inherently greater risk. Although bananas are not considered high-risk foods in NZ guidelines, a recent systematic review found "slippery" foods (bananas and melon) caused choking episodes in baby-led complementary feeding practices, suggesting national guidelines need more specific food preparation recommendations (Correia et al., 2024). These findings indicate that clearer guidance on age-appropriate food preparation and presentation may be warranted, rather than avoidance of commonly consumed fruits and vegetables.

The younger infants (7 to < 8 months) in our study population, following a baby-led weaning practice (BLW) had significantly more FRC episodes compared to those following a parent-led, traditional spoon-feeding (TSF) practice (p = .015). This finding also differed from most of the international literature, which found no significant differences between parent and baby-led complementary feeding practices and FRC episodes (Correia et al., 2024). Older literature reported that infants aged 7 to < 8 months used a mixture of sucking and early munching movements to break down foods, with 8 month old infants only just beginning to manage small pieces of slippery foods, though this represented significant improvement from earlier months (p = .005) (Gisel, 1991). Building on this understanding later studies introduced small pieces of soft foods from 8 months onwards to examine food texture acceptance (da Costa et al., 2017; Demonteil et al., 2019).

Our study provided, to our knowledge, the first weighted estimated prevalence for FRC and liquid choking in community dwelling infants aged 7 to 10 months of age. This is important as the weighting accounts for differences in ethnicity and area-level deprivation between our study

population and the true population. Making our estimate more generalisable to our NZ population. Similar studies, while reporting prevalence on choking episodes in their study populations have not adjusted for population characteristics. Our weighted estimated prevalence on food was 18.2%, 95% CI [15.3, 21.5], and 15.2% (95% CI: [12.5-18.4] for liquids for infants 7 to 10 months of age.

Summary

This study found an FRC prevalence of 19.2% in NZ infants aged 7 to 10 months, consistent with international cross-sectional studies during complementary feeding. More importantly, this represents the first weighted prevalence estimate for this age group, providing a population-adjusted rate of 18.2% (95% CI [15.3, 21.5]) that enhances generalisability to the broader NZ population. Our findings revealed important differences from international patterns, with fruits and vegetables, particularly bananas, being the most frequently reported foods involved in FRC events, rather than the typically reported nuts and seeds. Additionally, younger infants (7 to < 8 months) following BLW experienced significantly more FRC episodes than those using TSF (p = .015), contrasting with international literature showing no such differences. These age-related findings align with developmental feeding literature indicating that infants this young are still developing the OFS necessary for safely managing textured foods. These results highlight the need for population-specific public health guidelines that provide detailed food preparation guidance, including appropriate bite sizes and textures for different developmental stages, balancing texture exposure benefits for OFS development with safety considerations.

Limitations of the Study

Our study's recruitment via convenience sampling likely introduced selection bias. This can result in an overrepresentation of parents and caregivers with higher education levels compared to the general New Zealand population. This approach may have also attracted participants with greater interest in their infants' OFS and feeding behaviours, potentially affecting the representativeness of

our findings. Additionally, participation was restricted to individuals with adequate English language skills and literacy levels necessary to complete the questionnaires, potentially excluding perspectives from other communities. The study's focus on two urban centres in New Zealand limits the generalisability of findings to rural populations or other g regions within the country.

Another limitation was our reliance on parent/caregiver-reported data without corresponding clinical observation or assessment of infants identified as having “concern” on the PROMs. While PROMs offer valuable insights, the absence of professional validation for infants identified with potential feeding difficulties represents a constraint.

Additionally, the combined 148 items on the PROMs present a potential burden for parents, evidenced by missing data in our study and from other studies using the ChOMPS and Pedi-EAT (Pados et al., 2024). Missing data can impact results with low response rates threatening the representativeness of findings (Dawson et al., 2010). Furthermore, our study did not exclude infants with diagnosed health conditions. Although the number was small, this may have biased the overall findings, given the known associations between certain health conditions and feeding difficulties.

Strengths of the study

Novel contribution to oral feeding skill knowledge

Our study represents the first cross-sectional study of OFS in New Zealand infants during the critical period of complementary feeding. By focusing specifically on skill development and identifying potential difficulties early in the feeding journey, we have addressed an important gap in the research literature. The findings are particularly valuable because we were able to establish age-specific reference scores for rapidly changing time points (7 to < 8 months, 8 to < 9 months, and 9 to < 10 months). These reference points provide nuanced benchmarks that can guide both researchers and clinicians in assessing typical versus delayed OFS development in infants.

Understanding feeding behaviours and their relationship to oral feeding skills

Our study evaluated the feeding behaviours of the study population and established monthly reference scores (7 to < 8 months, 8 to < 9 months, and 9 to < 10 months). We explored the meaningful connections between OFS and feeding behaviours using validated PROMs that capture the parent perspective. This approach acknowledges that parents are uniquely positioned to observe their infant's daily feeding patterns.

Food-related choking findings with real-world application

Our study provides valuable insights into FRC in infants under 12 months who consume solid foods through various complementary feeding practices. The findings revealed that fruits and vegetables were the most commonly associated foods with choking episodes. Interestingly, we observed that infants following a BLW practice at 7 to < 8 months experienced more choking episodes compared to those following TSF. These insights have direct implications for how parents approach introducing and presenting food to their infants.

Methodological strengths

Several key methodological strengths support our findings. Our study included a substantial sample of 625 participants, providing the statistical power needed to identify meaningful patterns. The sample represented diverse ethnic backgrounds and socioeconomic circumstances, collected from two urban centres in New Zealand, which enhances the generalisability of our findings. We used validated PROMs, the ChOMPS and the Pedi-EAT, found to be the most robust when identifying impairments in the Feeding Skill Domain of PFD (Marshall et al., 2023). Additionally, these PROMs rely on parent reporting who know their child best across mealtimes and environments.

This study advances the methodological rigour of choking research during complementary age in two key ways. First, complementary feeding practices were systematically classified through detailed parent reports with clear FRC versus gagging criteria (Correia et al., 2024; Fangupo et al., 2016). Second, and most significantly, weighted estimated prevalence was calculated to provide, to

our knowledge, the first population-level estimate of choking burden in infants during complementary feeding—filling an important methodological gap in the existing literature.

Impact of the study

Promoting validated patient-reported outcome measures for early identification

Validated PROMs serve as useful tools to capture developmental trajectories across diverse environments and critical timepoints (Sdravou, Fotoulaki, et al., 2021; Serel-Arslan et al., 2023). These tools can be used to monitor typical progression and early warning signs of Paediatric Feeding Disorder (PFD), enabling timely intervention before difficulties become entrenched learned behaviours. Our implementation of the ChOMPS and Pedi-EAT questionnaires demonstrated their utility in identifying potential feeding challenges within our infant study population. This highlights an opportunity: these validated tools could be integrated into routine Well Child Health checks, providing primary health care providers with practical and reliable resources to detect feeding difficulties early.

Further development of national feeding guidelines

Current national feeding guidelines primarily focus on nutritional parameters, while giving less attention to the development of OFS. This nutrition-centred approach, common in guidelines from the World Health Organization, and the NZ Ministry of Health, address breastfeeding duration, complementary feeding timing, and nutritional composition, but provide limited guidance for infants managing increasingly complex food textures (Delaney et al., 2021; Fewtrell et al., 2017; Ministry of Health, 2021; World Health Organization, 2023).

From a developmental perspective, NZ guidelines would benefit from strengthening the connection between OFS and nutrient requirements during the second half of infancy. More comprehensive guidance should consider multiple factors, including food texture types, consumption frequency, dietary variety, and their contribution to overall energy intake. Establishing evidence-

based benchmarks for age-appropriate OFS progression that align with children's developmental capabilities.

Lastly, rather than focusing on complementary feeding practices (whether they are parent or baby-led), parents would benefit from practical guidance on appropriate food preparation and presentation (appropriate bite sizes/ food pieces). Aligning nutritional guidance with OFS would provide clearer expectations for typical oral feeding development and help prevent both choking episodes and unnecessary texture restrictions and lack of progression.

Directions for future research

Future research should prioritise further validation of the ChOMPS and Pedi-EAT to establish monthly cut-off scores for infants under 12 months of age, thereby reducing the risk of misdiagnosis. Specifically, studies examining sensitivity and specificity across diverse countries and clinical settings are needed to strengthen the tools' utility for early identification and as outcome measures in therapeutic interventions. Where possible, pooling individual participant data from comparable international studies using the ChOMPS and Pedi-EAT would enable the development of robust normative reference values based on large, internationally representative samples.

Additional research is also warranted in the second half of infancy, particularly within the under-researched Feeding Skill and Nutrition Domains of Paediatric Feeding Disorder. Interdisciplinary studies should aim to establish age-appropriate feeding benchmarks for infants aged 6 to 12 months. This includes determining optimal bite sizes of nutrient-dense foods that support safe texture progression, while concurrently examining energy intake across a range of food textures as feeding skills develop. Furthermore, longitudinal investigations should aim to clarify how early texture and bite size exposure contribute to feeding skill development, dietary diversity, and the early identification of feeding vulnerability.

Translational research into supporting the development and evaluation of consumer-friendly food preparation resources tailored for parents adopting baby-led approaches to complementary feeding. Future studies should focus on the co-design of such resources with stakeholders, for example, parents, healthcare providers, and feeding specialists, followed by consumer testing to evaluate clarity, practical applicability, and effectiveness in reducing choking risk while supporting feeding skill development. Research in this area has the potential to bridge the gap between theoretical knowledge and practical implementation, supporting parents to confidently navigate BLW and other baby-led practices while prioritising infant safety.

Finally, future research should explore the integration and effectiveness of education about typical feeding development and feeding-related red flags within antenatal programmes for first-time parents. Research evaluating whether such education improves parental understanding of normal developmental variation, reduces anxiety, and supports timely identification of feeding concerns would provide valuable evidence to guide preventative feeding education initiatives.

Appendices

Appendix A: Information Sheet of First Foods Study

Feeding our babies – are we getting it right?

FIRST FOODS
— New Zealand —

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

July, 2020

Investigators

Assoc Prof Anne-Louise Heath, University of Otago (Dunedin)
Prof Rachael Taylor, University of Otago (Dunedin)
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Dr Lisa Te Morenga, Victoria University (Wellington)

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Why?

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

What does this study involve?

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

What would I be asked to do?

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

First visit

This visit will take place at our Albany Massey University research center, your home, or your preferred location. Our research center is a comfortable and safe place with a breastfeeding area and plenty of toys for your babies and/or other children. There is also free parking available. During visit one we will measure baby's weight and length and ask you to fill out a couple of questionnaires about baby's feeding and health. We will ask you to tell us what, and how much, baby ate the day before. Because this can be difficult to remember, we will ask you to take photos of baby's food at the start of their meals and snacks the day before we visit. These are just taken on a phone or camera – we can lend you one if needed. This visit will take about one and a half hours.

Second visit

This visit will take place at our Albany Massey University research center, your home, or preferred location. One of our staff will take some photographs of baby's mouth and teeth. Then we will ask you to tell us what, and how much, baby ate the previous day (like you did for the first visit). This visit will take less than one hour.

There will be one last online questionnaire after this visit.

Third visit

This visit will be at your local Lab test collection center. A blood test will be taken, so that we can measure your baby's iron levels. The blood test will be done by someone who is very experienced at collecting blood samples from babies, and we will provide you with a numbing gel to make sure it doesn't hurt.

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

If you are breastfeeding

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

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

Who pays for the study?

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

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

Consent form for the First Foods NZ study

Please tick to show you consent to the following		
I have read and understand the information pamphlet for volunteers in the First Foods NZ study.		
I have had enough time to decide if I want to take part in the study.		
I have had the opportunity to get friend, family, or whānau support to help me ask questions and understand the study.		
I am happy with the answers I have been given about this study and I have a copy of this consent form and the information pamphlet.		
I understand that taking part in this study is my choice and that I may withdraw from the study at any time without it affecting my health care or that of my baby.		
I consent to a blood sample being from my baby from an appropriate Labtest facility.	Yes ☐	No ☐
If I consent to a blood sample being taken from my baby: I understand that any blood that is left over after analysis will be disposed of with: a) Standard biohazard laboratory disposal ☐ OR b) An appropriate karakia ☐		
I consent to allowing the researchers to access information about my child's growth and dental health from their "B4 School Check" when they are about four years old. I understand that this means they will need to access my baby's National Health Index (NHI) number.	Yes ☐	No ☐
If I decide to withdraw from the study, I agree that the information collected about me up to the point when I withdraw may continue to be processed.	Yes ☐	No ☐

[PTO]

I consent to my baby's GP being informed about any significant abnormal results from their iron blood test. Name of GP ..... Address or Name of GP's practice		
I consent to a dentist or dental therapist being informed about any significant abnormal results from my baby's teeth check. Name of my preferred dentist or dental therapist ..... Address or Name of practice		
I don't have a preferred dentist or dental therapist so if there are any significant abnormal results from my baby's teeth check please refer my baby to my local Community Oral Health Service (a free service).	Yes ☐	No ☐
I understand that taking part in this study is confidential and that no material which could identify me, or my baby, will be used in any reports on this study.		
I understand the ACC provisions in case of injury during the study.		
I know who to contact if I have questions about the study.		
I understand my responsibilities as a volunteer taking part in the study.		
I wish to receive a summary of the results from the study when the study is finished and will keep the researchers informed if my address changes.	Yes ☐	No ☐
I am happy for the data collected in this study to be used in future research on topics related to this study.	Yes ☐	No ☐
I am happy to be contacted in the future to see if I might be interested in taking part in other related studies.	Yes ☐	No ☐

[PTO]

Declaration by participant:

I hereby consent to take part in this study.

Participant's name: _____

Signature: _____ Date: _____

Declaration by member of research team:

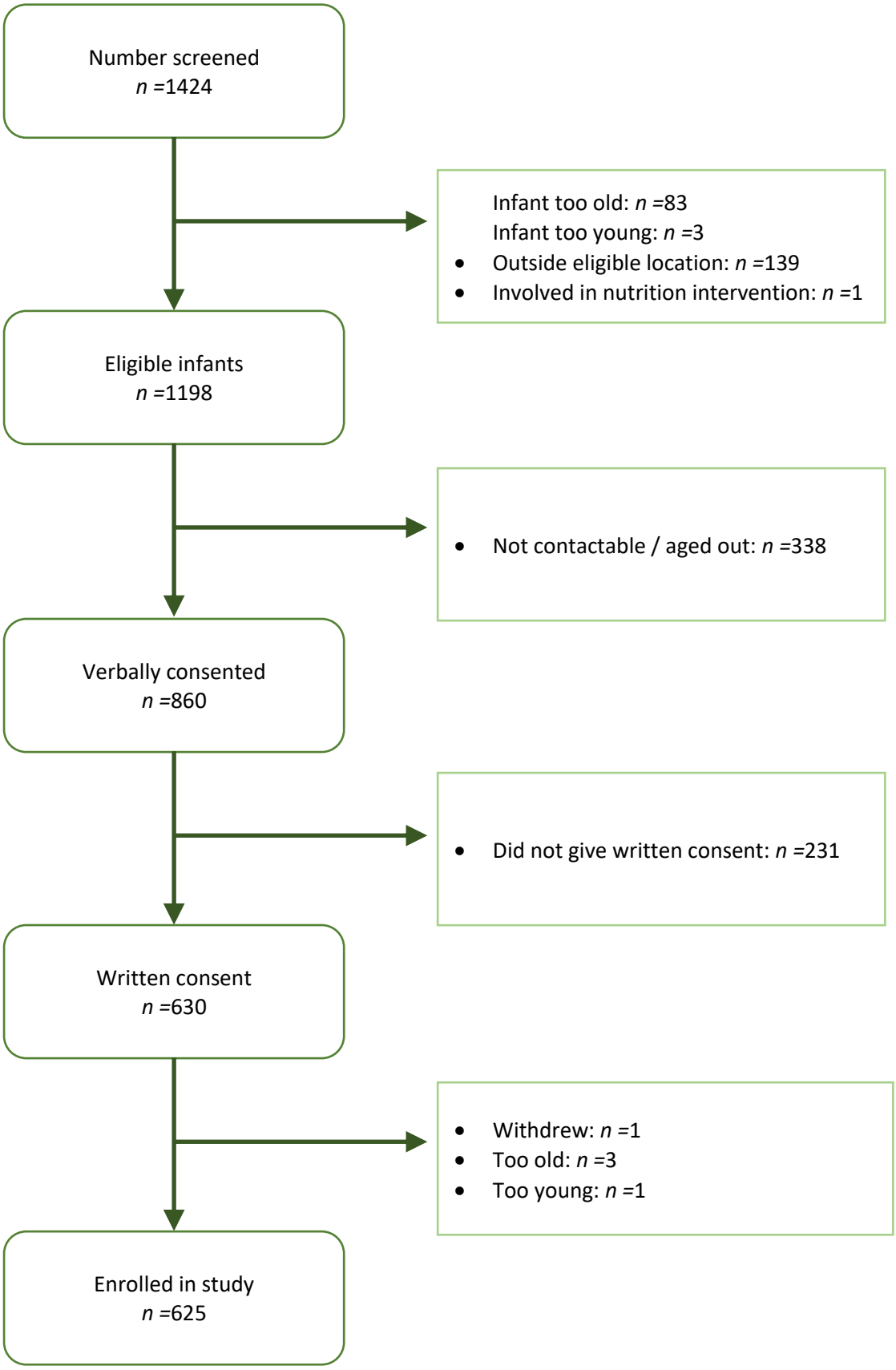
I have given a verbal explanation of the research project to the participant, and have answered the participant's questions about it.

I believe that the participant understands the study and has given informed consent to participate.

Researcher's name: _____

Signature: _____ Date: _____

Appendix C: Flowchart of Participants for First Foods New Zealand



Office use only

Date:

Code:

Main Questionnaire (first visit)

Welcome and thank you for being part of the FFNZ Study.
This questionnaire is split into 10 sections and should take about 20 minutes to complete.
Please answer every question - *there are no right or wrong answers.*
Please ask the researchers if you have any questions – **thank you for your time**.

Section 1: Some questions about you

1. How are you related to this baby?

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

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

3. What is today's date? _____ / _____ / _____ (day / month / year)

Section 2: Some questions about your pregnancy and baby

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

- ☐ Yes Please describe: _____
- ☐ No

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

- ☐ Yes
- ☐ No

If answer is 'No' – skip [medication Qs]; go to ***Question 8***

5a. What was the name of the prescribed medication? ("Medication 1")

_____

5b. When was this prescribed medication taken? *Please select <u>all</u> that apply*.

- ☐ First trimester
- ☐ Second trimester
- ☐ Third trimester

6. Did you (or baby's mother) take any other prescribed medications during your pregnancy? ("Medication 2")

- ☐ Yes
- ☐ No

If answer is 'No' – skip [next Qs]

6a. What was the name of the prescribed medication?

_____

6b. When was this prescribed medication taken? *Please select <u>all</u> that apply*.

- ☐ First trimester
- ☐ Second trimester
- ■ Third trimester

7. Did you (or baby's mother) take any other prescribed medications during your pregnancy? ("Medication 3")

- ☐ Yes
- ☐ No

If answer is 'No' – skip [next Qs]

7a. What was the name of the prescribed medication?

_____

7b. When was this prescribed medication taken? *Please select <u>all</u> that apply*.

- ☐ First trimester
- ☐ Second trimester
- ■ Third trimester

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

- ☐ Forceps were used
- ☐ Caesarean birth
- ☐ Other Please describe: _____

9. When was your baby born? _____ / _____ / _____
day month year

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

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

11. Is your baby a girl or a boy?

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

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

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

13. Which ethnic group(s) does your baby belong to? *Please select all answers that apply.*

- ■ NZ European
- ■ Māori
- ■ Samoan
- ■ Tongan
- ■ Cook Island Māori
- ■ Niuean
- ■ Chinese
- ■ Indian
- ■ Other (such as Dutch, Japanese, Tokelauan). Please state: _____

14. Does your baby have any diagnosed health conditions?

- ■ Yes Please state: _____
- ■ No

Section 3: Some questions about your baby and food

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

- ■ They didn't have any breast milk
- □ Breast milk is the only drink they have had so far
- ■ Less than 1 month old
- □ 1 month old
- □ 2 months old
- □ 3 months old
- □ 4 months old
- □ 5 months old
- □ 6 months old
- □ 7 months old
- □ 8 months old
- □ 9 months old
- □ 10 months old
- □ 11 months old

If answer is 'They didn't have any breast milk' – skip [breastfeeding Q's]

16. Is baby still being breastfed?

- ■ Yes
- ■ No

If answer is 'Yes' – skip [next Q]

16a. How old was your baby when they stopped being breastfed?

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

17. Are you *currently* offering your baby any drinks other than water or breast milk?

- ■ Yes
- ■ No

If answer is 'No' – skip [next Q]

17a. What other drinks are you *currently* offering your baby? *Please select all that apply.*

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

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

- □ Yes
- ■ No

If answer is 'No' – skip [formula Q's (a-c)]

18a. How old was your baby when they first had infant formula?

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

18b. Do they still drink infant formula?

- □ Yes
- □ No

If answer is 'Yes' – skip [next Q]

18c. How old was your baby when they stopped drinking infant formula?

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

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

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

20. How old was your baby when they first had solid foods?

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

If answer is 'They haven't had solids yet' – skip [rest of solids Q's, incl. rest of section 3, section 4 & 5, and choking on food Q's]
*If answer is '6 months' – skip [double up 6-7 mo/started solids Q's (**Q21**)]*

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

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

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

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

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

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

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

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

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

24a. How old was your baby when you first tried baby-led weaning?

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

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

- ☐ Yes Please describe: _____
- ☐ No

26. When your baby was *around 6 months* of age, did they eat bought powdered infant cereal? (foods like Farex rice cereal, Only Organic baby rice)

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

If answer is 'No…' – skip [next Q]

26a. How often did they eat powdered infant cereal?

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

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

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

If answer is 'No…' – skip [next Q]

27a. How often did they eat red meat (like beef or lamb)?

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

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

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

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

_____

30. Does your baby have any known food allergies?

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

If answer is 'No' – skip [next Q]

30a. Comments (especially how these allergies were diagnosed)

_____

Section 4: Your baby and baby food pouches

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

- ☐ Yes
- ☐ No

*If the answer is 'No' – go to [pouch dislikes; **Q44**]*

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

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

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

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

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

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

If answer is 'Always on a spoon' – skip [pouch nozzle Q's: ***Q34a, Q36, Q37****]*

34a. When baby has food straight from a baby food pouch nozzle, who puts the pouch in baby's mouth?

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

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

1. Brand and flavour of baby food pouch baby eats most commonly:

_____

How often has your baby eaten this food *in the past month*?

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

2. Brand and flavour of baby food pouch baby eats second most commonly:

_____

How often has your baby eaten this food *in the past month*?

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

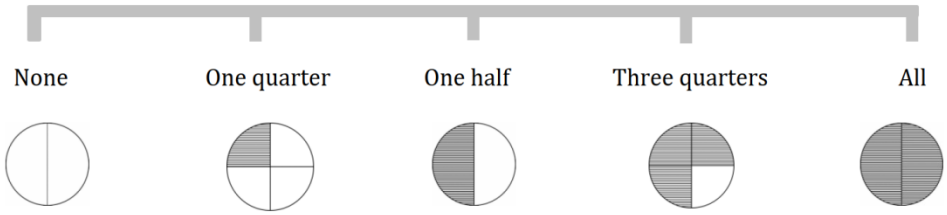
3. Brand and flavour of baby food pouch baby eats third most commonly

_____

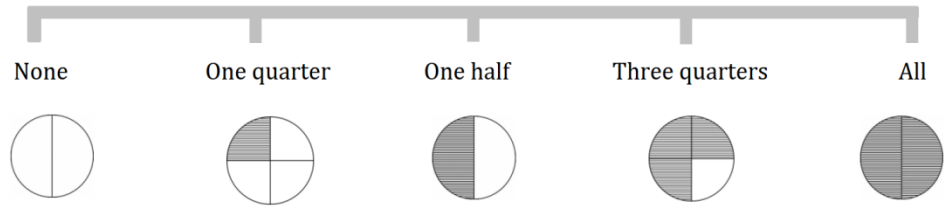
How often has your baby eaten this food *in the past month*?

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

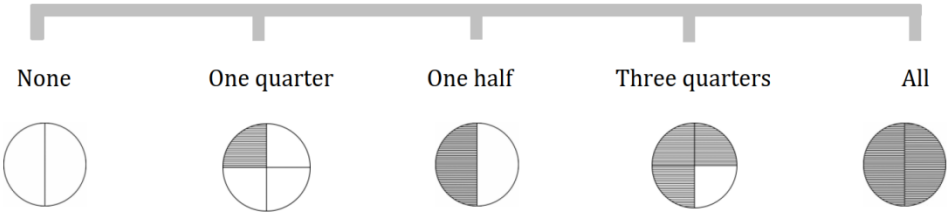
36. On the sliding scale, [*draw a line to*] show what proportion of all your baby's foods your baby eats by holding a pouch *themselves* and sucking through the nozzle:



37. On the sliding scale, [*draw a line to*] show what proportion of all your baby's foods your baby eats by *you* holding a pouch while baby sucks through the nozzle:



38. On the sliding scale, [*draw a line to*] show how much of the pouch your baby *usually* eats when offered food from a baby food pouch:



39. When baby is given food from a baby food pouch, how long does it take them to eat it?

- ☐ Less than 10 minutes
- ☐ 10 to 20 minutes
- ☐ 20 to 30 minutes
- ☐ 30 to 40 minutes
- ☐ 40 minutes or longer

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

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

41. Does baby eat from baby food pouches anywhere else? *Please select all options that apply.*

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

42. How often do you, or another adult, sit with your baby when they are eating from a baby food pouch?

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

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

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

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

- ☐ Yes Please state: ___
- ☐ No

45. When your baby first *<u>started eating solids</u>*, were they having food from baby food pouches?

- ☐ Yes
- ☐ No

46. Was your baby eating food from baby food pouches at *<u>around 6 months</u>* of age?

- ☐ Yes
- ☐ No

If answer is 'No' – skip [next Q]

46a. How often would baby eat food from a baby food pouch at *around 6 months* of age?

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

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

Children's Eating Behaviour Questionnaire – satiety responsiveness and food responsiveness subscale (Wardle); Toddler-Parent Mealtime Behavior Questionnaire – Picky eater subscale (Horodynski)

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

47. My baby gets full up easily

■	■	■	■	■
Never	Rarely	Sometimes	Often	Always

48. My baby has a big appetite

■	■	■	■	■
Never	Rarely	Sometimes	Often	Always

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

■	■	■	■	■
Never	Rarely	Sometimes	Often	Always

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

■	■	■	■	■
Never	Rarely	Sometimes	Often	Always

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

■	■	■	■	■
Never	Rarely	Sometimes	Often	Always

52. My baby eats slowly

■ Never ■ Rarely ■ Sometimes ■ Often ■ Always

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

■ Never ■ Rarely ■ Sometimes ■ Often ■ Always

54. My baby finishes his/her meal very quickly

■ Never ■ Rarely ■ Sometimes ■ Often ■ Always

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

■ Never ■ Rarely ■ Sometimes ■ Often ■ Always

56. My baby's always asking for food

■ Never ■ Rarely ■ Sometimes ■ Often ■ Always

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

■ Never ■ Rarely ■ Sometimes ■ Often ■ Always

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

■ Never ■ Rarely ■ Sometimes ■ Often ■ Always

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

■ Never ■ Rarely ■ Sometimes ■ Often ■ Always

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

■ Never ■ Rarely ■ Sometimes ■ Often ■ Always

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

■ Never ■ Rarely ■ Sometimes ■ Often ■ Always

62. My baby refuses vegetables

■ Never ■ Rarely ■ Sometimes ■ Often ■ Always

63. My baby is a picky eater

■ Never ■ Rarely ■ Sometimes ■ Often ■ Always

64. My baby refuses fruits

■ Never ■ Rarely ■ Sometimes ■ Often ■ Always

65. My baby accepts new foods

■ Never ■ Rarely ■ Sometimes ■ Often ■ Always

Please add any comments here if you wish:

_____

Section 6: Some questions about your baby's health

66. Does your baby currently have reflux?

- ■ Yes
- ■ No

If answer is 'No' – skip [next Q]

66a. Does this change how or what you feed them?

- ■ Yes Please describe: _____
- ■ No

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

- ■ Yes If yes, how many times? _____
- ■ No

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

- ■ Yes If yes, how many times? _____
- ■ No

*If answer is 'No' – skip [choking on food Q's; go to **Section 7**]*

68a. Thinking of the most serious choking episode (on food) which of the following did your baby do? *Choose as many as apply.*

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

68b. Thinking again of the most serious choking episode (on food), which of the following happened? *Choose as many as apply.*

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

68c. Thinking again of the most serious choking episode (on food), what was the food responsible?

_____

68d. Thinking again of the most serious choking episode (on food), what form was the food in?

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

68e. Thinking again of the most serious choking episode (on food), who fed the baby the food that was responsible?

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

68f. How old was your baby when this incident happened?

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

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

- ■ Yes If yes, how many times? _____

- No

*If answer is 'No' – skip [choking on pouch Q's; go to **Section 7**]*

69a. Was the most serious choking episode (on food from a baby food pouch) the same as an incident you described above?

- Yes
- No

*If answer is 'Yes' – skip [choking on pouch Q's; go to **Section 7**]*

69b. Thinking of the most serious choking episode (on food from a baby food pouch) which of the following did your baby do? *Choose as many as apply.*

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

69c. Thinking again of the most serious choking episode (on food from a baby food pouch), which of the following happened? *Choose as many as apply.*

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

69d. Thinking again of the most serious choking episode (on food from a baby pouch), who fed the baby the food that was responsible?

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

69e. How old was your baby when this incident happened?

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

Section 7: Some questions about your baby's teeth

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

- □ My baby doesn't have any teeth in their mouth yet
- □ Birth
- □ 1 month old
- □ 2 months old
- □ 3 months old
- □ 4 months old
- □ 5 months old
- □ 6 months old
- □ 7 months old
- □ 8 months old
- □ 9 months old
- □ 10 months old
- □ 11 months old

*If answer is 'My baby doesn't have upper teeth in their top jaw yet' – skip [dental health Q's; go to **Section 8**]*

71. Do you clean your baby's teeth?

- □ Yes
- ■ No
- ■ Sometimes

If answer is 'No' – skip [next Q]

71a. How do you clean baby's teeth? (e.g., brush with a soft brush, wipe with a damp cloth)

_____

72. Do you do anything else to look after your baby's teeth?

- ☐ Yes
- ■ No

If answer is 'No' – skip [next Q]

72a. What else do you do to look after your baby's teeth?

_____

73. Do you have any concerns about your baby's teeth?

- ☐ Yes
- ■ No

If answer is 'No' – skip [next Q]

73a. What concerns do you have about your baby's teeth?

_____

Section 8: Some questions about supplements

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

- ■ Yes
- ■ No

*If answer is 'No' – skip [supplement Q's; go to **Section 9**]*

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

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

[apply skip logic as appropriate]

75a. Multivitamin and/or multimineral: How often did your baby take the supplement?

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

75b. Multivitamin and/or multimineral: Is your baby currently taking this supplement?

- ■ Yes
- ■ No

75c. Multivitamin and/or multimineral: If you know the brand name and/or the product name please write them here. Please provide as much information about the product as possible.

_____

75d. Multivitamin and/or multimineral: If you have the supplement please could the researcher take a photo of it.

[*upload photo*]

76a. Single vitamin or mineral: Please tell us what vitamin or mineral it was:

_____

[repeat option]

76b. Single vitamin or mineral: How often did your baby take the supplement?

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

76c. **Single vitamin or mineral**: Is your baby currently taking this supplement?

- ■ Yes
- ■ No

76d. **Single vitamin or mineral**: If you know the brand name and/or the product name please write them here. Please provide as much information as possible.

_____

76e. **Single vitamin or mineral**: If you have the supplement please could the researcher take a photo of it.

[*upload photo*]

77a. **Other**: How often did your baby take the supplement?

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

77b. **Other**: Is your baby currently taking this supplement?

- ■ Yes
- ■ No

77c. **Other**: If you know the brand name and/or the product name please write them here. Please provide as much information as possible.

_____

77d. **Other**: If you have the supplement please could the researcher take a photo of it.

[*upload photo*]

Section 9: Some questions about food security

Please read the following statements and select the answer most appropriate to how you feel.

78. I/we can afford to eat properly

- Often
- Sometimes
- Never

79. Food runs out in my/our household due to lack of money

- Often
- Sometimes
- Never

80. I/we eat less because of lack of money

- Often
- Sometimes
- Never

81. The variety of food I am/we are able to eat is limited by a lack of money

- Often
- Sometimes
- Never

82. I/we rely on others to provide food and/or money for food for my/our household when I/we don't have enough money

- Often
- Sometimes
- Never

83. I feel stressed because of not having enough money for food

- Often
- Sometimes
- Never

84. I feel stressed because I can't provide the food I want for social occasions

- Often
- Sometimes
- Never

Section 10: Some final questions

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

85. Which ethnic group(s) do you belong to? *Please select all answers that apply.*

- ☐ NZ European
- ☐ Māori
- ☐ Samoan
- ☐ Tongan
- ☐ Cook Island Māori
- ☐ Niuean
- ☐ Chinese
- ☐ Indian
- ☐ Other (such as Dutch, Japanese, Tokelauan). Please state: _____

86. Do you currently work outside the home?

- ☐ No
- ☐ Yes – part-time
- ☐ Yes – full-time

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

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

88. How tall are you without shoes?

_____ cm *or* _____ feet and _____ inches

89. How much do you weigh?

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

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

- One
- Two
- Three
- Four or more

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

- One
- Two
- Three
- Four or more

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

- One
- Two
- Three
- Four or more

93. Is your baby regularly looked after by someone other than yourself? *Please select all answers that apply.*

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

Thank you very much for completing this questionnaire

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

- One
- Two
- Three
- Four or more

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

- One
- Two
- Three
- Four or more

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

- One
- Two
- Three
- Four or more

93. Is your baby regularly looked after by someone other than yourself? *Please select all answers that apply.*

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

Thank you very much for completing this questionnaire

First Foods Final Questionnaire

Confidential

Final Questionnaire

Thank you for continuing to be part of the First Foods New Zealand Study.

This questionnaire is split into 3 sections and takes about 20 minutes to complete.

Take your time and talk to others who also care for your baby, if needed.

Please answer every question - there are no right or wrong answers.

Please ask the researchers if you have any questions - our contact details are included in the email.

Thank you for your time.

Date [*DATA REMOVED*]

How are you completing this survey?

◯ Phone ⊗ Computer ◯ Laptop ◯ Tablet

Is your baby younger than 9.0 months old?

◯ Yes
⊗ No

Section 1: Activities Child oral and motor proficiency scale (ChOMPS)

We are interested in what your baby can do at the moment, which may be different from what they are willing to do.
Your baby may be too young to do some of the skills - in that case, please tick "Not Yet".
Please ask the researcher if you aren't sure how to answer any of the questions.

Part 1: Movement patterns I

My baby can...

		Yes	Sometimes	Not yet
1	stand without holding on to anything	○	○	○
2	walk 10-20 steps by himself/herself	○	○	○
3	run 10-20 steps without falling	○	○	○
4	walk up 2-3 stairs holding on to someone or something	○	○	○
5	walk up 2-3 stairs without holding on to someone or something	○	○	○
6	walk down 2-3 stairs holding on to someone or something	○	○	○
7	walk down 2-3 stairs without holding on to someone or something	○	○	○
8	jump with both feet without holding on to anything	○	○	○

My baby can...

		Yes	Sometimes	Not yet
9	drink from an open cup held by an adult with no or little spilling of liquid from mouth	○	○	○
10	hold an open cup and drink by himself/herself with no or little spilling of liquid from mouth	○	○	○
11	keep tongue in mouth when drinking from an open cup (held by self or an adult)	○	○	○
12	drink from an open cup holding rim with lips (not biting rim with teeth)	○	○	○
13	use a filled spoon or fork to bring food to mouth	○	○	○
14	can scoop food onto a spoon or fork and bring to mouth	○	○	○
15	use a fork to stab a piece of food and bring to mouth	○	○	○
16				

	use tongue to lick food off top lip	○	○	○

My baby can...

		Yes	Sometimes	Not yet
17	use tongue to lick food from corners of mouth	○	○	○
18	use upper teeth or lip to clean food from bottom lip	○	○	○
19	pucker lips to kiss or blow	○	○	○
20	drink from a straw	○	○	○
21	take a bite of hard, crunchy food, such as a carrot stick	○	○	○
22	eat hard, crunchy food, such as a raw carrot stick, without gagging, coughing, or choking	○	○	○
23	speak using words that people outside our family can understand	○	○	○

Part 2: Movement patterns II

My baby can...

		Yes	Sometimes	Not yet
24	hold head up when lying on tummy	○	○	○
25	pull up to stand	○	○	○
26	stand holding on to something (such as, a table or couch)	○	○	○
27	walk holding on to someone or something	○	○	○
28	support weight on forearms when lying on tummy	○	○	○
29	bring one or both hands to mouth	○	○	○
30	hold a toy in hand	○	○	○
31	bring a toy or piece of food to mouth	○	○	○

My baby can...

		Yes	Sometimes	Not yet
32	hold a bottle or sippy cup	○	○	○
33	bring a bottle or sippy cup to mouth	○	○	○
34	roll over from tummy to back	○	○	○
35	use fingers like a rake to bring food or a toy towards self	○	○	○
36	grasp a piece of food between thumb and another finger (such as, pick up a pea)	○	○	○
37	move a toy or a piece of food from one hand to the other	○	○	○
38	roll over from back to tummy	○	○	○
39	keep head steady when in a supported position (such as, with back against a chair or while being held)	○	○	○

My baby can...

		Yes	Sometimes	Not yet
40	sit upright with support (such as, sit with back against a chair or while being held)	○	○	○
41	sit upright without support	○	○	○
42	twist body to their left and right while sitting without support (such as, to reach for a toy or look at something)	○	○	○
43	crawl when placed on tummy	○	○	○

Part 3: Oral-motor coordination

My baby can...

		Yes	Sometimes	Not yet
44	use tongue to move food around in mouth	○	○	○
45	keep solid food in mouth when eating	○	○	○
46	keep tongue in mouth when food is offered on a spoon	○	○	○
47	move jaw up and down to chew	○	○	○
48	drink thin liquids, such as water or juice, without gagging, coughing, or choking	○	○	○
49	take a bite of soft food, such as a muffin or banana	○	○	○
50	take a bite of firm food, such as a cracker or biscuit	○	○	○
51	eat a spoonful of smooth food, such as a baby food or yogurt, without gagging, coughing, or choking	○	○	○

My baby can...

		Yes	Sometimes	Not yet
52	eat food that dissolves, such as a baby puff, without gagging, coughing, or choking	○	○	○
53	eat soft food, such as a pancake, without gagging, coughing, or choking	○	○	○
54	eat textured food, such as coarse oatmeal, without gagging, coughing, or choking	○	○	○
55	eat textured food with some lumps, such as a lightly mashed banana, without gagging, coughing, or choking	○	○	○
56	eat firm food, such as a peeled slice of apple, without gagging, coughing, or choking	○	○	○

57

eat chewy food, such as a piece of sausage, without gagging, coughing, or choking	○	○	○

Part 4: Oral-motor skills

My baby can...

		Yes	Sometimes	Not yet
58	close lips completely	○	○	○
59	move tongue inside mouth from side to side	○	○	○
60	stick tongue out past teeth or gums	○	○	○
61	open mouth wide enough to accept a spoon	○	○	○
62	bite down so that teeth or gums touch	○	○	○
63	move chin down to chest	○	○	○

64 If you would like to explain any of your answers or provide more information, please do so here:

Section 2: Sustainability

Please indicate your strength of agreement with each of the following statements:

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
65	The balance of nature is very delicate and easily upset by human activities	○	○	○	○	○
66	The earth is like a spaceship with only limited room and resources	○	○	○	○	○
67	Plants and animals do not exist primarily for human use	○	○	○	○	○
68	Modifying the environment for human use seldom causes serious problems	○	○	○	○	○
69	There are no limits to growth for nations like Australia and New Zealand	○	○	○	○	○
70	People are created to rule over the rest of nature	○	○	○	○	○

71 Please choose how important the following are when deciding what to feed your baby:

		Not at all important	A little important	Moderately important	Very important
71a	Baby enjoys	○	○	○	○
71b	Convenience	○	○	○	○
71c	Cost	○	○	○	○
71d	Environmental sustainability	○	○	○	○
71e	Health	○	○	○	○
71f	Nutritional value	○	○	○	○
71g	Organic	○	○	○	○
71h	Preservative free	○	○	○	○

Please choose how environmentally sustainable you think each of the following is as a way to feed your baby:

		Not at all sustainable	A little sustainable	Moderately sustainable	Very sustainable
72a	Can	○	○	○	○
72b	Glass jar	○	○	○	○
72c	Home-made food not in a pouch	○	○	○	○
72d	Pouch bought with food inside	○	○	○	○
72e	Reusable pouch with home-made food inside	○	○	○	○

Section 3: Eating behaviours Pediatric Eating Assessment Tool (PediEAT)

The items in this section may not apply to every child. When filling this out, think about what is typical for your child at the moment.

Part 1: Physical

My child...

		Never	Almost Never	Sometimes	Often	Almost Always	Always
73	gets watery eyes when eating	○	○	○	○	○	○
74	gets red colour around eyes or face when eating	○	○	○	○	○	○
75	coughs during or after eating	○	○	○	○	○	○
76	sounds gurgly or like they need to cough or clear their throat during or after eating	○	○	○	○	○	○
77	sounds different during or after a meal (for example, voice becomes hoarse, high-pitched, or quiet)	○	○	○	○	○	○
78	chokes or coughs on water or other thin liquids	○	○	○	○	○	○
79	moves head down toward chest when swallowing	○	○	○	○	○	○
80	has food or liquid come out of nose when eating	○	○	○	○	○	○

My child...

		Never	Almost Never	Sometimes	Often	Almost Always	Always
81	gets pale or blue colour around his/her lips during meals	○	○	○	○	○	○
82	breathes faster or harder when eating	○	○	○	○	○	○
83	needs to take a break during the meal to rest or catch their breath	○	○	○	○	○	○
84	gets tired from eating and is not able to finish	○	○	○	○	○	○
85	sweats/gets clammy during meals	○	○	○	○	○	○
86	tilts head back while eating	○	○	○	○	○	○
87	burps more than usual while eating	○	○	○	○	○	○
88	throws up during mealtime	○	○	○	○	○	○

My child...

		Never	Almost Never	Sometimes	Often	Almost Always	Always
89	throws up between meals (from 30 minutes after the last meal until the next meal)	○	○	○	○	○	○
90	arches back during or after meals	○	○	○	○	○	○
91	gags when it is time to eat (for example, when they see food or when placed in high chair)	○	○	○	○	○	○
92	gags with smooth foods like pudding	○	○	○	○	○	○

		My child isn't offered textured food	Never	Almost Never	Sometimes	Often	Almost Always	Always
93	gags with textured food like coarse oatmeal	○	○	○	○	○	○	○

		Never	Almost Never	Sometimes	Often	Almost Always	Always
94	gags, coughs, or vomits when brushing teeth Note: If your child does not have teeth, select Never. If your child will not allow you to brush his/her teeth, select Always	○	○	○	○	○	○
95	gets a bloated tummy after eating	○	○	○	○	○	○
96	turns red in face, may cry with pooing	○	○	○	○	○	○

My child...

		Never	Almost Never	Sometimes	Often	Almost Always	Always
97	has gas	○	○	○	○	○	○
98	drools when eating	○	○	○	○	○	○
99	has a hard time eating due to stuffy nose	○	○	○	○	○	○

100 If you would like to explain any of your responses, please do so here:

Part 2: Mealtime behaviours

My child...

		Never	Almost Never	Sometimes	Often	Almost Always	Always
101	avoids eating by playing or talking	○	○	○	○	○	○
102	has to be told to start eating	○	○	○	○	○	○
103	has to be reminded to keep eating	○	○	○	○	○	○
104	won't eat at meals, but wants food later	○	○	○	○	○	○
105	stops eating after a few bites	○	○	○	○	○	○
106	refuses to eat	○	○	○	○	○	○
107	shows more stress during meals than during non-mealtimes (whines, cries, gets angry, tantrums)	○	○	○	○	○	○
108	likes something one day and not the next	○	○	○	○	○	○

My child...

		Never	Almost Never	Sometimes	Often	Almost Always	Always
109	insists on food being offered in a certain way (such as, how food is on the plate or what dish or spoon is used, or where they sit)	○	○	○	○	○	○
110	insists on being fed by the same person(s)	○	○	○	○	○	○
111	becomes upset by the smell of food	○	○	○	○	○	○
112	throws food or pushes food away	○	○	○	○	○	○
113	prefers to drink instead of eat	○	○	○	○	○	○

		My child isn't offered crunchy foods	Never	Almost Never	Sometimes	Often	Almost Always	Always
114	prefers crunchy foods	○	○	○	○	○	○	○

	Never	Almost Never	Sometimes	Often	Almost Always	Always
115 eats better when entertained	○	○	○	○	○	○
116 takes more than 30 minutes to eat	○	○	○	○	○	○

My child...

	Never	Almost Never	Sometimes	Often	Almost Always	Always
117 needs mealtime to be calm	○	○	○	○	○	○
118 wants the same food for more than two weeks in a row	○	○	○	○	○	○
119 likes to eat	○	○	○	○	○	○
120 eats a variety of foods (fruits, vegetables, proteins, etc.)	○	○	○	○	○	○
121 is willing to stay seated during mealtime	○	○	○	○	○	○
122 opens their mouth when food is offered	○	○	○	○	○	○
123 is willing to touch food with their hands	○	○	○	○	○	○

124 If you would like to explain any of your answers, please do so here:

Part 3: Eating

My child...

		My child isn't offered mixed texture foods	Never	Almost Never	Sometimes	Often	Almost Always	Always
125	will eat mixed texture foods	○	○	○	○	○	○	○

		Never	Almost Never	Sometimes	Often	Almost Always	Always
126	will eat food warmer than room temperature	○	○	○	○	○	○
127	is willing to feed self (if younger in age, holds cup, feeds self crackers)	○	○	○	○	○	○
128	keeps food in mouth when eating (food means non-liquids)	○	○	○	○	○	○
129	keeps liquids in mouth when drinking	○	○	○	○	○	○
130	keeps their tongue inside mouth during eating	○	○	○	○	○	○
131	acts hungry before meals	○	○	○	○	○	○

My child...

		My child isn't offered this	Never	Almost Never	Sometimes	Often	Almost Always	Always
132	will eat foods that need to be chewed	○	○	○	○	○	○	○
133	will eat textured food like coarse oatmeal	○	○	○	○	○	○	○
134	will eat frozen food, like ice cream	○	○	○	○	○	○	○

My child...

		My child isn't offered chewable food	Never	Almost Never	Sometimes	Often	Almost Always	Always
135	chews their food enough	○	○	○	○	○	○	○

	Never	Almost Never	Sometimes	Often	Almost Always	Always
136 moves food in their mouth when chewing without help	○	○	○	○	○	○
137 sniffs food or objects	○	○	○	○	○	○
138 spits food out	○	○	○	○	○	○
139 eats too fast	○	○	○	○	○	○

140 If you would like to explain any of your responses, please do so here:

Part 4: Oral processing

My child...

		Never	Almost Never	Sometimes	Often	Almost Always	Always
141	stores food in their cheek or roof of mouth	○	○	○	○	○	○
142	gets food stuck in their cheek or roof of mouth	○	○	○	○	○	○

		My child has only ever been offered smooth foods	Never	Almost Never	Sometimes	Often	Almost Always	Always
143	prefers smooth foods like yogurt	○	○	○	○	○	○	○

		Never	Almost Never	Sometimes	Often	Almost Always	Always
144	puts too much food in mouth at one time	○	○	○	○	○	○
145	puts fingers in mouth to move food	○	○	○	○	○	○
146	prefers strong flavours	○	○	○	○	○	○
147	bites down on the spoon or fork and does not release it easily	○	○	○	○	○	○
148	grinds teeth when awake Note: If your child does not have teeth, please select Never	○	○	○	○	○	○
149	chews on toys, clothes, or other objects	○	○	○	○	○	○

My child...

		My child isn't offered chewable foods	Never	Almost Never	Sometimes	Often	Almost Always	Always
150	has to be reminded to chew food	○	○	○	○	○	○	○
151	sucks on food to soften or moisten it, rather than chewing it	○	○	○	○	○	○	○
152	chews food but doesn't swallow it	○	○	○	○	○	○	○
153	chews a bite of food for a long time (~30 seconds or longer)	○	○	○	○	○	○	○

154 If you would like to explain any of your responses, please do so here:

P-35: Communicating feeding assessment results indicating risk of swallowing difficulties and risk of aspiration

Study:	FFNZ	*Version number:*	Version 4
Prepared by:	EJ, CC, ALH, NM	*Date prepared:*	11 Feb 2021

Objectives

- Identify answers to Pedi-EAT and ChOMPS scales in the Final Questionnaire indicating ongoing referral
- Communicate these results to the participant and participant's GP.

Equipment

Protocols	**P-35: Communicating feeding assessment results indicating risk of swallowing difficulties and risk of aspiration** – *this protocol*
Documents	**O-40a: Feeding assessment results – Letter to GP** **O-40b: Feeding assessment results – Letter to participant** **O-7a: Participant Information Pamphlet (for mail)** **O-7a: Participant Information Pamphlet (for email)** Massey University letterhead
Equipment	Laptop with access to REDCap

Steps

1. Emily Jones, PhD candidate and speech-language therapist to review REDCap weekly.

2. **Identify concerning results:**
   - **a. Pedi-EAT assessment**
   - ALWAYS, ALMOST ALWAYS to any of the following:
     - Question 3. Coughs during or after feeding
     - Question 6: Chokes or coughs on water
     - Question 9: Gets pale or has a blue colour around his/her lips during meals.
   - **b. ChOMPS assessment**
   - NOT YET to the following:
     - Question 48: Drinks thin liquids such as water or juice without gagging, coughing or choking.

3. Emily will email a letter to the participant and email and post a letter to the GP.

4. Prepare letters for the participant and GP using the letter templates.
   - **a.** Dropbox>FFNZ>Protocols>
     - Letter to GP template (see **O-32a: Feeding assessment results – Letter to GP**)
     - Letter to participant template (see **O-32b: Feeding assessment results – Letter to participant**)

Appendix G: GP Letters

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

COLLEGE OF HEALTH
TE KURA HAUORA TANGATA

Dr
Greenwood Medical Centre
641 Manukau Road
Royal Oak
Auckland, 1023

5th December, 2021

Dear Dr

Re: (DOB / /2020) child of

The University of Otago and Massey University are currently undertaking a study called the First Foods New Zealand (FFNZ) Study to investigate how infants are being introduced to solid foods and what impact this has on their nutrition and health. Please find enclosed our Information Pamphlet for Parents/Guardians, for your information.

As a part of the study we administer two parent-reported feeding skills questionnaires: "The Child Oral and Motor Proficiency Scale" (ChOMPS), and "The Pediatric Eating Assessment Tool" (PediEAT). Your patient, returned results that indicate *he* may be at risk of aspiration:

- Their parent reported in response to the question *"My child drinks thin fluids, such as, water and juice, without coughing, gagging or choking"*:
  NOT YET

His parents have been advised of the answers that have indicated a GP referral.

I am a Speech-Language Therapist (MSpchLangTher, MNZSTA) and, although I am not in a position to offer clinical care to participants in the FFNZ study, I would be happy to answer any questions you might have about our measurement tools and the possible implications of these findings.

Yours sincerely,

Emily Jones
PhD Candidate
Speech-language therapist
FFNZ Study
School of Sport, Exercise & Nutrition
Massey University
Phone (09) 414 0800 ext. 43532

Assoc Prof Anne-Louise Heath
Co-Principal Investigator
FFNZ Study
Department of Human Nutrition
University of Otago
Phone (03) 479 8379

IN CONFIDENCE

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

COLLEGE OF HEALTH
TE KURA HAUORA TANGATA

ID:

Te Manu Aute Whare Oranga - Clinic Services
Maurewa Marae
81 Finlayson Avenue
Clendon
Auckland, 2103

5th December, 2021

Dear *Te Manu Aute Whare Oranga,*

Re: (DOB / /2020) child of

The University of Otago and Massey University are currently undertaking a study called the First Foods New Zealand (FFNZ) Study to investigate how infants are being introduced to solid foods and what impact this has on their nutrition and health. Please find enclosed our Information Pamphlet for Parents/Guardians, for your information.

As a part of the study we administer two parent-reported feeding skills questionnaires: "The Child Oral and Motor Proficiency Scale" (ChOMPS), and "The Pediatric Eating Assessment Tool" (PediEAT). Your patient, , returned results that indicate *[He/she]* may be at risk of aspiration:

- Their parent reported in response to the question *"My child coughs and chokes on water": Almost always*

Her parents have been advised of the answers that have indicated a GP referral.

I am a Speech-Language Therapist (MSpchLangTher, MNZSTA) and, although I am not in a position to offer clinical care to participants in the FFNZ study, I would be happy to answer any questions you might have about our measurement tools and the possible implications of these findings.

Yours sincerely,

Emily Jones
PhD Candidate
Speech-language therapist
FFNZ Study
School of Sport, Exercise & Nutrition
Massey University
Phone (09) 414 0800 ext. 43532

Assoc Prof Anne-Louise Heath
Co-Principal Investigator
FFNZ Study
Department of Human Nutrition
University of Otago
Phone (03) 479 8379

IN CONFIDENCE

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

COLLEGE OF HEALTH
TE KURA HAUORA TANGATA

ID =

Dunedin, 9018

5th December, 2021

Dear and

Thank you very much for taking part in the First Foods New Zealand (FFNZ) study and for completing the Final Questionnaire. We have now received the results back from this, and although most of the results were as expected, one or more of the answers indicated that your child may be at risk of breathing in food and drink when they are eating and drinking. We have come to that conclusion because you reported that your child, *almost always coughs during or after feeding.*

We are not able to provide clinical advice so we advise you to contact your General Practitioner with this letter to discuss the results. We have sent a letter to Dr from *Albany Street Medical Centre* as provided on your Consent form for the study.

If you would like to discuss anything to do with the FFNZ study, please feel free to call us (contact details below). Thank you very much again for taking part in the FFNZ study.

Yours sincerely,

Emily Jones
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TE KURA HAUORA TANGATA

Corstorphine
Dunedin, 9012

5th December, 2021

Dear and

Thank you very much for taking part in the First Foods New Zealand (FFNZ) study and for completing the Final Questionnaire. We have now received the results back from this, and although most of the results were as expected, one or more of the answers indicated that your child may be at risk of breathing in food and drink when they are eating and drinking. We have come to that conclusion because you reported that your child *doesn't yet drink thin liquids such as water or juice without gagging, coughing or choking.*

We are not able to provide clinical advice so we advise you to contact your General Practitioner with this letter to discuss the results. We have sent a letter to Dr from *Dunedin South Medical Centre* as provided on your Consent form for the study.

If you would like to discuss anything to do with the FFNZ study, please feel free to call us (contact details below). Thank you very much again for taking part in the FFNZ study.

Yours sincerely,

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