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Variety and Frequency of Fruit and Vegetables Eaten by Young New Zealand Children

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

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Abstract

Background: Habitually consuming a variety of fruit and vegetables (FVs) is vital for healthy physical and neurocognitive development in children. High FV variety is positively associated with increased fibre and micronutrient intake. Despite amassing evidence relating health benefits to FV intake and variety in the early stages of life, little is known about the frequency and variety of FVs that young children in Aotearoa New Zealand (NZ) consume.

Aims and objectives: The overall aim of this study was to explore FV intake in the diets of young NZ children aged 1-4 years. The primary objective was to describe the frequency and variety of FV consumption. The secondary objective was to explore socioeconomic factors associated with the frequency and variety of FV consumed in NZ children.

Methods: This study is an observational cross-sectional study utilising data from the Young Foods New Zealand study. Dietary and socioeconomic data from 289 children aged 1-4 years was collected through two 24-hour dietary recalls and a questionnaire. Dietary data were analysed using FoodWorks nutrient analysis software based on the New Zealand food composition database. Independent t-tests and one-way ANOVAs determined differences between variety scores and demographic characteristics.

Results: Bananas (71%) and carrots (49%) were the fruits and vegetables consumed by the highest proportion of participants. Leafy greens was the vegetable subgroup consumed the least (20.8%). The fruit variety score (FVS), vegetable variety score (VVS) and fruit and vegetable variety score (FVVS) achieved by the highest number of children was three (22%), four (15%) and nine (15%), respectively. Children's ethnicities influenced fruit variety score (FVS) ($F[3, 284] = 5.42$, p=0.001), vegetable variety score (VVS) ($F[3, 285] = 6.09$, $p < 0.001$) and FV variety score (FVVS) ($F[3, 285] = 8.95$, $p < 0.001$). Variety scores increased with lower number of children in a household. Variety scores were also inversely associated with household deprivation levels. Respondents (i.e., a parent or caregiver) being on unpaid parental leave resulted in the highest variety scores (FVS= 4.77, VVS= 4.91, FVVS=10.55). Regarding the respondent's education level, those who went to university cared for children with the highest variety scores (FVS = 3.75, VVS = 4.81, FVVS = 9.33).

Conclusion: All socioeconomic factors measured influenced children's FV variety scores in some way. Results regarding the most frequently consumed FVs were similar to that of past literature. The results from this study provide a picture of what FVs young children in Aotearoa NZ are consuming and suggest that the relationship between FV consumption and socioeconomic factors warrants further investigation.

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List of Abbreviations

Abbreviation	Definition
24HR	24-hour recall
ANOVA	Analysis of variance
AR	Adjusted Ratio
BRCA	Breast Cancer gene
CHD	Coronary heart disease
CI	Confidence interval
CNS02	2002 National Children's Nutrition Survey
COVID-19	Coronavirus disease of 2019
CVD	Cardiovascular disease
DNA	Deoxyribonucleic acid
ESPGHAN	European Society for Paediatric Gastroenterology, Hepatology, and Nutrition
FAO	Food and Agriculture Organization
FFNZ	First Foods New Zealand
FV	Fruits and vegetables
FVS	Fruit variety score
FVVS	Fruit and vegetable variety score
GUiNZ	Growing Up in New Zealand
IQ	Intelligence quotient
MOH	Ministry of Health
MPI	Ministry for Primary Industries
MSM	Multiple Source Method
NHS	National Health Service
NZ	New Zealand
NZDEP	NZ Index of Deprivation
OECD	Organisation for Economic Co-operation and Development
PPE	Personal protective equipment
SD	Standard deviation
SES	Socioeconomic status
T2DM	Type II Diabetes Mellitus
UK	United Kingdom
USA	United States of America
VVS	Vegetable variety score
WHO	World Health Organization
YFNZ	Young Foods New Zealand

Chapter 1. Introduction

1.1 Background

The nutrition that young children receive greatly influences their growth and development. Food eaten provides the energy and nutrients needed for brain, organ, muscle and immune system development (Askari et al., 2021). Compared to adults, children require more nutritious food in proportion to their size (Raymond and Marrow, 2021). Young children are vulnerable to malnutrition. While malnutrition can cause wasting and stunting of physical development, poor nutrition during childhood can also have significant health consequences including behavioural issues, obesity, cognitive impairment, and poor school performance (Raymond and Marrow, 2021, Florence et al., 2008). The roots of chronic diseases such as cardiovascular disease, cancer, diabetes, and obesity can be established during childhood (Raymond and Marrow, 2021). Furthermore, eating habits and lifestyle behaviours developed in infancy and early childhood can track to later in childhood (Lioret et al., 2015, Wall et al., 2013), adolescence (Emmett et al., 2015), and adulthood (Marshall et al., 2014, Lipsky et al., 2015).

Fruit and vegetables (FV) are rich in micronutrients and bioactive substances and provide substantial quantities of carbohydrates and dietary fibre. It is recommended to consume a variety of minimally processed FVs to support optimal health, and disease prevention (Ministry of Health, 2012, Mennella et al., 2008, Marshall et al., 2020). Eating a variety of FVs (that is, consuming different foods of the FV food group, such as apples and bananas, or lettuce and spinach) is beneficial through providing exposure to a range of nutrients, making it easier to achieve nutritional adequacy (Marshall et al., 2020). In children, eating a greater variety of vegetables has been shown to improve growth and micronutrient status, and has been associated with high dietary quality (Ramsay et al., 2017, Rush et al., 2019, Arimond and Ruel, 2004). Repeated exposure to FVs and a variety of flavours during the first years of life can also increase childhood acceptance of FVs (Gerritsen et al., 2017, Mennella et al., 2008, Bucher et al., 2014, Rapson et al., 2022).

1.2 Purpose of the study

The NZ Health Survey provides annual data regarding what children in Aotearoa New Zealand (NZ) eat, such as the percentage meeting FV recommendations, eating breakfast or frequently drinking fizzy drinks (Ministry of Health, 2021a). However, currently, little data details the level of variety in the FVs children eat. The 2002 National Children's Nutrition Survey (CNS02) reported the most commonly consumed FV, but FV variety was not explored in this two-decade-old survey (Parnell et al., 2003). Since this time, the food supply has changed, as have dietary behaviours. In high-income

countries, processed foods have increasingly become a significant, and in some cases the only, source of dietary energy (Baker et al., 2020). This may be a concern due to processed foods displacing unprocessed or minimally processed foods in the diet, and associated fibre and nutrients. We know little about what FV young children are eating, nor socio-demographic factors that may influence the FVs children do or do not consume. Factors known to influence children's diets include age, ethnicity, and level of deprivation (Aemro et al., 2013, Arimond and Ruel, 2004, Barros et al., 2019, Di Noia and Byrd-Bredbenner, 2014, Eicher-Miller and Zhao, 2018, Hanson and Connor, 2014, Rasmussen et al., 2006). Having comprehensive knowledge about FV intake will allow the Ministry of Health (MOH), health professionals, and Well Child providers to formulate impactful guidelines around children's eating habits, focusing on factors that influence adequate FV intake and variety. Additionally, understanding how geographical deprivation affects FV consumption is required to provide specialised support for children who may need it most. The current study therefore aimed to fill the knowledge gaps on the frequency and variety of FVs eaten by Aotearoa NZ's young children and explore factors that may influence this variety.

1.3 Aim and objectives

The overall aim of this study was to explore FV intake in the diets of young NZ children aged 1-4 years. The primary objective was to describe the frequency and variety of FV consumption. The secondary objective was to explore socioeconomic factors associated with frequency and variety of FV consumed in NZ children.

1.4 Thesis structure

Chapter 1 explains the research's purpose, goals, objectives, and justification. Chapter 2 reviews the literature on the fundamental influences that FV consumption and variety have on children's health trajectory. This leads to a discussion on the challenges associated with assessing dietary intake in young children, and what is currently known about FV intake and variety in young children. Chapter 3 is the research study, presented as a manuscript for publication. Finally, Chapter 4 discusses the study's findings and how they connect to existing knowledge in the field, as well as future research recommendations. Supplementary appendices include the dietary assessment tools used in the study and additional supplementary results not included in the manuscript.

1.5 Researcher's contributions

Table 1.0 Summary of researcher's contributions to the study

Author	Contribution to study
Grace Laws MSc Nutrition and Dietetic candidate	Primary author of the thesis. Involved in data analysis for the primary study 'Young Foods New Zealand' and writing the literature review, analysing statistics, and interpreting results.
Professor Cathryn Conlon Primary Academic Supervisor	Academic supervisor. Directed notes to literature review. Advised about data analysis and assisted in the dissemination of the study. Reviewed and approved thesis chapters and manuscript.
Professor Pam von Hurst Co-Supervisor	Co-supervisor. Directed notes to literature review. Advised about data analysis and assisted in the dissemination of the study. Reviewed and approved thesis chapters and manuscript.
Associate Professor Kathryn Beck Co-Supervisor	Co-supervisor. Directed notes to literature review. Advised about data analysis and assisted in the dissemination of the study. Reviewed and approved thesis chapters and manuscript.
Dr Jill Haszard FFNZ Co-Investigator & Biostatistician	Analysed and cleaned data. Provided data pertinent to the thesis and advised suitable data analysis techniques.
Dr Karen Mumme Postdoctoral research fellow	Advised data analysis.

The Young Foods Research Team

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Chapter 2. Literature Review

Despite increasing evidence relating health benefits to fruit and vegetables (FV) variety and frequency of consumption, there exist large gaps in the knowledge of the specific FVs that Aotearoa NZ's children are consuming. Chapter 2 encompasses a review of the literature and key evidence regarding FV consumption, including FV variety and frequency, has been identified. Also covered are the challenges associated with assessing dietary intake in young children and what is currently known about FV variety in young children. This chapter critically analyses and summarizes pertinent information to present the necessary background and justification of this study.

2.1 Search Strategy

Literature was identified by searching the online databases Discover, Web of Science and Google Scholar. Search terms used included:

- Diversity, e.g., divers*, vari*, range*, mixture*, “diet quality”, “diet variety”, “food variety”, “diet* diversity”
- Diet, e.g., diet*, food*, nutri*, intake, “eating habit*”, “eating pattern*”, “pattern of eating”
- Fruit, e.g., fruit*
- Vegetables., e.g., vegetable*
- Deprivation, e.g., depriv*, “food security*”, “food insecurity*”, socioeconomic, “low-income”, socio*, “socioeconomic status”
- Occupation, e.g., work*, job
- Education, e.g., education, “maternal education”, “parental education”, “paternal education”, school, university, “high school”
- Family size, e.g., “family size”, “number of children”, “household size”, overcrowding
- Child, e.g., child*, toddler*, babies, baby, preschool*, “children under 5”, pediatric, paed*

Further publications were identified by manually searching reference lists of key research articles and following links to related studies. Current dietary guideline documents were found via website searches. Relevant articles were exported to EndNote X9 (The EndNote Team, 2013). These articles were limited to being published prior to December 2023 and to those published in English.

2.2 Importance of fruit and vegetable consumption

FVs are known to be rich in an array of micronutrients such as carotenoids, vitamins C and E and other food components including fibres, flavonoids, sterols, and phenols (Kushi et al., 2012). FV consumption also contributes to fibre intake, which is linked to health benefits such as improving gut

flora and reducing the risk of cardiovascular disease (CVD) (Padayatty and Levine, 2008, Pereira et al., 2004, Lairon et al., 2005). The global total mortality rate attributable to inadequate consumption of FVs has been estimated to be up to 2.635 million deaths per year (Lock et al., 2005). FV consumption is vital throughout the lifespan, however, is particularly important in the early stages of life (Knai et al., 2006). Childhood is a crucial period for growth and development, and FV intake during this time provides nutrients that support such functions (Appleton et al., 2016). FV exposure and sufficient intake in early childhood is also important in promoting preference and selection of these foods into adulthood (Eicher-Miller and Zhao, 2018, Maier-Nöth et al., 2016).

Globally, governments recommend consuming multiple servings of FVs each day, due to their recognised contribution to health. Aotearoa NZ's Ministry of Health (MOH) recommends that adults consume a varied range of foods every day, emphasising the intake of plenty of FVs (Ministry of Health, 2020). The MOH recommends toddlers aged 1-2 years consume two to three servings of vegetables, and half a serving of fruit (Ministry of Health, 2021b). For pre-schoolers (ages 2-5), the MOH recommends providing at least two servings each of FVs daily, however, this recommendation is currently being updated and is likely to increase (Ministry of Health, 2017).

2.2.1 Chronic disease risk reduction

FV consumption at a young age can help to prevent chronic disease development in multiple ways, either directly through establishing lifelong adequate FV intake (Rose et al., 2017), or through improving chronic disease risk factors and overall health (Liu, 2013). Rich concentrations of micronutrients and bioactive substances in FVs contribute to both complementary and overlapping mechanisms in the body, such as antioxidant actions, binding and diluting carcinogens in the gastrointestinal tract, assembly of detoxification enzymes, inhibition of nitrosamine formation, and modifying hormone metabolism (La Vecchia et al., 2001, Lucenteforte et al., 2008). FVs, with their high fibre concentration, may also slow carbohydrate absorption, attenuating rapid increases in blood glucose after meals, which is in itself a risk factor for CVD in adults (Oh et al., 2005). The World Health Organization (WHO) has recognised inadequate intake of FV as a factor in 14% of gastrointestinal cancer deaths, 11% of ischemic heart disease deaths, and 9% of stroke deaths globally (World Health Organization, 2013). Additionally, the WHO has placed poor FV consumption within the top 10 risks of death worldwide (World Health Organization, 2013).

Regular consumption of FVs is associated with reduced incidence of many common forms of cancer, CVD, coronary heart disease (CHD), hypertension and stroke (Garavello et al., 2008, Lucenteforte et al., 2008, Naude, 2013, Ness and Powles, 1997, Hung et al., 2004, Boeing et al., 2012, Wallace et al., 2020), many of which are major causes of death in Aotearoa NZ (Ministry of Health, 2018).

Populations consuming low levels of FVs (low in both frequency and volume) have increased incidence and mortality from cancers of the digestive tract, among other sites (La Vecchia et al., 2001). Meta-analyses of cohort studies have shown that each additional portion of FVs reduces the risk of CHD by 4% (95% CI: 0.93, 0.99) (Dauchet et al., 2006) and the risk of stroke by 5% (95% CI: 0.92, 0.99) (Dauchet et al., 2005). In other meta-analyses of cohort studies, participants eating greater than five servings of FVs per day had a 36% reduced risk of stroke (95% CI: 0.82, 0.97) (He et al., 2006) and a 17% reduced risk of CHD (95% CI: 0.77, 0.89) (He et al., 2007) compared to those eating less than three servings per day. In young people specifically, reduced FV intake is associated with signs of developing noncommunicable diseases. A study of 4,110 children and adolescents reported that those with higher C-reactive protein levels (a marker of sub-clinical inflammation and predictor of future CVD) ate significantly fewer vegetables (Qureshi et al., 2009). This association was unchanged after controlling for body composition, suggesting that the beneficial effects of vegetables may not be related to the association between obesity and inflammation (Qureshi et al., 2009). A comprehensive review of epidemiological and experimental evidence in 2015 found that FV consumption was positively linked to cardiovascular health in young people (Funtikova et al., 2015). Similarly, eight years of follow-up data from 95 children, initially 3-6 years old, reported that those who consumed more FVs during preschool years had smaller annual gains in systolic blood pressure throughout their childhood, and had lower systolic blood pressure in adolescence (Moore et al., 2005). As high blood pressure is one of five conditions of metabolic syndrome, the association between FV intake and metabolic syndrome is not unexpected. In a cross-sectional study of 4811 students aged 6-18 years, an increased frequency of consumption of FVs, alongside increased dairy consumption, decreased the risk of having metabolic syndrome [age-adjusted odds ratio (95% CI): boys: 0.8 (0.7, 0.9); girls 0.7 (0.6,0.9)] (Kelishadi et al., 2008). As with all cross-sectional studies, it cannot be concluded that FV intake causally contributed to the incidence of metabolic syndrome, however, similar associations between FV intake and metabolic syndrome have been reported in different populations (Yoo et al., 2004).

2.2.3 Improved cognition

The early childhood years are a time for rapid brain and neurocognitive development. This rapid period of development can be hindered by many factors, including poor nutrition (Bryan et al., 2004, Isaacs et al., 2008). Undernutrition at a young age can lead to impaired cognitive development and poor educational achievement which are impossible to reverse later in life (Fanjiang and Kleinman, 2007). Micronutrients, antioxidants, and phytochemicals are found in high quantities within FV and have been reported to be beneficial with respect to cognitive performance, such as sustaining visual and audial attention (Shiraseb et al., 2016, Polidori et al., 2009). A 2009 cross-sectional study of 193

adults aged 45-102 years reported cognitive performance to correlate directly with blood levels of the antioxidants α-tocopherol and lycopene, independent of many confounding variables (Polidori et al., 2009). Due to the one-time point of assessment, causality between these antioxidants found in FV and cognitive performance cannot be inferred, however, researchers concluded that the best cognitive performance was reached by those with a high daily intake of FV (Polidori et al., 2009). In a systematic review of the relationship between dietary patterns and cognitive outcomes in early childhood, Tandon et al. (2016) found preliminary evidence of a positive association between diets rich in fruits, vegetables and wholegrains before 5 years of age, and later childhood cognitive outcomes. Cognitive outcome measures that Tandon et al. (2016) included executive function, intelligence quotient (IQ), preschool academic achievement, or learning. A paucity of literature on dietary patterns and cognitive development meant that studies that Tandon et al. (2016) reviewed varied in design and measurement tools, precluding the ability to make direct comparisons between studies. Thus, while a positive association between FVs and cognitive development in early childhood is suggested, more research is required to confirm a causal relationship.

2.2.4 Body size

Global rates of overweight and obesity have tripled since 1975 and continue to rise (World Health Organization, 2021). Obesity is a concern as it is a key risk factor for many noncommunicable diseases such as type II diabetes (T2DM) (Wang et al., 2005), CVD, hypertension (Wilson et al., 2002), some cancers (Basen-Engquist and Chang, 2011, Vucenik and Stains, 2012), and premature death (Hruby et al., 2016). A systematic review of evidence from 2002-2010 found that overweight and obesity in childhood and adolescence have adverse consequences on premature mortality and physical morbidity in adulthood, particularly cardiometabolic morbidity (Reilly and Kelly, 2011). Additionally, children who are overweight and obese may face social and emotional challenges such as low self-esteem, depression and bullying (Sanderson et al., 2011). Those who are obese in childhood are more likely to maintain obesity into adolescence and adulthood (Simmonds et al., 2016). Aotearoa NZ has the third highest prevalence of adult overweight and obesity of the Organisation for Economic Co-operation and Development (OECD) countries and has held this title since 2007 (Organisation for Economic Co-operation and Development, 2017). This prevalence in adulthood will likely increase as Aotearoa NZ’s childhood overweight and obesity rates continue to increase (New Zealand Health Survey, 2021). Results from the first four years of the national B4School Check Programme (2009-2012) found that in the sample of 4-year-olds (n = 168,744), at least one in three children was either overweight or obese (Rajput et al., 2015). The prevalence of overweight or obesity was higher in Pacific and Māori children and those living in more socioeconomically deprived areas in this cross-sectional study (Rajput et al., 2015).

Multiple studies, including systemic reviews, have reported that increased intake of FVs relates to reduced risk of overweight and obesity (Boeing et al., 2012), in both adults (Buijsse et al., 2009, Mytton et al., 2014, He et al., 2004, Rolls et al., 2004) and children (Epstein et al., 2001, Ledoux et al., 2011). It should be noted that many of the reviewed studies were not specifically designed to test the relationship between FV intake and body weight and that more research is required to determine causality. A recent longitudinal study found infants (n = 910) with higher vegetable consumption were less likely to be overweight later in childhood (6 years of age) compared to those who consumed fewer vegetables (Rose et al., 2017). Similarly, a multi-centre study of children aged 6-7 years (n = 77 243) reported that those who consumed more vegetables had a lower body mass index (BMI), although weight and height were largely self-reported (Wall et al., 2018). Suggested mechanisms behind the relationship between FVs and healthy body weight include fibre in FVs reducing total food intake through satiation; or, FVs displacing energy-dense foods that are high in fat and sugar from the diet (Epstein et al., 2001, Rolls et al., 2004). More research is needed to confirm and clarify the nature of, and mechanisms for, the relationship between FVs and body weight.

2.2.5 Fruit and vegetable consumption frequency

Detail on the frequency of FV consumed, including the most and least frequently consumed, is an important aspect of understanding the eating patterns and food choices of young children. As mentioned above, FV overall intake (typically measured in grams or servings) is correlated with many benefits throughout the lifespan. However, the frequency of FV consumption alone, irrespective of quantity, has been linked to health benefits. In assessing the relationship between FV consumption and CHD, Dauchet et al. (2004) reported plasma concentrations of β-cryptoxanthin and vitamin C to be correlated with the frequency of fruit intake ($r = 0.32$, $p<0.005$ and $r = 0.33$, $p<0.004$, respectively). Likewise, the frequency of vegetable intake was correlated with plasma concentrations of α-carotene (r = 0.26, $p<0.03$), β-carotene (r = 0.29, $p<0.02$), β-cryptoxanthin (r = 0.32, $p<0.04$) and vitamin C (r = 0.24, $p<0.04$) (Dauchet et al., 2004). While the relationship between FV consumption and the reduction of obesity risk is ongoing, data from the annual Canadian Community Health Survey (n = 60,000) found that a lower frequency of FV intake was associated with a higher BMI (Colapinto et al., 2018). A 2018 study by Aotearoa NZ researchers of 77,243 children from 18 countries reported that the children who consumed vegetables three or more times a week had a lower BMI −0.079 (0.031) kg/m2 than those who never consumed vegetables. Additionally, children who consumed vegetables one to two times a week had BMI −0.057 (0.031) kg/m2 lower than those who never consumed vegetables.

Consistent with quantity, FV frequency alone has been associated with reduced heart disease risk (Dauchet et al., 2004), even in adults who smoke (Dauchet et al., 2010). Finally, the frequency of consumption of FV at 1 year of age has been found to relate to increased intake of FV at 2 years (Gregory et al., 2011).

2.2.6 Future fruit and vegetable consumption

Because FV intake in early life can impact FV intake throughout the lifespan (Rose et al., 2017, Mikkilä et al., 2005, Caton et al., 2014), offering plenty of FVs to young children is encouraged (Fewtrell et al., 2017). However, cross-culturally, vegetables are the food that children find most difficult to like and accept, as they can be bitter (Zeinstra et al., 2007), and most children experience mild neophobia (Cooke and Wardle, 2005).

A recent randomised controlled trial on NZ infants (n = 117) found that providing only vegetables as a first food in complementary feeding increased vegetable intake at nine months of age, suggesting that capitalizing on infants' willingness to try new foods may be an important strategy to support childhood vegetable intake (Rapson et al., 2022). This finding has been reported elsewhere in the small but growing body of evidence (Remy et al., 2013, Hetherington et al., 2015, Barends et al., 2013, Barends et al., 2014), with results of increased vegetable liking up to six years later (Maier-Nöth et al., 2016). However, major variations in study designs limit the generalisability of findings currently. Even so, the message of introducing vegetables (as well as fruit) as a first food, or early into complementary feeding, is relayed by authorities such as the National Health Service, UK (NHS) (National Health Service) and the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) (Fewtrell et al., 2017). Unfortunately, this recommendation is not fully adhered to, as studies using longitudinal data from the Growing Up in New Zealand study (GUiNZ) found that 10% of the nationally generalisable infant cohort had a late introduction to FVs (n = 5770) (Ferreira et al., 2022), and 12-15% of the 9 months old infants were not consuming FVs daily (n = 6853) (Schlichting et al., 2019). While repeated exposure to FVs in infancy is crucial, maintaining regular exposure to FVs throughout childhood (thus increasing familiarity) is important in supporting liking and acceptance of the food group (Cooke and Wardle, 2005, Cooke, 2007).

2.3 The important role of variety in fruit and vegetable consumption

Eating a wide range of foods is crucial to achieving optimal nutrition and sufficient intake of all essential nutrients. Because a range of nutrients in varying concentrations are found different FVs, a lack of variety will lead to reduced access to certain nutrients. While some nutrients are commonly found in many FVs (i.e., vitamins A and C, and potassium), there can be large differences in overall nutrient content between different FVs (Drewnowski, 2005). It is necessary here to clarify exactly

what is meant by 'diversity' and 'variety', as the two terms are often used interchangeably. Throughout this thesis, the term 'diversity' is used to describe biologically distinct foods throughout all food groups, such as apples and cashews. 'Variety' may imply different foods that are fundamentally similar or are in the same food group, such as apples and bananas (Writing Tips, 2020). The term 'variety' does not take into consideration differences between types of the same food, however. For example, both Braeburn apples and Jazz apples are simply considered apples.

Diverse diets have been shown to protect against chronic diseases (Fernandez et al., 2000, Franceschi et al., 1995, Garavello et al., 2008, Garavello et al., 2009, La Vecchia et al., 2001, Lucenteforte et al., 2008), and are associated with prolonged longevity (Kant et al., 1995) and improved health (Bernstein et al., 2002). The World Health Organization (WHO) recommends consuming a varied diet comprised mainly of plants (World Health Organization, 2020). Beyond FV quantity, at least 25 governments mention diversity or variety as part of their national dietary guidelines (Kennedy, 2004, U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). The 2003 WHO/Food and Agriculture Organization (FAO) joint report of Diet, Nutrition and the Prevention of Chronic Diseases noted that some consider that as many as 30 biologically distinct foods eaten within a week, with an emphasis on plant foods, is required for healthy diets (World Health Organization and Food and Agriculture Organization, 2003). High FV variety is positively associated with fibre and micronutrient intake, especially β-carotene, vitamin C, total carotenoids, vitamin A, α-carotene, and lutein (Fulton et al., 2016). Because FVs are limited in many children's diets (Rush et al., 2019), variety within this food group can be especially limited. For example, fruit juice has been reported as the leading source of fruit in studies in the United States of America (USA) exploring children's diets, followed by apples and oranges, which indicates a lack of variety needed to promote optimal health (Lorson et al., 2009, Ramsay et al., 2014, Ramsay et al., 2017).

2.3.1 Reduced disease risk and mortality

Consuming a diet higher in diversity increases the likelihood of consuming all essential nutrients at levels sufficient to lower chronic disease risk. Adequate consumption of micronutrients and bioactive compounds supports cell maintenance and prevents the pathophysiology of some noncommunicable diseases, such as CVD or many cancers (Marshall et al., 2020, Van Duyn and Pivonka, 2000). Correspondingly, habitually consuming a small range of food has been associated with increased incidence of chronic diseases such as cancer (Garavello et al., 2008, Mirmiran et al., 2006) and metabolic syndrome (Azadbakht et al., 2005a, Vadiveloo et al., 2015), as well as cardiovascular risk factors (Azadbakht et al., 2006).

Cancers reported to reduce in incidence with a diverse diet include squamous cell oesophageal (Jeurnink et al., 2012, Lucenteforte et al., 2008), lung (Büchner et al., 2010), stomach (La Vecchia et al., 2001, Kushi et al., 2012) oral, pharyngeal (Garavello et al., 2008), laryngeal (Garavello et al., 2009), colorectal (Fernandez et al., 2000), and breast cancer (Malin et al., 2003, Franceschi et al., 1995, Ghadirian et al., 2009). For some cancers, the associations with diversity remained consistent after controlling for tobacco smoking and alcohol drinking, showing independence from major carcinogenic risk factors (Büchner et al., 2010, Garavello et al., 2008, Garavello et al., 2009). When reviewing the influence of diet on breast cancer risk, Franceschi et al. (1995) noted that the variety of vegetables eaten seemed to have a beneficial effect beyond the advantage of high vegetable intake per se. A strong and significant interaction between FV variety and the development of breast cancer in BRCA (Breast Cancer gene) mutation carriers was revealed in a case-only study of 738 women (Ghadirian et al., 2009). This interaction is consistent with other studies that found a relationship between FV variety and breast cancer risk (Malin et al., 2003, Franceschi et al., 1995). While BRCA mutation carriers have an increased risk of breast cancer because of a reduced ability to suppress tumours, Ghadirian et al. (2009) suggest that consuming a variety of FVs is a factor that can modify the risk of hereditary breast cancer. FV variety encourages a high intake of vitamins which are directly involved in deoxyribonucleic acid (DNA) repair and methylation and, during wound repair and cellular proliferation that follows ovulation, could support creating an environment protective from DNA damage (Ghadirian et al., 2009). Other mechanisms in which a diet high in FV variety is thought to be protective against carcinogenesis include: a high intake of antioxidants which may protect against free radical formation (Floyd, 1990); and a high intake of fibre which binds to oestrogen in the enterohepatic circulation, interfering with its reabsorption, reducing circulating oestrogen concentrations (Xu et al., 2000). Specific bioactive compounds in vegetables also possess anticarcinogenic properties, such as polyphenols in tomatoes (Wang et al., 2003) and indole-3-carbinol in cruciferous vegetables (Lord et al., 2002). The beneficial overlapping mechanisms of micronutrients and bioactive compounds in FVs are favoured by a diet characterised by many different FVs (Lucenteforte et al., 2008), explaining the correlation between a diet with high FV variety and lower incidence of some cancers (Garavello et al., 2008, La Vecchia et al., 2001, Lucenteforte et al., 2008).

Cooper et al. (2012) reported associations of greater variety in fruit (Hazard ratio 0.70 [95% confidence interval 0.53–0.91]), vegetables (0.77 [0.61–0.98]), and combined FVs (0.61 [0.48–0.78]) intake with lower hazard ratios of T2DM. The beneficial associations between FV variety and T2DM were independent of intake quantity and known confounders such as hypertension, dairy intake, red/processed meat intake, total fibre intake, and percentage energy from macronutrients (Cooper et al., 2012). After accounting for FV intake quantity and potential confounding factors, the incidence of

T2DM was reduced by 8% with each additional two items per week increase in FVs variety (Cooper et al., 2012). In 2010, Bhupathiraju and Tucker (2011) found that greater variety in FV intake, but not necessarily volume, was associated with lower inflammation markers, which are strong independent risk indicators for CVD. Variety within vegetable intake has also been shown to be inversely associated with cardiovascular risks, (Azadbakht et al., 2006). Other changes associated with increased vegetable variety include reduced metabolic risks, energy intake, and the likelihood of obesity (Azadbakht et al., 2006).

Alongside the reduced risk of developing noncommunicable diseases later in life, there may be some short-term benefits of consuming a varied diet. In a cross-sectional study of 647 school children, Castro Mendes et al. (2021) found that higher vegetable variety was negatively associated with self-reported asthma (95% CI: 0.47, 0.95), and vegetable variety of >3 food items/day was negatively associated with airway inflammation (95% CI: 0.16, 0.88) and breathing difficulties (95% CI: 0.16, 0.97). However, due to the cross-sectional nature of this study, causal correlations are not possible to draw.

2.3.2 Nutritional adequacy and diet quality

There is considerable evidence that dietary diversity is related to adequate nutrient intake and/or status, both in developing and developed countries, as consuming a wider range of food items increases the possibility of adequate intake of all nutrients (Arimond and Ruel, 2004, Arsenault et al., 2013, Nicklas et al., 2001, Oldewage-Theron and Kruger, 2008, Ruel, 2003a, Ruel, 2003b, Steyn et al., 2006). A diversified diet promotes a high level of micronutrient intake, both between and within food groups (Arsenault et al., 2013, Liu et al., 2021, Narmaki et al., 2015). When investigating demographic and health surveys of 11 developing countries (Benin, Cambodia, Colombia, Ethiopia, Haiti, Malawi, Mali, Nepal, Peru, Rwanda, and Zimbabwe), Arimond and Ruel (2004) found a positive association between dietary diversity and child nutritional status, even with inconsistent methodological approaches and populations studied, concluding that the association is robust. A diet characterised by a variety of fruit has been correlated positively with vitamin C intake, and with the probability of vitamin A, vitamin C, and potassium adequacy in past studies (n = 295 men and n = 286 women) (Azadbakht et al., 2005b) (Mirmiran et al., 2006). Interestingly, higher intakes of vitamin C, carotenoids, flavonoids and dietary fibre, but not energy, was also associated with greater FV variety in a large prospective population-based cohort study (n = 20,069) (Griep et al., 2012). While this study’s participants were adults, if FV variety increases micronutrient intake without increasing energy intake in children, it may be a key strategy in reducing childhood obesity. Furthermore, experts outline that many health benefits associated with consuming FVs (such as reducing the risk of cancer, CVD, stroke, etc.) may be attributed to the additive and synergistic effects of the different

mixtures of nutrients and bioactive compounds in each different FV (Liu, 2003). Thus, increasing FV variety may have more powerful effects than only increasing the frequency or volume of FV consumption.

Diversity has been suggested to be a major domain of quantifying diet quality in research (Bernstein et al., 2002, Drewnowski et al., 1997). Dietary diversity is related to diet quality as diversity increases the likelihood of meeting nutrient recommendations. In a review of dietary research priorities, Ruel (2003b) outlined that diversity has been extensively validated against diet quality in developed countries, and an increasing number of validation studies in developing countries are confirming a strong association. In a more recent cross-sectional study of 2595 American pre-schoolers (aged 2-5 years), Ramsay et al. (2017) demonstrated a relationship between overall diet quality (measured by the Healthy Eating Index 2010, a diet quality index that measures conformance with American dietary guidance), and variety of FVs in diets, especially fruit variety. However, the study is limited in that only one day of intake was analysed, so nuances of different days of the week or different seasons were overlooked. From their results, Ramsay et al. (2017) suggest that stronger emphases may need to be placed on children's variety of FVs, to support greater overall diet quality and optimise health. In short, each FV has a unique nutrient profile, and consuming a variety of FVs can help meet nutrient requirements for optimal health, growth, and development during childhood.

2.3.3 Body size

Excessive dietary variety of energy-dense foods is suggested to be linked to obesity, by reducing sensory-specific satiety (the reduction of pleasure derived from consuming a food repeatedly), promoting further consumption (Nicklas et al., 2001, Vadiveloo et al., 2013).

However, FV variety is associated with positive health outcomes via the same mechanisms leading to increased consumption of FVs which are high in micronutrients, fibre and water content, and comparatively low in energy (Rolls et al., 2004). Increasing variety in FVs encourages increased frequency and volume of intake, competing with energy-dense foods, often resulting in reduced energy intake and body fatness (Nicklas et al., 2001, Azadbakht et al., 2005a). As mentioned earlier, in a prospective cohort study of 20,069 Dutch adults aged 20-65 years, increased FV variety did not influence total energy intake (r = -0.01), even when intake of nutrients increased (Griep et al., 2012). In another study, FV variety was negatively associated with energy intake and body fatness in adults aged 20-80 years (n = 71), after controlling for age and sex (McCrory et al., 1999). More recently, in a 16-week clinical trial, Haws et al. (2017) reported that vegetable variety had a significant effect on weight loss over time in women who were overweight and obese (n = 134). Haws et al. (2017) used robust dietary data collection methods, such as daily food records to compare against data from

random 24-hour recalls performed by dietitians, using the multiple pass method, and in-depth demonstrations of portion sizing and measuring utensils to ensure accuracy. However, it should be noted that these women were actively trying to lose weight, making the research associative and restricting the ability to make definitive casual statements. The relationship between FV variety and body size in children has yet to be thoroughly explored, however, as mentioned above, adulthood obesity can be predicted from obesity in childhood (Simmonds et al., 2016).

2.3.4 Food acceptance and future fruit and vegetable variety

Food satisfaction and enjoyment is an important aspect of dietary choices. Eating behaviours will not be sustained if they are not enjoyed (Webber et al., 2009). Beyond the nutritional benefits, eating a varied diet influences the psychological element of eating, as variety, both within and between meals, contributes to the pleasure of eating (Vilela et al., 2018). One way to ensure dietary enjoyment and satisfaction is to include a wide range of foods (Clausen et al., 2005). Children who like a broad variety of FVs are more likely to eat ample amounts of these foods more frequently (Maier-Nöth et al., 2016).

Young children can learn to accept a greater variety of foods and flavours through repeated exposure (Birch et al., 2007). It is widely accepted that children may need up to 15 taste exposures to accept a food initially rejected as a regular part of their diet (Sullivan and Birch, 1990). Therefore, food exposure is a strong determinant of children's food preferences, and thus their dietary intake (Cooke et al., 2007, Harris et al., 2019). Researchers have noted that high dietary diversity in childhood is associated with a greater interest in food (Vilela et al., 2018) and is inversely associated with fussy eating or food neophobia (Falciglia et al., 2000). A crossover trial of 61 children found that offering a variety of FVs during preschool increased the likelihood of FV selection ($p<0.0002$) as well as the overall FV intake ($p<0.0001$) (Roe et al., 2013).

Longitudinal evidence suggests that offering a varied range of foods, especially FVs, will support a willingness to try new foods with age (Harris et al., 2019, Skinner et al., 2002, Birch and Anzman-Frasca, 2011). Early and repeated exposure to FV variety gives young children the opportunity to establish a lifelong liking for FVs easily from a young age (Chambers, 2016). Both intervention and observational studies have also shown that exposure to a variety of FV is particularly effective in increasing FV acceptance (Barends et al., 2019). In 2016, a longitudinal intervention study found that at 6 years of age, children who had been exposed to a high level of vegetable variety in infancy consumed more vegetables as well as having a higher liking score for vegetables (Maier-Nöth et al., 2016). Those exposed to high vegetable variety also showed greater acceptance of familiar vegetables later in childhood and were more willing to taste vegetables, whether they were new or familiar

(Maier-Nöth et al., 2016). This research is however limited by the fact that parents' behaviour is difficult to account for, and that parents cannot be blind to the treatment. It is possible that parents in the group assigned to more vegetable variety could have offered vegetables more often than parents in the control group, helping the child become more familiar with vegetables. In a qualitative study on low-income American children's thoughts about FVs, both Mexican-American and Caucasian children mentioned that offering a variety of FVs supports their liking and intake of FVs (Keim et al., 2001). Lastly, a lack of variety in available FVs has been highlighted by children as a barrier to FV consumption in qualitative studies (Molaison et al., 2005, Nicklas et al., 1997). Accordingly, repeated exposure to a variety of flavours during early life is encouraged by expert opinion and accepted in clinical practice to increase acceptance of FVs in childhood (Gerritsen et al., 2017, Birch and Anzman-Frasca, 2011, Mennella et al., 2008). When a variety of FVs are frequently offered, FV intake is stimulated in children (Bucher et al., 2014, Roe et al., 2013).

2.3.5 Dietary and lifestyle behaviours

To the author's knowledge, there is no published research exploring the relationship between FV variety in early childhood and dietary behaviours in adulthood. However, it is well recognised that dietary behaviours established in the first few years of life can impact future dietary behaviours, potentially influencing health status (Birch et al., 2007). A study of 3245 Belgians 15 years and older found that increased vegetable variety was positively associated with fulfilling vegetable quantity guidelines (Vandevijvere et al., 2010). Griep et al. (2012) also found FV variety to be associated with increased FV intake and, unsurprisingly, higher micronutrient intakes ($r = 0.81$, $p < 0.0001$). The correlation between high FV variety and increased FV intake has also been found in other studies (Leenders et al., 2015), even after FV quantity was adjusted for (Bhupathiraju et al., 2013). A variety of both FVs has also been associated with the behaviour of eating breakfast every day (n = 411) (Azadbakht et al., 2013). In a study of 112 ethnically diverse low-income American women, those who had high vegetable variety consumed more vegetables ($p<0.001$), had a higher quality diet (based on the Healthy Eating Index 2005) ($p<0.001$), a lower energy density ($p<0.001$), more healthy attitudes about food and eating ($p = 0.015$) and allocated more money towards their food ($p<0.01$) (Keim et al., 2014). In a multicentre cohort study of 521,468 Europeans aged 25-70 years, those who consumed a high variety of FVs more frequently had a lower BMI, were never smokers and consumed more FVs (Büchner et al., 2011). However, potential confounding factors were uncontrolled in this study. The association between FV variety and non-smoking has also been reported by others (Estaquio et al., 2008, Conrad et al., 2018, Griep et al., 2012, Bhupathiraju et al., 2013), as has the relationship between FV variety and being physically active (Estaquio et al., 2008, Griep et al., 2012, Bhupathiraju et al.,

2013). If FV variety is encouraged in the early stages of life, it may lead to maintaining other healthy behaviours throughout the lifespan.

2.4 Factors affecting variety and frequency of fruit and vegetable intake

There are multiple barriers to consuming adequate volumes of FVs frequently with sufficient variety. These barriers are dependent on the environment of the individual and their family. Ethnicity and socioeconomic status (SES) of children are significant predictors of volume and variety of FVs among children (Pinket et al., 2016, Krølner et al., 2011), however, differences in FV variety have been seen in populations of the same ethnicity and SES (Skinner et al., 2002), meaning that there are likely other influencing variables. Additionally, measures of factors such as SES differ across the literature, making it difficult to compare results between studies.

2.4.1 Ethnicity

Ethnicity and race are two major determinants of culture, and an individual’s culture can have a significant influence on child feeding practices (Rosenkranz and Dzewaltowski, 2008). Some have suggested that a family’s cultural ideas of child feeding can be as influential to food consumption as food availability or household income (Dettwyler, 1989, Bahr, 2007). Keim et al. (2001) described the differences in Caucasian and Mexican-American low-income children’s thoughts about FVs, which influences their eating behaviours. Mexican-American children described a greater ability to prepare food than Caucasian children, possibly due to it being more culturally normal to help prepare food at a younger age (Keim et al., 2001). More Caucasian than Mexican-American children mentioned that FVs were not available in the home, meaning Caucasian children had fewer visual cues to encourage FV consumption (Keim et al., 2001). Caucasian children were also more likely to add high-fat ingredients to vegetables such as butter, cheese, peanut butter or Ranch dip, reflecting the methods of vegetable consumption by the Caucasian children’s families (Keim et al., 2001). Out of 57 children, all mentioned offering a variety of FVs as a way to increase FV consumption and a reason for liking FVs (Keim et al., 2001). Using data from the Healthy Eating Index-2005, Hiza et al. (2013) found that Hispanic children had higher scores for total FV consumption compared to white and black children (n = 2,286). Regarding Aotearoa NZ children, the 2002 National Children’s Nutrition Survey (CNS02) provides some detail on differences in FV intake between prominent ethnic groups. At the time, Pacific children were more likely to consume fruit at least twice a day compared to Māori children, and Māori children were more likely to eat canned or cook fruit than European children (Parnell et al., 2003). Less European children ate kūmara than Pacific and Māori children, but more ate carrots and broccoli (Parnell et al., 2003). Pacific children were more likely to eat taro, cooked green bananas,

and cassava, likely because these foods are considered to be intertwined with Pacific culture (University of Hawaiʻi at Mānoa, 2022).

Aside from cultural beliefs and practices, socioeconomic factors also likely influence differences in health outcomes among ethnicities. In many countries, including Aotearoa NZ, there is a relationship between SES and ethnicities, leading to ethnic disparities in food consumption and health outcomes (Kirkpatrick et al., 2012). Māori and Pacific people are more likely to live in deprived areas across all regions of Aotearoa NZ compared to NZ Europeans (Mare et al., 2001). The CNS02 found that households with Pacific children (60%) were more likely to report that they often limit the variety of foods they were able to eat because of lack of money, than households with Māori (45%) and NZ European children (28%) (Parnell et al., 2003). While lacking money can be attributed as SES issue, it is interesting to note the difference in how households of different ethnicities change their behaviour when faced with depravity. Asfour et al. (2015) found that whether household food security affected children's consumption of healthy food depended on the child's ethnicity. In the cross-sectional study of 1,211 2-5 year old American children, food-secure Cubans and non-Hispanic whites were less likely to consume unhealthy foods, but food-secure Haitians were more likely to consume unhealthy food compared to their less food-secure counterparts (Asfour et al., 2015). Conversely, (Kirby et al., 1995) found that the pattern of FV consumption of 10-11 year olds differed between SES and regional factors, but not between ethnicities. The reporting of ethnicity not impacting FV intake by (Kirby et al., 1995) may be questioned though because ethnic groups were categorised into white and non-white, discounting the differences between African-American, Asian-American and Hispanic children, all of who were categorised as non-white. While there is evidence of poorer health outcomes for Māori adults (Slim et al., 2021), and recent data showing Māori adults being less likely to meet recommended FV guidelines (New Zealand Health Survey, 2021), this is not reflected in recent data regarding NZ children. The NZ Health Survey 2020/21 reported the likelihood of different ethnic groups would meet the FV dietary guidelines compared to other ethnic groups. Of children aged 2-14 years, Māori were more likely to meet the daily recommended amount of FV servings than non-Māori (Adjusted ratio [AR] 1.63) (New Zealand Health Survey, 2021). Compared to other ethnic groups, Pacific (AR 0.18) and Asian (AR 0.22) were less likely to meet the daily FV recommendations.

CNS02 described differences in frequently eaten FV between children of different ethnicities. Pacific children enjoyed bananas more often than Māori or NZ European children (Parnell et al., 2003). NZ European children were more likely to eat carrots and broccoli weekly and less likely to eat kūmara compared to Māori and Pacific children. Māori children were more likely to eat kūmara silverbeet, spinach, puha or watercress (Parnell et al., 2003), potentially because these vegetables were

predominant sources of nutrition for traditional Māori (Roskruge N., 2019). Furthermore, a higher proportion of Pacific children ate taro, cooked green banana, and cassava weekly (Parnell et al., 2003), foods that are again connected to the Pacific culture (Malolo et al., 1999). While there is limited recent data on the specific foods that NZ children of different ethnicities enjoy, it is evident that ethnicity can influence the type of FVs that children eat. That influence may be by means of either cultural influence determined by a group's ethnicity, or, through SES determining what FVs are available and/or accessible to eat.

2.4.2 Deprivation

In Aotearoa NZ, socioeconomic deprivation is measured by the NZ Index of Deprivation (NZDep), which defines deprivation as "a state of observable and demonstrable disadvantage relative to the local community or the wider society or nation to which an individual, family or group belongs" (Salmond and Crampton, 2012). Small areas across the country are measured for their level of deprivation, depending on data from the most relevant Census. The most recent NZDep, NZDep2018, combines the following Census variables: people with no access to the Internet at home, people aged 18-64 years receiving a means tested benefit, unemployed or without any qualifications, people living in equivalised households with income below an income threshold, people not living in own home, people aged <65 years living in a single parent family, people living in equivalised households below a bedroom occupancy threshold, people living in dwellings that are always damp and/or always have mould greater than A4 size (Atkinson et al., 2020). The first GUiNZ Vulnerability Report outlined that 28% (n = 1860) of children participating in the GUiNZ study were born to families living in areas of greatest deprivation (NZDep2006 deciles nine and ten) (Morton et al., 2014).

The link between socioeconomic deprivation and child nutrition and health outcomes has long been established (Arimond and Ruel, 2004, Hatløy et al., 2000). The environment that a child lives in influences food availability, thus influencing the food they eat. Unfortunately, nutrient-rich foods such as FVs are often more expensive and perishable and therefore less affordable, especially in low-income households or in deprived areas. Families with limited financial means are likely to have reduced accessibility and availability of FVs in low-income neighbourhoods (Blakstad et al., 2021, Di Noia and Byrd-Bredbenner, 2014, Dubowitz et al., 2008). A recent national review of food insecurity among Aotearoa NZ children outlined that rates of household food insecurity were higher among children in households on low incomes and children in the most deprived neighbourhoods (Ministry of Health, 2019). The 2015/16 NZ Health Survey reported that children aged 2-14 years living in areas of high deprivation were 20% less likely to have met the daily FV intake recommendation, compared with children living in the least deprived areas (Cox, 2016). A range of different FVs may also be

difficult to access in areas with low availability to markets, and/or, areas with easily accessible energy-dense, nutrient-poor foods (such as takeaways).

Parents with lower incomes tend to be more attentive to the cost of groceries, convenience and shelf life (Morton and Guthrie, 1997), potentially resulting in purchasing larger quantities of processed foods and smaller quantities of FVs (Wroten et al., 2012). Buying smaller quantities of FVs results in children having reduced availability and accessibility of FVs in the home, factors that are strongly associated with the intake of this food group (Hearn et al., 1998, Van der Horst et al., 2007, Rasmussen et al., 2006, Taylor et al., 2005, Krølner et al., 2011). Despite the importance of nutrition in early childhood and the proven rise in the cost of living, there remains a paucity of evidence on dietary differences in children from different socioeconomic backgrounds in Aotearoa NZ.

Among adults, the consumption of FVs has been independently associated with income (Lallukka et al., 2010). In a cohort study of 9580 British adults, FV variety was inversely associated with lower social class and difficulty paying bills (Conklin et al., 2015). Giskes et al. (2002) also reported that lower-income Australian adults consumed a lower variety of FVs compared to higher-income adults. The most recent nationwide child-focused nutrition survey in Aotearoa NZ, CNS02, showed that 34.6% of households reported that the variety of foods they were able to eat was limited by a lack of money sometimes (25.6%) or often (9%) (Parnell et al., 2003). In addition, households identified to be in areas of highest socioeconomic deprivation were most likely to limit the variety of food they ate because of lack of money often (14.4%), and sometimes (38.8%), compared to households with lower deprivation levels (Parnell et al., 2003). While this data is two decades old and focused on the later stages of childhood (ages 5-14 years), an upward trend of families requiring emergency food assistance (Child Poverty Action Group, 2020) indicates that this inverse relationship between variety and lack of money will be similar now, if not more severe. Additionally, CNS02 reported only the most consumed FV, and did not consider the range of all different types of FVs eaten by young children. Evidence that is more recent is required to identify effective interventions to increase FV variety and quantity in young NZ children.

2.4.3 Parental/caregiver education

There is a growing body of work that recognises the influence of parental education on the health outcomes of the children they raise (Barrera, 1990, Chou et al., 2010, Headey, 2013, Vollmer et al., 2017). Parental education is also commonly used in combination with other characteristics (e.g., occupation, level of deprivation, income) to measure SES. For example, Pinket et al. (2016) assessed the SES of pre-schoolers by only the educational level of the mother and found that pre-schoolers had a higher quality diet when their mothers achieved 14 or more years of education. Maternal/caregiver

education is thought to be a strong predictor of overall dietary diversity, in both developing (Aemro et al., 2013, Christian et al., 2016, Darapheak et al., 2013, Joshi et al., 2012, Kemboi et al., 2020, Nguyen et al., 2013, Solomon et al., 2017) and developed countries (Barros et al., 2019, Pinket et al., 2016, Scott et al., 2012, Cooke et al., 2004). Knowledge and skills attained through education may increase a person's cognitive functioning, making them more receptive to health education messages (Galobardes et al., 2006). Parents and caregivers need to be receptive to health information, as parents (mainly mothers) influence the food choices of their children through education and modelling eating behaviours (Yee et al., 2017). Additionally, caregivers with good health literacy are more likely to feed their children a wide range of foods (Quezada-Sánchez et al., 2020).

Parental education has also been associated with increased FV frequency in children (Groele et al., 2019, Bere et al., 2008, van Ansem et al., 2014). This may be due to increased education level resulting in job positions with higher income, allowing families to afford more FVs (Bere et al., 2008). Income has been associated with increased FV frequency in adults, irrespective of education (Lallukka et al., 2010). Another reason for the association between parental education and FV consumption may be that higher levels of education lead adults to eat more FV, modelling these eating behaviours to children. A recent cross-sectional study in 21 European countries reported that highly educated adults showed increased odds of consuming fruit (OR 1.53 (95% CI 1.43, 1.63) and vegetables (1.86 (1.74, 2.00) compared to low educated participants (Stea et al., 2020). Furthermore, a systematic review of literature published in English found a consistent and positive association between parental modelling/intake and children's FV consumption (Pearson et al., 2009). While there is currently no evidence related to parents' education level and FV variety, overall dietary diversity has been positively associated with a greater level of parental education (Quezada-Sánchez et al., 2020).

According to the Ministry of Education, the number of New Zealanders with education qualifications has been increasing for decades, but this growth has slowed since 2019 (Ministry of Education, 2022). In 2021, 13% of 25- to 64-year-old adults did not hold a school qualification. In adults of the same age group, 21% had a school qualification, 28% had a tertiary certificate or diploma (such as those attained at a Polytechnic Institute), and 35% of New Zealanders had a Bachelor's degree or higher (Ministry of Education, 2022). Similar to other SES indicators, there is a persistent education gap between Māori and Pacific New Zealanders compared to other New Zealanders (Ministry of Education, 2022). Degree of higher attainment for Māori and Pacific peoples is increasing, but not as much as for other groups, with the proportion of Māori, Pacific, and other New Zealander adults with a bachelors or higher qualification being 18%, 16% and 25%, respectively (Ministry of Education, 2022). As the education attainment of parents/caregivers is linked with the consumption of nutrient

dense foods in children, an education gap between ethnic groups may help to instigate disparities in health outcomes.

2.4.4 Number of children in the household

The number of children living in a household is another measure often used to get a picture of SES and/or child health. It has been hypothesised that an increased number of children dilute the resources available to care for the children, resulting in poorer health outcomes (Mmopelwa, 2019). This is also often referred to as the quantity-quality model (Zhong, 2017). Additionally, if a family or household is already of low SES, resource dilution may have a significant impact on child health. Evidence of this effect is seen when viewing the results of child health outcomes and family size in developed countries compared to developing countries, where resource dilution has been shown to influence child stunting (Mmopelwa, 2019).

The initial report published using GUiNZ data reported that families with more children tended to have less total household income (Morton et al., 2010). Larger families with less total income result in significant resource dilution to support the care of children in these families. In CNS02, households that were food secure were most likely to have the least number of children (Parnell et al., 2003). Additionally, households with five or more children were approximately two times more likely to sometimes run out of food than households with 3-4 children (Parnell et al., 2003). Interestingly, whether or not the number of children in a household influenced if parents 'felt stressed because they could not provide the food they wanted for social occasions', depended on ethnicity (Parnell et al., 2003). Households with the greatest number of Māori and Pacific children more frequently experienced this food related stress. However, there is currently little evidence to suggest that family size affects FV consumption specifically in children. Large reviews of the literature have reported no evidence of an association between family size and children's FV consumption (Rasmussen et al., 2006, Pearson et al., 2009).

There is currently no literature that reports an association between FV variety and size of household/number of children. A recent study of households in Uttar Pradesh found a significant negative impact between household size and dietary diversity (Sangeetha et al., 2019). The authors speculated that increased household sizes leave less time for parents/caregivers to prepare a range of different meals whilst catering to the needs of all members of the household, reducing the variety of food products prepared.

2.4.5 Parents/caregiver work status

As mentioned above, income and financial status have a large influence on family food choices. There is evidence that children consumed more FVs when their parents, especially when their mothers-

work (Groele et al., 2019). The number of adults who work and bring in income for a family, as well as their work status (e.g., full-time vs part-time); affects the family's food budget. Increased income and/or financial status is associated with higher FV consumption in both adults and children (Giskes et al., 2002, Lorson et al., 2009). This is likely attributed to higher quality diets (e.g., diets that are rich in FVs) simply costing more (Drewnowski and Darmon, 2005, Maillot et al., 2007). In examining different diets of 837 French adults, Drewnowski et al. (2004) found that with each 100g increment in FVs within a diet, there was an associated increase in diet costs of 0.18-0.29 € per day. In the past year, the prices of FVs in Aotearoa NZ have increased by 17%, and were the largest contributor to the rise in overall food prices (StatsNZ, 2022c).

Within the GUiNZ cohort, 64% of mothers (n=6,384) had a paid job while pregnant (Morton et al., 2012), with 84% of these mothers taking some form of leave before or after their baby was born. When their children were aged 9 months, 30% of the mothers that had taken leave were still on leave. It is common for New Zealand mothers to utilise a combination of leave from work entitlements. The predominant form of leave taken by mothers of the GUiNZ cohort was paid parental leave (87%), however over half of the mothers took unpaid parental leave, and 34% utilised paid annual leave. Regarding partners of the GUiNZ mothers, 83% of those who worked took leave before or after their baby was born, at 0.6% were still on leave when the baby was aged 9 months. Finding a balance between caring for a child and employment is very individualised and dependent on factors such as the price/suitability of childcare, cost of living, and flexibility of employment hours.

2.5 Measuring fruit and vegetable intake and variety

Dietary assessment in young children is necessary for monitoring the nutrients needed for growth and development but is complicated for several reasons. This includes persons other than the parents who may be responsible for child feeding, as well as common features of feeding young children, such as food spillage and wastage (Fisher et al., 2008). When assessing habitual diets, there is no 'gold standard' tool, however, 24-hour recalls (24HR) are often considered an accurate method for acquiring FV intake data (Roark and Niederhauser, 2013, Greene et al., 2008, Subar et al., 2007). In the 24HR, an interviewer typically assists the respondent in recalling all the foods and beverages consumed in the preceding 24hrs or the previous day (Thompson and Subar, 2017). 24HRs are less demanding for the participant and less likely to influence the actual diet of subjects than other dietary assessment methods (such as weighed food records or food frequency questionnaires) (Cade et al., 2002). Because there is comparatively less burden on respondents, those who agree to do 24HRs are more likely to be representative of the population than those who agree to more burdensome dietary assessment methods (Thompson and Subar, 2017). The 24HR method is therefore useful across a wide

range of populations and, also considering that 24HRs are also cost-effective and open-ended, the method is beneficial for population-based research with large samples (Fisher et al., 2008, Biro et al., 2002). However, one 24HR is not necessarily representative of an individual's intake, and several 24HRs are more likely to represent an individual's intake. Errors that often arise with this method relate to relying on memory, having the participants conceptualise portion sizes and the possible distortion of reported diets. One way to reduce the risk of errors is to repeat 24HR at least once on different days of the week (Roark and Niederhauser, 2013). Whether a study utilizes 24HR, weighed or estimated food records, or food frequency questionnaires, mixed meals are a challenge when quantifying food group intake. It is common for mixed dishes to be disaggregated, and for the individual ingredients to be added to their appropriate food groups.

A limited number of studies have quantified variety within FV food groups, rather, it is more common to assess overall dietary diversity by calculating the number of different food groups consumed over a particular period. Several studies have used a 24HR to assess dietary diversity (Castro Mendes et al., 2021, Sharma et al., 2013, Arsenault et al., 2013, Narmaki et al., 2015, Mirmiran et al., 2006). When assessing overall dietary diversity (that is, looking at all food groups) in large populations, some researchers describe food groups according to the Minimum Dietary Diversity for Women Guide, as the defined food groups are mutually exclusive (no food or ingredient is placed in more than one food group) (FAO, 2016, Castro Mendes et al., 2021). Other large-scale studies separate foods into groups according to their richness in specific nutrients (e.g., vitamin C-rich FVs separated from other FV) (Arimond et al., 2010, Narmaki et al., 2015). When exploring FV intake in five-year-old NZ children, Yu (2016) assigned FVs into the food groups fruit, fruit juice, dried fruit, vegetables, vegetable juice, fried potatoes and other potatoes. When assessing variety within food groups, Mirmiran et al. (2006) divided the five main food groups into 23 sub-groups so that, for example, vegetable categories included potato, green vegetables, or tomato products. Disaggregating FVs into subcategories has also been done by other researchers, such as Ramsay et al. (2017), who separated FVs into citrus fruit, non-citrus fruit, 100% fruit juice, dark green vegetables, red and orange vegetables, starchy vegetables and other vegetables. The level of specificity in the dividing of FV food groups is dependent on the study objectives and resources available. When researchers seek to explore variety within food groups, splitting the food group as specifically as possible theoretically makes sense, however, this requires more time to process and evaluate a greater number of variables. Ways in which FV food groups have been disaggregated in past studies to measure FV variety are shown in **Table 1.1**.

Throughout the literature on FV intake assessment, definitions of FVs are highly variable. Specific FVs may be excluded from some studies, and the rationale for such exclusions is inconsistent. The terms 'fruits' and 'vegetables' covers a highly heterogeneous group of foods, especially across different cultures and geographic locations (Roark and Niederhauser, 2013). FV definitions may be based on food preparation, culinary use, or botanical terms. Some researchers exclude starchy vegetables from the vegetable food group (Huybrechts et al., 2008, Yngve et al., 2005, Sharma et al., 2013), while some studies and national health programmes include beans and legumes in their vegetable definition (Sharma et al., 2013, Ramsay et al., 2017, Castro Mendes et al., 2021, Mirmiran et al., 2006). In Aotearoa NZ, starchy vegetables such as potatoes, kūmara and taro are included within the recommended FV intake (Ministry of Health, 2012), while in the United Kingdom, potatoes, yams, cassava and plantain are excluded from the national "5-a-day" program as they are defined as a starchy food (National Health Service, 2018, Ashfield-Watt et al., 2004). Other countries that do not include potatoes within their national food-based guidelines for FVs include Austria, Belgium, Denmark, Iceland, Netherlands, Portugal, Spain and Sweden (Yngve et al., 2005). The decision to include fruit/vegetable juice or dried fruit/vegetables in the definition of FVs is also controversial, as additional processing can alter nutritional profiles, and participants may not be able to differentiate between 100% fruit/vegetable products (e.g. 100% fruit juice) and fruit/vegetable flavoured products (e.g. fruit flavoured beverages) (Roark and Niederhauser, 2013, Thompson et al., 2002, Yngve et al., 2005). Easily available and commonly eaten FVs also differ internationally. For example, taro is considered a staple starch of Polynesian cuisine but is relatively unknown in Central Europe. Lastly, the minimum quantity of FVs to include in analysis can differ depending on research objectives. Several studies suggest that it is feasible to exclude very small quantities of food intake to maintain relevance in large-scale surveys, with 10 g or 15 g (approximately 1 tablespoon) commonly used as the minimum quantity for this food group (FAO, 2016, Arimond et al., 2010, Gewa et al., 2014, Martin-Prével et al., 2015). The number of different food and beverages included within the predetermined terms of FVs can have a substantial impact on results when assessing FV variety, as excluding certain foods such as potatoes can skew results by limiting potential variability (Roark and Niederhauser, 2013).

2.6 Fruit and vegetable frequency and variety among children

Failing to meet the recommended FV quantities is a common issue for populations globally (Kalmpourtzidou et al., 2020, Lee et al., 2022, Micha et al., 2015, Lawrence et al., 2022). Findings from the Prospective Urban Rural Epidemiology study found 60% of the 143 305 participants from 18 low- to high-income countries did not meet the recommended FV intake (Miller et al., 2016). Results of the 2020/21 New Zealand Health Survey showed that only 30% of adult New Zealanders consumed at

least three servings of vegetables and two servings of fruit each day (New Zealand Health Survey, 2021). This result is notable as from 2020, the recommended number of FV servings per day has increased to at least five servings of vegetables and two servings of fruit for adults (Ministry of Health, 2020). The latest United Kingdom (UK) FV intake statistics highlighted that only 14% of children aged 5-7 years ate five or more FVs servings each day (National Health Service, 2019). Evaluating NZ children's' compliance of FV guidelines is difficult due to inconsistencies between the age's guidelines are set at (0-2 years, 2-18 years), and the ages evaluated in the NZ Health Survey (2-4 years, 5-14 years). Additionally, the healthy eating guidelines for NZ babies and toddlers were updated in September 2021 (Ministry of Health, 2021b), while the guidelines for children and young people (2-18 years) are currently in the process of being updated. The recommended intake of FV servings for children are expected to increase with updating just as the adult FV recommendations did (Ministry of Health, 2020). Nevertheless, the prevalence of NZ children eating at least two servings of fruit per day has not risen above 76% since 2011 (Ministry of Health, 2021a). Furthermore, the prevalence of children eating at least three servings of vegetables per day (ages 5-14 years) or at least two servings (ages 2-4 years) peaked at 57.6% in the years between 2011-2021, with only 41.9% of children achieving this indicator in the most recent annual health survey (New Zealand Health Survey, 2021). The ongoing GUiNZ longitudinal cohort study (n = 6435) reported low adherence to the infant feeding guidelines of eating fruit twice or more daily (37% adherence) and eating vegetables twice or more daily (33% adherence) at nine months (Gontijo de Castro et al., 2018). CNS02 described FVs frequently eaten over a four-week period (Parnell et al., 2003). Apples, pears, oranges/mandarins and bananas were the most frequently consumed fruit during this period (Parnell et al., 2003). While potatoes (boiled, mashed, baked, roasted, or fried) were the most consumed vegetable, and other frequently eaten vegetables differed between ethnicities as previously discussed; NZ European children consumed carrots and broccoli most frequently, Māori children consumed silverbeet, spinach, pūhā, and watercress most frequently, and Pacific children consume taro, green banana, cassava, and tomatoes most frequently (Parnell et al., 2003). As this data is over twenty years old, it is not known if/how young children's FV consumption frequency has changed overtime; however, results appear similar to international findings. Research in the US has reported fruit juice and potato products (e.g., French fries) to be among the most frequently consumed FVs, respectively (Lorson et al., 2009, Ramsay et al., 2014). Additionally, in the exploration of 821 young children's FV consumption Ramsay et al. (2014) reported that 5% of children did not consume a fruit or vegetable during a 24 hour dietary analysis period. Excluding juice, the most frequently consumed fruits were bananas, apple, and grapes. In the same study, the most frequently consumed vegetables (excluding condiments) were lettuce, tomatoes and carrots (Ramsay et al., 2014).

Although there is no yet exploration into the variety of FVs consumed by young people in Aotearoa NZ, this topic has been reviewed in other countries. Scott et al. (2012) found a mean FV variety score of 2.84 (range of 0-10), where a maximum score was 16 (Scott et al., 2012). Maternal educational was a strong independent predictor of FV variety, and maternal age was also directly associated with overall FV variety. The study by Ramsay et al. (2017), describing US children's FV intake in terms of amount and variety, used a 7 point variety score. Only 2% of children consumed seven different FV categories. The highest percentage of children (74%) consumed 3-5 different FVs on the assessed day, however this one day of dietary data likely does not represent habitual intake. Ramsay et al. (2017) concluded that greater variation in FVs was associated with a higher diet quality. Castro Mendes et al. (2021) built two different variety scores, one each for FV, and categorised participants according to reported median consumption of different FVs (≤3 and >3, for vegetables; ≤1 and >1, for fruit). Of the 647 Portuguese children studied by Castro Mendes et al. (2021), 22.7% consumed >3 different vegetables per day, and 37.4% consumed >1 type of fruit each day.

2.7 Summary

This review has highlighted the current evidence regarding the benefits of eating an adequate variety of FVs frequently for young children. While more research is needed, especially in young children, consuming a wide range of FVs has been associated with reduced disease risk, nutritional adequacy, improved food enjoyment and acceptance of new foods. Additionally, those who frequently consume a variety of FVs are more likely to maintain healthy behaviours. This literature review has also drawn attention to the challenges in assessing FV intake and variety in young children, and various ways in which this can be done. Few studies have explored the FV consumption in young New Zealand children. Exploring the FV intake of young New Zealand children, including FV frequency and variety, will be useful in deepening our understanding of children's eating habits and associations with socio-demographic factors.

Table 1.1 Examples of studies that have examined fruit and vegetable variety in children and the different ways FV food groups have been disaggregated

Study	Subjects	Title	Purpose	Dietary Assessment Method	FV variety measure; dividing of food groups [a]
Steyn et al. (2006)	220 South African children, 1-8.9 years old	Food variety and dietary diversity scores in children: are they good indicators of dietary adequacy?	To assess whether a food variety score and/or a dietary diversity scores are good indicators of nutrient adequacy of the diet of South African children.	24HR	Individual fruits and vegetables
Scott et al. (2012)	1,905 Australian children, 2 years old	Food variety at 2 years of age is related to duration of breastfeeding	To investigate the relationship between breastfeeding duration and food variety amongst a cohort of Australian 2-year-old children	24HR	Dark green vegetables, deep yellow/orange vegetables, potatoes, French fries/hot chips, tomatoes, other starchy vegetables, other green vegetables, other vegetables, apples, bananas, berries, citrus fruits, melon, pears, stone fruit, dried fruit, other fruits
Ramsay et al. (2017)	2,585 US children, 2-5 years old	Variety of fruit and vegetables is related to pre-schoolers' overall diet quality	Describe children's fruit and vegetable intake in terms of amount and variety of fruit and vegetables	24HR	Citrus whole fruit, non-citrus whole fruit, 100% fruit juice, dark green vegetables, red and orange vegetables, starchy vegetables, other vegetables
Gewa et al. (2014)	529 Kenyan children, 4-14 years old	Determining minimum food intake amounts for diet diversity scores to maximize associations with nutrient adequacy: an	To explore multiple methods of calculating diet diversity scores to maximize associations with predicted dietary	Three 24HRs	Cereals and tubers, dark-green leafy vegetables, vitamin A-rich fruits and vegetables, vitamin C-rich fruits and vegetables, other fruit and vegetables

		analysis of schoolchildren's diets in rural Kenya	micronutrient adequacy among schoolchildren in rural Kenya		
Study	Subjects	Title	Purpose	Dietary Assessment Method	Fruit and vegetable variety measure; dividing of food groups [a]
Castro Mendes et al. (2021)	647 US children, 7-12 years old	Higher diversity of vegetable consumption is associated with less airway inflammation and prevalence of asthma in school-aged children	Assess the association between vegetable and fruit diversity consumption and asthma and its related outcomes in school-aged children	24HR	Dark green leafy vegetables, other vitamin A-rich fruits and vegetables, other vegetables, other fruits

Abbreviations: 24HR, 24-hour recall.

[a] Including studies measuring dietary diversity

Chapter 3. Research Manuscript: Frequency and Variety of Fruit and Vegetables Eaten by Young New Zealand Children

3.1 Abstract

Background: Habitually consuming a variety of fruit and vegetables (FVs) is important for healthy physical and neurocognitive development in children. High FV variety has been positively associated with increased fibre and micronutrient intake. Despite amassing evidence relating health benefits to FV intake and variety, little is known about the frequency and variety of fruit and vegetables that young children in Aotearoa New Zealand (NZ) consume.

Aims and objectives: The overall aim of this study was to explore FV intake in the diets of young NZ children aged 1-4 years. The primary objective was to describe the frequency and variety of FV consumption. The secondary objective was to explore socioeconomic factors associated with frequency and variety of FV consumed in NZ children.

Methods: This study is an observational cross-sectional study utilising data from the Young Foods New Zealand study. Dietary and socioeconomic data from 289 children aged 1-4 years was collected through two 24-hour dietary recalls and a questionnaire. Dietary data was analysed using FoodWorks nutrient analysis software based on the New Zealand food composition database. Independent t-tests and one-way ANOVAs determined differences between variety scores and demographic characteristics.

Results: Bananas (71%) and carrots (49%) were consumed by the highest proportion of participants. Leafy greens was the vegetable subgroup consumed the least (20.8%). The fruit variety score (FVS), vegetable variety score (VVS) and fruit and vegetable variety score (FVVS) achieved by the highest number of children was three (22%), four (15%) and nine (15%), respectively. Children's ethnicities influenced fruit variety score (FVS) ($F[3, 284] = 5.42$, p=0.001), vegetable variety score (VVS) ($F[3, 285] = 6.09$, $p < 0.001$) and FV variety score (FVVS) ($F[3, 285] = 8.95$, $p < 0.001$). Variety scores increased with lessening number of children in a household. Variety scores also decreased with increased deprivation. Respondents being on unpaid parental leave resulted in the highest variety scores (FVS= 4.77, VVS= 4.91, FVVS=10.55). Regarding the respondent's education level, those who went to university had children with the highest variety scores (FVS = 3.75, VVS = 4.81, FVVS = 9.33).

Conclusion: All socioeconomic factors measured influenced children's FV variety scores in some way. Results regarding the most frequently consumed FVs were similar to that of past literature. The results from this study provide a picture of what FVs young children in Aotearoa NZ are consuming

and suggests that the relationship between FV consumption and socioeconomic factors warrants further investigation.

3.2 Introduction

Optimal nutrition is critical for young children. Nutrition and growth in early life affect not only neurodevelopmental outcomes but also the long-term trajectory of health and wellbeing (Cormack, 2013). Toddlers and young children grow and develop rapidly, making them particularly vulnerable to nutritional inadequacies (Mann and Truswell, 2017). Fruits and vegetables (FVs) are low in energy, fat, and sodium and can make valuable contributions to the intakes of vitamin C, carotenoids, folate, and dietary fibre, among other nutrients and bioactive compounds (Mann and Truswell, 2017).

The importance of consuming a variety of FVs is often overlooked, likely because public health messages focus on increasing FV quantity to meet dietary guidelines (Ramsay et al., 2017). The term variety describes different foods within the same food group, such as apples and bananas, both of which are fruit but are different foods. Variety specifically in FVs is beneficial to young children's health. Consuming a variety of FVs increases the range of nutrients consumed and increases the likelihood of meeting FV guidelines (Marshall et al., 2020). Children whose diet features a variety of FVs have a higher quality diet (Ramsay et al., 2017), and are more likely to enjoy food and accept new food (Vilela et al., 2019). In adults, FV variety has been associated with reduced risk of developing type II diabetes (Cooper et al., 2012), metabolic syndrome (Vadiveloo et al., 2015), cardiovascular risk factors (Azadbakht et al., 2006) and some cancers (Marshall et al., 2020).

The New Zealand (NZ) Health Survey conducted annually found 5.7% of children were eating the recommended FV servings; 2.5-5.5 servings of vegetables and 1-2 servings of fruit, depending on age and gender, for those aged 2-14 (Ministry of Health, 2021a). The 2002 National Children's Nutrition Survey (CNS02) (Parnell et al., 2003) found about two out of five NZ children ate fruit at least twice a day and about three out of five ate vegetables three or more times a day, with the most commonly consumed FV being apples/pears and potatoes. While detailed data regard FV variety in NZ children is lacking this topic has been reviewed in other countries. Scott et al. (2012) developed a FV variety score in investigating the relationship between breastfeeding duration and food variety amongst 2-year-old Australians and found a mean FV variety score of 2.84 of a possible 16. However, the variety score was calculated from a single 24-hour recall (24HR), and the authors noted that the intake data were of varying quality and frequently poorly quantified. In a large sample (n=2,595) of American children, FVs was described in terms of amount and variety by Ramsay et al. (2017). In this sample, the highest percentage of children consumed 3–5 different FVs on the recalled day: 3-year-old children (22%), 4-year-old children (29%), and 5-year-old children (24%). While these studies have their limitations, they contribute valued knowledge of the food consumption patterns of the young children of their country.

What is also important is to consider external factors that may influence the level of FV variety children may eat. For example, ethnicity and socioeconomic status has been shown to be significant predictors of volume and variety of FVs among children (Pinket et al., 2016, Krølner et al., 2011). Whether or not a child is living in an area characterised by high deprivation as measured by the NZ Deprivation Index has been shown to impact the variety of foods available to them in the past (Parnell et al., 2003). Furthermore, the level of education attained by a child's parents or caregiver impacts the eating behaviours that they model (Yee et al., 2017), and may influence the amount and type of fruit and vegetables they provide for their children (Barros et al., 2019, Pinket et al., 2016, Scott et al., 2012, Cooke et al., 2004). The number of children living in a household may also impact the ability of a family to provide a range of FVs to their children, as it has been hypothesised that increased number of children dilute the resources available to care for the children (Mmopelwa, 2019). Lastly, whether or not a child's parents/caregivers work, and what type of parental leave they take may impact a child's FV variety by influencing the household's income (Giskes et al., 2002, Lorson et al., 2009).

This study aims to deepen our understanding of young children's diets by exploring fruit and vegetable intake in the diets of young NZ children. The primary objective was to describe the frequency and variety of fruit and vegetable consumption of children aged 1-4 years. The secondary objective was to explore socio-demographic factors associated with frequency and variety of fruit and vegetable consumed in NZ children 1–4-year-olds.

3.3 Materials and methods

3.3.1 Study design

The Young Foods New Zealand study (YFNZ) is a multi-centre observational, cross-sectional study investigating what young children aged 1 year to 3.9 years of age are being fed, how they are being fed, and what effect this has on their nutrition. YFNZ is being conducted in parallel with the First Foods New Zealand (FFNZ) study, a New Zealand Health Research Council funded study. Information from both studies is being utilised by colleagues from Massey University, University of Otago, and Victoria University of Wellington for a variety of objectives. The information collated by YFNZ has been requested by the Ministry for Primary Industries (MPI), to help MPI lead scientific risk assessments to ensure the safety and suitability of the New Zealand food supply for its young children. The sample size of 300 was chosen by YFNZ to estimate mean nutrient intake to a 95% precision level of +/- 0.1 SD (standard deviations), and to allow for estimations of prevalence of inadequate intakes to a 95% precision level of +/- 6%.

3.3.2 Participants and recruitment

Eligibility of potential participants was determined via an online screening questionnaire after indicating interest. Inclusion criteria involved parents/guardians being at least 16 years of age and living in Dunedin, Wellington or Auckland, and their child being 5.5 months – 3.9 years old (for both FFNZ and YFNZ). Children with developmental or congenital issues that affect growth were included so that the sample reflected the wider population. Exclusion criteria included parents/guardians not being able to communicate in English, or their child having recently participated in a nutrition intervention study. Authors aimed to recruit a sample broadly representative of the ethnicity (50-60% European, 20-25% Māori, 10-15% Pacific, 10-15% Asian) and socioeconomic status (30% high deprivation, 40% mid deprivation, 30% low deprivation) of Aotearoa NZ children, using the NZ deprivation index (Atkinson et al., 2014). Ethical approval was granted by the University of Otago Human Ethics, Dunedin, New Zealand (H20/040). Prior to participation, written informed consent was obtained from all caregivers on behalf of themselves and their children at the first main visit.

Recruitment for YFNZ conducted included Facebook advertisements in community and special interest groups (i.e., mothers, baby and women support groups), posters and fliers distributed in community hubs, day-care centres, and churches, promotion at Marae Health Centre Meetings, and via word of mouth. To ensure ethnic and socioeconomic representation, particular focus was placed on recruiting parent/caregivers of Māori, Pacific, and Asian children, which was achieved by targeting communities with a high proportion of people of these ethnicities, utilising community connections of research team members. The YFNZ recruitment flowchart is shown in Appendix J.

Parents/caregivers of potentially eligible children completed the online screening questionnaire (Appendix A) by either A) Following the link after seeing an advertisement on social media, B) Contacted a researcher via phone or email who then sent a link, or C) Was referred to the study by word of mouth. Researchers determined participant eligibility from the completed screening questionnaires and contacted the parent or legal guardian of potential participants. At this time, the researcher introduced and explained the study, and, if the parent/legal guardian was still interested in participating, emailed or posted an information pamphlet (Appendix B). Approximately one week later, a researcher contacted the parent/legal guardian of the potential participant again, gained verbal consent and booked the first main visit.

3.3.3 Data collection

Data was collected over two visits in university clinic rooms, community centres, or participant homes. The first main visit consisted of completing the first 24hr dietary recall, and the main

questionnaire (Appendix C). The main questionnaire included demographic data (age, sex, ethnicity, number of children in the household, and the respondents' education and work status), utilising NZ census questions where relevant. A second 24hr dietary recall were collected during visit two, approximately 1-2 weeks following the first visit. As data collection occurred throughout differing NZ coronavirus disease of 2019 (COVID-19) Alert Levels, changes were made to data collection protocols to ensure the health and safety of the research team, the children and their whānau. During Alert Level 2 and above, the second main visit was conducted over the phone to limit contact infection risk. During home visits, social distancing of 1 m was observed. During anthropometric measurements, <1m contact was limited to 15 minutes. A mask and gloves were worn throughout home visits, hands were sanitised prior to donning personal protective equipment (PPE) and after doffing PPE. All equipment used were sanitised before and after each use.

Dietary data were collected via two 24 hr dietary recalls, approximately a week apart. To gain an accurate picture of the participant's diet, the 24HRs were performed on different days of the week. Collecting two recalls also enables the calculation of 'usual intake' using the Multiple Source Method (MSM) (Harttig et al., 2011) for estimating usual dietary intake of individuals. To minimise recall bias, parents/caregivers were asked to take photos of the child's food and beverages to be used as recall-assisting prompts. Parents/caregivers were asked to photograph (using their own smartphone or a camera provided) the eating surface (e.g., plate, highchair surface, and table) at the start of all meals and snacks from midnight to midnight on the day before the visit. Interviewers followed the multiple source method (MSM), when conducting the 24HRs consisted of three stages: a quick list, a detailed list, and the third stage. A quick list was formed by asking the parent/caregiver to list every food or beverage consumed by the participant from midnight to midnight the previous day. The detailed list gathered information on when and where the food was eaten, the cooking method used, any product brands, and the amount consumed. Here, a diet recall photo book displaying photos of different quantities of foods, and measurement aids and visuals, was utilised to help the participant estimate food quantities. The third pass acted as a review with probing for forgotten foods. The interviewer then listed all food and beverages consumed and probed for potentially forgotten items and asked if any salt or sugar was added to any foods (including days not captured by the dietary recall). This multiple pass method allowed for comprehensive and detailed reporting of all foods and beverages consumed. If the child consumed food and or beverages while in the care of another adult or while in childcare, a foods fed by other adults form was provided to fill out (Appendix D). The 24HR protocol is outlined in Appendix H.

3.3.4 Dietary data entry and analysis

Dietary data was firstly checked for inconsistencies or mistakes that may have occurred during the recalls or inputting. The dietary recalls were then entered into the nutrient software programme FoodWorks (Xyris, 2019), using New Zealand Food Composition database FOODfiles 2018 Version 01. When homemade recipes were used and no appropriate match could be found in the FoodWorks database, the researcher created a new recipe using foods within the FoodWorks database. Nutrition information for commercial infant foods and milk were determined by modifying recipes so that the nutrients that do not appear on the nutrition information panel were included. Generating recipes using the ingredients lists of the products and modifying quantities to match the nutrient information panel on the packet did this. The protocol for entering dietary recall data into FoodWorks is outlines in Appendix H.

Trained researchers (including the candidate) used multiple codebooks to firstly code foods eaten (including mixed dishes) into allocated foods groups, which were based on the Ministry of Health (MOH) Eating and Activity guidelines (Ministry of Health, 2020); fruit, vegetable, dairy food, animal protein, plant protein, or grain food. Foods that did not fit within these food groups (such as baked goods, margarine, potato chips etc.) were allocated specific discretionary food group codes. For example, if a child ate cheese and flavoured crackers, this would be allocated the code for 'dairy food and discretionary grain food'. Secondary coding involved allocating foods into specific food codes, including disaggregating ingredients of mixed dishes and coding individually. Commercial foods that may have had small portions of fruit or vegetables within them (e.g., fruit cake), were not coded as a fruit or vegetable as Aotearoa NZ's nutrition guidelines do not count foods from these sources towards a fruit or vegetable serving. The food categories used were based on the NZ Adult Nutrition Survey (University of Otago and Ministry of Health, 2011), modified to suit the data coding of young children's diets. Exact protocols of dietary data entry and coding can be found elsewhere (Appendix I).

3.3.5 Fruit and vegetable variety

Separate variety scores were calculated for fruits (fruit variety score; FVS), vegetables (vegetable variety score; VVS) and fruits and vegetables (FVs) (fruit and vegetable variety score; FVVS). Variety was measured as the number of different FV categories consumed over the two days of diet recall, with each type of FV consumed given a score of 1 (i.e., if an apple was consumed twice, it was counted once). This method of scoring variety is similar to that used previous studies (Ramsay et al., 2017, Castro Mendes et al., 2021, Do et al., 2008, Jansen et al., 2004, Estaquio et al., 2008, Oldewage-Theron and Kruger, 2008, Giskes et al., 2002). Maximum numbers indicating variety was 11 for the FVS, 18 for the VVS, and 29 for the FVVS. Portion sizes were not taken into consideration. Foods that

were coded as a fruit or vegetable but were excluded from the variety scores includes: legumes, pulses, and their products; vegetable powder; potato chips, wedges, croquette, and hash browns, potato crisps; dried fruit including fruit leather/roll ups and bliss balls/snack balls; fruit and vegetable puree/concentrates. These exclusions allowed the FV categories to better align with the FV guidelines, or, as with the case of vegetable powder, any children did not consume the food during the assessed days.

Table 3.1 Categorisation of fruits, vegetables, and subgroups

Group	Subgroup	Item	Group	Subgroup	Item
Fruit			Vegetables		
	Pomme fruit			Leafy greens [b]	
		Apple		Beans/peas/corn	
		Pear		Tomatoes	
		Other pomme fruit			Fresh tomato
	Berry fruit				Tomato products [c]
		Berry fruit		Orange vegetables	
		Kiwifruit			Carrots
	Stone fruit				Pumpkin/squash/butternut
	Citrus fruit				Yams
		Oranges		Brassicas [d]	
		Other citrus fruit		Onion/leeks	
	Tropical fruit			Other vegetables	
		Banana			Other root vegetables [e]
		Pineapple			Courgette/eggplant
		Other tropical fruits [a]			Other vegetables [f]
				Vegetable mixes	
					Carrots/peas/beans/corn mixes
					Stir-fry mixes
				Potato/kūmara	Potato
					Kūmara
					Taro

[a] Includes grapes, watermelon feijoa.
[b] Includes lettuce, spinach, silver beet, Bok choy.
[c] Includes canned, pureed, pastes.
[d] Includes cauliflower, broccoli, Brussels sprout, cabbage, and leaves from turnip/swede.
[e] Includes parsnip, beetroot, swede, turnip, radish.
[f] Includes cucumber, capsicum, seaweed, asparagus, celery.

3.3.6 Fruit and vegetable consumption proportions

The proportion of the children who consumed different types of FVs was created using a count system, where consumption of a fruit or vegetable across the two days of dietary analyses equalled one count (no matter the portion size consumed). For additional analysis of FV consumption, the FV categories were also allocated into subgroups. **Table 3.1** displays the division of fruit into five subgroups (pomme fruit, berry fruit, citrus fruit, stone fruit, and tropical fruit) and vegetables into nine subgroups (leafy greens; beans, peas, and corn; brassicas; onion and leeks; orange vegetables; tomatoes; starchy vegetables; other vegetables; and vegetable mixes). For example, potato, kūmara and taro were all included within the starchy vegetable subgroup. If a participant consumed both potato and kūmara within the dietary analysis period, it was measured as one count each in the potato and kūmara categories, and one count for in the starchy vegetable subgroup.

3.3.7 Deprivation

Level of deprivation was evaluated upon enrolment from home addresses via the NZ Deprivation Index (NZDep-18) score Atkinson et al. (2014). Ethnicity was categorised using a prioritisation method, in the order of Māori, Pacific (Samoan, Cook Island Māori, Tongan, Niuean, Tuvaluan, Tokelauan, Fijian, Tahitian), Asian (South East Asian, South Asian, East Asian), Others (Other, West Asian, African, South American), and European (NZ European, European, other European). When comparing means between ethnicities, Asian and Others were collapsed to one group titled Asian and others.

3.3.8 Statistical analysis

Statistical analysis was conducted using SPSS (IBM) version 27 software, the significance level set a $p \leq 0.05$. Categorical data was presented as numbers and percentages and other data was summarised as mean (standard deviation). To determine differences between variety scores and demographic characteristics with two independent groups (e.g., age groups or sexes), independent t-tests were run using two-sided p values (as the hypotheses was non-directional). To determine differences between variety scores and demographic characteristics with several independent groups (e.g., ethnic groups or deprivation levels), one-way analysis of variances (ANOVAs) were undertaken Post-hoc Bonferroni analyses were used to identify where differences between individual groups lay. Levene's test for Equality of Variance was undertaken to test the assumption of homogeneity.

3.4 Results

In total, 289 of the 310 children in the YFNZ study had sufficient dietary data for this analysis. The demographic characteristics of the children are shown in **Table 3.2.** The proportion of children from

either sex was approximately equal, with a mean (SD) age of 2.5 (0.89) years. Over half (63%) of the sample were pre-schoolers aged 3-4 years. Using prioritised ethnicity, 43% of the children were European, 26% Māori, 16% Pacific, 13% Asian and 2% of other ethnicities.

Table 3.2 Demographic characteristics of children (n=289)

	n (%)	**Mean (SD)**
Sex		
Male	142 (49.1)	
Female	147 (50.9)	
Age (years)		2.50 (0.89)
Toddler (1-2 years)	108 (37.4)	
Pre-schooler (3-4 years)	181 (62.6)	
Ethnicity, prioritised[1]		
Māori	75 (26.0)	
Pacific	47 (16.3)	
Asian	37 (12.8)	
Others	5 (1.73)	
European	125 (43.3)	

[1] Ethnicity is prioritised in the order of Māori, Pacific, Asian, Others, and European

Table 3.3 shows the demographic characteristics of the respondents (the parents/caregivers of the children). Over one-third (36%) were aged between 30-34 years, followed by 29% aged 35-39 years. Using prioritised ethnicity, over half (53%) were European. 19% of respondents were Māori, 14% Pacific, 11% Asian and 2% of other ethnicities. Approximately half (51%) of respondents reported having two children in the household. The spread of respondents across low, medium, and high deprivation levels was 27%, 43% and 29%, respectively. Respondents were primarily (96%) mothers of the children. Over half (58%) of respondents reported their highest level of educational attainment to be at university level. Over one-third (35%) of respondents were not working, while 31% worked part-time.

Table 3.3 Demographic characteristics of respondents (n= 289)

	n (%)	Mean (SD)
Age (years) (n=287)		33.6 (5.3)
20-24	15 (5.2)	
25-29	51 (17.6)	
30-34	104 (36.0)	
35-39	84 (29.1)	
40+	33 (11.4)	
Ethnicity, prioritised[1] (n=286)		
Māori	55 (19.0)	
Pacific	40 (13.8)	
Asian	32 (11.1)	
Others	5 (1.7)	
European	154 (53.3)	
No. of children in household (n=284)		
One	45 (15.6)	
Two	147 (50.9)	
Three	54 (18.7)	
Four or more	38 (13.1)	
NZDep Decile[2]		
Low deprivation	79 (27.3)	
Medium deprivation	125 (43.3)	
High deprivation	85 (29.4)	
Respondent Relation (n=288)		
Mother	276 (95.5)	
Father	7 (2.4)	
Guardian	2 (0.7)	
Other	3 (1.0)	
Level of education (n=286)		
School	55 (19.0)	
Polytech	64 (22.1)	
University	167 (57.8)	
Work status (n=285)		
Not working	100 (34.6)	
Part-time	89 (30.8)	
Unpaid parental leave	22 (7.6)	
Paid parental leave	12 (4.2)	
Full-time	62 (21.5)	

[1] Ethnicity is prioritised in the order of Māori, Pacific, Asian, Others, and European
[2]The New Zealand Deprivation Index 2018, where deciles have been categorised: Low deprivation (deciles 1-3), medium deprivation (deciles 4-7), and high deprivation (deciles 8-10). Decile 1 represents areas with the least deprivation and decile 10 represents areas with the most deprivation (Atkinson et al., 2020).

3.4.1 Fruit and vegetable frequency and proportions

Table 3.4 displays the frequency of the specific FVs consumed, and the percentage proportion of children that consumed that specific fruit or vegetable, over the two days of dietary analysis. Banana was consumed by the highest proportion of children (71%), compared to other fruit. Carrots were the most frequently consumed vegetable (49%). Both yams and other pomme fruit were consumed once. The other vegetables subgroup were the vegetable subgroup consumed by the highest proportion of participants (55%). Leafy greens were the vegetable subgroup consumed the least (21%).

Table 3.4 Frequency and proportions of FVs consumed over days of dietary analysis

	n (%)
Fruit	**273 (94.5)**
Pomme fruit	179 (61.9)
Apple	146 (50.5)
Pear	74 (25.6)
Other pomme fruit	1 (0.3)
Berry fruit	150 (51.9)
Berries	108 (37.4)
Kiwifruit	74 (25.6)
Stone fruit	57 (19.7)
Citrus fruit	155 (53.6)
Oranges	67 (23.2)
Other citrus fruit	105 (36.3)
Tropical fruit	232 (80.3)
Banana	204 (70.6)
Pineapple	37 (12.8)
Other tropical fruit	87 (30.1)
Vegetables	**263 (91.0)**
Leafy greens	60 (20.8)
Beans/peas/corn	102 (35.3)
Tomatoes	124 (42.9)
Fresh tomato	58 (20.1)
Tomato products	87 (30.1)
Orange vegetables	154 (53.3)
Carrot	142 (49.1)
Pumpkin, squash or butternut	43 (14.9)
Yams	1 (0.3)
Brassicas	105 (36.3)
Onion/leek	124 (42.9)
Other vegetables	158 (54.7)
Courgette/eggplant	40 (13.8)
Mushroom and fungi	40 (13.8)
Other vegetables	135 (46.7)
Other root vegetables	17 (5.9)
Starchy vegetables	156 (54.0)
Potato	131 (45.3)
Kūmara	64 (22.1)
Taro	4 (1.4)
Vegetable mixes	68 (23.5)
Carrots, peas, beans and corn mixes	62 (21.5)
Stir fry mixes	17 (5.9)

3.4.2 Variety scores

Table 3.5 summarises the variety scores over the two days of diet recall. Over the two days of dietary analysis, 16 children (6%) did not consume fruit, 26 children (9%) did not consume vegetables, and one child did not consume any fruits or vegetables. The FVS, VVS and FVVS achieved by the highest number of children was three (22%), four (15%) and nine (15%), respectively. . The highest FVS over the two days of diet recall was nine, achieved by one child (0.3%). The highest VVS was 11, (reached by four children). One child attained a FVVS of 21, the highest over the analysed days. **Table 3.6** displays the mean variety scores across demographic factors. **Table 3.7** displays statistically significant differences in mean variety scores across demographic factors.

Table 3.5 Variety scores (n=289)

No. of different types consumed	FVS n (%)	VVS n (%)	FVVS n (%)
0	16 (5.5)	26 (9.0)	1 (0.3)
1	35 (12.1)	23 (8.0)	5 (1.7)
2	42 (14.5)	36 (12.5)	7 (2.4)
3	62 (21.5)	35 (12.1)	15 (5.2)
4	60 (20.8)	43 (14.9)	21 (7.3)
5	46 (15.9)	31 (10.7)	20 (6.9)
6	19 (6.6)	34 (11.8)	27 (9.3)
7	3 (1.0)	23 (8.0)	30 (10.4)
8	5 (1.7)	16 (5.5)	22 (7.6)
9	1 (0.3)	12 (4.2)	43 (14.9)
10		6 (2.1)	16 (5.5)
11		4 (1.4)	24 (8.3)
12			10 (3.5)
13			17 (5.9)
14			11 (3.8)
15			8 (2.8)
16			6 (2.1)
17			2 (0.7)
18			2 (0.7)
19			1 (0.3)
20			0 (0.0)
21			1 (0.3)

FVS: Fruit variety score (range 0-11)
VVS: Vegetable variety score (range 0-18)
FVVS: Fruit and vegetable variety score (range 0-29)

3.4.3 Child ethnicity

The children's ethnicities were significantly associated with FVS ($F[3, 284] = 5.42$, $p = 0.001$), VVS ($F[3, 285] = 6.09$, $p < 0.001$) and FVVS ($F[3, 285] = 8.95$, $p < 0.001$). Mean FVS was different between European (FVS = 3.76) and Pacific (FVS = 2.64) children ($p = 0.001$, 95% confidence interval [CI] = 0.32, 1.92). European children had significantly different VVS (VVS = 5.01) compared to Māori (VVS = 3.83) ($p = 0.015$, 95% CI = 0.15, 2.21) and Pacific children (VVS = 3.40) ($p = 0.003$, 95% CI = 0.40, 2.81).

Significant differences in FVVS occurred between European children (FVVS = 9.64) and children of Pacific (FVVS = 6.79) $p < 0.001$, 95% CI = 1.17, 4.52), Māori (FVVS = 7.77) $p = 0.004$, 95% CI = 0.43, 3.30) and the Asian and Other group (FVVS = 7.64) $p = 0.16$, 95% CI = 0.24, 3.75).

3.4.4 Number of children in household

Varying numbers of children in the household also resulted in significant differences between VVSs, $F[3, 280] = 3.5$, $p = 0.016$. Mean VVS was different in households with one child (VVS = 5.36) compared to those with four or more children (VVS = 3.53) ($p = 0.013$, 95% CI = 0.25, 3.4). Differences in FVVS occurred between the number of children in the household ($F[3, 280] = 3.57$, $p = 0.015$). Households with one child (FVVS = 9.84) had different FVVS compared to households with four or more children (FVVS = 7.16) ($p = 0.009$, 95% CI = 0.46, 4.91).

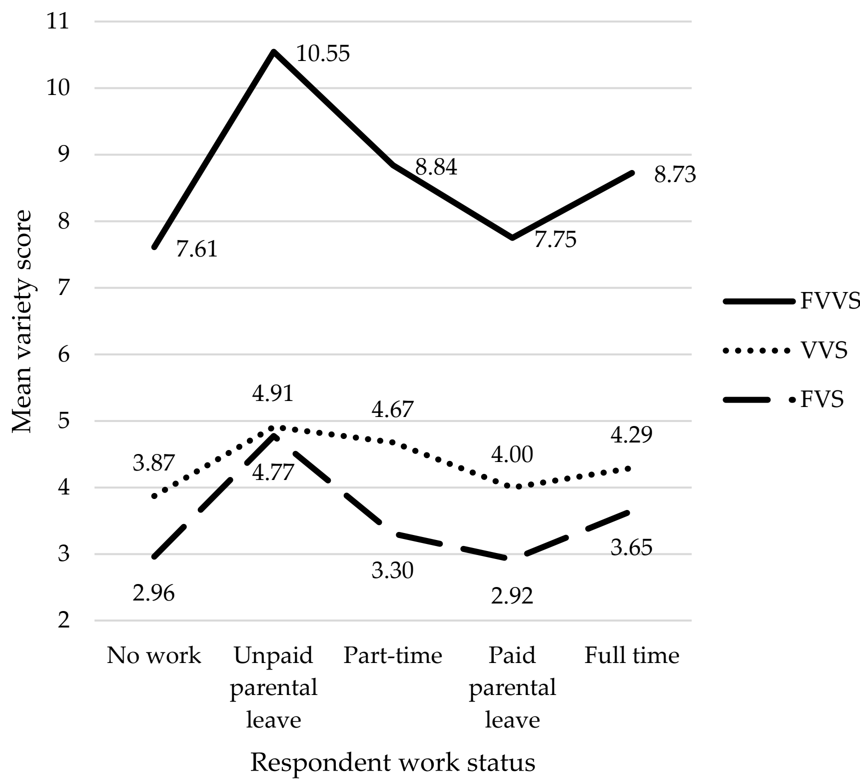
3.4.5 Deprivation

The deprivation category of the household influenced FVS $F(2, 286) = 3.45$, $p = 0.34$, with differences seen between those in the low (FVS = 3.59) and high (FVS = 2.92) deprivation category ($p = 0.048$, 95% CI = 0.01, 1.35). Differences in deprivation categories also resulted in significantly different FVVS $F(2, 286) = 3.44$, $p = 0.034$. Those in low deprivation categories (FVVS = 9.03) had different FVVSs compared to those in high deprivation categories (FVVS = 7.53) ($p = 0.038$, 95% CI = 0.06, 2.93).

3.4.6 Respondent work status

FVS was significantly different according to the different work statuses of the respondents, $F(4, 280) = 5.62$, $p < 0.001$. Respondents on unpaid leave had differences in FVS (FVS = 4.77) compared to those on paid parental leave (FVS = 2.92) ($p = 0.031$, 95% CI = 0.10, 3.62), those not working (FVS = 2.96) ($p < 0.001$, 95% CI = 0.66, 2.97), and those who worked part time ($p = 0.004$, 95% CI = 0.3, 2.64). **Figure 3.1** displays the mean variety scores for each work status reported. FVVS changed based on the respondents' work status ($F[4, 280] = 3.38$, $p = 0.010$). Those who were on unpaid parental leave had different FVVS (FVVS = 10.55) compared to respondents who did not work (FVVS = 7.61) ($p = 0.010$, 95% CI = 0.43, 5.44).

Figure 3.1 Mean variety score vs respondents' work status



FVS: Fruit variety score (range 0-11)
VVS: Vegetable variety score (range 0-18)
FVVS: Fruit and vegetable variety score (range 0-29)

3.4.7 Respondent education level

The education level of the respondents resulted in different FVS $F(2, 283) = 11.02$, $p < 0.001$. Children of respondents who achieved a university level education had a significantly higher FVS (FVS = 3.75) compared to children of polytechnic (FVS = 2.72) ($p < 0.001$, 95% CI 0.41, 1.64) and school (FVS = 2.84) educated respondents ($p = 0.003$, 95% CI 0.26, 1.56). The respondents' education level also resulted in different mean FVVS ($F[2, 283] = 12.47$, $p < 0.001$). Differences in FVSS were found between those who attended university (FVVS = 9.33) and those whose highest level of education attained was school (FVVS = 7.64) ($p < 0.001$, 95% CI = 1.25, 4.02) or polytechnic (FVVS = 6.69) ($p = 0.006$, 95% CI 0.38, 3.00).

Table 3.6 Variety scores by demographic factors

Characteristic	FVS Mean (SD)	VVS Mean (SD)	FVVS Mean (SD)
Child ethnicity			
Māori	3.12 (1.70)	3.83 (2.77)	7.77 (3.89)
Pacific	2.64 (1.94)	3.40 (3.01)	6.79 (4.17)
European	3.76 (1.71)	5.01 (2.45)	9.64 (3.48)
Asian and Others	3.14 (1.82)	3.79 (2.56)	7.64 (3.46)
No. of children in household			
One	3.73 (1.92)	5.36 (2.90)	9.84 (3.92)
Two	3.44 (1.85)	4.18 (2.57)	8.44 (3.70)
Three	3.19 (1.75)	4.15 (2.73)	8.17 (4.09)
Four or more	2.82 (1.43)	3.53 (2.83)	7.16 (3.67)
Deprivation level			
Low deprivation	3.59 (1.87)	4.65 (2.77)	9.03 (4.22)
Medium deprivation	3.42 (1.66)	4.36 (2.90)	8.60 (3.73)
High deprivation	2.92 (1.89)	3.76 (2.31)	7.53 (3.55)
Respondent work status			
Not working	2.96 (1.65)	3.87 (2.42)	7.61 (3.34)
Part-time	3.30 (1.75)	4.67 (2.75)	8.84 (3.68)
Unpaid parental leave	4.77 (1.85)	4.91 (2.83)	10.55 (4.14)
Paid parental leave	2.92 (1.51)	4.00 (2.63)	7.75 (3.80)
Full-time	3.65 (1.83)	4.29 (3.04)	8.73 (4.34)
Respondent education level			
School	2.84 (1.82)	3.02 (2.26)	7.64 (3.28)
Polytechnic	2.72 (1.60)	4.00 (2.42)	6.69 (3.28)
University	3.75 (1.76)	4.81 (2.82)	9.33 (3.97)

Table 3.7 Statistically significant mean differences between variety scores and sociodemographic characteristics

Variety score	Child ethnicity	Child ethnicity	Mean difference	Std. Error
FVS	European	Pacific	1.12	0.30
VVS	European	Māori	1.18	0.39
		Pacific	1.60	0.45
FVVS	European	Asian and others	2.0	0.66
		Māori	1.87	0.54
		Pacific	2.85	0.63
Variety score	**Deprivation category**	**Deprivation category**	**Mean difference**	**Std. Error**
FVS	Low	High	0.68	0.28
FVVS	Low	High	1.50	0.60
Variety score	**Respondent education level**	**Respondent education level**	**Mean difference**	**Std. Error**
FVS	University	School	0.91	0.27
		Polytechnic	1.03	0.26
FVVS	University	School	2.64	0.58
		Polytechnic	1.69	0.54
Variety score	**Number of children in household**	**Number of children in household**	**Mean difference**	**Std. Error**
VVS	One	Four or more	1.83	0.59
FVVS	One	Four or more	2.69	0.84
Dependent variable	**Respondent work status**	**Respondent work status**	**Mean difference**	**Std. Error**
FVS	Unpaid parental leave	Not working	1.81	0.41
		Part-time	1.47	0.41
		Paid parental leave	1.86	0.62
FVVS	Unpaid parental leave	Not working	2.94	0.89

3.5 Discussion

The overall aim of this study was to explore FV intake in the diets of young NZ children aged 1-4 years. The primary objective was to describe the frequency and variety of FV consumption. The secondary objective was to explore socioeconomic factors associated with frequency and variety of FV consumed in NZ children. Banana was consumed by the most (71%), which corresponds with data reporting FV consumption of NZ children in 2003 (Parnell et al., 2003). As banana's are very sweet in

taste, and children are proven to prefer sweet-tasting foods (Drewnowski et al., 2012), this finding was unsurprising. Carrots were the most frequently consumed vegetable (49%), followed by potato (45%), which most NZ children consumed in CNS02 (Parnell et al., 2003). Starchy root vegetables are commonly reported as the most frequently consumed vegetables in children internationally (Kim et al., 2014, Talvia et al., 2006, Landon and Baghurst, 2010), due to its low cost to nutrient ratio (related to the minimal size of land required to grow (Gustavsen, 2021, Drewnowski and Rehm, 2013), and the sweet, mild taste matching the taste preferences of young children (Birch, 1999). Leafy greens, inclusive of lettuce, spinach, silver beet, and Bok choy, was the subgroup of vegetables least consumed (21%). This may be because leafy green vegetables tend to be bitter in taste and young children often dislike bitter-tasting foods (Birch, 1999, Zeinstra et al., 2007).

Regarding variety scores, none of the children achieved the maximum scores possible. The most common FVVS was 9 out of 21, achieved by 15% of children, meaning these children consumed nine different fruit and vegetables over the two days of dietary analysis . This score is slightly higher than the mean FVVS of 2.84 (of a maximum 10) reported by Scott et al. (2012). This may be because all children of the study by Scott et al. (2012) were aged 2 years, an age where children are known to be more food neophobic and hence less willing to try unfamiliar flavours (Nicklaus, 2009, Cashdan, 1998). Children participating in this study were aged 1-4 years and so were at a wider range of stages in weaning and behavioural development compared to the children studied by Scott et al. (2012). The lower FVVS reported by Scott et al. (2012) can also be attributed to the difference in variety score measurements which resulted in a maximum possible score of 10 . Furthermore, Scott et al. (2012) used dietary data collected through only one 24HR, reducing the chance of children consuming different FVs during dietary assessment, and likely contributing to lower variety scores compared to this study which utilised two 24HRs.In the sample of 2,595 children, Ramsay et al. (2017) reported that 4-year-old children were most likely (29%) to consume 3-5 different FVs on the recalled day, compared to children aged 3 years (22%) or 5 years (24%).

In the children of the YFNZ sample, the most common VVS was 4 out of 11, achieved by 15% of children, and 30% of the children had a VVS of two or less. Additionally, 26 children (9%) did not consume any vegetables over the two non-consecutive days of dietary analysis. These results reflect those of Ramsay et al. (2017), who also found that consumption of a variety of vegetables was low. Ramsay's study of American children reported the most commonly consumed vegetable was white potatoes, which accords with this study's findings of potatoes being consumed by 45% of children, second only to carrots (Ramsay et al., 2017). In the current study using YFNZ data, most children

consumed three different fruit (22%) and 32% had a FVS of ≤2. While the highest FVVS was 19, only 10% of the children achieved a FVVS ≥14 during data analysis days.

FVS and FVVS were positively associated with lower levels of deprivation. This relationship may simply be related to the high cost of FVs (Darmon et al., 2005, StatsNZ, 2022a). Low income, unemployment, and/or requiring a benefit impact a household's ability to purchase a range of FVs, as economic constraints are known barriers to fruit and vegetable consumption (Miller et al., 2016). In Aotearoa NZ, the cost of FVs raised 20% between November 2021 and November 2022 (StatsNZ, 2022a). Low levels of income limits food choice and, when viewed in the context of cost per calorie, FVs are much more expensive compared to treat foods (Darmon and Drewnowski, 2015). Low levels of income limits food choice and, when viewed in the context of cost per calorie, FVs are much more expensive compared to other foods (Drewnowski et al., 2004, Darmon et al., 2004). The relationship between FV variety and deprivation is consistent with the findings of Giskes et al. (2002) who reported slightly lower FV variety in adolescents and adults with lower household income. More research on the impact of deprivation, SES, and household income on the FV variety of children is needed to provide definitive evidence. Previous studies comparing FV consumption with deprivation level or SES are difficult to compare because of varying dietary assessment methods, FV categories, and deprivation indicators. While the discrepancies in methodology likely contribute to inconsistencies in the literature, the findings of this study are consistent with past studies, in that children from households in higher deprivation areas have lower variety in their FV intake.

All three-variety scores were influenced by the ethnicity of the child. European children had the highest mean variety scores, while Pacific children had the lowest. These findings may not be surprising given that Pacific peoples are more likely to live in deprived areas (Robson and Harris, 2007), and earn on average $269 less per week than Europeans (StatsNZ, 2022b). The National Children's Nutrition Survey 2002 (CNS02) found that households with Pacific children were more likely to report that they often limit the variety of foods they were able to eat because of lack of money, than households with Māori or European children (Parnell et al., 2003). While there is no other literature on FV variety across ethnic groups in Aotearoa NZ, a similar pattern between ethnicity and diet quality has been reported. In a study by Kulkarni et al. (2015), European adolescents were most likely to have a high quality diet compared to Māori, Pacific and Asian adolescents. Wong et al. (2014) also reported European adolescents to have more healthy dietary habits than their Māori and Pacific counterparts, with Pacific adolescents having the least.

Children in households of four or more children tended to consume a lower variety of vegetables than those who were the only child in the household. Unfortunately, there is no similar studies to

compare this result to however this finding is unsurprising. A recent study of households in Uttar Pradesh found a significant negative relationship between the number of people in a household and overall dietary diversity (Sangeetha et al., 2019). Increased number of children dilute the resources available in a household to care for children, affecting the ability to purchase a range of FVs (Mmopelwa, 2019). A study on NZ families found that those with more children tended to had less total household income (Morton et al., 2010). In CNS02, households that were food secure were most likely to have the least number of children (Parnell et al., 2003).

Consistent with previous research, FV variety scores increased with respondent's education level. Statistically significant differences in FVS and FVVS was found between the parents/caregivers who attended university, and those whose highest level of education attained were a polytechnic or school. In Aotearoa NZ, it is law that children aged 6-16 years attend school, therefore school is the lowest level of education attainable (education.govt.nz, 2022). As 96% of the respondents were mothers of the children, it can be assumed that maternal education influenced FV variety of the children in this sample. Scott et al. (2012) similarly reported that maternal education was an independent predictor of FVVS in pre-schoolers. More educated parents/caregivers tend to follow healthy eating guidelines and eat healthier than those less educated (Stea et al., 2020) and these differences (especially when seen in mothers) are reflected in the diets of their children (Robinson et al., 2007, van Ansem et al., 2014). Education level may also indirectly influence FV variety, as parental education level is often used to measure SES of children or their household (McLeod et al., 2011), and as SES increases the likelihood of FV variety.

Variety scores showed statistically significant increases when respondents reported being on unpaid parental leave at the time of data collection. This finding is surprising as increased household income has been associated with higher fruit and vegetable variety in adults (Giskes et al., 2002). In Aotearoa NZ, a pregnant woman and/or her partner may be entitled to parental leave, where their employer must keep their job open for them for a specific period of time (Plunket, 2022). The government funds eligible parents/caregivers up to 26 weeks of paid parental leave, and employers must allow for up to 52 weeks of unpaid parental leave (Plunket, 2022). Given the children of this study were aged 1-4 years, it can be assumed that parents were either on unpaid parental leave for the child in the study, or for a sibling of said child. While unpaid parental leave gives parents/caregivers the opportunity to continue caring for their baby, they must have sufficient funds or additional income to cover the cost of living during unpaid parental leave. It may be therefore assumed that parents/caregivers who had the ability to take unpaid parental leave have sufficient income or higher SES to provide a higher

variety of FVs for their children (Meil et al., 2017). Further work is required to establish the viability of this assumption, and the impact of different types of parental leave on child's diets.

VVS was less influenced by variables compared to FVS and FVVS. No statistically significant differences in mean VVS were found between groups of deprivation category, respondents' education level, or work status of respondents. This may be because young children can be particularly neophobic to vegetables because they can be bitter and differ in taste and texture, and are thus less willing to consume different vegetables (Birch, 1999, Zeinstra et al., 2007). Food preference and liking is considered to be the biggest driver of certain food intake in young children (Blanchette and Brug, 2005, Resnicow et al., 1997). Therefore, while socioeconomic factors may influence the types of FVs available and accessible to children, these influences may not be enough to meaningfully increase vegetable variety.

3.5.1 Strengths and limitations

A key strength of this study is that the children broadly represent Aotearoa NZ's population in terms of ethnic and deprivation spread; 50-60% European, 20-25% Māori, 10-15% Pacific, 10-15% Asian and 30% high deprivation, 40% mid deprivation, 30% low deprivation (Atkinson et al., 2014). Additionally, dietary data was gathered using 24HRs delivered by trained interviewers using MSM and supportive tools (e.g. photographs and food models), meaning the children's usual intake was estimated to an accurate standard (Harttig et al., 2011). The study was however limited in terms of recruitment. The inclusion criteria of the parents/caregivers speaking English limited the sample's ability to represent some children, such as those from migrant families. Furthermore, recruitment was only performed in three geographical locations, and thus the results are limited in representing the entire population of New Zealand, especially rural NZ. Selection bias is also present as YFNZ recruitment was voluntary and people who are willing to volunteer for health-related research are likely more interested in their health than the general population, which affects their health behaviours.

3.5.2 Conclusions

The insights gained from this study may be of assistance to those who are interested in the FV intake of young NZ children, and factors that influence FV variety. Over the two days of non-consecutive dietary assessment, most children achieved a FVS, VVS and FVVS of three, four and nine, respectively. The ethnicity of the children was found to influence the variety of FVs eaten. Variety scores decreased with increased level of household deprivation. The work status and the level of education of the children's parents/caregivers also had a considerable impact on the number of different FVs eaten other the two days. While further research is required to confirm and validate the

findings of this study, the findings contribute to the literature topic of factors that affect the foods that children eat and their diet quality. Especially in Aotearoa NZ, where there is no in-depth look into the diets of children aged below 5 years, this study, as well as others utilising YFNZ data, provides a detailed picture of what our young children are eating and what may impact their diet.

Chapter 4. Conclusions and Recommendations

4.1 Introduction

Nutrition influences growth and development in young children. Therefore, a high-quality diet supports optimal growth and development. Eating plenty of fruits and vegetables (FVs), and eating a variety of FVs, is a key characteristic of a high-quality diet (Ruel, 2003a).

In children, consuming plenty of FVs has many health benefits. FVs can reduce the risk of developing chronic disease later in life, by establishing a lifelong habit of FV consumption (Rose et al., 2017), and by reducing inflammation (Qureshi et al., 2009), and supporting cardiovascular (Funtikova et al., 2015, Moore et al., 2005) and metabolic health (Kelishadi et al., 2008). Eating a high daily intake of FVs has also been associated with positive cognitive outcomes later in childhood (Tandon et al., 2016). As childhood obesity is a major issue in many countries including Aotearoa New Zealand (NZ), it is empirical to highlight that increased FV intake is associated with reduced risk of childhood overweight and obesity (Epstein et al., 2001, Rose et al., 2017), including in NZ children (Wall et al., 2018). Even when quantity is not considered, increased FV frequency has been associated with health benefits such as increased blood vitamin concentration (Dauchet et al., 2004), although this topic has not yet been explored in children.

In Chapter 2, literature that explored the benefits of FV variety in young children was also reviewed. While FV variety has been associated with reduced risk of cancer (Ghadirian et al., 2009), type II diabetes (Cooper et al., 2012) and cardiovascular disease (Bhupathiraju and Tucker, 2010, Azadbakht et al., 2006) in adults, higher vegetable variety has been found to reduce asthma and airway inflammation specifically in children (Castro Mendes et al., 2021). As increased variety reduces sensory-specific satiety, eating a variety of FV has been shown to support weight loss in adults (Haws et al., 2017), but not yet in children. Finally, FV variety has been associated with greater alignment with dietary guidelines (Ramsay et al., 2017), and a greater preference for FVs (Chambers, 2016).

4.2 Conclusion and achievement of aims and objectives

This study achieved multiple objectives. It was found that bananas and carrots were the most frequently eaten FVs, and yams and 'other pomme fruit' (pomme fruit excluding apples and pears) were the FVs eaten the least. Leafy greens was found to be the vegetable subgroup consumed by the least number of children, which is noteworthy as leafy green vegetables are often considered an excellent source of many vitamins and minerals (Natesh et al., 2017), but are a group of vegetables often disliked by children (Zeinstra et al., 2007). This study also found that most children achieved a

fruit variety score (FVS) of 3 and a vegetable variety score (VVS) of 4 over two non-consecutive days, which is similar to the findings of the few other studies that have reported FV variety in children (Scott et al., 2012, Ramsay et al., 2017). The use of non-consecutive 24 hour recalls (24HRs) utilising the Multiple Source Method (MSM) denotes the assumption that consuming three different fruit and four different vegetables over two days is habitual for the children studied (i.e., it is their 'usual' level of FV variety) (Harttig et al., 2011). While it has been suggested that consuming 20-30 different biologically distinct foods within a week, with an emphasis on plant foods, is needed for a healthy diet (World Health Organization and Food and Agriculture Organization, 2003), there is currently no quantified guideline specific to FV variety. Therefore, it cannot be concluded whether the children studied are consuming adequate FV variety or not. What the findings do provide is a description of the variety of FVs eaten by young children, which was an objective of the study. The secondary objective was to explore socioeconomic factors that may be associated with the frequency and variety of FVs consumed by young children, to fill in gaps in the knowledge of what influences the diets of this population. It was found that ethnicity, deprivation level, number of children in the household, respondent education level and work status all influenced the FV variety scores in some way.

Regarding the total FV variety score (FVVS), the largest distinction in the number of different FVs seen was between children of respondents who were on unpaid leave, and those who were not working (mean difference = 2.94). It is hypothesised that this relationship is due to parents/caregivers with the ability to take unpaid parental leave have sufficient alternative income or are of a higher SES, compared to those who are unemployed or who are working. The ethnicity of the children had the second largest impact on FVVS, with a significant distinction in FV variety between European and Pacific children (mean difference = 2.85). This difference is thought to coincide with the substantial difference in SES between European and Pacific New Zealanders, which contributes to proven discrepancies in income, education, and health status. The number of children living in a household also made a meaningful impact on children's FVVS, with a higher number of children coinciding with a lesser FV variety (mean difference = 2.69). This relationship may be explained by the increased dilution of a household's resources with an increased number of children living there, limiting a family's ability to provide a range of FVs. Whether a child's parent/caregiver attended university or only school also affected FVVS (mean difference = 2.64). This may be due to higher education making parents/caregivers more responsive to healthy eating messages, and/or, maintaining a work position with a higher salary, thus being better resourced to purchase more FVs. Lastly, a household's level of deprivation, measured by the NZ Deprivation Index (NZDep-18) influenced FVVS, with children living in low deprivation having larger FVVSs than those living in high deprivation (mean difference = 1.5). Deprivation influences what children eat through the income of the household and through the

accessibility and availability of FVs to purchase. As the socioeconomic factors mentioned above can influence the level of deprivation, it is surprising that the deprivation category resulted in the smallest mean FVVS difference. This may be because NZDep-18 calculates the deprivation of a geographical area, rather than an individual household. Finance is a consistent theme linking all the factors that significantly influenced FVVS. The level of income a household has affects the food budget and the quantity and variety of FVs that can be bought. When viewed in the context of price per calorie, many FVs are very expensive. Furthermore, when developing eating behaviours that affect young children's food preferences, many families cannot afford to purchase FVs that their children may not accept. Unfortunately, the cost of FVs may be the leading barrier to young children frequently consuming a variety of FVs.

4.3 Strengths and limitations

A key strength of this study is that a high number of Māori and Pacific children and children living in areas of high deprivation were represented. These groups are vulnerable, face social and health inequities and are unfortunately often underrepresented in the literature. The ethnic and deprivation spread of the sample achieved what Young Foods New Zealand (YFNZ) aimed for, which were proportions that broadly represents the NZ population; 50-60% European, 20-25% Māori, 10-15% Pacific, 10-15% Asian and 30% high deprivation, 40% mid deprivation, 30% low deprivation (Atkinson et al., 2014). Being given a $100 voucher as a thank you for participation may have motivated parents/caregivers who were economically disadvantaged, allowing for the overrepresentation of these groups. Furthermore, Māori and Pacific families may have been encouraged to participate because of the involvement of Māori researchers who advised on the recruitment and engagement of these groups. The dietary data was also gathered by trained interviewers utilising Multiple Source Method (MSM) and supportive tools such as photographs and food models, allowing for accurate estimates of usual intake (Harttig et al., 2011). Previous studies have also assessed FV variety using 24-hr diet recalls, as it allows for dietary assessment without inducing changes in children's dietary patterns (Thompson and Subar, 2017, Scott et al., 2012).

Multiple limitations exist that must be considered when interpreting the findings of this study. Measuring deprivation with the New Zealand Deprivation Index 2018 (NZDep-18) is limiting because NZDep-18 is a geography-based measurement (Atkinson et al., 2020), which negates households that may be of a high socioeconomic status (SES) in a deprived area, or vice versa. Another major limitation was the quantities or portion sizes of FV consumed were not considered in data analysis, as the protocol of entering mixed dishes YFNZ dietary data into FoodWorks and the subsequent coding of data prohibited the calculation of FV quantities. Lack of quantity limits the conclusions that can be

drawn and limit the ability to compare against literature that has measured FV quantity. The data presented also cannot provide a complete picture of the total FV variety. The nuances of the days of the week that dietary analyses were completed, and the season during which data was collected, likely limits reporting of food intake, especially of FVs that are rarely eaten. There were also multiple instances in the data collection and handling process where errors may have been made, as data was manually typed, entered into FoodWorks, then exported into REDCap. Detailed protocols were followed, and various quality control measures were taken to reduce the risk of human errors; however the risks can never be eliminated. Multiple types of bias also likely affected the results. In the main interviews, interviewers were trained, and detailed protocols were followed, however the potential of distortion of participants' responses due to the interviewing process cannot be overlooked. The potential of distorted responses is especially high for questions regarding deprivation, as many find the topic uncomfortable to discuss (Davis et al., 2010). Researchers took care to minimise recruitment bias by targeting all young children, however, recruitment only took place in three cities of Aotearoa NZ, thereby excluding children who live elsewhere. Bias can also be derived from over reporting consumption, particularly among those respondents with higher education levels. Better educated people have more knowledge about healthier food items (Hiza et al., 2013), and it is possible that they would tend to exaggerate their children's consumption of these items (Macdiarmid and Blundell, 1998). Finally, the cross-sectional design of this study means that causal relationships between FV variety and influencing factors cannot be established (Kesmodel, 2018).

4.4 Recommendations for future research

There is a need for a nationally representative cross-sectional study that reports both FV variety and quantity. With the newly updated guidelines for children and young people (2-18 years) to be published in the coming year, it is empirical for researchers and health professionals to have an understanding of the amount of FVs young children are actually consuming. Future research needs to continue reporting children's FV consumption and exploring factors that affect discrepancies in FV consumption between groups. It is recommended that future studies delve into differences in FV variety over different stages of taste preference development, rather than young children as a whole; because there may be large differences in the FV between children aged 2 years and children aged 4 years. There is also a requirement for standardisation and validation of FV variety measurement, to support future comparisons between literature. As mentioned in Chapter 3, it is difficult and inaccurate to compare findings when studies create different variety scores. More research on the impact of deprivation, SES, and household income on the FV variety of children. Furthermore, while

there is evidence of health inequity and discrepancies in healthcare outcome between ethnic groups, more research is required on the detailed differences in diet between ethnicities, and why these differences may occur, to support the demand of preventative nutrition from early life. The NZ government is obliged by Te Tiriti O Waitangi to create and adapt policies to support health equity for all New Zealanders. Policymakers cannot make meaningful changes without data to base the need for change on, nor can health professionals, such as dietitians, make recommendations for changes in eating behaviour without evidence to support their suggestions.

To conclude, this study provides insight into the frequency and variety that young children in Aotearoa NZ eat and socioeconomic factors that influence the variety of FVs they eat. The findings appear to have suggested that children who are Pacific, who live in households with four or more children, who live in areas of higher deprivation, and whose parents/caregivers are on unpaid parental leave or did not complete tertiary education are less likely to consume a variety of FVs. Because FV variety is linked to diet quality and optimal growth and development, these findings provide evidence of socioeconomic areas where some families require more support to provide the best nutrition for their children. However, this topic requires further investigation by researchers to confirm the findings and further support a causal relationship.

5. Appendices

Appendix A: Screening questionnaire

Appendix B: Participant information pamphlet

Appendix C: Main questionnaire

Appendix D: Food fed by other adults diary

Appendix E: 24-hour recall recording sheet

Appendix F: 24-hour recall protocol

Appendix G: Foods fed by other adults follow up protocol

Appendix H: 24 hour recall dietary data entry

Appendix I: 24-hour recall coding protocol

Appendix J: YFNZ recruitment flowchart

Appendix K: Additional results

Appendix A: Screening questionnaire

Screening questionnaire

How did you find out about this study?

- ○ Facebook
- ○ Website
- ○ Poster/flyer, please specify where you saw this: __________
- ○ Someone I know took part in the study
- ○ Friend/family member/colleague
- ○ Other, please specify: _______

Contact details

These first few questions ask about your contact details. (*Ask Q's as applicable*)

1. What is your name?

____

2. What is the name of your child who might take part in the study?

First name: _______________

Last name: _______________

3. Is [*child's name*] a girl or a boy?

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

4. How are you related to [*child's name*]?

- ○ Mother
- ○ Father

○ Grandparent
○ Guardian
○ Other Please state: ________

5. Are you the primary caregiver of [*baby's name*]?

○ Yes
○ No

6. What is your mobile number?

____

7. What is your email address?

____

8. What is your postal address?

____
(Street number and name, City, Region, Postcode)

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

○ Māori
○ Pacific
○ New Zealand European
○ Other

General screening questions

The next few questions will help us tell whether you and [*child's name*] are eligible to take part in this study.

10. What is [*child's name*]'s date of birth?

_______ / _______ / _______
dd mm yyyy

IF baby is 3.9 years old or younger **(GO TO Q10)**
IF baby is older than 3.9 years **(CLOSE)**

"We're sorry but unfortunately your child is outside our age range which means you cannot take part in our study - but thank you for taking the time to get in touch with us, and all the best."

11. What is your date of birth?

_______ / _______ / _______
dd mm yyyy

OR If you would feel more comfortable doing this could you tell me whether you are 16 years of age or older?

- ○ Yes, I am 16 years of age or older
- ○ No, I am less than 16 years of age

IF respondent is 16 years of age or older **(GO TO Q11)**
IF respondent is less than 16 years of age **(CLOSE)**

"We're sorry but we need our participants to be 16 years of age or older – this means you cannot take part in our study – but thank you for taking the time to get in touch with us, and all the best."

12. Which area of New Zealand do you live in?

- ○ Auckland **(GO TO Q11a)**
- ○ Wellington **(GO TO Q11a)**
- ○ Dunedin **(GO TO Q11a)**
- ○ None of the above **(CLOSE)**

"Unfortunately we need our participants to live in the Auckland, Wellington, or Dunedin area. We're sorry but this means you cannot take part in our study - but thank you for taking the time to get in touch with us, and all the best."

12a. Which Town/City do you live in?

[*See list of eligible Town/City's for respective regions at the end of this document*]

IF respondent lives in eligible town/city **(GO TO Q12)**
IF respondent does not live in eligible town/city **(CLOSE)**

"Unfortunately we need our participants to live in the Auckland, Wellington, or Dunedin area. We're sorry but this means you cannot take part in our study - but thank you for taking the time to get in touch with us, and all the best."

13. Has [*child's name*] been in a study over the last 6 months where you were asked to change what they eat?

- ○ Yes **(GO TO Q12a)**
- ○ No **(GO TO Q13)**

13a. What was the name of the study?

____

13b. Please briefly describe what the study involved: (especially what changes you were asked to make to what [*child's name*] ate)

____

13c. Who was running the study?

____

RESEARCHER: Confirm whether the study baby participated in was a nutrition intervention study *[NB: See P-2b for guidance on determining this].*

- ○ Child has participated in a nutrition intervention study **(CLOSE)**
- ○ Child has not participated in a nutrition intervention study **(GO TO Q13)**

"Unfortunately we need our participants to have a child who hasn't participated in a nutrition intervention study recently. We're sorry but this means you cannot take part in our study - thank you for taking the time to get in touch with us, and all the best."

Childcare

We would like to know about your use of childcare with [*child's name*] - this will help with
planning study visits.

14. Is [*child's name*] regularly looked after by someone other than yourself? *Please select all answers that apply.*

- ○ No **(FINISH QUESTIONNAIRE HERE; GO TO CLOSING)**
- ○ 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: ____

14a. On what days is [*child's name*] usually looked after by someone other than yourself? *Please indicate whether each day specified is for the morning or afternoon, or both.*

Monday

- ○ Yes
  - ○ AM
  - ○ PM
- ○ No

Tuesday

- ○ Yes
  - ○ AM
  - ○ PM
- ○ No

Wednesday

- ○ Yes
  - ○ AM
  - ○ PM
- ○ No

Thursday

- ○ Yes
  - ○ AM
  - ○ PM
- ○ No

Friday

- ○ Yes
  - ○ AM
  - ○ PM
- ○ No

Saturday

- ○ Yes
  - ○ AM
  - ○ PM
- ○ No

Sunday

- ○ Yes
  - ○ AM
  - ○ PM
- ○ No

14b. Any comments about childcare?

____

__Closing__

If eligible including child correct age (5.5 months to 3.9 years)
*"Thanks for that; you're able to take part in the study if you decide you'd be interested in doing that when you know a bit more about it." **Return to P-3***

If baby too young to decide eligibility (< 5.5 months)
"Thank you for that information. Because [child's name] is not quite old enough yet, we'll be back in touch when your baby is around 6 months old. Thank you so much for taking the time to get in touch with us - we'll talk soon. Bye."

Appendix B: Participant information pamphlet

What if I have any questions?

For questions day-to-day see our contact details on our website:
www.firstfoods.co.nz/young-foods

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

Investigators
Pamela von Hurst (Auckland)
09 414 0800
P.R.vonhurst@massey.ac.nz

Rachael Taylor (Dunedin)
03 470 9180
rachael.taylor@otago.ac.nz

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

If you want to talk to someone who isn't involved with the study, you can contact an independent health and disability advocate on:
Phone: 0800 555 050
Fax: 0800 2 SUPPORT (0800 2787 7678)
Email: advocacy@advocacy.org.nz
For Māori health support, please contact:
Turuki Health Care
Phone: 09 275 5788 (Māngere) / 09 570 8643 (Panmure)
Email: mangere@thc.org.nz / panmure@thc.org.nz
You can also contact the University of Otago Human Ethics Committee (Health) that approved this study on:
Phone: 03 479 8256
Email: gary.witte@otago.ac.nz

Feeding our young children – are we getting it right?

YOUNG FOODS
— New Zealand —

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

September 2020

Why?

We want to look at how and what young children 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 feeding their children. This study has ethical approval from the University of Otago Human Ethics Committee: H20/040.

What does this study involve?

We are looking for parents or guardians from Dunedin, Auckland or Wellington with young children who are 6 months to 3.9 years of age to take part in this study. Young Foods NZ is an 'observational' study, looking at what and how young children are fed. You will **not** have to change the way you feed your child in any way or do anything different. We need to recruit a large number of families – a total of 300 – so expect that the study will finish in 2022.

What would I be asked to do?

Attend two visits when your child is between 6 months and 3.9 years old. These visits will take place over two weeks and will take 2-3 hours in total.

How will my information be used?

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

What happens after the study?

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

We will store information, including images, on a secure online storage system overseen by the University of Otago for at least 10 years after your child turns 16 years old, after which time the information will be destroyed. Researchers will only have access to this information for specific study-related tasks.

2

7

What if something goes wrong?

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

What are my rights?

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

First visit

This visit will take place at our Albany Massey University research center, your home, or preferred location. Our research center is a comfortable and safe place with a breastfeeding area and plenty of toys for your child. We will measure your child's weight and length/height and ask you to fill out a couple of questionnaires about your child's feeding and health. We will ask you to tell us what, and how much, your child ate the day before. Because this can be difficult to remember, we will ask you to take photos of child'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 is in our clinic. One of our staff will take some photographs of your child's mouth and teeth. Then we will ask you to tell us what, and how much, your child ate the previous day (like you did for the first visit). This visit will take less than one hour.

We will ask your permission to let us access information from your child'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 child's National Health Index (NHI) number to do this.

Who pays for the study?

This study is funded by the Ministry for Primary Industries. There is no cost for you to take part. However, as a recognition for taking part in the study we will give you a $100 voucher as a thank you.

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

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

What are the benefits if I take part?

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

- Know that you are helping improve the health of NZ children
- Be helping health workers give parents and whānau advice they can trust

What are the potential risks?

We don't think there are any large risks to taking part in this study.

Appendix C: Main questionnaire

YOUNG FOODS
— New Zealand —

Main Questionnaire

Welcome and thank you for being part of the YFNZ Study.
This questionnaire is split into 7 sections and will probably take about 15 minutes to do.
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 child?

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

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

2a. What is today's date? _______ / _______ / _______ (day / month / year)

Section 2: Some questions about your pregnancy with this child

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

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

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

- ○ Yes
- ○ No
- ○ Don't know

*If answer is 'No' – skip [medication Qs]; go to **Question 5***

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

____

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

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

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

- ○ Yes
- ○ No

If answer is 'No' – skip [next Qs]

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

____

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

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

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

- ○ Yes
- ○ No

If answer is 'No' – skip [next Qs]

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

____

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

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

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

- ○ Forceps were used
- ○ Caesarean birth
- ○ Other Please describe: ____________________
- ○ There were no interventions

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

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

7. Is your child a girl or a boy?

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

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

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

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

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

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

- ○ Yes
- ○ Don't know
- ○ No

If answer is 'No' – go to Q11

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

- ○ Yes
- ○ No

If answer is 'No' – go to Q11

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

Iwi: ______________________________

Region: ______________________________

Iwi: ______________________________

Region: ______________________________

Iwi: ______________________________

Region: ______________________________

Iwi: ______________________________

Region: ______________________________

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

- ○ Yes Please state: ______
- ○ No

Section 3: Your child and food

12. How was your child 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

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

- ○ 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]

13a. How old was your child 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
- ○ 12 months old or older

14. Are there any traditional or cultural (family or whānau) foods you like your child to have?

- ○ Yes Please describe: __________
- ○ No

15. How knowledgeable are you of traditional **Māori** culture and lifestyle?

○	○	○	○	○
Very knowledgeable	Somewhat knowledgeable	Neutral or no response	Somewhat not knowledgeable	Not at all knowledgeable

16. How knowledgeable are you of traditional **Pacific** culture and lifestyle?

○ ○ ○ ○ ○

Very knowledgeable	Somewhat knowledgeable	Neutral or no response	Somewhat not knowledgeable	Not at all knowledgeable

17. How <u>knowledgeable</u> are you of **New Zealand European/Pākehā** culture and lifestyle?

○ Very knowledgeable	○ Somewhat knowledgeable	○ Neutral or no response	○ Somewhat not knowledgeable	○ Not at all knowledgeable

18. How <u>involved</u> are you in **Māori** culture and lifestyle?

○ Very involved	○ Somewhat involved	○ Neutral	○ Somewhat not involved	○ Not at all involved

19. How <u>involved</u> are you in **Pacific** culture and lifestyle?

○ Very involved	○ Somewhat involved	○ Neutral	○ Somewhat not involved	○ Not at all involved

20. How <u>involved</u> are you in **New Zealand European/Pākehā** culture and lifestyle?

○ Very involved	○ Somewhat involved	○ Neutral	○ Somewhat not involved	○ Not at all involved

21. How do you <u>feel toward</u> the **Māori** culture and lifestyle?

○ Very positive	○ Somewhat positive	○ Neutral or no response	○ Somewhat negative	○ Very negative

22. How do you <u>feel toward</u> the **Pacific** culture and lifestyle?

○ Very positive	○ Somewhat positive	○ Neutral or no response	○ Somewhat negative	○ Very negative

23. How do you <u>feel toward</u> the **New Zealand European/Pākehā** culture and lifestyle?

○ Very positive	○ Somewhat positive	○ Neutral or no response	○ Somewhat negative	○ Very negative

24. How important is it for you to maintain a **Māori** lifestyle and identity?

○	○	○	○	○
Very important	Somewhat important	Neutral or no response	Very little importance	No importance at all

25. How important is it for you to maintain a **Pacific** lifestyle and identity?

○	○	○	○	○
Very important	Somewhat important	Neutral or no response	Very little importance	No importance at all

26. How important is it for you to maintain a **New Zealand European/Pākehā** lifestyle and identity**?**

○	○	○	○	○
Very important	Somewhat important	Neutral or no response	Very little importance	No importance at all

Section 4: Your child and food pouches

The questions in this section ask about squeezable food pouches with a nozzle. Some examples are shown below. Please don't include pouches without a nozzle.

27. Has your child ever eaten food from a food pouch?

○ Yes
○ No

*If the answer is 'No' – go to [pouch dislikes; **Q43**]*

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

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

- ○ 2-3 times a month
- ○ Once a month
- ○ Less than once a month

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

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

30. When your child has food from a food pouch, how do they 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: ***Q31, Q35, Q36, Q37, Q38]***

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

- ○ An adult
- ○ Mostly an adult, sometimes child
- ○ About half of the time an adult and half of the time child
- ○ Mostly child, sometimes an adult
- ○ Child

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

32a. Brand and flavour of food pouch child eats most commonly:

____

32b. How often has your child 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

33a. Brand and flavour of food pouch child eats second most commonly:

____

33b. How often has your child 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

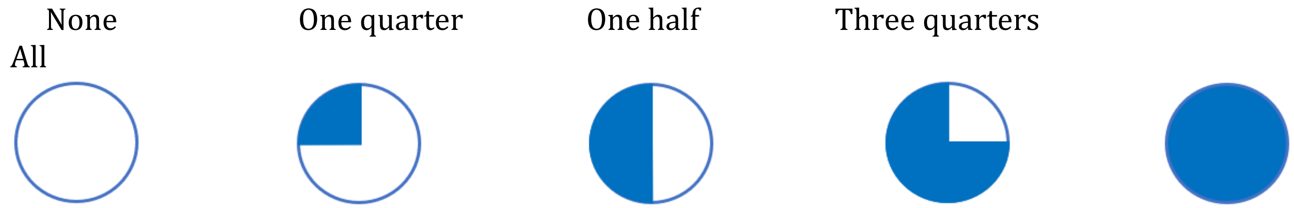
34a. Brand and flavour of food pouch child eats third most commonly

____

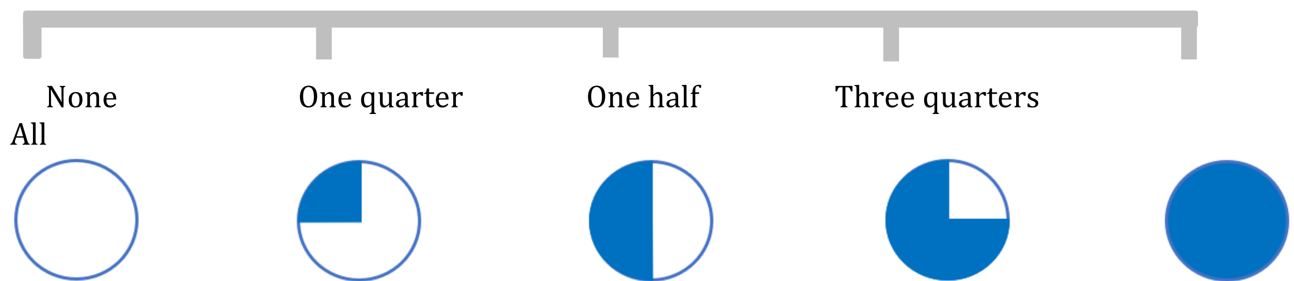
34b. How often has your child eaten this food *in the past month*?

- ○ 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

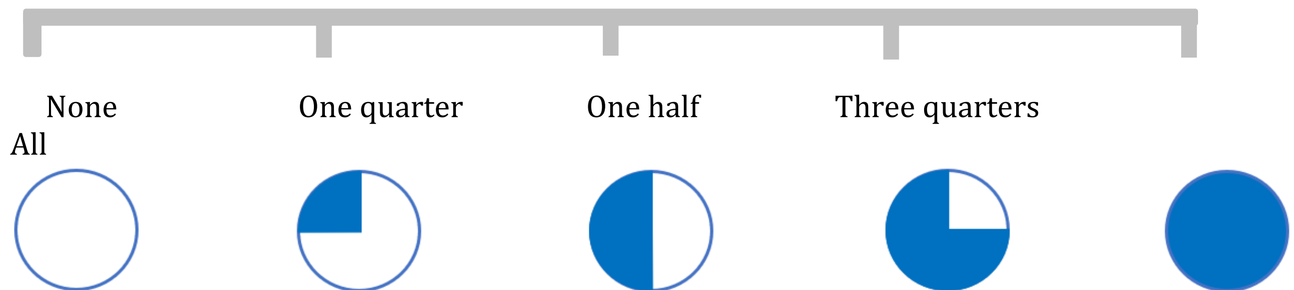
35. Out of all the food your child eats, what proportion do they eat by feeding themselves directly from a pouch (holding a pouch themselves and sucking through the nozzle)? Show this on the sliding scale:



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



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



If the answer is 'None' – skip Q38 and go to [pouch 'where'; Q39]

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

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

39. Where is your child usually when they are given a food pouch? *Please select the option that is the* *<u>most common</u>.*

- ○ 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: ____

40. Does your child eat from 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: ____

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

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

42. Why do you use food pouches? *Please select all options that apply.*

- ○ Easy to use
- ○ Less mess
- ○ Cost less
- ○ Takes less time
- ○ Practical

- ○ I have my hands free to do other things
- ○ My child 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 child eats
- ○ Healthier than foods the family eats
- ○ The food in them is good for child
- ○ Organic
- ○ Doesn't waste as much food
- ○ The packaging keeps the food fresh
- ○ Safety
- ○ Other Please state: ____

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

- ○ Yes Please state: ____
- ○ No

Section 5: Some questions about your child's teeth

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

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

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

- ○ Yes

○ No
○ Sometimes

If answer is 'No' – skip [next Q]

45a. How do you clean your child's teeth (or mouth if they don't have any teeth)? (e.g., brush with a soft brush, wipe with a damp cloth)

____

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

○ Yes
○ No

If answer is 'No' – skip [next Q]

46a. What else do you do to look after your child's teeth (or mouth if they don't have any teeth)?

____

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

○ Yes
○ No

If answer is 'No' – skip [next Q]

47a. What concerns do you have about your child's teeth (or mouth if they don't have any teeth)?

____

Section 6: Some questions about supplements

48. Has your child taken any supplements in the past month?

○ Yes
○ No

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

49. 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]

50a-i. **Multivitamin and/or multimineral:** How often did your child take the supplement in the past month?

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

50a-ii.
Multivitamin and/or multimineral: Is your child currently taking this supplement?

○ Yes
○ No

50a-iii.
Multivitamin and/or multimineral: If you know the brand name and/or the product name please write them here. Please provide as much information about the product as possible.

____

50a-iv.
Multivitamin and/or multimineral: If you have the supplement please could the researcher take a photo of it.

[*upload photo*]

[repeat option]

51a-i. Single vitamin or mineral: Please tell us what vitamin or mineral it was:

____

51a-ii.

Single vitamin or mineral: How often did your child take the supplement in the past month?

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

51a-iii.

Single vitamin or mineral: Is your child currently taking this supplement?

- ○ Yes
- ○ No

51a-iv.

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

____

51a-v.

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

[*upload photo*]

[repeat option]

52a-i. Other: How often did your child take the supplement in the past month?

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

52a-ii.
Other: Is your child currently taking this supplement?

- ○ Yes
- ○ No

52a-iii.
Other: If you know the brand name and/or the product name please write them here. Please provide as much information as possible.

____

52a-iv.
Other: If you have the supplement please could the researcher take a photo of it.

[*upload photo*]

[repeat option]

Section 7: Some final questions

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

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

- ○ NZ European
- ○ Māori
- ○ Samoan
- ○ Cook Island Māori
- ○ Tongan
- ○ Niuean

- ○ Chinese
- ○ Indian
- ○ other, eg Dutch, Japanese, Tokelauan. Please state: ________

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

- ○ Yes
- ○ Don't know
- ○ No

If answer is 'No' – go to Q55

54a. Do you know the name(s) of your iwi (tribe or tribes)?
See the Guide Notes for a list of iwi.

- ○ Yes
- ○ No

If answer is 'No' – go to Q55

54b. Enter the name(s) and region(s) of your iwi (tribe or tribes):
See the Guide Notes for a list of iwi.

Iwi: ______________________________

Region: ______________________________

Iwi: ______________________________

Region: ______________________________

Iwi: ______________________________

Region: ______________________________

Iwi: ______________________________

Region: ______________________________

55. Do you currently have paid employment?

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

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

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

57. How tall are you without shoes?

_______ cm *or* _______ feet and _______ inches

58. How much do you weigh?

_______ kg *or* _______ pounds *or* _______ stone and _______ pounds

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

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

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

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

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

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

62. Is your child 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 e.g., Kohanga Reo, Pacific term? kindy, creche, daycare
- ○ Yes, they go to homebased care
- ○ Yes, other Please state: ___

If answer is 'No' – go to Q63

62a. How many hours does your child usually spend in someone else's care each week?

- ○ None
- ○ Fewer than 5 hours
- ○ 5 to 10 hours
- ○ 11 to 20 hours
- ○ 21 to 30 hours
- ○ 31 to 40 hours
- ○ More than 40 hours

63. Is your child currently being breastfed (or having expressed breast milk)?

- ○ Yes
- ○ No

Thank you very much for completing this questionnaire

Appendix D: Food fed by other adults diary

We know how busy it can be looking after little ones – thank you very much for filling out the information on these pages. We really appreciate your support of the parents' participating in this study.

If you would like to know more about the Young Foods NZ study, our website is www.firstfoods.co.nz/young-foods

If you have any comments or questions, then feel free to contact the study on 0212791290 or auckland@firstfoods.co.nz

We would like you to please:

- **Step 1 & 2**: Write down what food and drink was offered to the child while in your care, and write the time of the day and place they were served these items. Please list each food or drink item individually (e.g., 'bread' 'cheese' instead of 'cheese on toast') and remember to include all water, breast milk and infant formula as well.
- **Step 3**: **Estimate** how much food and drink s/he has **EATEN (this might be less than they were offered)**. You can use household measures (e.g., cups or spoons), sizes of packets (e.g., 140g yoghurt pottle, 15g "Kids" bar).
- **Step 4**: Tick the option that best describes who put the food in his/her mouth. You can tick both options if it was a combined effort (like when you guide the spoon to their mouth but they help push the spoon in).
- **Step 5**: Tick to indicate whether food was from a food pouch. If yes, tick the option that best described how child was fed food from the pouch. *Note*: *child fed directly from pouch* means child held pouch and sucked through pouch nozzle, *adult fed child directly from pouch* means adult held pouch and child sucked through pouch nozzle.
- **Step 6**: If any foods eaten are recipes, please attach a copy of the recipe to this sheet, including the number of portions the recipe makes. Then in the "amount eaten" column, please record how many of these portions s/he ate e.g., ½ a portion or 2 portions.

2

Young Foods NZ

Foods Fed by Other Adults Diary

"Other Caregiver" name: ______________ Date: __________

Caregiver's role (e.g., family member, Early Childhood Centre staff): ______________________________

If Early Childhood Centre staff, please state name of centre:

____

________________ is involved in a study looking at what and how children eat. We would really appreciate it if you could write down a complete description of what s/he eats today while in your care, following the instructions on the next page. Your help in completing this diary will provide information so that health professionals and policy makers can advise parents and whānau on feeding their children.

7

Recipes

Step 6: Please record the full recipe and number of portions it makes

Here's an example of how to fill out the food diary:

Step 1	Step 2			Step 3	Step 4				
Time and Place	Food name	Food brand	Cooking method	Amount eaten	Was food from a food pouch?				
					No	Yes			
						Child fed self directly	Adult fed child directly	Adult fed child from spoon	Child fed self pouch via spoon
10 am floor	*Apple, pear and berries squeeze pouch*	*Watties*		*1 pouch (120 g)*		✓			
	Orange flavoured fruit drink	*Raro*		*¼ cup*	✓				
12 noon Highchair	*Lasagne – See Recipe*	*Homemade*		*1 portion*	✓				
	Potato		*boiled*	*¼ cup*	✓				
	Peas		*boiled*	*10 peas*	✓				

Food diary:

Step 1	Step 2			Step 3	Step 4				
Time & Place	Food name	Food brand	Cooking method	Amount eaten	Was food from a food pouch?				
					No	Yes, how was food from pouch fed?			
						Child fed self directly from pouch	Adult fed child directly from pouch	Adult fed child from spoon	Child fed self pouch via spoon

Appendix E: 24 hour recall recording sheet

Participant ID: ____________ Interviewer: ________________

Date: ____________ Day of the Week: ________________

1. Was the child unwell yesterday?	☐ NO	☐ YES
1a. If unwell, did this influence the child's appetite?	☐ NO	☐ YES

QUICK LIST

☐ ______________________________
☐ ______________________________
☐ ______________________________
☐ ______________________________
☐ ______________________________
☐ ______________________________
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☐ ______________________________
☐ ______________________________
☐ ______________________________

Yes **No**	**Is salt added to any foods or drinks (including on days not covered by the 24 hour recall)?** **If yes, was the salt iodised and .. what foods/ drinks?**
Yes **No**	**Is sugar added to any foods or drinks (including on days not covered by the 24 hour recall)? If yes .. what foods/ drinks**
Yes **No**	**Is the child offered any drinks other than breast milk, formula, or water (things like juice, flavoured milk, soft drinks, tea, alcohol or any other drink) If yes .. what drinks**

Ask about drink & snack consumption and foods fed by other adults at the end of quick list

Participant ID: ____________ Interviewer: ________________

Date: ____________ Day of the Week: ________________

DETAILED 24-H RECALL

Time	Place	Description of Food/Drink	Brand	Amount consumed	Pouch used?				
					No	Yes			
						Child fed self directly	Adult fed child directly	Adult fed child from spoon	Child fed self pouch via spoon

3

P-6b1: 24-h recall protocol

Copy no. ______

Study:	YFNZ	*Version number:*	Version 5
Prepared by:	NM, LF, ALH, HD	*Date prepared:*	08/06/2020

Objective

- Capture a detailed assessment of the child's diet from the previous day, while also capturing data relevant to food pouch use and dental health.

Equipment required

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

Process – Before

In office:

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

At appointment:

- Download photos following **P-6b2: Transfer 24-h recall photos**.
- Open Countdown website on laptop.

- Set out measurement aids and visuals. ***Caution*:** This set contains dried beans which are a choking hazard for young children.

Process – During

Introduction

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

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

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

Carry out 24-h recall interview.

Stage One: Quicklist

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

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

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

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

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

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

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

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

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

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

If child consumed food/drink while in the care of another adult/in childcare:

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

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

Stage Two: Detailed list

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

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

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

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

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

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

- **Time**. Collect time of consumption of the first mouthful of food for each meal/snack. *NB*: You may find this information by viewing the image details.
- **Place**. Collect location fed for each eating occasion – include both specific and broad place fed (e.g., highchair at home, car seat in car).
- **Description of Food/Drink**. Record the name of the food and cooking method used. Use **O-16: Food Description Prompts sheet** to guide you about specific details to obtain from certain foods and drinks. Record each food/drink item in a different row.
- **Brand**. Record the product brand (or record 'brand unknown') (*note*: to identify the brand, look at the product packaging on the photograph, in the home (visit 1), or search for the product on Countdown website). Alternatively, note if the food/drink item was 'homemade' (if so, ask for recipe – record in the 'Recipe' section).
- **Amount**. Record the amount consumed. Use size of packet information if possible (see product package). Alternatively, use bottles, dishes and utensils in the home (visit 1), or measurement aids and visuals, to help the participant estimate the portion size. *Note*: in visit 1 (home) record in the 'Notes' section of your recording

sheet a description of the size of the bottle/dish/utensil (e.g., 120 mL Sippy cup), so you can refer to this to compare sizing in visit 2 (clinic).

- **Used pouch**. Tick to indicate whether food was from (stored in or served from) a food pouch (including commercial and home-filled pouches). If so, tick the option that best describes how the pouch was used:
  - Child fed self directly (i.e. child holds pouch and sucks through nozzle)
  - Adult fed child directly (i.e. adult holds pouch and child sucks through nozzle)
  - Adult fed child via spoon
  - Child fed self pouch via spoon
  - If another method was used, record this.

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

"Did they have anything with that?"

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

→ *If <u>'Foods Fed by Other Adults' form was attempted</u>, write 'SEE FFOA FORM' on the recording sheet. Check the 'Foods Fed by Other Adults' form has been filled out correctly and completely.*

→ *If <u>participant provided food to eat while in their care</u> (e.g., packed lunch box), find out what food was provided and how much was sent home. Record this on the 24-h recall recording sheet.*

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

Stage Three: Review and probe for forgotten foods

Ask about and record:

1. *Forgotten foods/liquids*
2. *Home-filled pouch use*
3. *Salt addition*
4. *Sugar addition*
5. *Other beverages*

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

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

1. *Review the list of foods and beverages with the participant.*
   E.g. "At 8 am, [child's name] ate a rice cracker and some peanut butter toast while in the car going to day care.

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

3. *Ask about home-filled pouch use:*

Has the parent/guardian reported any pouch use

YES **(GO TO 'b')**
NO **(END)**

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

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

3. *Salt addition*
   Is salt added to any foods or drinks (including on days not covered by the 24-hour recall)? If yes, was it iodised and what foods/ drinks?

4. *Sugar addition*
   Is sugar added to any foods or drinks (including on days not covered by the 24-hour recall)? If yes, what foods/ drinks?

5. *Other beverages*
   Is the child offered any drinks other than breast milk, formula, or water (things like juice, flavoured milk, soft drinks, tea, alcohol or any other drink) If yes, what drinks?

Thank the participant for their time.

Process – After

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

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

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

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

   Save files to a folder labelled in the following format:
   [*Participant ID*]_DR[*1/2*]
   E.g., YF1001AB_DR1

   Label each file with Participant ID, diet recall number, document name, and date:
   [*Participant ID*]_DR[*1/2*]_[*document name*]_[*date*]
   E.g., YF1001AB_DR1_RecordingSheet_10Jun2020

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

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

   Save files to a folder labelled in the following format:
   [*Participant ID*]_DR[*1/2*]
   E.g., YF1001AB_DR1

   Label each file with Participant ID, diet recall number, document name, and date:
   [*Participant ID*]_DR[*1/2*]_[*date*]
   E.g., YF1001AB_DR1_10Jun2020

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

Appendix G: Foods fed by other adults follow up protocol

P-6b3: Foods fed by other adults follow up protocol

Copy no. ______

Study:	YFNZ	*Version number:*	Version 2
Prepared by:	NM, ALH	*Date prepared:*	08/06/2020

Objective

- Obtain information about what the child ate and drank while in the care of 'other caregivers' (i.e. not parent/caregiver being interviewed) that was not obtained during the 24-h recall.

During 24-h recall – Equipment

Protocols: **P-6b3: Foods fed by other adults follow up protocol** (this protocol)

Documents: **O-15: 24-h recall recording sheet**

During 24-h recall – Process

A1 *"It looks like we are missing some information about [what/how much/etc] [child's name] ate while in [other caregiver's] care. Would you be happy for us to call [other caregiver] so we can get a complete record of what [child's name] ate yesterday?"*
→ YES **(CONTINUE)**
→ NO **(GO TO A2)**
→ NO – PARTICIPANT WOULD PREFER TO MAKE CONTACT **(GO TO A2a)**

A1a → IF MISSING INFORMATION FROM CHILDCARE SETTING **(GO TO A1a1**)
→ IF MISSING INFORMATION FROM ANOTHER ADULT **(GO TO A1a2)**

A1a1 CONFIRM/ASK FOR NAME OF CHILDCARE CENTER AND NAME OF THE STAFF MEMBER WHO OVERSEES CHILD IF KNOWN **(GO TO A1c)**

A1a2 CONFIRM/ASK FOR [*other caregiver's*] FIRST AND LAST NAMES

A1b *"May we have [other caregiver]'s phone number?"*
→ YES: WRITE PHONE NUMBER IN NOTES; REPEAT BACK PHONE NUMBER TO VERIFY
→ NO: "Is there another way you'd prefer we contacted them?"

A1c *"If we contact [other caregiver] and they don't feel comfortable about answering our questions about what [child's name] ate, can we say that you would be happy to talk to them to reassure them about the study?"*
→ YES **(CLOSE)**
→ NO **(NOTE THIS; CLOSE)**
START FOLLOW UP CONTACT IMMEDIATELY AFTER APPOINTMENT

A2 *"Would you be able to contact [other caregiver] to find out what [child's name] ate and drank when [he/she] was with them?"*
→ YES **(CONTINUE)**

→ NO **(CLOSE; RECORD FFOA FOLLOW UP CONTACT AS UNRESOLVED)**

A2a "*Excellent – thank you. I'll send you an email with the information we need right after we're finished here today. It would be great if you could get this information from [other caregiver] before he/she forgets anything – would you be able to contact that person today or tomorrow? Thank you – that would be really good.*"
MAKE NOTE TO SEND EMAIL **(CLOSE; RETURN TO P-6b1)**
START FOLLOW UP CONTACT IMMEDIATELY AFTER APPOINTMENT

Follow up contact – Equipment

Documents: **P-6b3: Foods fed by other adults follow up protocol** (this protocol)
P-6b1: 24-h recall protocol
O-12: Foods Fed by Other Adults form (if attempted)
O-15: 24-h recall recording sheet (incomplete)

Equipment: **Laptop with access to REDCap**

Follow up contact - Steps before

1. During the 24-h recall identify missing information about foods fed by other adults (**P-6b1**) and record this in the 'Notes' section of the recording sheet (**O-15**).
2. Only follow up about ***<u>significant</u>*** missing information:
    a. what the child ate/drank
    b. amount eaten
    c. whether (and how) a pouch was used
    d. in some circumstances, the brand name (e.g., to determine whether a food was iron fortified).

   You do not need to follow up about time fed or place fed.
3. Ensure you have clearly identified the significant information to follow up on before making follow up contact.
4. <u>As soon as possible after the appointment</u>, make follow up contact with the 'other caregiver' via phone **(START AT B1)** or with the participant via email, as appropriate.

Follow up contact – Steps during:

Via <u>phone</u>

NOTE: Attempt initial follow up contact a maximum of 5 times. If no response after the fifth attempt at initial follow up contact, record FFOA follow up contact as unresolved (on the Diet recall form (under the appropriate visit) in REDCap).

B1 "*Hello, my name is [researcher's name]. May I please speak with [other caregiver]?*
→ INITIAL CONTACT **(GO TO B1a)**
→ RESCHEDULED CONTACT **(GO TO B2)**

B1a *"Hello, my name is [researcher's name]. [Respondents name] gave me your number to talk to about what [child's full name] ate on [day of interest] while [he/she] was in your care. It's for a study that [child's name] is taking part in about what children eat called the Young Foods New Zealand study. Is now a good time to ask you a few questions about this?"*
→ YES **(GO TO B5)**
→ NO – NOT A GOOD TIME **(GO TO B4)**
→ NO – WANTS TO DISCUSS WITH PARTICIPANT **(GO TO B3)**
→ NO – REFUSED INTERVIEW **(TERMINATE; RECORD FFOA FOLLOW UP AS UNRESOLVED)**

B2 "*Hello, it's [researcher's name] here from Young Foods New Zealand. I recently contacted you to ask you about what [child's full name] ate on [day of interest] while he/she was in your care for a study about what children eat. Is now a good time for you to talk?*"
→ YES **(GO TO B5)**
→ NO – NOT A GOOD TIME **(GO TO B4)**
→ NO – WANTS TO DISCUSS WITH PARTICIPANT **(GO TO B3)**
→ NO – REFUSED INTERVIEW **(TERMINATE; RECORD FFOA FOLLOW UP AS UNRESOLVED)**

B3 "*I understand. [Respondents name] has told us they are happy for you to contact them if you have any concerns about talking to us. Would you like me to call you back after you've had the chance to talk to them?*"
→ YES **(GO TO B4)**
→ NO – REFUSED FURTHER CONTACT **(TERMINATE; RECORD FFOA FOLLOW UP AS UNRESOLVED)**

B4 "*When would be a good time to call you back?*"
NOTE TIME AND DATE **(CLOSE; START FOLLOW UP CONTACT AT B1)**

B5 → IF FOODS FED BY OTHER ADULTS FORM WAS ATTEMPTED **(GO TO B5a1)**
→ IF FOODS FED BY OTHER ADULTS FORM WAS NOT ATTEMPTED **(GO TO B5a2)**

B5a1 "*Excellent, thank you. I understand you filled in the form about what [child's name] ate while he/she was in your care on [day of interest]. There are a few things on this form I would like to ask you about.*"
GO THROUGH AND RECORD MISSING INFORMATION ON *NOTES* SHEET
ONCE ALL INFORMATION OBTAINED **(CLOSE)**

B5a2 "*Excellent, thank you. I'm interested to know everything [child's name] ate while in your care on [day of interest] – that includes snacks, drinks and water, even just having a small taste of something, as well as meals.*
First, I'd like to make a quick list of all the things [child's name] ate and drank while in your care [on day of interest]. After that, I'll ask you to give me some more details about each food and drink, like the amounts eaten and how they were fed. I know how challenging it is to keep track of what little ones eat, so I really appreciate you helping us with this.
So, what was the first thing [child's name] ate while in your care [on day of interest]?"
RECORD DIRECTLY ONTO INCOMPLETE 24-H RECALL RECORDING SHEET
COMPLETE QUICKLIST AND COLLECT ONLY SIGNIFICANT FURTHER DETAIL (#2 above)
ONCE INFORMATION IS OBTAINED **(CLOSE)**

CLOSE

"Thank you very much for your time. You have been a great help to us for this important study. Goodbye."

TERMINATE

"Thank you very much for your time. Goodbye."

Via email

1. Prepare email for the participant using email template in **Appendix 1**:
    a. Foods Fed by Other Adults form attempted (see **FFOA form attempted**)
    b. Foods Fed by Other Adults form not attempted (see **FFOA form not attempted**)

>> **If participant responds with information**: Print off the email thread and staple it to the back of the 24-h recall recording sheet.

>> **If participant does not respond within 2 days of initial follow up contact attempt**: Send one reminder email to the participant.
   i. **If participant responds with information**: Print off the email thread and staple it to the back of the 24-h recall recording sheet.
   ii. **If no response**: Record FFOA follow up as unresolved (on the Diet recall form (under the appropriate visit) in REDCap).

Follow up contact – Steps after

1. Make a note of each contact and attempt at contact on the **Participant Tracking Form** in REDCap – in the appropriate section of the 'Participant Contacts' section. Save and exit the form.

2. Update the **Diet Recall form** (under the appropriate visit) on REDCap:
    a. Ensure the 'Has [*the FFOA follow up*] been resolved?' field has been answered.
    b. Ensure the 'Final 24-h recall status' field has been answered. If 'Incomplete', specify the reason incomplete and type of missing information.
    c. Mark the form status as 'Complete' then save and exit the form.

3. Staple the missing information notes back to the original 24-h recall recording forms.

4. Download all 24-h recall documentation to HCS:
    - DUNEDIN: Scan all completed 24-h recall documentation and download this to the University High-Capacity Central File Storage system (*location XXX*) – please use the format shown below for file and folder names.
    - MASSEY/WELLINGTON: Scan/mail completed 24-h recall recording sheets to XXX (address) – please use the format shown below for file names. XXX will download this to the University High-Capacity Central File Storage system (*location XXX*).

Save files to a folder labelled in the following format:

[*Participant ID*]_DR[*1/2*]

E.g., YF1001AB_DR1

Label each file with Participant ID, diet recall number, document name, and date:

[*Participant ID*]_DR[*1/2*]_[*document name*]_[*date*]

E.g., YF1001AB_DR1_24-h recall recording sheet_10Jun2020

5. File paperwork in locked filing cabinet (*location XXX*).

P-19: 24-h recall dietary data entry (to FoodWorks)

Copy no. ______

Study:	YFNZ	*Version number:*	Version 2
Prepared by:	NM, LF, ALH	*Date prepared:*	23 July 2020

Objectives

- To ensure accurate and consistent entry of YFNZ 24-h recall data into FoodWorks.
- To allocate an 'item ID' and 'amount offered in grams' value to each food item reported in the 24-h recall.

Equipment required

Protocols: **P-19: 24-h recall dietary data entry** (this protocol)

Documents:
O-15: 24-h recall recording sheet
O-12: Foods Fed by Other Adults form (if used by participant)
O-34: FoodWorks instructions
'YFNZ Codebook' excel file (access via YFNZ google docs via student desktop)
'New foods and substitutions request' excel file (access via YFNZ google docs)

Equipment: "Your" coloured pen (for annotating the 24-h recall recording sheet if needed – see below)
Computer with access to:
- Shared student desktop
- Sci-hunt-firstfoods HCS share (\\storage.hcs-p01.otago.ac.nz\sci-hunt-firstfoods)
- YFNZ FoodWorks database
- Kai-culator
- REDCap

NB: Any notes/marks added to the original 24-h recall must be in a different pen colour (e.g., pink) and the name of the person who made the notes and the date they were made must be recorded on the front of the 24-h recall recording sheet with the colour of the pen (or a scribbled sample of the colour). The colour used by each annotator should be recorded in the 'YFNZ Codebook' (see 'Codebook Instructions' sheet).

Steps - before

- Make sure you are familiar with the nature and scope of the 'YFNZ Codebook'
- 24-h recall (and follow up if necessary) has been completed.
- Move the participant's checked 24-h recall documents folder to the *Entry in progress* folder in HCS:

  FROM: *24-h recall > 24-h recall documents > [area] > 2. Not entered*

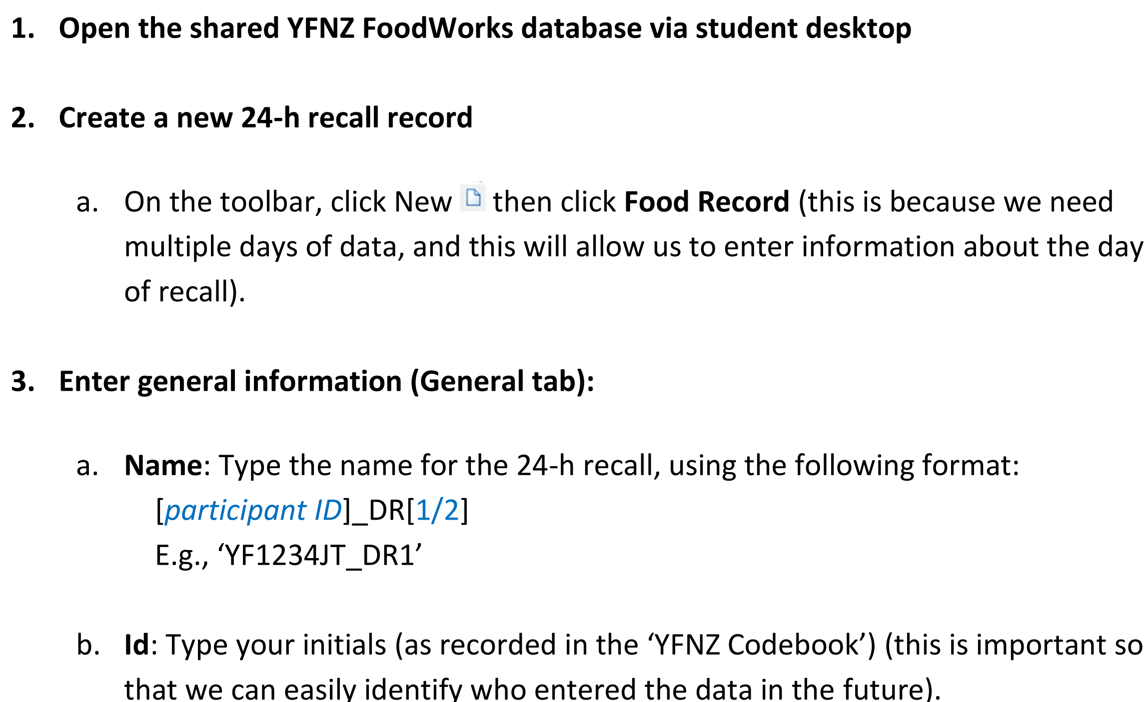
  TO: *24-h recall > 24-h recall documents > [area] > 3. Entry in progress*
- Print the participant's 24-h recall documents (recording sheet +/- Foods Fed by Other Adults form)
- Only **one person at a time** may use the shared FoodWorks database. Before opening FoodWorks, please make sure that this is your scheduled time to use FoodWorks, or that you have checked that the person who is scheduled to use FoodWorks at this time is not using it.

Steps – during

Enter 24-h recall in FoodWorks

NB1: Refer to **O-34: FoodWorks instructions** for specific instructions on how to use FoodWorks if needed.

NB2: Always have the 'YFNZ Codebook' open beside you when you work so it is easy to refer to (access via student desktop so that you can copy and paste default and substitute foods directly to the FoodWorks database).



1. **Open the shared YFNZ FoodWorks database via student desktop**

2. **Create a new 24-h recall record**

   a. On the toolbar, click New then click **Food Record** (this is because we need multiple days of data, and this will allow us to enter information about the day of recall).

3. **Enter general information (General tab):**

   a. **Name**: Type the name for the 24-h recall, using the following format:
      [*participant ID*]_DR[1/2]
      E.g., 'YF1234JT_DR1'

   b. **Id**: Type your initials (as recorded in the 'YFNZ Codebook') (this is important so that we can easily identify who entered the data in the future).

c. **Folder**: Click the folder drop-down and select the 'YFNZ' folder to save the record in. *NB*: You will need to create a new folder initially. To create a new folder, click the ellipsis (…) button, type the folder name (i.e. YFNZ), and click **OK**.

d. You do not need to enter other personal details (e.g., age, gender).

4. Enter information about foods in the order that they were consumed (Foods tab):
NB: It is important that foods and drinks are entered in order so that the file is an accurate reflection of the original 24-h recall – this means that (where possible) drinks should not be combined and should be entered as a single volume.

a. In the **Day** column, select the date the 24-h recall was administered.

b. In the **Meal** column, record the time started solids
[*time started as HH:MM using 24-h time*]
E.g., If a meal started at 1:00 pm, type: **13:00**

c. In the **Food** column, select the food item that best matches the food item reported in the 24-h recall; create a new recipe to select if needed (see '**Create a new recipe**' section on page 5).

Refer to **Appendix 1: Food and Quantity entry rules** for:
1. Selecting foods in FoodWorks (including the use of food DEFAULTS and SUBSTITUTIONS)
2. How to enter breastfeeding

d. In the **Quantity** column enter the quantity consumed.

General | Foods | NRVs/Goals | Notes

Day	Meal	Food	Quantity
01-Apr-20			
	10:00|10:15		
		Peaches,canned in juice	0.33 cup

Refer to **Appendix 1: Food and Quantity entry rules** for:
3. Selecting food quantities in FoodWorks (including the use of quantity estimation DEFAULTS).

e. In the **Notes** column, allocate an item ID to the food/drink item. The item ID is a unique three-digit number (starting at 001) that must be recorded for each food/drink item, because it will be used for future data linking. Subsequent food/drink items should be allocated an item ID in increments of one (i.e. 002,

003, 004). Use a vertical bar (|) and no spaces to separate the item ID from any additional notes. *NB*: there is a 50-character limit.

*****TEXT IN THE NOTES COLUMN MUST BE RECORDED IN THE FOLLOWING FORMAT*****

[*item ID*] |[*additional notes*]
E.g., 001|[*additional notes*]

Note: Please refer to Codebook for additional code to enter when "amount eaten unknown".

f. Save the 24-h recall.

g. Repeat the steps as necessary.

5. Review and save 24-h recall

a. When all the foods and drinks have been entered to FoodWorks, double check that:
   i. All foods and drinks recorded on the 24-h recall recording sheet have been entered to the FoodWorks record
   ii. The text in the **Meal** column and **Notes** column is in the correct format (see example below)

b. Save the 24-h recall.

Example of entered 24-h recall

Diet recall name format:

FF1001AB_DR1 - FFNZ_NM

General | Foods | NRVs/Goals | Notes

Day	Meal	Food	Quantity	Note
01-Apr-20				
	10:00|10:15			
		Peaches,canned in juice	0.33 cup	001|100|assumed canned in juice
		Fruit drink concentrate,o/mango,dil...	0.75 1 cup	002|200
	12:00|12:30			
		FF1001AB_DR1_spaghetti bolognaise	1 Serve	003|200
		Potato,boiled/steamed,from fresh,p...	50g	004|50
		Peas,green,frozen,boiled	0.10 1 cu...	005|20
	13:30|13:40			
		Fruit bar,strawberry	1 1 bar	006|17.5

Time started solids

Item ID

Amount eaten

Recipe name format:

Create a new recipe

NB: Refer to **O-34: FoodWorks instructions** for specific instructions on how to create a new recipe in FoodWorks if needed.

1. **Create a new recipe**

   a. On the toolbar, click New then click **Recipe**.

2. **Enter general information (General tab):**

   a. **Name**: Type the name for the recipe, using the following format:
      [*participant ID*]_DR[1/2]_[*name of recipe*]
      E.g., 'YF1234JT_DR1_spaghetti bolognaise'

   b. **Id**: Type your initials.

   c. **Folder**: Click the folder drop-down and select the 'YFNZ recipes' folder to save the recipe in. NB: To create a new folder, click the ellipsis (…) button, type the folder name (i.e. YFNZ recipes), and click OK.

3. **Enter the ingredients for the recipe (Ingredients tab)**

   a. Enter ingredients and ingredient amounts for the whole recipe.

   b. Enter the serve weight/number of serves for the whole recipe.

   c. If the processing step for this recipe will result in a change in weight due to the loss or gain of water, then you need to set the yield. Enter the yield for the recipe using yield factors used in similar recipes in the Kai-culator database (which are based on the USDA Moisture Retention Factors (Version 4.1, 2010). If there are no similar recipes in the Kai-culator database use the USDA Moisture Retention Factors (Version 4.1, 2010) that can be found in the Kai-culator "Main menu" under "Composition data" in "Moisture factors".

   d. Set retention factors for ingredients in the recipe (see **O-34: FoodWorks instructions** – *Section 3e*).

   e. Save the recipe and return to the 24-h recall record entry. You can now start typing the recipe name (e.g., search using participant ID) in the **Food** column and select this recipe to use.

Steps - After

1. Reviewing and tracking 24-h recall entry

1. Check to make sure all items on the 24-h recall recording sheet and Foods Fed by Other Adults form have been recorded in FoodWorks in order (checking: Quicklist to Detailed list, Detailed list to FoodWorks, Foods Fed by Other Adults list to FoodWorks).
2. Check to make sure all solids start time, item IDs, and amounts eaten have been entered.
3. Ensure your name has been recorded on the front of the printed 24-h recall recording sheet with the colour of the pen which was used to make notes on the recording sheet.
4. Move participant's 24-h recall documents folder to the folder: *4. Entry complete*.
5. Scan and upload annotated documents to a new folder within the participant's 24-h recall documents folder – suffix folder name and file names with '_v2'.
6. Complete the **FoodWorks entry form** (under Diet recall 1 data entry or Diet recall 2 data entry, as appropriate) in REDCap.
    a. Leave any notes/questions/clarifications in the 'Comments field' and follow up as appropriate (e.g., "No [*new infant/child food*] in FoodWorks – added request to the New Foods and Substitutions request sheet. Emailed Rio [*DATE*].")
    b. Mark the form status as 'Complete', 'Unverified' or 'Incomplete, as appropriate – then save and exit the form.

2. Regular meetings

1. Attend regular group meetings to make decisions about substitution requests etc, and check that we are getting what we need from the 24-h recall collection.

3. Backing up the YFNZ FoodWorks database

2. Rio will back up the FoodWorks database at least once per week. To do this:
    a. Copy the FoodWorks database and save to a different location (e.g., University OneDrive).
    b. Include the date on the back-up FoodWorks database file name.
    c. Delete the previous version of the back-up FoodWorks database file from the folder.

Food and Quantity entry rules

NOTE:

- A food item '**<u>default</u>**' is used when insufficient food information is provided to determine the exact food item (e.g., 'apple' → 'Apple,flesh & skin,raw,combined varieties') OR when no exact match is present in FoodWorks (e.g. 'The Collective Gourmet raspberry yoghurt' → 'Yoghurt,premium,assorted fruits'), but a closely related food is available.
- A food item '**<u>substitution</u>**' is used when there is NO food item in FoodWorks that is closely related to the food item reported in the 24-h recall (e.g., chicken bacon would have to be substituted with deli chicken).

1. Selecting Foods in FoodWorks

1. **All food items selected should have the 'pear in the square' icon OR the 'bowl and spoon' icon to their left (indicating that they are from FOODfiles 2016 or are a previously created recipe, respectively). <u>DO NOT</u> select foods from the 'don't use' folder.**

2. **The following rules must be followed when entering homemade and commercial baby foods:**
   - A commercial infant/child food product must be entered for all commercial baby foods reported – if the one consumed is not in FoodWorks then notify Rio (cc: Becky)
   - Homemade baby/child foods must **not** be substituted with commercial infant/child food products
   - A recipe must be created for all home-filled pouches that contain more than one ingredient. Please state "home-filled pouch" in the recipe name.

3. **Selecting foods in FoodWorks:**
   <u>If complete food item information (e.g., brand, flavour, type) is reported</u>:
   - Match by brand/flavour/type (e.g., light, reduced fat)
   - A peeled/flesh and unpeeled/flesh&skin option is not available for all fruits and vegetables. If the fruit and vegetable has been reported in the 24-h recall in a form that is not available, you can select the alternative form. We are assuming that where both the peeled/flesh and unpeeled/flesh&skin options for a fruit or vegetable do not exist, it is because the nutrient content is not sufficiently different and therefore it has not been analysed in its separate forms.
   - If there is no exact match, refer to the YFNZ Codebook to check for established DEFAULT rules for the food item:
     - If there is a match in the YFNZ Codebook
       - Select the DEFAULT food in FoodWorks
       - Update the YFNZ Codebook document default/substitution entry with:

            - Count of times the DEFAULT has been used
            - YFNZ participant ID for future reference
    - If there is no established DEFAULT rule, enter the food item with all possible details into the 'New foods and substitutions request' document.
    - Once an appropriate DEFAULT has been established it will be entered into the 'Default foods' sheet in the YFNZ Codebook to ensure consistent use across all YFNZ projects. The "requester(s)" will be notified of this, and will then update the diet recall of interest.

<u>If incomplete food item information is reported</u>:

- Establish which specific food item data is missing – e.g., flavour/type information supplied but no brand information (e.g., edam cheese, unknown brand) ***OR*** brand and flavour information supplied but no type (e.g., Yoplait berry yogurt, unknown whether full fat/light/sweetened etc)
- Refer to YFNZ Codebook to check for established DEFAULT rules for the food item
    - If there is a match in the YFNZ Codebook
        - Select the DEFAULT food in FoodWorks
        - Update the YFNZ Codebook document default/substitution entry with:
            - Count of times the DEFAULT has been used
            - YFNZ participant ID for future reference
    - If there is no DEFAULT rule for the food item enter the food item with all details into the 'New foods and substitutions request' document.
    - Once an appropriate DEFAULT has been established it will be entered into the 'Default foods' sheet in the YFNZ Codebook to ensure consistent use across all YFNZ projects. The "requester(s)" will be notified of this, and will then update the diet recall of interest.

<u>If there is NO food item available in FoodWorks that is closely related to the reported food item</u>:

- A SUBSTITUTION must be established.
- Check 'New foods and substitutions request' document for baby foods, infant formulas and general foods that are not available in FoodWorks.
    - For foods that have already been requested – update the request count and add the YFNZ participant ID.
    - For foods that have not been requested – add a new food request line to the 'New foods and substitutions request' document.
    - Once an appropriate SUBSTITUTION has been established it must be entered into the 'Substitution foods' sheet in the YFNZ Codebook to

ensure consistent use across all YFNZ projects. The “requester(s)” will be notified of this, and will then update the diet recall of interest.

4. **Entering breads**
   - Breads ***must*** come from the 'Bread: Iodine modified YFNZ' folder. If the bread match of interest has not been given an updated iodine value (i.e. is not in the 'Bread: Iodine modified YFNZ' folder), then we need to create an updated version – Kirsten Webster can provide advice on how to do this.
     NB: Will need to create the 'Bread: Iodine modified YFNZ' folder initially
   - Check the ‘DEFAULTS - Bread matches’ sheet in the YFNZ Codebook:
     - If there is a match in the YFNZ Codebook, select the DEFAULT bread match in FoodWorks.
     - If there is no bread match, enter the food item with all possible details into the ‘New foods and substitutions request’ document.
     - Once an appropriate DEFAULT has been established it will be entered into the ‘Default foods’ sheet in the YFNZ Codebook to ensure consistent use across all YFNZ projects. The “requester(s)” will be notified of this, and will then update the diet recall of interest.

2. How to enter breastfeeding

Each time breastfeeding is reported in the 24-h recall, it must be entered in the following format:

a) In the **Food** column, select ‘YFNZ breast milk (no nutrients)’
b) In the **Quantity** column, enter ‘0 g’ or enter the reported quantity of breast milk consumed (only for expressed breastmilk).
c) In the **Notes** column, enter ‘[*item ID*]||[*additional notes*]’

3. Selecting Quantities in FoodWorks

1. **If there is no quantity reported for a food item in the 24-h recall:**
   - To estimate the quantity of the food item reported:
     i. Use quantities of the food item reported to have been offered or eaten by the infant on another occasion.
     ii. Use estimation rules in the YFNZ Codebook from the ‘Food quantity estimation RULES’ sheet and the ‘Food weight estimation DEFAULT’ sheet.
        a. When a weight estimation for a food is not available in the ‘Food weight estimation DEFAULTS’ sheet it should be added to the ‘New foods and substitutions request’ document.
        b. Once an estimation quantity has been established it is entered into the ‘Food weight estimation DEFAULTS’ sheet in the ‘YFNZ

CODEbook' to ensure consistent use across all YFNZ 24-h recall projects. The "requester(s)" will be notified of this, and will then update the diet recall of interest.

- Make a note in the notes field regarding the entry.

P-22 24-h recall food coding

Copy no. ______

Study:	FFNZ and YFNZ	*Version number:*	Version 1
Prepared by:	KB, IK	*Date prepared:*	1 Aug 2022

Objectives

- To allocate all foods, beverages, and recipes into appropriate food codes/groups to meet FFNZ and YFNZ student aim and objective needs.
- To ensure accurate, consistent, and correctly formatted coding of all foods, beverages, and recipes.

Equipment required

Protocols: **P-22: 24-h recall food coding** (this protocol)

Equipment: Computer with access to: FFNZ and YFNZ teams file “Food groups work”

Within this file the following documents will be required.

1. General food coding
2. Infant and toddler food coding
3. Mixed food coding
4. FFNZ/YFNZ recipes for food groups project
5. FFNZ/YFNZ recipes
6. Meeting agenda (with relative date)

Note: codebooks are frozen and will not change once allocations have begun (unless a problem food is found). These can be downloaded onto personal computers for ease when allocating.

***IMPORTANT* – Do not download any other Teams files to your personal computer. All work needs to be done on the live documents through Teams only.**

Student allocation roles

FFNZ
Kim:

1. FFNZ participant recipes (n=3705)
2. FFNZ YFNZ foods (n=26)
3. FFNZ commercial foods (n=34)

Ioanna:

1. Infant foods (n=?0)
2. Ingred_baby foods (n=?0)
3. Infant formulae (n=219)
4. ?commercial baby foods (n=503)

Liz:

1. ANS foods (n=1,172)

YFNZ

Kim:

1. FFNZ/YFNZ generic recipes (n=86)
2. FFNZ/YFNZ commercial foods (n=404)

Ioanna:

1. Infant foods (n=381)
2. Ingred_baby foods (n=108)
3. Infant formulae (n=269)

Grace:

1. YFNZ recipes (row # 54-1,294)
   n=1,240

Jayshree:

1. YFNZ recipes (row # 1,295-2,534)
   n=1,240

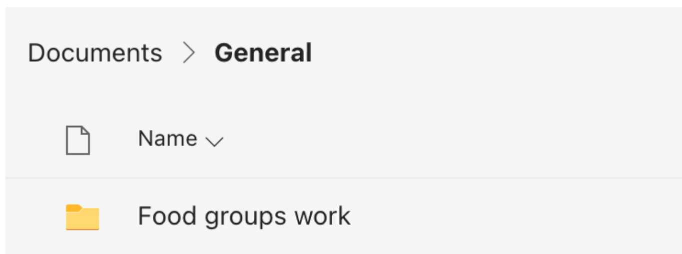
Liz:

1. Same as FFNZ

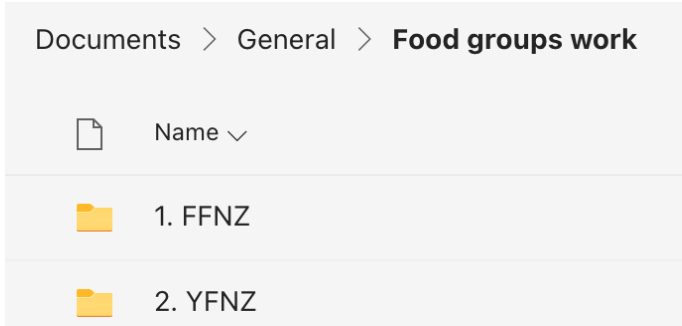
1. Finding the correct documents: "Foods, beverages, and recipes to code"

Steps during

1. Open Teams folder named "**Food groups work**"



2. Open “**FFNZ**” or “**YFNZ**” folder (depending on which study you are coding).



3. Open respective “**FFNZ/YFNZ recipes for food groups project**” and “**FFNZ/YFNZ recipes**” Excel spreadsheets.

4. Open respective **spreadsheet tab** according to coding role (reminder: coding roles are those listed under **“Student allocation roles”** on page 1-2 of this protocol).
   - For example in the below screenshot, the **“Participant recipes”** tab has been opened for the **“Participant recipes”** coding role. Scroll down page to view foods or allocated row number (see allocated row numbers for coding under **“Student allocation roles”).**

16	482194366	YF1001KN_DR2_chicken
17	1095600988	YF1001KN_DR2_porridge
18	277992325	YF1001KN_DR2_sandwich
19	174679569	YF1002PC_DR1_Apple & oat muffin
20	1484316863	YF1002PC_DR1_Cheese sauce
21	1142208476	YF1002PC_DR1_Egg on toast
22	1421858386	YF1002PC_DR1_Mac Cheese
23	984945901	YF1002PC_DR1_Marmite sandwich

Participant recipes | YF_FFNZ generic recipe | Commercial foods

2. Allocating appropriate codes: *Generic recipes/Commercial foods /ANS recipes*

Steps during

Once the list of foods to allocate has been found, coding into food groups can begin.

Step A:

1. Check food listed in "**column B**" and compare with minor food group codes available in the "**General food coding**" spreadsheet to find an appropriate code.
   e.g.
   Pams Ricotta & Basil Ravioli = Filled pasta (e.g. ravioli) (Grains and Pasta)

   Food in Column B needs to be coded

	A	B	C	D
1	DocId	DocName	ONZFG2023 Minor Group name	ONZFG2023 Minor Group code
292	692776399	Pams Ricotta & Basil Ravioli		

This is a general food. Refer to **General food coding** spreadsheet for appropriate name and code to assign food:
Minor group name = Filled pasta (e.g. ravioli) (Grains and Pasta)
Minor group code = 01.03.03

ONZFG2023 Minor Group name	ONZFG2023 Minor Group code	Notes/rules
Use ONLY for individual foods	Use ONLY for individual foods	
Filled pasta (eg ravioli) (Grains and Pasta)	01.03.03	Plain only

2. Copy and paste appropriate **"minor group name"** and **"minor group code"** into column C and D for the food being coded.

   Filled pasta (e.g. ravioli) (Grains and Pasta) [*minor group name*] and **01.03.03** [*minor group code*] pasted to columns C and D.

	A	B	C	D
1	DocId	DocName	ONZFG2023 Minor Group name	ONZFG2023 Minor Group code
292	692776399	Pams Ricotta & Basil Ravioli	Filled pasta (eg ravioli) (Grains and Pasta)	01.03.03

Note: If the food is a mixed food "mixed food coding" will be required. Step B must then be followed.

Step B:

If the food to be coded is a **mixed food**, individual ingredients within that mixed food need to be coded in their corresponding columns (Columns F – S contain the food groups).

Food groups:

Fruit (code 2)

Vegetable (code 3)

Dairy food (code 4)

Animal protein (code 5)

Plant protein (code 6)

Grain (code 7)

Other (code 8)

- If there are two or more ingredients from the same food group they must be **entered into the same cell with a ","** between the coding (words and numbers).
  See below that numbers separate the minor group names and minor group codes:

Grain food: Minor Group name	ONZFG2023 Minor Group code7
Plain pasta (Grains and Pasta), Wheat flour-white (Grains and Pasta)	01.03.02, 01.02.01

- Leave other food groups empty if the recipe does not contain an ingredient belonging to them. There is no need to write "N/A", just **leave cells blank** (e.g. as in below example where the food does not contain any animal protein ingredients).

Animal protein: Minor Group name	ONZFG2023 Minor Group code5

- If ITF (infant and toddler foods) are used, enter in all corresponding food groups.
- All corresponding food groups are to be entered **irrespective of the quantity in the recipe**. For example, even 0.5 tsp of parmesan cheese must entered – no amount is too small to be counted!

Note: if you are uncertain about the code please highlight the whole row in yellow for team discussion at the next meeting. You can then add a note in the upcoming agenda of foods to discuss.

3. Allocating appropriate codes: *Infant foods/infant formulae/ingred_baby foods*

Steps during

Once the list of foods to allocate has been found, coding into food groups can begin.

Step A:

1. Check food listed in **"column B"** and compare with minor group codes available in **"Infant and toddler food coding"** spreadsheet to find an appropriate code.
   e.g.
   White rice, dehydrated for commercial infant foods = White rice (includes parboiled & basmati) (Grains and Pasta)

   Food in Column B needs to be coded

	A	B	C	D
1	DocId	DocName	ONZFG2023 Minor Group name	ONZFG2023 Minor Group code
108	1373551415	White rice, dehydrated for commercial infant foods		

This is a general food. Refer to **General food coding** spreadsheet for appropriate name and code to assign food:
Minor group name = White rice (includes parboiled & basmati) (Grains and Pasta)
Minor group code = 01.01.01

	E	F	
2	ONZFG2023 Minor Group name	ONZFG2023 Minor Group code	Notes/rules
3	Use ONLY for individual foods	Use ONLY for individual foods	
7	White rice (includes parboiled & basmati) (Grains and Pasta)	01.01.01	Plain only

2. Copy and paste appropriate **"minor group name"** and **"minor group code"** into column C and D.

   White rice (includes parboiled & basmati) (Grains and Pasta) [*minor group name*] and **01.01.01** [*minor group code*] pasted to columns C and D.

	A	B	C	D
1	DocId	DocName	ONZFG2023 Minor Group name	ONZFG2023 Minor Group code
108	1373551415	White rice, dehydrated for commercial infant foods	White rice (includes parboiled & basmati) (Grains and Pasta)	01.01.01

Note: if the food is a mixed food "mixed food coding" will be required. Step B must then be followed.

Step B:

If the food to be coded is a **mixed food**, individual ingredients within that mixed food need to be coded in their corresponding columns (Columns F – S contain the food groups).

Food groups:

Fruit (code 2)

Vegetable (code 3)

Dairy food (code 4)

Animal protein (code 5)

Plant protein (code 6)

Grain (code 7)

Other (code 8)

- If there are two or more ingredients from the same food group they can be **entered into the same cell with a ","** between the coding (words and numbers).
  See below that numbers separate the minor group names and minor group codes:

Grain food: Minor Group name	ONZFG2023 Minor Group code7
Plain pasta (Grains and Pasta), Wheat flour-white (Grains and Pasta)	01.03.02, 01.02.01

- Leave other food groups empty if the recipe does not contain an ingredient belonging to them. There is no need to write "N/A", just **leave cells blank** (e.g. as in below example where the food does not contain any animal protein ingredients).

Animal protein: Minor Group name	ONZFG2023 Minor Group code5

- If ITF (infant and toddler foods) are used, enter in all corresponding food groups.
- All corresponding food groups are to be entered **irrespective of the quantity in the recipe**. For example, even 0.5 tsp of parmesan cheese must entered – no amount is too small to be counted!

Note: if you are uncertain about the code please highlight the whole row in yellow for team discussion at the next meeting. You can then add a note in the upcoming agenda of foods to discuss.

4. Allocating appropriate codes: *Participant recipes*

Steps during

Once the list of foods to allocate has been found, coding into food groups can begin.

Step A:

1. Check food listed in **"column B"** and find corresponding recipe in the **"All recipe_ingred"** spreadsheet.
   Note:
   a) It is easiest to **copy the recipe name and paste** into search bar, as below:

   Find ×
   Find what:
   YF1000EN_DR1_nachos
   Wildcards can expand search. For example, "sm?th" finds "smith".
   About using wildcards to search
   › Search Options
   Find next | Find all | Replace...

   b) If a recipe has recipes within it, **these must be checked too.**
   e.g. *YF1000EN_DR1_nachos* contains *YF1000EN_DR1_vegetables*. The *YF1000EN_DR1_vegetables* recipe must be checked to see what ingredients it contains.

C	G	H
DocName	FoodID	FoodName
YF1000EN_DR1_nachos	904948448	Cheese Edam Alpine-2021-non-fortified
YF1000EN_DR1_nachos	691871157	YF1000EN_DR1_vegetables
YF1000EN_DR1_nachos	2:100273	Cream,sour
YF1000EN_DR1_nachos	2:8501014	Corn chip,plain,salted,fried in assorted oils
YF1000EN_DR1_nachos	2:8501016	Corn chip,assorted flavours,salted,fried in assorted oils

2. Compare ingredients in the recipe (or recipes if there are recipes within the recipe) with minor food group codes available in the **"Mixed food coding"** spreadsheet to find an appropriate code.
   - Note all corresponding food groups are to be entered **irrespective of the quantity in the recipe**. For example, even 0.5 tsp of parmesan cheese must entered – no amount is too small to be counted!

3. Copy and paste appropriate **"minor group name"** and **"minor group code"** into column C and D for the food being coded.

Step B:

If the food to be coded is a **mixed food**, individual ingredients within that mixed food need to be coded in their corresponding columns (Columns F – S contain the food groups).

Food groups:

Fruit (code 2)

Vegetable (code 3)

Dairy food (code 4)

Animal protein (code 5)

Plant protein (code 6)

Grain (code 7)

Other (code 8)

- If there are two or more ingredients from the same food group they can be **entered into the same cell with a ","** between the coding (words and numbers).
  See below that numbers separate the minor group names and minor group codes:

Grain food: Minor Group name	ONZFG2023 Minor Group code7
Plain pasta (Grains and Pasta), Wheat flour-white (Grains and Pasta)	01.03.02, 01.02.01

- Leave other food groups empty if the recipe does not contain an ingredient belonging to them. There is no need to write "N/A", just **leave cells blank** (e.g. as in below example where the food does not contain any animal protein ingredients).

Animal protein: Minor Group name	ONZFG2023 Minor Group code5

- If **ITF (infant and toddler foods)** are used, enter in all corresponding food groups.

  Note: Infant and toddler foods are named in a standard way and always begin with "**FFNZ**". Then followed by [***packaging type***], [***product name***], [***texture*** (if applicable)], [***brand***], [***target age group***], [***stage*** (if applicable)], [***weight***]

  Example: FFNZ Can, Pumpkin, potato & beef, Pureed, Wattie's For Baby, 6-7 months, Stage 2, 120

- All corresponding food groups are to be entered **irrespective of the quantity in the recipe**. For example, even 0.5 tsp of parmesan cheese must entered – no amount is too small to be counted!

Note: if you are uncertain about the code please highlight the whole row in yellow for team discussion at the next meeting. You can then add a note in the upcoming agenda of foods to discuss.

***Example 1*:. *Step A:* YF1057AL_DR2_Macaroni Cheese**

Ingredients:
Pasta,white wheat flour,assorted shapes,regular,boiled,drained,no salt added
Cheese,Edam
Milk,cow,standard 3.3% fat,fluid
Margarine
Flour,wheat,white
Spice,pepper,black
Salt,table,iodised

Questions to ask yourself

A. What ingredients (= food groups) are present in the recipe?
B. Are the ingredients any of the following:
   - Contains: **pouch commercial ITF**
   - Contains: **"wet" commercial ITF**
   - Contains: **"other" commercial ITF**
   - Contains: **breastmilk**
   - Contains: **formula**

For the above example **(YF1057AL_DR2_Macaroni Cheese)**

A. What ingredients (= food groups) are present? = **Grain and dairy**
B. Are ingredients any of the following:
   i. Contains: pouch commercial ITF = **No**
   ii. Contains: "wet" commercial ITF = **No**
   iii. Contains: "other" commercial ITF = **No**
   iv. Contains: breastmilk = **No**
   v. Contains: formula = **No**

Code assigned:

Dairy Foods and grain food: No commercial ITF as ingredients

36.18.01

Note: if you are uncertain about the code please highlight the whole row in yellow for team discussion at the next meeting. You can then add a note in the upcoming agenda of foods to discuss.

Step B: **YF1057AL_DR2_Macaroni Cheese**

Ingredients:	**Minor group name**	**Minor group code**
Pasta,white wheat flour,assorted shapes,regular,boiled,drained,no salt added	Plain pasta (Grains and Pasta)	01.03.02
Cheese,Edam	Medium fat cheese (20-30g fat/100g) edam, processed cheese, cheese spread, camembert (Cheese)	11.02.01
Milk,cow,standard 3.3% fat,fluid	Whole fluid (Milk)	08.01.01
Margarine	Polyunsaturated margarine (approximately 70%)-includes flavoured margarine (Butter and Margarine)	12.03.01
Flour,wheat,white	Wheat flour-white (Grains and Pasta)	01.02.01
Spice,pepper,black	Condiments, salt and other flavourings (Savoury sauces and condiments)	30.02.01
Salt,table,iodised	Condiments, salt and other flavourings (Savoury sauces and condiments)	30.02.01

Minor group names and codes for ingredients present in *YF1057AL_DR2_Macaroni Cheese* added to spreadsheet:

Grain food: Minor Group name	ONZFG2023 Minor Group code7	Other	Other code
Plain pasta (Grains and Pasta), Wheat flour-white (Grains and Pasta)	01.03.02, 01.02.01	Polyunsaturated margarine (approximately 70%)-includes flavoured margarine (Butter and Margarine), Condiments, salt and other flavourings (Savoury sauces and condiments)	12.03.01,30.02.01

Dairy food: Minor Group name	ONZFG2023 Minor Group code4
Medium fat cheese (20-30g fat/100g) edam, processed cheese, cheese spread, camembert (Cheese), Whole fluid (Milk)	11.02.01, 08.01.01

Example 2: **YF1081JL_DR2_Peanut butter sandwich**

Ingredients:
Bread,soy & linseed,sliced,prepacked (fortified with folate)
Peanut butter,smooth & crunchy,salt added,no sugar added

A. What ingredients (= food groups) are present? **Grain and plant-based protein**
B. Are ingredients any of the following:
- Contains: pouch commercial ITF = **No**
- Contains: "wet" commercial ITF = **No**
- Contains: "other" commercial ITF = **No**
- Contains: breastmilk = **No**
- Contains: formula = **No**

Code assigned:

Plant protein and grain food: No commercial ITF as ingredients

36.21.01

Minor group names and codes for ingredients present in *YF1081JL_DR2_Peanut butter sandwich* added to spreadsheet:

Plant protein: Minor Group name	ONZFG2023 Minor Group code6	Grain food: Minor Group name	ONZFG2023 Minor Group code7
Nut butters (Nuts and Seeds)	28.02.01	Mixed grain (Bread (inc rolls & speciality breads))	02.01.04

Example 3: FF1000JS_DR2_potato-beef-pumpkin-apple-carrot

Ingredients:
FFNZ Can, Pumpkin, potato & beef, Pureed, Wattie's For Baby, 6-7 months, Stage 2, 120
FF1000JS_DR1-Apple-stewed

A. What ingredients (= food groups) are present? **Grain and plant-based protein**
B. Are ingredients any of the following:
   - Contains: pouch commercial ITF = **No**
   - Contains: "wet" commercial ITF = **Yes**
   - Contains: "other" commercial ITF = **No**
   - Contains: breastmilk = **No**
   - Contains: formula = **No**

Code assigned:

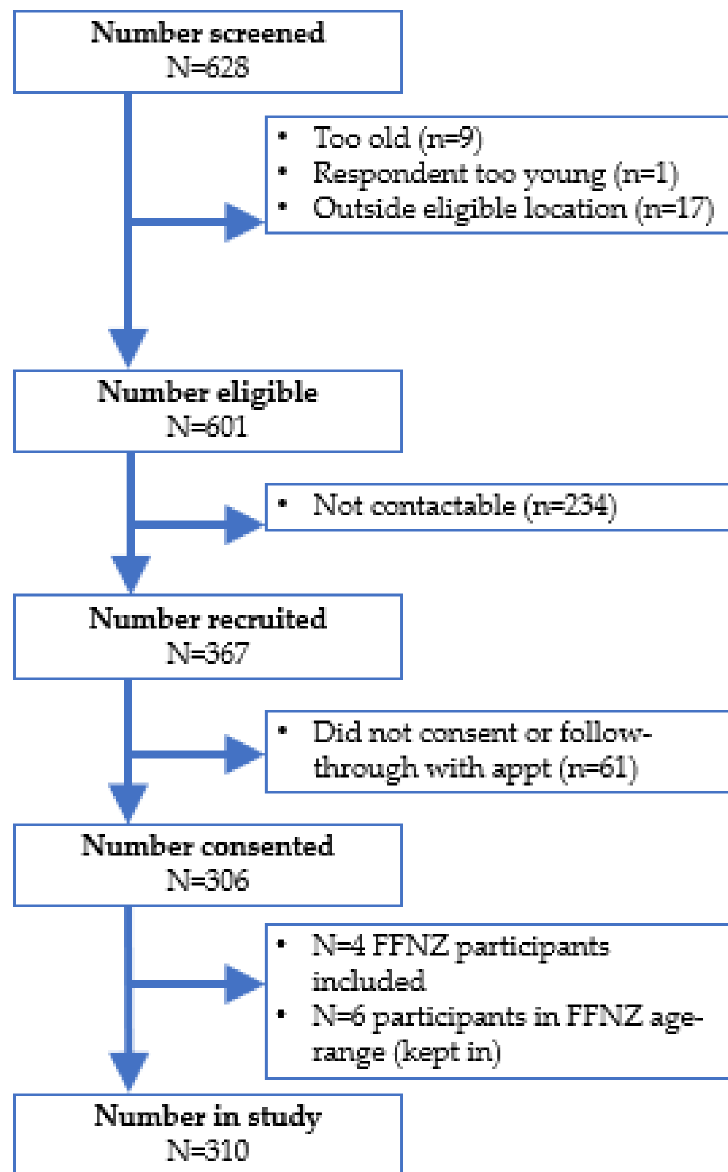
Fruit, vegetable, and animal protein: One or more ingredients is a "wet" commercial ITF 36.23.03

Vegetable: Minor Group name	ONZFG2023 Minor Group code3	Dairy food: Minor Group name	ONZFG2023 Minor Group code4	Animal protein: Minor Group name	ONZFG2023 Minor Group code5
Vegetable and animal protein : wet foods (cans, jars, microwaveable bowls, pouches without nozzles)	35.12.02			Vegetable and animal protein : wet foods (cans, jars, microwaveable bowls, pouches without nozzles)	35.12.02

5. Fourth level allocation

In some cases students may need to do further coding. In these cases the corresponding student will do further coding to meet their study needs and they will be made aware of this.

Appendix J: YFNZ recruitment flowchart



Appendix K: Additional results

Figure 4.1 Spread of fruit and vegetable variety scores (FVVS)

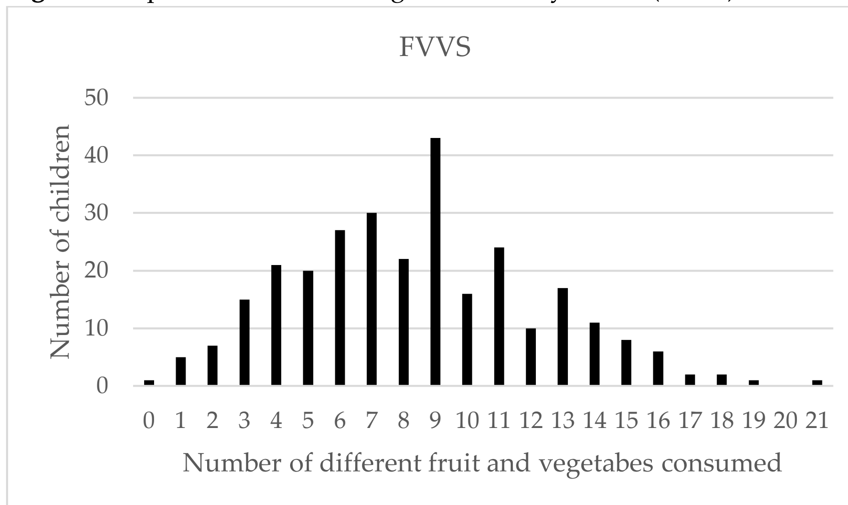


Figure 4.2 Spread of fruit variety scores (FVS)

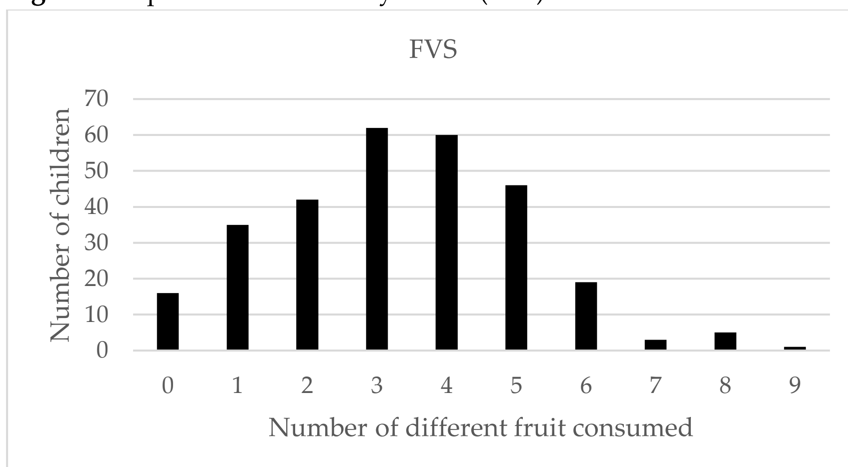
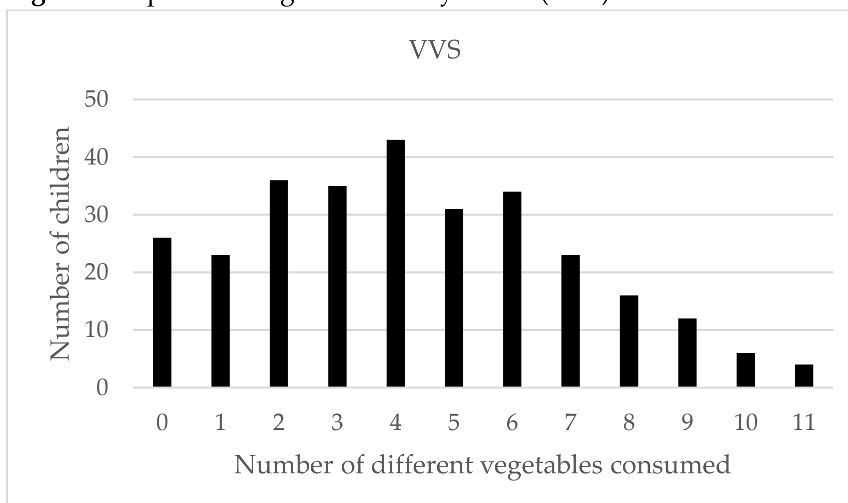


Figure 4.3 Spread of vegetable variety scores (VVS)



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