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Nutrition and oral health in the early years: Trends and influences in children aged 0-5 years

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Nutrition and oral health in the early years: Trends and influences in children aged 0-5 years

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Abstract

Background

Establishing healthy dietary intakes in childhood is important for growth, development and the prevention of overweight/obesity and many non-communicable diseases such as dental caries. There is a lack of longitudinal data on children's dietary intake between birth and five years. A substantial proportion of Australian children are regularly cared for by their grandparents, yet there is little research exploring the influence of this environment on child health. The aim of this thesis is to describe what young children are eating across the first five years of life and examine the role that informal care, particularly grandparent care, plays in the promotion of nutrition and oral health behaviours in early childhood.

Methods

This thesis was guided by socio-ecological models of health and comprises four studies: 1. Examining the validity and reliability of a food frequency questionnaire (FFQ) for use with young children and pilot testing new context of eating questions (quantitative, primary data collection); 2. Exploring food and beverage consumption in Victorian children between 6 months and five years of age (secondary analysis of data from an existing birth cohort study); 3. Examining dietary intake and oral health/hygiene behaviours in three to four year old children and the association with attending formal and/or informal care (secondary analysis of data from an existing birth cohort study); 4. Exploring the role of the grandparent care environment in the promotion of nutrition and oral health behaviours (qualitative interviews with parents and grandparents).

Results

The FFQ is reliable and valid for use at a group rather than individual level however, the context of eating questions require further development. Discretionary foods are observed in the diets of children as early as six months of age and become more common as children get older. Living in a regional area, having an older parent or parent with high fruit and vegetable intake was associated with more frequent consumption of core foods between 6 months and 5 years of age. A socio-ecological model demonstrating the range of factors which influence nutrition and oral health in the grandparent care environment was developed. Communication between

family members, knowledge, past experience and perception of roles are key influences on nutrition and oral health in this environment.

Conclusion

This PhD research contributes new knowledge about the dietary intakes of young children in Australia and the influence of grandparent care on dietary intake and oral health care behaviours. Early introduction and consumption of discretionary foods and drinks has ongoing implications for a range of health issues including dental caries, overweight and obesity. Dietary intake and oral health behaviours in young children are influenced by a complex mix of factors across different socio-ecological and physical environments. Grandparent care is one such environment where provision of food and oral health behaviours are influenced by a range of factors and are underpinned by the relationship dynamics within a family. Opportunities exist for further research and health promotion interventions involving grandparents.

Declaration

This is to certify that:

i. the thesis comprises only my original work towards the PhD
ii. due acknowledgement has been made in the text to all other materials used
iii. the thesis is less than 100,000 words in length, exclusive of tables, maps, bibliographies and appendices

Date: 6th August 2019

Signed:

Preface

This preface summarises the work in this thesis carried out in collaboration with others, the publication status of one chapter and an acknowledgement of all sources of funding.

This thesis contains one multi-author paper which was accepted for publication with *Public Health Nutrition* on May 4th 2020.

This thesis includes two studies (Chapters 6 and 7) with secondary analysis of data collected from the VicGen study, a longitudinal birth cohort described in detail in Chapter 4. Data for this study were collected by research assistants and I was responsible for entering and cleaning the majority of this data as part of my paid research role, prior to my PhD.

The paper, *Nutrition and oral health in early childhood: Associations with formal and informal care* (Chapter 7) was initiated by me and multi-authored with several VicGen investigators and my PhD supervisors. I was independently responsible for the paper's concept, reviewing the background literature and cleaning and analysing the data. I drafted and led the manuscript. Professor Stuart Dashper, Professor Mark Gussy and Professor Hanny Calache jointly contributed to the design of the VicGen study, from which the data were obtained. All authors provided critical comment on the interpretation of the results and re-drafting of the manuscript. All authors read and approved the final manuscript for submission. A 'declaration for thesis publication' form acknowledging that I contributed more than 50% of the work in the publication has been signed by the co-authors and is submitted with this thesis.

Chapters 5 and 6 of this thesis contain studies with quantitative statistical methods. I undertook all the analyses myself, however Cameron Patrick from the Statistical Consulting Centre at the University of Melbourne provided advice on the statistical tests to use and assisted with interpretation of the results.

I was awarded a National Health and Medical Research Council (NHMRC) Postgraduate Scholarship (APP1093703, $83,429.00) to undertake this PhD. The VicGen Study was funded by the NHMRC (APP425829), The Financial Markets Foundation for Children (Project Grant 2011-161) and The Victorian Government Department of Education and Training. In-kind salary support for investigators on the VicGen study was provided by La Trobe University, Dental Health Services Victoria, The Jack Brockhoff Foundation and the Oral Health Cooperative Research Centre.

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Firstly, this PhD thesis would not have been possible without all the families who gave up their valuable time to complete surveys or be interviewed. Thank you for sharing your experiences with me and allowing them to be included this thesis.

I would like to thank my supervision team Professor Lisa Gibbs and Associate Professor Anthea Magarey. You have both made my PhD journey an exceptionally positive experience. You have provided ongoing encouragement and feedback which helped me push myself and my research to a higher standard. Anthea, I am thankful for your advice and support on everything nutrition and I am particularly grateful that you took on my supervision on the eve of your retirement from academic life. Lisa, your support, flexibility, encouragement and enthusiasm has been instrumental in allowing me to produce this PhD thesis whilst maintaining my sanity, a job, and a stable home-life. I have learnt so much from you over the past four years and will be forever thankful that I was given the opportunity to work with you.

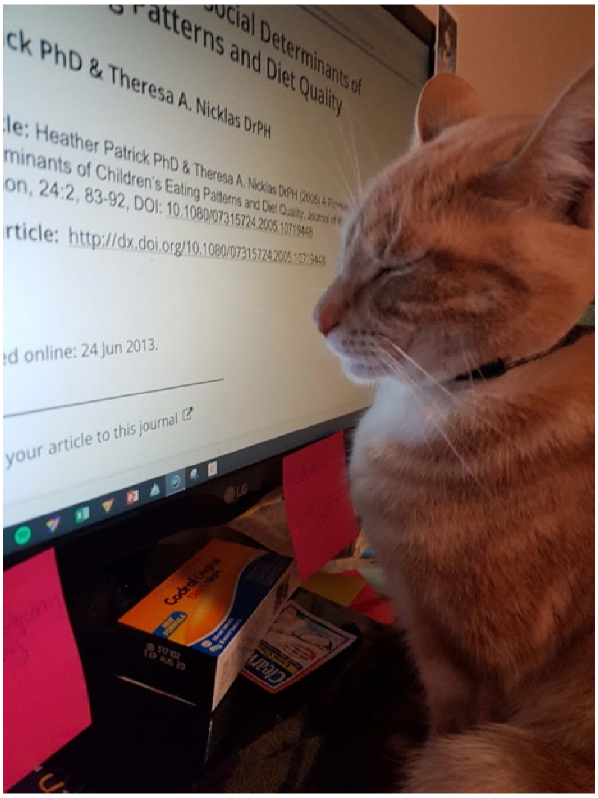
I would also like to acknowledge the late Professor Elizabeth Waters, who was my primary supervisor until her death in 2015. Without Liz's encouragement I would not have undertaken this PhD. I am proud to have produced a piece of research that includes grandparents, a topic that we had discussed at length prior to her death.

Thank you to the members of my advisory group, Dr. Melanie Nichols and Dr. Rebecca Perry. You have provided me with support and encouragement throughout this PhD. To Mel in particular, thank you for your pay-it forward coffees, and for pushing me when I needed to be pushed. I would also like to acknowledge and thank my current advisory chair, Associate Professor Rebecca Bentley, and my previous chair Associate Professor Hannah Badland for their encouragement and keeping me on track.

To Professor Stuart Dashper, Professor Mark Gussy and Professor Hanny Calache, thank you for your encouragement and support and giving me the opportunity to use data from the VicGen study you created, as part of my PhD.

To the staff and students (past and present) at the Jack Brockhoff Child Health and Wellbeing Program, you are like my second family. It is rare to find such a wonderful group of people which make coming into the office a delight. I would like to acknowledge fellow past and present PhD students Rachel Boak, Bradley Christian, Adina Heilbrunn and Elena Swift for the advice, debriefs, general chit-chat and laughs. It is reassuring to know that everyone goes through the same struggles.

Finally, I would like to acknowledge my amazing family and friends who have been on this journey with me for the past four years. My mum, Barbara, and Dad, Richard have provided love and support throughout this time. My wonderful team of friends Jane, Chantelle, Alicia, Rob, Pete and Tim have helped me laugh and relax in stressful times. My two fur-children Nala and Mumford have kept me company during the long days and nights of researching, analysing and writing. Finally, my biggest thanks to Leighton, who went from being a boyfriend to fiancé and then husband through the course of this PhD. Your encouragement has meant so much to me and you have been my biggest supporter since day one.



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Chapter 1: Introduction

The links between poor dietary intake and a wide range of non-communicable diseases are well established. Dental caries is one of the most common chronic diseases in childhood with the latest national survey demonstrating that 34% of 5-6 year old children have had some experience of dental caries, with 26% having untreated caries [1]. The extent of dental disease in children younger than this is under-researched, however in epidemiological studies, caries has been observed in Australian children as early as 18 months of age [2]. There are also reports of children as young as 18 months attending the Royal Dental Hospital in Melbourne, Victoria for the removal of cavitated teeth, and hundreds of children aged five years and under having general anaesthetics for the removal of cavitated teeth [3].

Dietary intake is an important factor in the development of dental caries [4]. Dietary intake of children has been a key focus of many public health researchers in the last 20 years in response to increasing rates of overweight and obesity. Initially there tended to be less focus on the dietary intake of infants and pre-schoolers compared to older children and adolescents, however this has changed over the last ten years with increasing focus on younger age groups, and recognition of how early experiences shape dietary intake in later years [5]. Whilst overweight/obesity and poor oral health have many common risk factors, oral health has tended to be under-researched in the public health field compared to overweight and obesity. This is changing, with researchers and health promotion professionals increasingly recognising the shared risk factors of poor oral health and overweigh/obesity as well as the importance of incorporating oral health into research and health promotion programs [6, 7].

The research presented in this thesis merges two key areas that I have worked in since finishing my undergraduate degree. My interest in child health developed when, as part of an honours program, I was involved in the evaluation of an obesity prevention intervention targeting primary school children in a disadvantaged area of Victoria. I then worked on the evaluation of a similar obesity prevention intervention targeting preschool-aged children. My primary role in both these interventions was related to the dietary intake of children and what role the interventions had in promoting and supporting healthy intake.

After taking up a research role at the University of Melbourne I was offered the opportunity to manage the data from a birth cohort study called VicGen. The study's purpose was to examine the complex mixture of biological, behavioural and environmental factors which lead to the development of dental caries in children aged less than six years – also known as early childhood caries. This study gave me the opportunity to work with experts in the fields of public health, dental health and microbiology. Through this study I was exposed to the research field of public dental health. Oral health had never been a focus of any of the work I had previously done, everything related to nutrition was focused on obesity prevention.

In the following years I gained experience in oral health research, through my involvement with the VicGen study as well as working as a researcher in a partnership between the University of Melbourne and Dental Health Services Victoria (DHSV). DHSV is the leading public oral health agency in the state of Victoria, Australia. They are funded by the state government and aim to improve the oral health of Victorians. I worked closely with the health promotion team at DHSV to evaluate numerous oral health promotion programs focussed on improving children's oral health. Although the primary focus of this work was oral health, there was always a strong emphasis on dietary intake and how best to measure this.

When the opportunity to commence a PhD presented, it gave me the chance to further combine my passion for nutrition and oral health. I particularly wanted to work in the space of early childhood because of my experiences with the VicGen study and oral health promotion programs at DHSV. In designing this PhD, I wanted to use both quantitative and qualitative methodologies. I also wanted to work with the large quantity of dietary data that had been collected as part of the VicGen study as well as exploring a new area, that of grandparent care. Throughout the VicGen study, anecdotes regarding the importance of extended family on children's health behaviours were apparent. More specifically the potential role of grandparents was an area which I and my initial primary supervisor, the late Professor Elizabeth Waters, were keen to explore.

This PhD consists of four distinct studies which fit together to answer an overarching research aim. Chapter 2 provides background and a detailed literature review of what we know about dietary intake in young children and the role of grandparent care in dietary intake and oral health. The overall aims and objectives of this thesis are presented in Chapter 2 on page 45. Chapter 3 outlines the research methodology and the guiding theoretical frameworks. Chapter 4 summarises the VicGen study. The first study (Chapter 5) examines the reliability and validity of the tool which was used to collect dietary data as part of the VicGen study. The second study (Chapter 6) explores the dietary data that were collected in the VicGen study between 6 months and 5 years of age. The changes in consumption over this period as well as related socio-demographic factors are assessed. In Chapter 7 the relationship between different types of childcare, dietary intake and oral health are examined. Chapter 8 presents qualitative interviews with parents and grandparents of preschool aged children, exploring what happens in the grandparent care environment in relation to nutrition and oral health. These four studies are tied together in Chapter 9 with an overall discussion and conclusion.

Chapter 2: Background & Literature Review

2.1 The importance of diet for health

There is a large body of evidence demonstrating the role of diet in the development of many chronic, non-communicable diseases including diabetes, obesity, cardiovascular disease, certain cancers and dental disease [8]. Whilst the prevention of disease is an important outcome of good nutrition, it is also important to remember that in young children, a healthy diet is essential for optimal physical and cognitive growth and development [9].

In children, overweight/obesity and dental caries are two of the most common chronic diet related conditions. The term early childhood caries (ECC) refers to dental caries in children under six years of age [10, 11]. Australian Health Survey data from 2017-2018 identified 24.6% of 2-4-year-old and 27.5% of 5-7-year old children as having overweight or obesity, an increase from the rates of 22.8% and 24.1% observed in 2012 [12, 13]. Dental caries is common in developed and developing countries, with a recent systematic review finding prevalence rates in five year old children ranging from 26% in Germany to as high as 90% in Indonesia [14]. There is a lack of national oral health data for children under five years of age, however the most recent national data for 5-6 year old children showed 26.1% had untreated caries in their primary teeth [15]. Recent research from Victoria, Australia showed 8% of 18-month-old children had at least one tooth with ECC, which increased to 23% of children aged three years of age [2].

Overweight/obesity and early childhood caries both have immediate and long term physical and psychological consequences for children including pain, bullying and the development of other conditions such as diabetes, hypertension and cardiovascular disease [16, 17]. These diseases are largely preventable, and the World Health Organization recommends primary prevention as the most cost-effective, affordable and sustainable way to combat chronic non-communicable diseases [8]. A number of factors contribute to the risk of developing dental caries including oral hygiene [18], and physical activity plays a large role in overweight/obesity [19], however a common, modifiable risk factor for both of these conditions is dietary intake.

Whilst overweight and obesity develop due to energy imbalance, the development of dental caries is more closely related to the chemical properties of foods and beverages consumed. The oral cavity contains more than 700 species of bacteria [20] and the colonisation of these bacteria and their by-products produce a biofilm on tooth surfaces [21]. The main bacteria thought to play a role in the development of dental caries are *Streptococcus mutans* and *Streptococcus sobrinus.* These bacteria metabolise fermentable carbohydrates (mainly sugars) found in foods and drinks with acids produced as part of this process [21, 22]. Acid reduces the pH in the mouth, causing partial demineralisation of the tooth surface leading to tooth enamel becoming softer and acid reaching further into the tooth [22]. Saliva and swallowing help to remove the substrate from the oral cavity, returning the biofilm pH to neutral and allowing remineralisation of the tooth to occur [22]. The presence of fluoride (through drinking fluoridated water, brushing with fluoridated toothpaste or having fluoride varnish applied to teeth) assists in remineralisation of teeth by helping phosphate and calcium diffuse into teeth [21]. This dynamic process of demineralisation and remineralisation does occur continually every day, however, frequent acid production and pH reduction can lead to a net loss of minerals below the surface of the tooth, causing white spots (early dental caries) which, if left untreated can progress to cavitation [22].

Diet, particularly free sugar intake, is a key driver in the development of dental caries as it provides the substrate for bacteria to metabolise [4]. The disaccharide sucrose (table sugar) is the most cariogenic sugar, followed by glucose and fructose [23]. The WHO define free sugars as "all mono and disaccharides added to food by manufacturer, cook or consumer plus those sugars naturally present in honey, syrups and fruit juices and concentrates" and recommend limiting intake to less than 10% of total energy [24]. Examples of foods and drinks containing high amounts of sugar include confectionery, cakes, soft drinks and sports drinks. The amount of sugar consumed is positively associated with incidence of dental caries, and to a lesser extent so is the frequency of sugar consumption [4]. It has also been suggested that starches (e.g. rice, breads, fruits and vegetables) may influence caries development, particularly when they are cooked. The current evidence suggests the cariogenicity of plain raw or cooked starches like rice and potatoes is low, but when starchy foods contain free sugars (e.g. cakes and biscuits), they become increasingly cariogenic [4].

Another condition linked to dietary intake is dental erosion. When teeth come into contact with acids causing the hard-dental tissues to be chemically etched away from the tooth surface [25]. Foods and beverages containing high acid levels, such as soft drinks, fruit juices and cordials, have been shown to promote dental erosion [26]. Continued erosion reduces the size of teeth and in some cases can completely destroy the tooth [27].

2.2 Determinants of dietary intake

Eating behaviours are influenced by multiple factors across different contexts and as such are complex and suited to an ecological framework, one of which has been proposed by Story and colleagues [28]. Factors in the macro, physical and social environments along with individual factors influence dietary intake. Factors at the macro level have an upstream influence on dietary intake and include cultural norms and values, economic systems, food production systems, government policy and food marketing. These systems and policies influence the environments where food is eaten or acquired (e.g. supermarkets, restaurants, schools, childcare). The social environment (family, friends, peers) can influence dietary intake through role modelling (particularly important for young children), social norms and support. A mix of factors, unique to the individual also influence dietary intake and include demographics, biology, lifestyle, attitudes, knowledge, skills, food preferences and behaviours [28].

The early years of life are particularly important in relation to dietary intake because many of the individual level factors influencing dietary intake, such as preferences and behaviours are shaped in these years and are likely to be carried through life [29]. Young children are reliant on parents and caregivers to provide nourishment to ensure optimal growth and development. As such, parents and caregivers play a vital role in shaping food preferences and eating behaviours in young children. The environments that children are exposed to on a regular basis have been shown to influence their development. As part of the care that is provided to young children, it is likely that they will be regularly fed by someone other than their parents [30].

Exposure to flavours from their mother's diet, both in utero and through breast milk can influence preference [31], whilst there is also evidence that children have an innate preference for sweet and salty foods [32-34] and as such will tend to accept them the first time they are offered [5]. In contrast, items that are not naturally sweet or salty (e.g. vegetables) can require repeated exposure (upwards of 8 times) before a young child will accept them [35-37]. This innate response can influence a parent or caregiver's perception of whether their child likes the foods and they may stop providing it before the child has been exposed enough times to like the item [30].

A range of other factors including food preferences, food availability, parental preferences, beliefs and attitudes, role modelling, portion size and feeding style all play a role in the dietary intake of children [38]. Parents and caregivers control factors in the child's environment including: teaching and role modelling behaviours (e.g. using utensils, eating fruit and vegetables), controlling the type and amount of food and drinks available, and providing the context in which food and drinks are consumed (e.g. eating at the table, finishing what is on your plate) [5].

2.3 The recommendations for food and beverage intake in young children

In Australia two documents provide guidance for dietary intake for children under five years of age. The Infant Feeding Guidelines (IFG) provide information on recommended dietary intake for infants until they are 12 months of age [39]. The IFG provide evidence-based recommendations regarding breast and formula feeding and guidance for the introduction of solid foods. It is recommended that solids are introduced to infants at around 6 months of age, but no earlier than 4 months of age [40], with iron rich foods such as fortified cereals recommended as the first foods. After this, the order of introducing foods is not so important as long as children are exposed to a wide variety of core foods that are prepared in a way that matches their developmental stage (e.g. pureed, mashed, chopped). By the time children are 12 months of age they should be consuming a wider variety of family foods (i.e. foods that are generally consumed in the family). From this age onwards, children are gaining a large proportion of their daily energy intake from family foods, and the Australian Dietary Guidelines (ADG) provide guidance for food and beverage intake [9].

The ADG recommend that people enjoy a wide variety of foods from the five **core** food groups each day, namely: fruit; vegetables and legumes/beans; dairy (mainly low fat if over two years of age); grains (mainly wholegrains and high fibre) and; lean meats and alternatives (e.g. tofu). It is also recommended that plenty of water is consumed. The guidelines provide age and gender specific recommendations for the number of serves of each group that should be eaten daily. The recommended daily serves for children aged between one and eight years are displayed in Table 2.1. Actual intakes of core foods may need to be adjusted depending on a child's height and their activity level. The ADG also recommended limiting intake of discretionary foods and beverages, items that tend to be high in saturated fat, added salt and added sugars (e.g. extruded snacks, crisps, biscuits, cakes, confectionery, chocolate and sweetened beverages). For children up to eight years of age, it is best to avoid discretionary foods all together or limit intake to ½ a serve per day [41]. The ADG also state that if fruit juice is consumed it should be 100% fruit juice and should only be consumed occasionally as substitute for whole fruit.

Table 2.1. Recommended average daily number of serves from each of the five core food groups

	Boys			Girls		
	1-2yrs	**2-3yrs**	**4-8yrs**	**1-2yrs**	**2-3yrs**	**4-8yrs**
Vegetables and legumes/beans	2-3	2 ½	4 ½	2-3	2 ½	4 ½
Fruit	½	1	1 ½	½	1	1 ½
Grain (cereal) foods	4	4	4	4	4	4
Lean meats, poultry, fish, eggs, tofu, nuts and seeds and legumes/beans	1	1	1 ½	1	1	1 ½
Milk, yoghurt, cheese and/or alternatives, mostly reduced fat	1-1 ½	1 ½	2	1-1 ½	1 ½	1 ½
Additional serves	-	0-1	0-2 ½	-	0-1	0-1

Adapted from Eat for Health: Educators Guide [41].

2.4 Dietary intakes of young children

From the time that the first solid foods are introduced, children are exposed to an increasing range of foods and beverages. Although breastmilk and infant formula are important sources of nutrition in the first one to two years of life, research examining consumption of these is a large field beyond the scope of this literature review, as it is not a primary focus of this PhD. The following literature review focuses on the published evidence regarding the other foods and drinks that children consume across the first five years of life.

It is also important to note that the literature presented in this review focuses on children residing in developed countries rather than developing countries, as the nutritional status of children and diet related diseases differs greatly between developed and developing countries and as such, so does dietary research. Further, the review focusses on studies that report the intake of foods and beverages or dietary patterns, rather than the intake of energy or specific nutrients. This focus is in line with the research presented in the later chapters of this PhD.

The studies presented in this review are summarised in Table 2.2 to Table 2.4 and are categorised into three types: 1. International literature reporting general food and beverage intake; 2. International literature reporting computer derived dietary patterns; and 3. Australian literature. Studies generally used a food frequency questionnaire or 24-hour diet record to collect dietary data and relied on parent reported data. Given the large sample sizes in these studies it is unsurprising that these methodologies were used, as they can be both cost-effective and time-efficient. There are, however, inherent limitations with these methodologies which need to be considered when examining the results presented for these studies. Using a single 24-hour recall may not accurately reflect a child's usual dietary intake and relies on parents accurately recalling everything eaten, whilst food frequency questionnaires may not identify everything that a child is consuming as only selected items may be included [42]. Three studies used parent-completed 3-day food records, with two of these being weighed food records, the third was not. Reliance on parent-reported data introduces the risk of mis-reporting, where parents may not disclose everything their child eats, either because they may not want to disclose unhealthy foods, they may just not remember everything that their child eats, or do not know as the child was not always in their care.

2.5 International literature: General food and beverage intake

Seventeen of the twenty studies summarised use cross-sectional data [43-59], whilst three report longitudinal data [60-62]. Nine papers from the Feeding Infant and Toddlers study (FITS) are included, with five reporting on 2002 data [46, 48-51] three reporting on 2008 data [45-47], and two reporting on 2016 data [52, 53]. Four papers report on the National Health and Nutrition Examination Survey (NHANES) from the United States [55-58], and two report on the Children in Focus Study, a sub-study of the Avon Longitudinal Study of Parents and Children (ALSPAC) from the U.K [59, 62]. Table 2.2 summarises the international literature reporting on general food and beverage intake in children under five years of age.

2.5.1 Cross-sectional studies

The results of cross-sectional studies suggest that discretionary foods are introduced into children's diets at an early age and consumption rates increase in older children. One of the largest international cross-sectional studies examining young children's diets is the Feeding Infants and Toddlers Study (FITS), conducted in the United States. The FITS study has examined the diets of infants and toddlers using a national random sample in three separate cross-sectional surveys in 2002 (n=3,022), 2008 (n=3,273), and most recently 2016 (n=3,248) [45-53, 63-67]. In 2002, FITS only collected data on children aged between four and 24 months of age [68] expanding the age group in 2008 and 2016 to children aged birth to four years [65, 69]. The methodology for these three timepoints are similar, with parents completing at least one, 24 hour-recall assisted with a set of food measurement aids to help them estimate portion sizes [65, 66].

In children between birth and 24 months of age, each wave of FITS has demonstrated the early intake of discretionary items and increasing proportions with age [45, 46, 49, 52]. For example, the most recent wave in 2016 showed 7% of 4-6 month old children, 34% of 6-12 months, and 80% of 18-24 months consumed sweet beverages and desserts [52]. Similarly, discretionary food consumption rates for 18-month-old children from the Children in Focus Study in the U.K varied between 46% (buns/cakes/pastries) and 87% (biscuits). This is a sub-study of the Avon Longitudinal Study of Parents and Children (ALSPAC), a longitudinal birth cohort, which recruited 14,541 pregnant women from South-West England between 1991 and 1992 [70]. A random selection of children (~10% of the total ALSPAC cohort) born in the last six months of the ALSPAC study were invited to take part in the Children in Focus sub-study [59].

Consumption of discretionary foods and drinks is even more common in older children. In the Czech Republic, three-year-old children consumed more breads and sweet pastries compared to one year old children [44]. FITS data suggest more than 90% of 2-4 year old children consume discretionary items [53], whilst 3-6-year-old German children consumed sweets (e.g. cookies, chocolate) on average 10 times a week, with 16% of children consuming them every day [43]. Eighty percent of a sample of 2,114, 4-5 year old Canadian children consumed unhealthy snacks like chips and chocolate more than once a week [54]. Additionally, NHANES, which reports representative data for 0-8 year old children in the United States, has demonstrated increased intakes of solid fats, oils and added sugars from foods like biscuits and pastries as age group increases [55]. It has also shown the major source of energy for children changes from full fat milk in younger (2-3-years) children to grain based desserts (e.g. biscuits, cakes) and breads in older (4-8yrs) children [57, 58]. Consumption of sweet beverages is also common, with up to 59% of children over two years reported to be consuming them [47, 53, 58, 59].

Rates of consumption for core foods such as grains, dairy and meat varies across the studies. They are difficult to directly compare given the variation of foods included in these groups, however in general, daily consumption rates vary between 70-98% [46, 51-53, 59]. From around 12 months of age onwards, a substantial proportion (20%-35%) of children are not consuming fruit and vegetables daily [47, 51, 52]. In general, consumption rates for fruit and vegetables were lower in older children compared to younger, although in contrast, NHANES data showed that older children (2-5 years) consumed more vegetables than younger (<2yrs) children. However, the actual amount consumed was always lower than recommendations (one cup per day) – no more than 0.7 cups a day [55].

There are several limitations with the cross-sectional studies described here. Response rates and the sampling frame varied across studies, and this may impact the generalisability of the results. Additionally, whilst the FITS study is broadly representative of the infant and toddler population in the United States, the 2016 sample had higher parental education levels and a lower proportion of Hispanic participants compared to the general population in the United States. Given the potential influence of education and ethnicity on dietary intake, it is possible that higher rates of discretionary item consumption may have been seen if the ethnicity and education levels were a closer reflection of the general population.

2.5.2 Longitudinal studies

Three international studies reporting general food and beverage intake longitudinally were identified [60-62]. These studies varied in their sample size (n=88 to 1078), data collection method (FFQ or weighed diet record) and the reported outcomes (fruit and vegetable only, core and discretionary foods/beverages). As children aged, consumption of discretionary foods and drinks such as fruit juice and lollies increased [60, 62]. The Children in Focus study also examined core foods and observed changes in the type of grain-based foods consumed between 18 months and three years, with more rice/pasta and white bread compared to wholemeal bread and high fibre breakfast cereals consumed in the older age group [62]. The proportion of children consuming fruit remained stable (83%-84%) with a slight increase in the actual amount consumed, however vegetable consumption fell (91% to 83%), with little change in the amount consumed [62]. Children who consumed fruit and vegetables frequently when they were infants were more likely to do so when they were older [61]. Follow up rates for these studies varied from 52% [61] to 97% [60] and those who provided follow up data tended to be less culturally diverse [61], more highly educated [61, 62] and have higher incomes [61] compared to those who did not provide follow up data. Additionally, compared to the general population, the overall ALSPAC sample had less ethnic diversity, single parent families and families living in rented accommodation [62]. These factors are likely to have an influence on the dietary intake of young children, with intakes of discretionary foods possibly underreported.

Table 2.2. Summary of international literature examining general food and drink intake of children aged 5 years and under

Author	Country, sampling and year collected	Sample (N, age, % female, follow up rate)	Methodology	Key outcomes	Notes
Pabayo et al. [54]	Canada Edmonton, Alberta only 2004-5	N= 2,015 4-5yrs 49% female	• Recruited at preschool immunisations. • Response rate 3.3% to 30.2% at different public health units. • Parent reported questionnaire: -Demographics. -20 item FFQ. • Usual daily or weekly intake. • Compared to *Eating Well with Canada's Food Guide.*	• % of children meeting recommendations: -29.6% vegetables -65.3% fruit -23.5% grains ->90% meat and milk • 80% had 'choose less often' foods (e.g. chips, fries, chocolate) >once/week. • Children from high SES less likely to consume choose less often foods.	Baseline data for a longitudinal study.
Schneider et al. [43]	Germany Baden-Württemberg (third largest state in Germany) 2008-9	N=879 3-6yrs 48% female	• Recruited from 52 kindergartens. • Parent reported questionnaire. • FFQ as part of a larger survey (6 responses never – several times daily). • 85.9% response rate. • Examined consumption of 'sweets' (combined cookies, gummy bears, chocolate bars, candies, cake and refrigerated sweet food).	• Sweets consumed on average 9.7 times/week. • 16% had sweets every day. • No age or gender differences. • Higher maternal education associated with lower consumption.	Unclear on inclusion of portion size. Baseline data from a nutritional intervention study.
Kudlova & Schneidr-ová. [44]	Czech Republic Prague & all 13 regions of Czech Republic 2008-10	N=1,130 1-5yrs 49% female	• Women approached on street if looked like had 1-5yr old child with them. • 76.7% response rate. • Parent reported questionnaire. • FFQ –Milk group, meat/fish/eggs/pulses, veg, fruits, grains, other (sweets and fried food). • Describe intake and associated factors.	• Most changes in intake occurred between 1-3yrs of age. • Intake of fruit, veg, poultry milk/milk products significantly decreased with age. • Intake of meat products, sweets and fried food increased with age.	
Saavedra et al. [45]	USA National random sample 2008-9	N=3,273 Birth – 4 yrs 47% female[1]	• Phone interview: -Multi-pass, 24-hour dietary recall, assisted by a food model booklet. -Dietary questionnaire (food introduction). • Describe what children are eating.	• Major changes happen to diet during 9-18 months of age • Dietary patterns seem set by 2 years of age • As children start to eat family foods, their diets start to mirror unhealthy patterns seen in adults • 16-27% of older infants & toddlers not having any fruit. • French fries the most commonly consumed 'vegetable' after 12 months of age • Sweet foods (e.g. biscuits) introduced as early as 4-5 months (5%). • Sweet foods consumed by 89% of 4-5yr olds.	Also reports on energy and macronutrient intake. Doesn't explicitly report on overall vegetable intake.
Siega-Riz et al. [46]	USA National random sample 2002 2008-9	2002 N=2,884 birth– 2yrs 48% female	• Phone interview: -Multi-pass, 24-hour dietary recall, assisted by a food model booklet. -Dietary questionnaire (food introduction). • Describe food consumption in 2002 and 2008.	• Early introduction (before 12 months of age) of cow's milk in 2002 & 2008. • Grain products consumed by ~90% of children by 6-8.9m of age.	FITS 2002 only went up to 2yrs of age.

Author	Country, sampling and year collected	Sample (N, age, % female, follow up rate)	Methodology	Key outcomes	Notes
		2008-9 N=1,596 birth– 2yrs 48.5% female		• ~15-35% children between 1 and 2 years not having any fruit (excluding FJ). • 20-30% of children not having any vegetables. • Less children consuming 100%FJ in 2008 compared to 2002, (but still 7.1% of 4-5.9m old in 2008). • Sweets drinks/foods introduced early (4-5.9 months). • % consuming sweet drinks/foods in 2008 was lower than in 2002, but still increased with age.	French fries are recorded as vegetables.
Fox et al. [47]	USA National random sample 2008-9	N=1,461 2-3yrs % female unreported	• Phone interview: -Multi-pass, 24-hour dietary recall, assisted by a food model booklet. -Dietary questionnaire (food introduction). • Describe food consumption	• Large drop in whole milk consumption after 24 months. • Flavoured milk consumed by 10% of 2yr olds, 14% of 3yr olds. • Daily consumption: -Vegetables: 70% -Fruit: 73% -Grain products: 98% -100%FJ: 59% -Sweetened beverage: 46% -Salty snacks: 26% -Desserts/lollies: 71% • French fries most commonly consumed vegetable.	French fries classified as a vegetable.
Skinner et al. [48]	USA National random sample 2002	N= 3,022 4-24 months 49% female[2]	• Phone interview: -Multi-pass, 24-hour dietary recall, assisted by a food model booklet. • Categorised beverages into 6 groups: milks, 100%FJ, fruit drinks, carbonated beverages, water and 'other'. • Examine consumption and whether some beverages displace others in toddler diets.	• Some form of milk consumed at each age but decreased as children got older. • Consistent increase in fruit drink consumption across age range. • 100% FJ consumed by 21% of 4-6m olds, 62% of 19-24m olds. • 72-77% 12m-24m consuming water. • Carbonated beverages and fruit drinks consumed as early as 4-6m, by 19-24m 12% consuming. • Consumption of carbonated beverages, fruit drinks & FJ associated with lower calcium density in diet.	
Skinner et al. [49]	USA National random sample 2002	N= 3,022 4-24 months 49% female[2]	• Phone interview: -Multi-pass, 24-hour dietary recall, assisted by a food model booklet. • Examined meal and snack patterns.	• Crackers, cookies and FJ/fruit drinks were common snack foods between 9-24 months • Fruit & veg was not a common morning/afternoon snack	Also looked at nutrients.
Ponza et al. [50]	USA National random sample 2002	N=3,022 4-24 months 49% female[2]	• Phone interview: -Multi-pass, 24-hour dietary recall, assisted by a food model booklet. • Compared participants of the WIC vs non-WIC participants.	• Non-WIC group more likely to be ever/currently breastfed between 4 and 11 months of age • WIC & non-WIC timing of solids similar • Higher % of WIC participants having fruit at 4-6months • Lower % of WIC consuming fruit between 7 to 24 months • Higher % of WIC consuming sweetened beverages	Also looked at nutrients.

Author	Country, sampling and year collected	Sample (N, age, % female, follow up rate)	Methodology	Key outcomes	Notes
Fox et al. [51]	USA National random sample 2002	N=3,022 4-24 months 49% female[2]	• Phone interview: -Multi-pass, 24-hour dietary recall, assisted by a food model booklet. • Examined food consumption.	85% of >=12 months consuming cow's milk (mainly full fat) • 65% of 4-6m consuming grain products Cereals were common Crackers/pretzels/rice cakes a common snack • Vegetables: 39% of 4-6m consuming, 81.6 of 19-24m. Most common veg from 15m onwards was French fries/fried potatoes. • Fruit: 41.9% of 4-6m consuming, 67.3% of 19-24m. • Meat/proteins: 14.2% at 4-6m, 97.2% at 19-24m • Sweet beverages: <1% at 4-6m, 44.3% at 19-24m • Salty snacks: 0% at 4-6m, 26.6% at 19-24m	They recommend 100% FJ as an 'alternative beverage' French fries classified as a vegetable.
Roess et al. [52]	USA National random sample Compared to USA census FITS sample had greater % of non-white Hispanic and greater % of higher education[3] 2016	N=2,635 Birth – 2yrs % female unreported	• Phone interview: -Multi-pass, 24-hour dietary recall, assisted by a food model booklet. • Percentage consumption examined.	• 17% of children <4m had received solids. • 6.7% of 4-6m had consumed some sort of dessert, sweet or sweetened beverage. • Older infants (6-12m) -74% having fruit - 72% having veg -27% having 100% FJ -1/3rd having sweets, including sugar sweetened beverages • Toddlers (12-24m) -75% having fruit - 60% having veg (if excluded potato) -30% unsweetened cereal -50% having 100%FJ (~½ exceeding recommended amount) - 75% having sweets, sugar sweet beverages • Grains:14% at <4m, 96% at 18-24m • Savoury snacks: 0.4% at 4m, 20% at 18-24m • Meat/protein: 1.7% at 4m, 91% at 18-24m • FJ: 4.2% at <4m, 55% by 18-24m • Sugar sweetened beverages: 27% at 12-18m, 31% at 18-24m.	Subgroup analysis by ethnicity also conducted.
Welker et al. [53]	USA National random sample Compared to USA census FITS sample had greater % of non-white Hispanic and greater % of higher education[3] 2016	N = 600 24-48 months 53% female	• Phone interview: -Multi-pass, 24-hour dietary recall, assisted by a food model booklet. • Percentage consumption examined.	Consumption rates • 81% cow's milk • 95% grains, most common: bread, cereal, crackers/pretzels/rice cakes • 73% vegetables, most common: fried potato • 77% fruit, most common banana • 45% 100%FJ • 88% protein/meat • 90% SSB/desserts/sweets • 36% savoury snacks	

Author	Country, sampling and year collected	Sample (N, age, % female, follow up rate)	Methodology	Key outcomes	Notes
Demmer et al. [55]	USA Nationally representative stratified probability sample. 2011-14	N=2,431 0-5yrs % female unreported	• In person, parent reported multiple pass 24-hour recall. • Examined food and nutrient intakes.	• Vegetable consumption increased with age, but always low – never more than 0.7 cups per day. • Fruit intake increased between 0 and 3 years, and then decreased. • Intake of solid fats, oils and added sugars quickly increased as children got older. • Ethnicity influenced the intake of different foods groups.	Also examined nutrient intakes.
Wang et al. [56]	USA Nationally representative stratified probability sample. 2009-14	N=3,345 0 – 5yrs 50% female	• In person, parent reported multiple pass 24-hour recall. • Examined leading sources of sugars, saturated fats and sodium.	• Cakes, cookies, pastries and pies were the leading source of added sugars, followed by FJ/fruit flavoured drinks. • Meat, poultry and fish were the leading source of sodium and saturated fat for children over 1yr. • Consumption of sugars saturated fats and sodium exceed limits in many children's diets prior to reaching school age.	
Reedy et al. [57]	USA Nationally representative stratified probability sample. 2003-4 2005-6	2-3yrs N=224 (2003-4) N=497 (2005-6) 4-8yrs N=781 (2003-4) N=899 (2005-6) % female unreported	• In person, multiple pass 24-hour recall. • Parent reported <=5yrs • Parent assisted. interviews with 6-11yr olds. • Examined mean intake and top sources of energy, solid fats and added sugars.	• Top energy sources: - 2-3yrs: Whole milk and 100%FJ - 4-8yrs: Grain desserts (muesli bars, cakes, cookies etc.) and yeast breads. • Top sources of fat - 2-3yrs: whole milk and fatty meats - 4-8yrs: whole milk and pizza. • Top sources of added sugar - 2-3yrs: fruit drinks, soda. - 4-8yrs: soda, fruit drinks. • There is overlap between major sources of energy and empty calories, which changes as children get older.	Paper reports on age 2-18 have reviewed information regarding children 2-3yrs and 4-8yrs.
O'Connor et al. [58]	USA Nationally representative stratified probability sample. 1999-2002	N=1,572 2-5yrs 50% female	• In person, parent reported multiple pass 24-hour recall. • Objective assessment of child height and weight. • Examined associations between beverage intake and weight status	• Consumption rates - 48% FJ - fruit drink - 39% soda - 82% milk: 47% whole milk, 15% chocolate milk. • No significant association between beverage intake and overweight/obesity.	
Cowin et al. [59]	U.K. Random selection of children born into last part of ALSPAC. 1994	N= 1,026 18 months 45% female	• Parent recorded 3-day unweighted diet record • 2 weekdays & 1 weekend day. • Parent interviewed after recording to check for completeness. • Examined food and beverage consumption and compared with National British Diet Survey (NDNS) 1990.	Percentage consuming • Grains: White bread and high fibre breakfast cereal- 72%, lower than NDNS. Biscuits 87%, puddings 57%, buns, cakes, pastries, fruit pies 46%. • Dairy: Whole milk 90%, yoghurt 70%, cheese 57%. • Meat: Chicken/turkey 45%, beef/veal 38%, fish 33%. • Veg: non-fried potatoes 78%, cooked carrots 33%, fried/roast potatoes 56%. • Fruit: FJ 38%, apples/pears: 44%. • Chocolate 63% (lower than NDNS)	

Author	Country, sampling and year collected	Sample (N, age, % female, follow up rate)	Methodology	Key outcomes	Notes
				• Savoury snacks 66%.	
Emmet et al. [62]	U.K. Random selection of children born into last part of ALSPAC. 1996	N=863 18 months and 3.5yrs % female unreported	• Parent completed 3-day food record. • 2 weekdays, 1 weekend day. • Interviewed to go over anomalies in diary. • Examined food and nutrient intakes and compared to intakes at 18 months and NDNS data.	• Rice/pasta & white bread most common grain at 3.5 years (same at 18 months). • Biscuits consumed by 87%, similar proportion to 18 months, but amount consumed had increased. • Cakes, buns, fruit pies consumed by 55%, an increase in consumers from 18 months and the amount had nearly doubled. • Between 18m and 3.5yrs whole milk consumption had decreased, skim milk consumption increased. • Chicken (45%-similar to 18m) and bacon/ham (45% - higher than 18m) were the most commonly consumed meats. • Vegetable consumption dropped by ~9% from 18m to 83% at 3yrs, but little difference in amount consumed. • Fried potato consumption increased from 56% to 72%. • Fruit dropped by ~ 2% to 83%, but slight increase in amount consumed. • Increases in savoury snacks, chocolate, confectionery for % consumers and amount consumed. • 44% having FJ and 59% having fizzy drinks at 3.5yrs.	Paper also looked at nutrient intake.
Kudlova et al. [60]	Czech Republic Randomly selected from maternity ward in one hospital in Prague. 1998 (baseline)	Birth: N=97 24 months: N=88 50% female 90.7% FU	• Followed up at 9, 12 and 24 months of age. • Parent reported questionnaire. • Parent recorded 3-day diet record. • Weighed or household measures. • 2 consecutive weekdays, 1 weekend day. • Examine dietary intake at each age.	• FJ and sweet consumption increased with age. • Not consuming vegetables daily: 23% (9m), 18% (12m) and 28% (24m). • Not consuming fruit daily 7% (9m), 18% (12m), (0%) 24m • 28-40% not consuming. meat/poultry daily • FJ consumed by 36% (9m), 30% (12m), 66% (24m).	
Grimm et al. [61]	USA National data, but not representative. Minorities underrepresented. 2005-7 (baseline) 2011-13 (FU)	N=1,078 10.5 months 6yrs 50% female 52% FU	• Parent completed, 28 item FFQ -How many times in the last 30 day did child consume…? -Times per day/week/month -used 6 items from FFQ (1 fruit, 5 veg) • Examined consumption frequency of fruit/veg at 10.5 months with intake at 6 years	• Children who ate fruit & veg less than once a day at 10.5 months had increased odds of eating fruit & veg <once/day at age 6.	

[1]Not reported in current paper, taken from FITS 2008 design/methods paper[67]; [2]Not reported in current paper, taken from FITS 2002 design/methods paper [68]; [3]Not reported in current paper, taken from FITS 2016 design/methods paper [65]. **Acronyms and abbreviations: ALSPAC:** Avon Longitudinal Study of Parents and Children; **BM:** Breastmilk; **FFQ:** Food Frequency Questionnaire; **FITS:** Feeding Infants and Toddlers Study; **FJ:** Fruit Juice; **FU:** Follow UP; **IF:** Infant Formula; **NHANES:** National Health and Nutrition Examination Survey; **SES** Socio-economic status; **SSB:** Sugar Sweetened Beverages; **WIC:** Special Supplemental Program for Women, Infants and Children; **+ive:** positive; **-ive:** negative.

2.6 International literature: Dietary patterns and profiles

Table 2.3 summarises the international literature reporting on dietary patterns and dietary profiles in children five years and under. Characterising food and beverage intake in terms of dietary patterns is a more recent phenomenon. These patterns are computed from reported dietary intake data. Twelve of the fourteen studies identified used principal components analysis (PCA) to derive dietary patterns from dietary data [71-82]. PCA is a type of factor analysis and reduces a large number of variables into a logical smaller set of variables [83]. Four studies report on data from the ALSPAC cohort [79-82], three the EDEN cohort from France [76-78] and two the Southampton Women's Survey from the U.K. [84] [75]. The other five papers report on individual studies from Norway [71], Brazil [72], Samoa [73], New Zealand [74] and Scotland [85]. Five studies report on cross-sectional data [71, 73, 80, 82, 85], eight longitudinal [72, 74, 75, 77-79, 81, 84] and one cross-sectional and longitudinal [76].

2.6.1 Cross-sectional studies

Most cross-sectional studies report dietary patterns for children two years and older [71, 73, 82], one for children between six and 15 months [80] and one for children between 19 and 24 months [85]. In each study at least two dietary patterns were identified. The specific foods and drinks loading onto each pattern differ due to varying data collection tools, however each study identifies a distinct healthy and distinct unhealthy pattern. Healthy patterns were characterised by things like fruits, vegetables, meats and wholegrains whereas unhealthy patterns tended to be characterised by processed foods such as biscuits, chips and chocolate. For children aged six months (n=5,129) and 15 months (n=3,998) in the ALSPAC cohort, two patterns were observed at both ages (one healthy, the other unhealthy) [80]. Two additional patterns were also observed which did not match at these ages, suggesting that there are changes in dietary intake occurring between these ages. In children older than two years, less variation in overall dietary patterns was observed, but there may still be changes in foods and drinks that load onto these patterns [73, 76, 82]. This suggests that while dietary intake still changes at older ages, it is not changing to the same extent as younger ages. Additionally, there is likely to be variation in dietary patterns for different generations of young children. Norwegian research with a cross-section of two-year-old children, once in 1999 and then again in 2007 identified a healthy and unhealthy pattern in each group of children, but also two additional dietary patterns which differed between 1999 and 2007 [71].

2.6.2 Longitudinal studies

Longitudinal dietary patterns have been reported for children up to two years of age in three studies [75, 78, 79] and children over two years of age in four studies [74, 76, 77, 81]. Two studies crossed over these ages, with Gatica and colleagues reporting on children between 12 and 48 months of age [72] and Okubo and colleagues examining children between six months and six years of age [84]. Follow up rates for each of these studies have varied greatly between 10% [79] and 94% [72], which is likely to influence how generalisable the results are to the wider population.

In children under two years of age, both studies from the U.K showed that children tended to transition to one of two dietary patterns (healthy and unhealthy) between six and 12 months [75] and six and 24 months of age [79]. In the Southampton Women's Survey study, which has a strong research design and uses a validated data collection tool, similar patterns were identified when children were six and 12 months of age and there was moderate correlation (r=0.45 to 0.46) between the patterns at these two ages [75]. However, the ALSPAC study did not look at tracking of the patterns they identified. In contrast the EDEN cohort identified three distinct patterns by 12 months of age: 1. Late complementary food introduction/use of baby foods; 2. Longer breastfeeding/late complementary food introduction/use of home-made foods; 3. Use of adult foods [78]. In both the EDEN and ALSPAC studies, older and more educated mothers ranked highly with the healthier patterns [78, 79].

In older children the number of dietary patterns identified and the degree to which they track across ages has varied. The EDEN cohort identified two distinct patterns (guidelines and processed/fast foods) between two and five years of age [76], ALSPAC identified three consistent patterns (1. processed foods, 2. health conscious and 3. traditional) at three, four, seven and nine years of age [81] and a New Zealand birth cohort identified three distinct patterns (1. Junk, 2. Traditional, 3. Healthy) at 3 ½ and seven years of age [74]. In the ALSPAC study, an additional pattern, snack foods, was identified only in three-year old children and the health-conscious pattern at age nine had more vegetarian type foods associated with it compared to the earlier ages. The disappearance of the snack pattern reflects children transitioning between ages three and four from snack type foods to more meal type foods, whilst the appearance of vegetarian type items may reflect children having more autonomy over their intake by nine years of age. Only two of these studies examined tracking of patterns. Weak to moderate correlation (r =0.11 to 0.39) was seen in the New Zealand cohort, whilst

ALSPAC had moderate correlations (r=0.35 to 0.46) between age three and nine years, with stronger correlations (r =0.52 to 0.69) across shorter periods.

Two longitudinal studies have reported on children under and over two years of age [72, 84]. In Brazil, similar dietary patterns were observed at 12 and 24 months of age, however changes occurred between 24 and 48 months of age, with one of the healthier patterns replaced with a less healthy pattern [72]. This study did not examine whether these patterns tracked over time. In the U.K, there was weak tracking for diet quality between six months and six years of age (r=0.32), with diet quality scores more similar for children at closer ages (six months and 12 r=0.53, 3 years and six years r=0.69) [84].

In summary, dietary pattern research demonstrates that distinct healthy and unhealthy patterns are present early in life. As children get older, similar patterns are observed, but the types of food and beverage items which load onto patterns may change. Additionally, whilst unhealthy patterns are constantly present, in some cases healthy patterns may become less healthy or be replaced completely by less healthy patterns.

Table 2.3 Summary of international literature examining dietary patterns and dietary profiles in children aged 5 years and under

Author	Country, sampling and year collected	Sample (N, age, % female, follow up rate)	Methodology	Key outcomes	Notes
Kristiansen et al. [71]	Norway All children born in Norway in a 3-week period in each year invited to participate. 1999 & 2007	2yrs 1999 N=1,373 50% female 2007 N=1,472 51% female	• Parent completed semi-quantitative FFQ via mail. • Photo booklet with portion sizes included. • Time frame of last 14 days. • 1999: 131 food items, put into 46 food groups. • 2007: 151 food items, put into 47 food groups. • Used PCA[2] to derive dietary patterns. • Examine associations between demographics and dietary patterns	• 4 dietary patterns derived in 1999 and 2007. • *Unhealthy pattern ('99 & '07):* high +ive load sweet/salty snacks, ice cream/puddings, SSB, hamburger buns, cakes/biscuits, fried potatoes, ketchup and pizza. • *Healthy pattern ('99 & 07):* high +ive load veg, pasta, rice, fish, poultry, water, fruits & berries -'07 also high load for soup, pancakes, pizza, cakes and biscuits. • *Low fat milk, pancakes, fruit & berries ('99 only):* high +ive load for listed foods and -ive load for full fat milk. • *Bread/spread ('99 only):* high +ive load semi/ wholegrain bread, butter/ margarine, meat, cheese, sweet spreads; high -ive load porridge and unsweetened cereal. • *Traditional ('07) only:* high +ive load meat, potatoes, sauce, butter/margarine, semi-wholegrain bread, fish, eggs, veg, meat stew, potato. • *Baby food ('07 only):* high +ive load porridge, unsweetened cereal, commercial baby food, sugar, high -ive load for semi/wholegrain bread and cheese. • Having siblings associated with higher score on unhealthy pattern ('07 & '99), low fat milk pattern and bread and spread pattern and lower mean score on baby food pattern. • Older mothers had children with significantly lower mean scores on the unhealthy pattern ('99 & '07) and the bread/spread pattern, but higher scores on baby food pattern. • Parents with higher education levels had children with lower mean scores on the unhealthy pattern. • As parent education level increased so did children's scores on the healthy pattern.	
Gatica et al. [72]	Brazil Pelotas (a city in Southern Brazil). Recruited 99% of births to women in the urban area. 2004 (baseline)	Birth N=4231 12 months N=3986* 94.2% FU 24 months N=3952* 93.4% FU	• Parent reported 24hr recall, no. times item consumed in past 24hrs. • No amount recorded. • 12 and 24m: 16 items. • 48m: 17 items. • Generate food profiles using PCA and look at associations with demographics.	Food profiles derived **12m** • *Milk:* breast milk (+), milk/IF (-) • *Staples:* (+) rice & beans, pasta (-). • *Meat & veg:* meat, veg/ legumes, potato/cassava (+) • *Beverages:* FJ (+), water/tea (-) • *Snack:* bread/cookies, coffee (+), fruit (-) **24m** • *Milk, staples and beverages* patterns identified.	Bread/cookies grouped in tool. *N is not reported for each wave, calculated from reported response rates. Factor loadings >=0.3 <=-0.3.

Author	Country, sampling and year collected	Sample (N, age, % female, follow up rate)	Methodology	Key outcomes	Notes
		48 months N=3884* 91.8% FU % female not reported		• Same as 12m but *snack* had yoghurt (-) instead of fruit and *meat* included fruit (+). **48m** • *Meat/veg* disappeared. • *Treats* observed: chips, sweets, chocolate (+). • *Milk:* cow's milk, IF, powdered chocolate drinks (+). • *Staples:* rice, beans, meat (+). • *Snack: coffee, water/tea, bread/cookies (+), yoghurt, soft drink (-).* • *Beverages:* FJ (+), soft drink (-). • At 12 & 24m poorer families tended to have higher snack scores • Greater consumption of treats (4yrs) associated with lower SES & lower maternal schooling.	
Choy et al. [73]	Samoa Ten villages from 1 Samoan Island (Upolu) 2015	N=305 24-59 months % female not reported	• Parent report questionnaire. • Parent completed 117 item FFQ. • 9 responses: <once/ month to ≥6 times/day. • 30-day reference period. • FFQ items put into 35 groups and PCA used to derive dietary patterns. • Examined dietary pattern associations with demographics.	• *Modern pattern:* red meat, whole grains, corn, French fries, butter, mayonnaise, nuts & snack foods (+). • *Neo-traditional:* Veg, local starchy crops, coconut, fish, poultry (+); desserts, pizza, dairy, infant foods (-). • *Modern* pattern associated with greater maternal education, higher SES and living in urban area.	Factor loadings >=0.3 <=-0.3
Wall et al. [74]	New Zealand Auckland and Waitemata District in NZ (not representative of NZ) 1995-2004	Birth N= 1714 3.5yrs N=548 29% FU 7yrs N=591 34%FU % female not reported	• Parent report questionnaire. • Parent completed, semi-quantitative FFQ. • 8 responses: never to ≥2 times/day. • 3.5yrs: 71 items. • 7yrs: 77 items. • PCA used to derive dietary patterns. • Examined dietary pattern association with demographics.	Similar patterns derived at both ages • *Junk:* candy bars, hamburgers, soft drinks chips (and chocolates/lollies at 7yrs) (+). • *Traditional:* cauliflower, peas, mixed veg, potatoes, pumpkin, beef (+). • *Healthy:* pineapple, tomatoes, cucumber, 'other' green vegetables, celery, mixed grain bread (+); white bread (-). • Patterns not highly correlated at each timepoint. • *Junk* pattern positive association at 3.5yrs with smoking in pregnancy, maternal BMI, attending antenatal classes, younger maternal age. • *Healthy* pattern associated with being married when pregnant (3.5yrs only). • *Traditional* pattern associated with being male, maternal smoking, younger maternal age (at 7yrs).	Only asked about chocolates/lollies at age 7 Only included European ethnicity respondents
Abraham et al. [85]	Scotland National random stratified sample. 2005-9	9-12 months N=5,217	• CATI face to face interview, variety of questions related to dietary intake and behaviours.	• Two dietary clusters defined at age 2: - *More positive:* high variety of fruit & veg daily, fruit between meals, less snacking, lower fruit, & veg.	Doesn't specify the tool used to collect dietary data.

Author	Country, sampling and year collected	Sample (N, age, % female, follow up rate)	Methodology	Key outcomes	Notes
		19-24 months N=4,512 86.5% FU 45-48 months old N=3,994 76.6%FU % female not reported	• SPSS two-step cluster analysis: group children with similar eating patterns (defined by fruit intake, variety of veg, snacking behaviour, intake of EDNP foods). • Examined associations between early infant feeding and (1) eating patterns in second year of life and (2) weight status in fourth year of life.	- *More negative:* lower fruit and veg, higher sweets, crisps, soft drink & snacking behaviours. • Breastfeeding associated with positive eating cluster. • Higher parent education associated with healthier cluster. • Healthier cluster had lower number of deprived families.	Longitudinal study but reports on eating pattern at one timepoint.
Robinson et al. [75]	U.K. All GPs in Southampton asked to invite non-pregnant female patients aged 20-34 years to participate. Children of those enrolled have been followed. 1999-2004	6 and 12 months N= 1,434 47% female 73% FU at both waves	• Parent reported FFQ, administered by research nurse. • Average frequency over previous 7 days (6m) or month (12m). • Portion size aids used. • 34 items (6m) and 78 items (12m) plus additional item not listed. • FFQ items grouped: 28 (6m), 56 (12m). • PCA used to define dietary patterns at each age. • Examined associations between dietary patterns and parent/child characteristics.	3 patterns identified at 6 months of age • *Infant guidelines:* veg, fruit, meat/fish, other home prep foods, breast milk (+); lower commercial baby foods, low IF (-). • *Adult foods:* bread, savoury biscuits, squash, breakfast cereal & chips (+); breast milk, baby rice & cooked/ tinned fruit (-). • *Baby jar foods*: Wet commercial baby foods (+); dried commercial baby foods (-) 2 patterns identified at 12m • *Infant guidelines:* fruit, veg, rice/pasta, fish, cheese, meat (+); baby jar foods (-). • *Adult foods:* crisps/savoury snacks, processed meat, fruit squash, chips, roast potatoes, white bread (+); commercial baby foods and IF (-). • Patterns were highly correlated between 6 and 12 months. • Higher *infant guideline* score associated with Higher maternal education and higher maternal diet score at 6m, but only maternal diet at 12m • Higher *adult foods* score associated at 6m & 12m with maternal: lower education, younger, higher BMI, smoking, lower diet score; child: higher birth order and earlier intro to solids.	Recruitment information from the cohort profile paper [86].
Okubo et al. [84]	U.K. All GPs in Southampton asked to invite non-pregnant female patients aged 20-34 years to participate. Children of those enrolled have been followed.	N= 1,018 6 months, 12 months, 3yrs, 6yrs (55% of original cohort) 48% female	• Parent reported FFQ, administered by research nurse. • Average frequency over previous 7 days (6m), month (12m), 3 months (3 & 6yrs). • Grouped foods according to similarity: 46 groups (6m), 56 (12m), 51 (3 & 6yrs). • Generated a 'diet quality score' depending on how well they scored compared to the	• Diet quality score (DQI) correlated across early years, most closely correlated at close time points (6m & 12m, 3yrs & 6yrs). • 6m-6yrs r=0.32 • Strong relationship between lower DQI and higher fat mass at age 6.	

Author	Country, sampling and year collected	Sample (N, age, % female, follow up rate)	Methodology	Key outcomes	Notes
	1999- 2010		'infant guideline/prudent dietary pattern' at each age. • Then given an overall score across early childhood 0-lowest quality,8 highest quality. • Compared diet quality across childhood to weight status at 6yrs.		
Lioret et al. [76]	France Recruited from two University hospitals in South-West France. 2003-11	N=989 2-5 yrs 52% of baseline sample. 46.7% female	• Parent completed questionnaire including FFQ. • 26-27 food groups with 7 response options: never to several times/day. • Derived cross-sectional and multi-point dietary patterns using PCA. • Examine associations of dietary patterns and demographics.	**Cross-sectional** **2yrs** • *Processed fast foods:* French fries, processed meat, soft drinks, chocolate, chips, cookies, pizza, FJ, meat, dairy desserts, and ice cream (+). Associated with lower mother education, younger age, presence of siblings in home • *Guidelines*: cooked & raw veg, rice, fresh fruit, low-fat fish, potatoes, ham, stewed fruit, and meat (+). Associated with higher mother education • *Baby foods*: baby foods, breakfast cereals, and stewed fruit (+); raw veg, fresh fruit (-). Associated with younger mothers, lower mother education. **3yrs** • *Guidelines & Processed fast foods* (similar to age 2). **5yrs** • *Protein rich & diversified:* animal origin (ham, meat, processed meat, fish, and eggs), starchy foods (potatoes, rice, legumes, and bread), vegetables (raw and cooked), fresh fruit, and pizza (+). • *Processed & fast foods*: chips, soft drinks, cookies, chocolate, dairy desserts, ice cream, and processed meat (+); cooked and raw veg, fresh fruit (-). **Multi-point** • *Processed & fast foods:* French fries, processed meats, chips, chocolate, carbonated soft drinks, cookies, meat, and FJ (+). • *Guidelines*: fresh fruit, raw and cooked veg, low-fat fish, and bread (+). • Moderate tracking of similar food profiles, stronger for healthier patterns	Don't explicitly report time of data for timepoints other than baseline - years calculated based on this.
Camara et al. [77]	France Recruited from two University hospitals in South-West France. 2003-11	N=974 2-6yrs 51.2% of original sample. 46.6% female	• Parent completed questionnaire including a FFQ. • 26-27 food groups with 7 response options: never to several times/day. • Derived multi-point dietary patterns using PCA.	• *Processed/fast foods* pattern associated with younger mothers, lower maternal education, presence of older siblings, household disadvantage and childcare. • *Guidelines* pattern associated with higher paternal and maternal education.	Used the *guidelines* and *processed/fast foods* patterns identified in [76]s

Author	Country, sampling and year collected	Sample (N, age, % female, follow up rate)	Methodology	Key outcomes	Notes
			• Examine associations of dietary patterns and demographics.		
Betoko et al. [78]	France Recruited from two University hospitals in South-West France. 2003-8	Birth-1yr N=1,004 49% female 52.9% FU	• Parent completed questionnaire • Type of milk feeding, age of complementary food (CF) introduction. • FFQ at 12 months of age. • PCA used to derive patterns from the above variables. • Examined patterns of feeding and associations with family characteristics.	Three patterns identified • *1. Late CF intro & use of baby foods:* intro of all listed foods and use of pre-prepared veg, fruit purees and baby main meals (+); home-made and ready prepared adult food (-). High scores on this related to higher family income, older & more educated mothers. • *2. Longer BF, late CF intro & use of homemade foods:* BF duration, older age of intro to meat, fish, veg, fruit, potatoes, cereals, dairy, biscuits and FJ, use of homemade soups, veg, fruit purees and fresh meat and fish (+); use of baby food (-). Associated with mothers who were older, had higher education and less likely to be obese. • *3.Use of adult foods:* Using ready-prepared dairy products, soups, fruit purees, FJ and biscuits (+); baby dairy products and on home-made fruit and veg purees, fish and meat (-). High scores associated with younger mothers and having more than 1 child.	Number of items in FFQ not stated.
Brazionis et al. [79]	U.K. Pregnant women in the former county of Avon (South-West England). Broadly representative of local Avon area (single parents, ethnic minorities, unmarried couples underrepresented). 1991-4	6 months 15 months, 24 months Diet only N=2,169 15.5% of original sample Diet and SES N=1,425 10.2% of original sample. 50% female	• Parent completed FFQ at age 6, 15 and 24 months through post. • 167 food and beverage items. • No portion size collected. • Recall period -6mQ: birth to 6m. - 15mQ: 6m to 15m. - 24mQ: 25m to 24m. • PCA used to derive transition dietary patterns between 6m and 24m. • Examined associations between dietary pattern and family characteristics.	• Two types of transition diets identified • *Healthy*: home prepared meat, veg (incl. potato); fish and fruit pudding, also raw fruit & veg (6m). Cooked veg, herbs, apple juice, bread/toast, cheese, fish, fruit pudding, nuts, raw fruit and veg (15m & 24m). • *Less Healthy*: IF, black current/rosehip juice, biscuits, chocolate (6m). Biscuits, canned soup, added salt (15m). Fruit drinks, carbonated drinks, tea, baked beans, snack foods (savory snacks, sweets, potato chips, cola, chocolate), added gravy, sugar (15m & 24m). Potato, coffee, ketchup (24m). • Older mothers and higher education associated with higher score on *healthy* diet. • Younger mothers, lower education associated with higher scores on *less healthy* diet.	
Smithers et al. [80]	U.K Pregnant women in the former county of Avon (South-West England). Broadly representative of local Avon area (single parents, ethnic minorities,	6 months N=7,052 15 months N=5,610	• Parent completed FFQ at age 6 and 15 months through post. • 6m: 43 items, 15m: 70 items. • No portion size collected. • Examined commonly consumed foods at each timepoint.	• 6m: Top 10 frequently consumed foods: IF, BM, baby rice cereal, baby fruit pudding, home prep veg, baby veg, baby meat, home prep potatoes, fruit drink, plain rusks. • 15m, consumed frequently: Cow's milk, cereal, bread/toast, biscuits, meat products, potatoes, veg, yoghurt, raw fruit. 6m: Diet patterns	

Author	Country, sampling and year collected	Sample (N, age, % female, follow up rate)	Methodology	Key outcomes	Notes
	unmarried couples underrepresented). 1991-4	49% female	• Used PCA to derive dietary patterns at each timepoint. • Examined associations between dietary patterns and family characteristics.	• *Meat, veg & desserts:* Home prepared veg, potato, meat, fish, fruit pudding, milk puddings (+). Higher score associated with married mothers & white ethnicity. Lower score associated with smoking in pregnancy, high maternal BMI, more siblings. • *Biscuits, sweets & crisps*: Biscuits, chocolate, tea, sweets, bread, cola, fizzy drinks adding sugar to bottles. Higher score associated with younger mothers, lower education, smoking in pregnancy, higher BMI, more siblings. • *Ready prepared baby foods*: Commercially manufactured baby foods. Higher score associated with younger mothers, lower education, smoking in pregnancy. • *Breastfeeding* –BM (+), IF (-). Raw fruit and veg (moderate). Higher score associated with older mothers with higher education, more siblings, less smoking in pregnancy, lower mother BMI. 15m diet patterns • *Herbs, raw fruit & veg:* herbs, legumes, raw fruit & veg, spices, cheese. Associated with older and more educated mothers, not being married, non-white ethnicity. • *Biscuits, sweets & crisps:* fizzy drinks, sweets, crisps, biscuits, ketchup. Associations same as seen at 6m. • *Ready prepared baby food:* commercially made baby food. Higher score associated with older mothers, not having other children, not being married. • *Reverse meat veg dessert:* home prepared potatoes, meat products, veg and milk puddings. Higher score associated with being married.	
Northstone et al. [81]	U.K. Broadly representative of local Avon area (single parents, ethnic minorities, unmarried couples underrepresented). 1991-2000	N=6,177 3, 4, 7 and 9yrs % female unreported 43.9% of original sample.	• Parent completed FFQ at each timepoint. • How often eating 'nowadays' - 5 response options: never to >once/day. • Similar FFQ items grouped together for analysis. No. groups: 34 (3yrs), 35 (4yrs), 41 (7yrs), 41 (9yrs). • PCA used to derive dietary patterns at each age.	• Three consistent patterns seen across time. • *Processed*: foods with high fat & sugar, processed, convenience foods. • *Health conscious* –salad, fruit, veg, fish, pasta, rice (3,4,7yrs). Termed *health conscious/vegetarian* at age 9 because of slight changes. • *Traditional*: meat, potato, poultry, veg. • *Snack*: cheese, fruit puddings, cakes, biscuits, crisps. Only seen at age 3yrs. • Correlated across timepoints, but not as much agreement in the later years. • Biggest differences were seen between 3 and 9 years.	

Author	Country, sampling and year collected	Sample (N, age, % female, follow up rate)	Methodology	Key outcomes	Notes
Northstone et al. [82]	U.K. Broadly representative of local Avon area (single parents, ethnic minorities, unmarried couples underrepresented). 1991-9	PCA only N=9,550 (4yrs) N=8,286 (7yrs) PCA & lifestyle N=6,592 (4yr) N=6,215 (7yr) 48% female	• Parent completed FFQ • 90 items, 5 response options never/rarely to > once/day. • Generated 57 food groups and then used PCA to derive dietary patterns.	Three patterns seen at both timepoints. • *Junk*: high fat processed foods (burgers, coated poultry, sausages), snack foods high in fat and/sugar (crisps, sweets, chocolate, ice lollies, ice cream). • At age 4yrs associated with non-white children, being vegetarian, the number of older siblings, lower maternal education. Kids who mainly ate snacks likely to have this diet. • At age 7yrs, similar associations to 4yrs with addition of: boys, more younger siblings, mothers who worked, living in council housing. • Traditional meat and veg, poultry & meat dishes, root veg, green veg, peas, sweetcorn, potatoes (+). • At age 4yrs associated with boys, mothers who didn't have partner, vegetarian mothers. Difficult eaters and snackers less likely to follow this diet. • At age 7yrs, similar associations with addition of younger mothers. • *Health conscious*: vegetarian style foods: meat substitutes, pulses/nuts, salad, rice, pasta, fruit, cheese, fish (+). • At age 4yrs: associated with: being vegetarian (mother and child), higher mother education. • At age 7, associations same as age 4, but more likely to be on this pattern if had more older siblings.	

Acronyms and abbreviations: ALSPAC: Avon Longitudinal Study of Parents and Children; **BM:** Breastmilk; **FFQ:** Food Frequency Questionnaire; **FJ:** Fruit Juice; **FU:** Follow UP; **IF:** Infant Formula; **PCA:** Principal Components Analysis; **SES** Socio-economic status; **SSB:** Sugar Sweetened Beverages; **SWS:** Southampton Women's Survey; **WIC:** Special Supplemental Program for Women, Infants and Children; **+ive:** positive; **-ive:** negative.

2.7 Dietary intake in children five years and under – Australian literature

Eight of the 15 studies identified report cross-sectional data [87-96] and seven report longitudinal data [97-103]. Three studies report on the South Australian Infants Dietary Intake (SAIDI) and NOURISH studies [94, 95, 97], two on the Infant Feeding Activity and Nutrition (INFANT) program [98, 99], two on the Childhood Asthma Prevention Study (CAPS) [92, 93] and two on the Longitudinal Study of Australian Children (LSAC) [100, 101]. The remaining studies report on a range of state-based and national data [87-91, 96, 102, 103]. Nine studies report on data from children under two years of age [91-98, 103], three report on children older than two years [87-90, 102] and three report on children above and below two years of age [99-101]. The most common methodologies were 24-hour recall [87-90, 94, 95, 97-99] and food frequency questionnaires [91, 96, 100-103]. One study used 3-day weighed records [92, 93]. A summary of the Australian literature reporting on dietary intake in children under five years of age is presented in Table 2.4.

2.7.1 Cross-sectional studies

Findings from Australian cross-sectional studies in children under two years of age are similar to those in the international literature. Most children are consuming a range of core foods early, however discretionary items appear in the diets of children as early as six to nine months of age [91, 96] and become more common as children get older [92, 93, 96]. Sweet beverages were also common in this age group with consumption rates ranging from 8% at six months [96], 19% at 12-16 months [95] to 41-42% at 18 months [92, 96]. Consumption of core foods tended to be high across all studies, however fruit consumption tended to be higher in nine month old children (92% fruit,) [91] compared to those aged 12-18 months (~88%) [93, 95]. A similar pattern was observed for vegetables in two studies (89% at nine months, 77% at 12-16 months) [91, 95], although one study reported 97% of 18 month old children consuming vegetables [93]. One study derived dietary patterns using PCA analysis when children were 12 and 24 months of age [94]. Similar to international research, two patterns were identified at each age; core items, basic combination at 14 months and core and non-core items at 24 months. Only the core items pattern was consistent at both times, suggesting changes in non-core intake over this period.

Cross-sectional research in children over two years of age is from the 2011-2012 Australian Health Survey [87-89] and the 2007 National Children's Nutrition and Physical Activity Survey [90] which are designed to be representative of the Australian population. Similar to children under two years, large proportions (at least 80%) of 2-3 year old children consumed discretionary items daily [88] and a substantial proportion of children did not consume fruit (20%) or vegetables (30%) daily. Those who consumed fruit did consume the recommended amount, but those who consumed vegetables fell well short of recommendations [104]. Dietary patterns were derived in one study with three distinct patterns (non-core food, healthy meat and vegetables and combination) seen between two and eight years of age [90].

2.7.2 Longitudinal studies

Three Australian longitudinal studies examined diet in children under two years of age [97, 98, 103], with high retention rates between 65% and 88%. These studies tended to support what is observed in cross-sectional studies, generally high consumption of core foods and increasing exposure to discretionary items as children get older. In the first year of life, exposure increases rapidly and by one year of age more than 60% of children have been exposed to discretionary foods and drinks [103]. Similar patterns were seen in the INFANT study between nine and 18 months of age [98] and in the NOURISH and SAIDI studies between 14 and 24 months of age [97]. Vegetable consumption remained relatively high and stable between nine and 18 months in INFANT, but between 14 and 24 months in NOURISH and SAIDI, consumption decreased slightly [97]. Increasing rates of fruit juice consumption with age were observed in both studies (INFANT 13% to 31%, NOURISH/SAIDI:19.3% to 39.9%).

Two longitudinal studies in children over two years of age were identified, both examining dietary patterns or dietary scores derived from dietary intake data [100, 102]. One study with a retention rate of 88% between two and 11 years of age used exploratory factor analysis [100], whilst the other with a retention rate of 21.7% reported on patterns between three and five years of age using latent class analysis [102]. Similar to international research, a healthy and unhealthy pattern was seen in both studies, but a moderately unhealthy pattern was also observed in the latter [102]. Children were unlikely (transitional probability 0.00) to move from the unhealthy to healthy pattern between age three and five, but children were likely to either stay the same (transitional probability 0.724) or move to the unhealthy pattern (transitional probability 0.276) by age five.

Only two of the identified longitudinal studies included children both under and over the age of two years. One is from the INFANT cohort and examines fruit, vegetable and discretionary item intake in relation to the dietary guidelines [99], whilst the other uses data from LSAC and focusses on beverage consumption [101]. Consumption of discretionary foods was common between nine months and five years of age, whilst fruit and vegetable consumption remained relatively stable. However, the percentage of children meeting fruit and vegetable consumption guidelines decreased between nine months and five years of age (fruit 98% to 38%, vegetables: 96% to 3%), primarily because intake remained stable whilst recommended intakes increased with age. Few children met the guidelines for discretionary intake at either age (nine months: 9%, five years: 2%) [99]. Similar to international and Australian studies, sweet beverage consumption was common from an early age, and the authors report a large increase in fruit juice consumption between 0-1 (data not reported) and two years of age (69%) [101]. Consumption rates of fruit juice then steadily decreased from age two to until age 10 (50% consumers) primarily due to a decrease in high (>once/day) consumers. In contrast, the proportion of children consuming cordial or soft drink increased steadily across this time. The retention rates for both studies were high: 86% for INFANT and 71-90% for LSAC (depending on the wave). However, the sample of parents recruited into the INFANT study were educated (54% university educated) first time parents residing within a 60km radius of the University campus (located in a metropolitan area). Additionally, participants exposed to the intervention (designed to improve dietary intake) were included in the longitudinal analyses. These factors limit the generalisability of the results.

2.8 Summary

Overall, international and Australian dietary data suggest that while many children are consuming foods from the five core food groups, discretionary items are also introduced into children's diets at an early age. In some children, this is around the time that they are transitioning from a milk-based diet to solid foods at around 4-6 months of age, however most children are regularly consuming discretionary items by their first birthday. Sweet beverages are commonly consumed, with fruit juice the most common in young children, and cordials and soft drink (soda) increasing in popularity as children get older. The evidence suggests that intake of core foods remains stable or declines slightly between one and five year of age, but that discretionary items steadily increase. Distinct healthy and unhealthy dietary patterns are observed early in life and throughout the first five years of life. The contribution of different foods and beverages to these patterns may change over time. Children who have unhealthy dietary patterns early in life are unlikely to transition to healthy patterns as they get older.

There is a lack of published Australian data on dietary intake in the first five years of life, with only two identified studies examining intake in children under and over two years of age. Whilst these studies provide useful evidence, one collected only limited information on dietary intake [101] and the other included a sample that may not be generalisable to the wider population, particularly those who are less educated [99]. In order to effectively promote healthy dietary intake in early childhood, we need to understand what children are consuming and how this change over time. Additional longitudinal evidence about intake between birth and five years from diverse populations will help to inform the key messages and critical time periods during which interventions to promote healthy eating should occur and whom these interventions and messages should target.

Table 2.4 Summary of Australian literature for dietary intake in children aged 5 years and under.

Author	Sampling and year collected	Sample	Methodology	Key outcomes	Notes
[87], [88] [89]	Stratified multistage area sample to be representative of Australian population, except for very remote areas. 2011-12	2-4yrs N=675 51% female 5-9yrs N=739 50% female	• In person interview. • Parent reported multi-pass 24hr recall. • Food model booklet to assist with portion size.	• High consumption of cereal products between 2-8yrs of age (>95%). • Fruit/veg juice/drink consumption ~44% for all ages. • Lower % consuming vegetables (69% 2-3yrs, 64% 4-8yrs) than fruit (83% 2-3yrs, 80% 4-8yrs), but both had lower % of consumers in older age group. • Slightly more older children consuming meat/poultry at 4-8yrs (69%) compared 2-3yrs (64%). • Dairy consumption rate higher in younger children (2-3yrs 94%, 4-8yrs 91%). • Higher % consuming in confectionery/ cereal bars (42% to 48%) and sweet cereal products (biscuits/cakes etc.) (76% to 84%) at 4-8yrs compared to 2-3yrs.	Second 24hr recall conducted over the phone ~8 days later, but not used in reported results. Age groups for foods are reported differently to the age groups in the demographics. Dairy includes frozen milk products and flavoured milk.
Grieger et al. [90]	Quota sampling stratified by state/territory. 2007	2-3yrs: N=1071 4-8yrs: N=1216 49% female	• 2 x 24hr recall. • 45 food groups generated. • PCA used to derive dietary patterns. • Initially separated age groups, but similar patterns see.	• Similar patterns observed in both age groups, so analysed together. Three distinct patterns observed: • *Non-core food groups:* whole fat dairy, cheese, deli meats, sugar-sweetened cereal, sweet biscuits (+ive), RF dairy, wholemeal breads, non-carbonated/non-nutritive beverages (-ive) • *Healthy, meat, vegetables:* vegetables, red meat, fruit, wholemeal bread (+ive), takeaway potatoes, carbonated SSB, takeaway foods, added sugar (-ive) • *Combination:* no fruit/veg, confectionery, other dairy (e.g. ice cream), pasta/rice, RF milk, nuts/seeds, cakes, chocolate (+ive).	Also examined association of patterns with breastfeeding
Conn et al. [91]	Pregnant women recruited at 1 public hospital and 3 private obstetricians. Broadly representative of population giving birth in South Australia. Only Caucasian women included 1999-2001	N=341 9m old 51% female	• Parent interview with structured open-ended questions about child's consumption over the past month. • FFQ format – food item, usual portion size. • Describe favourite and regularly consumed foods. • Checklist of commonly eaten foods and photos of labels for prompts. • Photo of bowl and actual bowl as portion size prompt. • Foods and beverages classified into 16 groups.	Food consumption rates • Cereal: 100% • Dairy: 95-96% • Fruit: 98% BF, 92% non-BF, BF consumed larger amount • Veg: 92% BF, 89% non-BF), BF consumed larger amount. • Food sources and amounts differed by BF and non-BF infants. • BF infants had more diverse diets. • Non-BF were more likely to have 'other' drinks including FJ, cordial and soft drinks. • Sugar and products: 31% BF, 39% non-BF.	Also looked at nutrients.

Author	Sampling and year collected	Sample	Methodology	Key outcomes	Notes
			• Examine food and nutrient consumption overall and by breastfeeding status.		
Koh et al. [103]	Recruited from two urban public hospitals in Perth. Slightly biased towards lower SES groups, More women who smoked during pregnancy compared to wider WA population. 2002-3	4wks: N=587 52wks: N=453 % female not reported 85% FU	• Phone interview with mother at 4,10, 16, 22, 32, 40- and 52-weeks post-partum. • Open and closed ended questions related to the introduction of solids	• FJ, soft drinks, cordials, biscuits cakes and ice creams introduced to some infants by 4wks of age. • FJ most common non-core item at 4wks with 2.3% consuming, increased to 57.5% at 52 weeks. • Cordial and soft drink consumption increased from 1.5% at 4 weeks to 32% at 52 weeks. • Sweet/savoury snacks (lollies, chocolate, potato crisps) seen at 10 weeks (1 person) by 52 weeks 63.8% consuming. • Hot chips – first seen at 16 weeks (0.8%), increased to 78.6% by 52 weeks. • When solids were introduced early, children were more likely to have introduced ice cream, hot chips, French fries, savoury snacks and takeaway foods in the first year of life.	Some info has come from Binns et al [105]
Webb et al. [92]	Pregnant women with children at risk of developing asthma recruited from antenatal hospitals in Western Sydney. 1998-200	N=429 18 months 50% female	• Parent recorded 3-day weighed food records. • 2 weekdays, 1 weekend. • Provided with dietitian instructions, scales and booklet. • Dietitian picked up when finished and ran through completeness. • Examined consumption of 'extra' foods, classified according to Australian Guide to Healthy Eating.	• All but one child consumed 'extra' foods in the 3-day period. • 90% consuming cereal-based products (biscuits, cakes, pastries etc.). • 70% consuming sweetened non-milk beverages (cordials, soft drink, fruit drink). • 60% consuming confectionery: chocolate 38%, lollies 28%, muesli/fruit bars 18%. • 67% consuming sweet biscuits • 54% consuming hot chips. consuming ice cream. • 22% consuming potato chips.	Couldn't have a pet cat at home - exclusion criteria. Did not report on FJ.
Webb et al. [93]	Pregnant women with children at risk of developing asthma recruited from antenatal hospitals in Western Sydney. 1998-2000	N=429 18m 50% female	• Parent recorded 3-day weighed food records. • 2 weekdays, 1 weekend. • Provided with dietitian instructions, scales and booklet. • Dietitian picked up when finished and ran through completeness.	• Small portion sizes in general. Consumption rates: • Milk products/dishes- 100%. • Cereal – 100%. • Vegetable products/dishes 97%. • Fruit products/dishes – 88%. • Meat/poultry 92%. • Apple juice 44%, orange juice. 30%, cola 17%. • Snack foods 39%. • Confectionery 60%.	Also examined nutrient intake. All children had some sort of allergy.
Bell et al. [94]	NOURISH: First time mothers at major maternity hospitals in Brisbane & Adelaide. The control arm of an obesity prevention intervention.	14 months: N=552 24months: N=493	• Parent reported, multi-pass 24hr recall over the phone with a dietitian. • 2-day food diary	14m patterns • *Core foods*: fruits, grains, non-white bread, veg, cheese, eggs, nuts (+). • Associated with higher education, older children, longer breastfeeding.	Patterns based on foods loading >=0.25 (slightly less than 0.3 used in other studies)

Author	Sampling and year collected	Sample	Methodology	Key outcomes	Notes
	SAIDI- Mothers at one metropolitan and 7 regional public hospitals in South Australia. 2008-2011	54% female	• Measuring spoons & measuring sheet provided • Foods categorised into 69 groups (14m), 73 groups (24m). • PCA used to derive dietary patterns. • Examined associations between dietary patterns and family characteristics.	• *Basic combination*: white bread, milk, spreads, frozen milks (e.g. ice cream) (+). No fruit or veg. • Associated with younger mothers, smokers, SAIDI participants, earlier introduction to solids, older children, shorter breastfeeding. 24m patterns • *Core foods*: fruit, non-white bread, nuts/seeds, meat, custard (+). • Associated with being born in Australia, later introduction to solids. • *Non-core foods*: sweetened beverages, spreads, high fat potatoes, snack products, chocolate, processed meat (+). Veg and breakfast cereal (-). • Associated with shorter breastfeeding and younger mothers.	
Byrne et al. [95]	NOURISH: First time mothers at major maternity hospitals in Brisbane & Adelaide. The control arm of an obesity prevention intervention. SAIDI- Mothers at one metropolitan and 7 regional public hospitals in South Australia. 2009-10	12-16 months N=551 54% female	• Parent-reported, triple-pass 24hr recall, over phone with dietitian. • 80% conducted on a weekday. • Diversity score calculated based on number of core foods groups consumed. • Explore food consumption and if diet diversity is associated with milk consumption.	Consumption rates: • 87% fruit, 77% veg. • 97% cereal. • 78% meat & alternatives. • 96% dairy. • 91% discretionary items (vegemite most common). • 19% sweet beverages. • 56% of children had diversity score of 5 (were consuming from all five core groups). • Diversity score increased as IF intake decreased.	
Mauch et al. [97]	NOURISH: First time mothers at major maternity hospitals in Brisbane & Adelaide. The control arm of an obesity prevention intervention. SAIDI- Mothers at one metropolitan and 7 regional public hospitals in South Australia. 2009-11	14 months N=409 55% female 24 months N=363 54% female 88% FU	• Parent-reported, triple-pass 24hr recall, over phone with dietitian. • 80% conducted on a weekday. • Describes foods/beverages consumed by ≥10% of sample – no. consumers and median serve size.	Consumption rates at 14 and 24m *Cereals* • Weetbix 65.3% and 54.8%, White bread 46.7% and 52.1%. *Dairy* • FF cow's milk- 61.8% and 88.7%. • Cheese – 62.3% and 65.0%, Child yoghurt 60.0% and 70.0%. *Fruit* • Bananas 76.3% and 70.2%, Apples 37.9% and 49%. *Vegetables* • Carrots 69.7% and 63.6%, Potato 60.4% and 50.7%. *Meat/alternatives* • Beef 48.2% and 46.6%, Chicken 42.5% and 43.3%. *Discretionary foods* • Yeast spreads 54% and 56.5%, Sweet biscuits 51.6% and 47.4%., Cake – only 24m 27%. Median serve sizes did vary greatly between 14 and 24 months of age.	

Author	Sampling and year collected	Sample	Methodology	Key outcomes	Notes
Amezdroz et al. [96]	Parents with newborn infants recruited from Maternal and Child Health Services in metropolitan, regional and rural Victoria. 2008-13	1-3 months N=438 6-8 months N=278 12-14 months N=268 18-20 months N=256 % female not reported	• Parent-reported FFQ as part of a larger questionnaire. • 33 food items, 12 beverage items. • Foods: 8 responses ranging from never to 4+ times/day (foods). • Beverages: times per day or week or month usually consumed. • Asked to report usual consumption. • Explored food and beverage intake in first 20 months of life.	• Highest consumption of core foods at 12-14 months, decreased by 18-20 months. • Discretionary foods identified as early as 6-8 months *Core foods consumed ≥once/day (6-m, 12-14m, 18-20m)* • Cheese: 2.6%, 22.3%, 32.1% • Yoghurt: 12.1%, 27.2%, 19.2% • Banana: 8.6%, 27.2%, 55.8% • Fresh fruit: 26.8%, 51.9%, 55.8% • Cereal: 56.4%, 68.7%, 54.2% • Vegetables (not potato): 51%, 68.3%, 65.1% • Meat: 32.7% (12-14m), 41.2% (18-20m) *Discretionary foods/beverages consumed ≥twice/week (6-m, 12-14m, 18-20m)* • Savoury biscuits: 26.3%, 82.1%, 82.4% • Sweet biscuits: 4.4%, 20.3%, 34.9% • Chocolates/lollies: 0.4%, 2.7%, 18.9% • Hot chips: 1.8%, 8.3%, 18% • Luncheon meats: 0.7%, 17.6%, 33.0% • Ice cream: 0.7%, 6.1%, 12.9% • Fruit juice 8.1%, 22.3%, 42.5%	
Lioret et al. [98]	English speaking, first time mothers recruited from Maternal and Child Health Services in Victoria. Recruited for nutrition/physical activity intervention, but report on control arm only. 2008-2010	9 and 18 months N=177 (65% of original sample) 48% female	• Parent report, multi-pass 24hr recall over the phone. • Unscheduled calls • 3 non-consecutive days. • Booklets to assist with portion size. • Explored food and nutrient intake and tracking between 9m & 18m.	Consumption rates at 9m and 18m • Sweet beverages: 13% and 31% (small amounts). • Cereal based products: 96% and 100% • Savoury EDNP snacks: 20% and 64%. • Sweet EDNP snacks: 38% and 86%. • Veg: 95% & 95%, but median consumption decreased between 9m and 18m. • Fruit: 95% and 98%. • Animal products: 89% and 97%. • For most foods, if you were consuming them at 9m you were likely to be consuming them at 18m.	Also examined nutrient intakes.
Spence et al. [99]	English speaking, first time mothers recruited from Maternal and Child Health Services in Victoria. Recruited for nutrition/physical activity intervention Metro Melbourne. 2008-2013	9 months to 5yrs N=467 47% female 86% of original sample.	• Unscheduled, parent report, multi-pass 24hr recall over the phone at 9m, 1.5yrs, 3.5yrs and 5yrs of age. • 3 non-consecutive days. • Booklets to assist with portion size. • Examined dietary intake compared to dietary guidelines. • Examined tracking of diet and association with family characteristics.	• Few children met the guidelines for discretionary foods at any timepoint • Lower fruit intake and higher discretionary item intake observed in children with lower SES at 9m and 1.5yrs. • Most children met fruit recommendations until 3.5yrs, few met veg recommendations after 9m. • Intake of fruit and veg at 9m didn't track to 5yrs. • Moderate tracking of discretionary foods.	Includes intervention and control group.

Author	Sampling and year collected	Sample	Methodology	Key outcomes	Notes
Gasser et al. [100]	Sampled from Medicare enrolment. Nationally representative Every two years from 2004-14	Baby (B) cohort, 0-1yrs at baseline 2-11yrs N=4,504 88.2% of original sample. Kinder cohort, 4-5yrs at baseline. 4-15yrs N=4,640 93.1% of original sample. 49% female	• Face to face, computer assisted interview. • Parent report (aged 2-9yrs). • Child report (10+yrs). • 12-16 questions regarding individual or grouped foods and drinks. • How many times consumed in past 24hrs. • Calculated a dietary score reflecting healthiness (0 = least healthy, 14 most healthy). • Used exploratory factor analysis to derive dietary patterns. • Examined longitudinal trajectories of scores and patterns.	• Tracking of dietary scores was moderately high in B cohort and moderate in K cohort • Four trajectories identified: never healthy, moderately healthy, becoming less healthy and always healthy. • Dietary scores began to decrease rapidly at age 7 years for those in the 'becoming less healthy' group. • Identified healthy and unhealthy pattern • *Healthy:* high fresh fruit, cooked & raw veg in all waves, water, dairy and bread in most waves • *Unhealthy*: High savoury snacks, sweet drinks in all waves, pies, hot dogs, hot chips, FJ in most waves, and sugary foods and energy drinks in later waves. • Moderate to strong stability of patterns over time.	Children missing waves tended to be lower SES. Included children with at least 2 waves of data.
Cockburn et al. [101]	Nationally representative 2006-2014	N=5,107 0-10yrs 49% female FU over waves varies between 71%-90%	• Face to face, computer assisted interview. • Parent report (aged 2-9yrs). • No portion sizes. • Beverage intake in last 24 hours, response options: none, once, >once. • Categorised consumption frequency: moderate: ≤ 1 drink over 24hrs, high consumption: >1 drink over 24hrs. • Examined consumption frequency between 2 and 10 years of age.	• High rates of FJ consumption at 2yrs (40% moderate, 29% high). • Overall FJ consumption decreased over time (moderate stayed same, high decreased). • Significant increase in FJ consumption between 0-1 and 2yrs. • FJ consumption in 0-1yrs higher in regional/rural and low SEIFA areas, children with medical conditions, and didn't speak English at home. • Soft drink consumption increased over time. Higher consumption in males, children with medical conditions, rural/regional areas. • Water consumption remained consistent over time. Higher water consumption for girls, living in a higher SEIFA area. • Decreases in full cream milk over time, increases in skim milk.	
Pitt et al. [102]	Pregnant women recruited from antenatal clinics in Queensland and NSW. 2006-13	3yrs: N=1565 53.8% of original sample. 51% female	• 7 dietary intake questions – daily intake **amount** of fruit, vegetables, added sugar; usual frequency (week/month) of takeaway foods, pre-prepared foods.	Three dietary patterns at age 3yrs • *Highly unhealthy* (29.1%): high consumption of processed foods, moderate consumption of fruit & veg. • *Healthier* (55.2%): high fruit & veg, low processed foods. • *Moderately unhealthy* (15.7%): moderate processed foods, low fruit & veg.	

Author	Sampling and year collected	Sample	Methodology	Key outcomes	Notes
		5yrs: N=631 52.8% female 21.7% of original sample.	• Six variables reported at both timepoints: fruit, veg, added sugar, sugary snacks, pre-prepared foods and takeaway foods. • Latent class models used to identify dietary patterns. • Examined associations between dietary patterns and family characteristics.	• Compared to kids with *healthy* pattern, those with *unhealthy* pattern more likely to have younger mothers, fathers with a high BMI, mothers in paid work. • *Moderately unhealthy* more likely to live in 2 carer household, less likely to have university educated mother. Two patterns at 5yrs • *Unhealthy* (52.8%): high processed foods, low fruit & veg. • *Healthy* (47.2%)*:* high fruit and veg, low processed food. • Children with *unhealthy* pattern more likely to have mothers currently working and live in a 2-carer household. • Unlikely to move from *unhealthy* to *healthy* between age 3 and 5. • More likely if *healthy* at age 3, will stay same or move to *unhealthy.*	

Acronyms and abbreviations: ABS: Australian Bureau of Statistics; **BF:** Breastfeeding; **CAPS** Childhood Asthma Prevention Study; **EDNP:** Energy Dense Nutrient Poor; **FJ:** Fruit juice; **FFQ:** Food Frequency Questionnaire; **IF:** Infant formula; **INFANT**: Infant Feeding Activity and Nutrition Program; **SAIDI:** South Australian Infants Dietary Intake Study; **SES:** Socio-Economic Status; **+ive** positive; **-ive** negative.

2.9 The grandparent care environment

2.9.1 General childcare

Societal changes over the last 30 years, including more women choosing to return to work after giving birth has increased the demand for, and use of childcare in Australia. The type of care that children are placed into can be either formal or informal. Formal care refers to a regulated service that occurs away from the child's home and includes services such as long day care, family day care and occasional care [106]. Long day care, also known as centre-based care, occurs in a child care centre, where children attend for most or all of the day and is operated by professional staff with a structured program. Family Day Care is care for a small group of children operated in the home of an approved Family Day Care Educator. Children can attend for all or part of the day on a regular or casual basis. Occasional Care is centre-based care for children who do not need regular care but may require care on an intermittent basis. In contrast, informal care is not regulated and may occur in the child's home. Informal care includes care provided by grandparents or other relatives/friends, nannies and babysitters [106].

In Australia, it is estimated that close to two million children aged 0-12 attend some sort of formal or informal childcare each week. Children aged between one and four years have the highest usage rates, with 59.2% to 71.8% of children in this age range attending some sort of care [107]. Approximately 32% of children attend only formal care, with long day care being the most commonly used care, followed by Family Day Care services. Just over 15% of children are estimated to be attending only informal care, where grandparent care is the most common type attended. Combining care types is also common, with around 19% of children aged between one and four years attending a mixture of formal and informal care during a typical week [107].

2.9.2 Grandparent caregivers

Varying rates, types and reasons for grandparent care have been observed across the globe. It is difficult to directly compare these rates between countries due to the differing definitions of 'care' and specified age range of children in each study. However, the following studies provide some evidence about the involvement of grandparents in the care of their grandchildren in numerous countries.

In Europe, the SHARE (Survey of Health, Ageing and Retirement in Europe) study surveyed 15,000 households across eleven European countries and found that 58% of grandmothers and 49% of grandfathers were providing care to their grandchildren [108]. Different rates and intensity of care were observed between countries. Grandparents in Denmark, The Netherlands, France and Switzerland were the most likely to provide care, but least likely to regularly look after their grandchildren. In the Mediterranean countries however, the opposite was observed, with grandparents in Greece, Italy and Spain the least likely to provide any care, but if they did provide care, they did it on a regular basis. Additional research in the United Kingdom showed that 63% of grandparents reported having cared for a grandchild in the last 12 months, whilst 19% of grandmothers and 14% of grandfathers provided at least 10 hours a week of care for their grandchildren [109].

2.9.3 Grandparent caregivers in Australia

Data from the ABS shows that the proportion of children cared for by a grandparent each week has decreased from 30% in 1999 to 23% in 2014 [110]. The most recent national data from Australia shows that in 2017 approximately 26% (~410,000) of children aged four years or less received care from a grandparent on a regular basis [107]. Grandparent care rates are highest at around 30% for one to two year old children, falling to around 24% for three to four year old children [107].

2.10 The grandparent care literature

The type of care that grandparents provide to their grandchildren can be broadly split into two types. Custodial care (which is also referred to as primary care in the literature) refers to circumstances where the grandparent is the main caregiver for their grandchild. They reside with their grandchild and in many cases have legal custody of them. The child's parents tend to not be present in these circumstances, with grandparents taking legal responsibility for their grandchild. Non-custodial care (also known as secondary care in the literature) refers to grandparents who are not the primary caregiver for their grandchild, but they provide care for their grandchild when required by the child's parents. These grandparents may or may not reside with their grandchild and the amount of care that they provide varies widely.

Much of the published literature has traditionally focussed on the first scenario, where grandparents have primary responsibility for their grandchild. In the last 20 years, however there has been increasing focus on non-custodial grandparents and the care that they provide to their grandchildren. Whilst the research presented in this thesis focuses primarily on grandparents who are providing non-custodial care for their grandchildren, it is difficult in some circumstances to disentangle custodial and non-custodial grandparent care in the published literature, as many papers have included grandparent carers from both care scenarios.

2.10.1 Grandparent care, nutrition and oral health

There is growing recognition of the important role that grandparent care providers play in the shaping of children's habits at an early age that may influence health both now and in the future [111]. A recent commentary by Bell et al [112] examined the case for grandparent involvement in lifestyle interventions that target obesity related behaviours such as nutrition and physical activity. The thinking around this could also be carried over to other health behaviours such as oral health.

Research into the influence of grandparents on their grandchildren's health is an emerging field. When the research presented in this thesis commenced in 2015 there were relatively few publications examining grandparents and grandchild health. In the three years since, there has been an increase in research published on this topic. The published research relevant to this thesis has tended to focus on dietary intake in relation to obesity prevention or has focussed solely on nutrition. As overweight and obesity is not the primary focus of this thesis, only a very brief overview of the literature in this area is provided, followed by what has been published specifically for nutrition and oral health. Although oral health shares some of the same risk factors as obesity, there is little published research examining the role that grandparent care providers may play in factors related specifically to the oral health of their grandchildren. Most research about grandparents has also tended to focus on children of primary school age or older, with less focus on preschool children.

2.10.2 Grandparent care and obesity

A recent systematic review of 15 studies suggested that use of childcare is associated with overweight and obesity in children under five years of age [113]. Although associations were seen for both formal and informal care types, the strongest relationship was seen with informal care, which in most cases was grandparent care. Furthermore, a Japanese cohort study of 4,592 children with a 20 year follow up, published subsequently to the above review examined the relationship between care type at age three years and subsequent eating behaviours and overweight and obesity rates. Compared to children cared for only by their parents at age three years, those cared for by a grandparent were more likely to eat between meals at age six and 12 years and tended to have a higher mean BMI over time [114]. This cohort had a follow up rate of 50% and 55% at age six and 12 years respectively and few characteristics of those who were lost to follow up are reported. Additionally, although these studies provide a useful insight into grandparent care and overweight/obesity, much of the anthropometric data were collected via participant self-report, which may lead to people misreporting height and weight, compromising the accuracy of the results.

2.10.3 Grandparent care and nutrition

Internationally, research that has specifically explored the influence of grandparents on their grandchild's nutrition behaviours is primarily qualitative in nature, coming from interviews conducted with grandparents and/or parents. Research in this area is relatively recent, with the majority coming from China [115-117], Japan [118], the United States [119-123] and the U.K [124] over the last 20 years. The research also varies in terms of the context in which grandparents may influence their grandchild's nutrition behaviours. While some published research specifically examines the influence that grandparents have whilst children are in their care [115, 116, 118, 120, 121, 125], other research has taken a more general approach examining the broad influence of grandparents, not specifying behaviours that may occur when children are only in their grandparents' care, but also looking at the general context of grandparenting [119, 122-124].

It is important to note that research from China sits in a different context to that of Western countries, as many grandparents provide a type of custodial care where grandchildren are left with their grandparents in rural villages whilst their parents leave to find work [115]. Many of the grandparents in these studies have also lived through times that have had a strong influence on their nutrition beliefs, such as 'the great famine' [115, 116]. Jiang and colleagues [116] interviewed 23 grandparents and parents to determine the influence grandparents had on young children's eating behaviours. Grandparents in these families tended to do most of the cooking, and as such the children tended to eat what grandparents ate. Grandparents encouraged children to eat bigger, more frequent serves of food, being influenced by their own experiences of poverty, and many used food as an emotional and educational tool. Similar themes to this emerged in work from Zhang and colleagues [115] who explored differences in grandparents' and parents' healthy eating beliefs regarding the children (aged 6-12 years) that they cared for. Grandparents tended to see food as a necessity for survival and were more concerned about having enough food to give to children rather than the nutritional value of what they were feeding them. Participants in each of these studies were diverse in terms of education levels and socio-economic status, however they were all recruited from one rural town and one major city. Given the vastness of China, the results may not truly reflect what is happening with grandparent care in other areas of China.

Additional mixed methods research with Chinese grandparents has demonstrated a lack of recognition about childhood obesity from grandparents and misperceptions about a healthy diet [125]. Quantitative data from this study with more than 500 children aged 8-10 years, showed that those living with their grandparents were more likely to be overweight or obese and eat significantly more unhealthy snacks [125]. Similar results were also seen in a group of younger Japanese children (aged 3-6 years), where those that lived with their grandparents were more likely to be overweight or obese than those not living with their grandparents [118].

In a society with a more similar sociocultural context to that of Australia, research from the United States has shown that grandmothers play a significant role in shaping their grandchild's nutrition environment, particularly in relation to fruit and vegetable consumption. A small sample of low-income mothers (n=44) and grandmothers (n=18) from rural areas of the USA reported that grandmothers were involved in many aspects of food production for their grandchildren. More than 70% of these grandmothers reported caring for their grandchildren at least 11 hours per week; however, it was unclear whether they were residing with their grandchildren. They purchased food, provided money to purchase food and also prepared food for their grandchildren [119]. There was the potential for grandmothers to pass on negative traits to their grandchildren. Many grandmothers were not eating the recommended serves of vegetables each day, which, as they were preparing meals, increases the likelihood of their grandchildren having inadequate vegetable intake. These results provide valuable information regarding grandmothers' influence; however, the small sample size and convenience sample of rural, low income families limits the generalisability of these results to the larger population.

Additional research in the United States from Eli and colleagues has explored parents' and grandparents' attitudes, knowledge and behaviours in regards to provision of beverages [121] and foods [120] to their preschool aged grandchildren. The samples for these two studies were drawn from the same pool of participants, with between 11 to 22 parents and 11 to 27 grandparents interviewed. Although this study did not report how often children were solely in the care of their grandparents, most children were seeing their grandparents at least once a week. It is also important to note that this research specifically targeted low-income families with children at risk of overweight and obesity, and thus the results may not reflect what occurs in families that do not fit these criteria. Water and soft drink were cited as the most and least healthy beverage options for young children, respectively, by all participants, however, opinions on the healthiness of fruit juice were ambiguous. Juice tended to sit somewhere between soft drink and water in terms of healthiness. In some cases, participants reported trying to increase the healthiness of juice by either watering it down or choosing only 100% fruit juice. Also, grandmothers, more so than parents, tended to argue that juice was a healthier option than soft drink. Grandmothers also identified the importance of role modelling, the home environment and finding a balance between restricting unhealthy drinks whilst also using them as treats or rewards.

In terms of food, Eli and colleagues [120] report that conflict tended to arise when parents and grandparents did not share the same beliefs regarding what was healthy. Parents reported that they tended to 'pick their battles' when speaking to grandparents about their behaviours. Grandparents were also more likely to provide unhealthy treats on a regular basis, with the amount of time spent with grandchildren identified as a key driver of this. Those grandparents that lived with their grandchild tended to show more 'parent' like behaviours regarding food provision to their grandchildren, which included things like having rules about consumption of sugary/fast food products and being less indulgent with treat foods. The notion of grandmothers' 'treats' was also raised in interviews that Johnson et al [122] conducted with seven mothers in the United States. Mothers tended to describe their child's maternal grandmother as being either helpful or hindering when it came to providing food to children. This research provides valuable insight into the dynamics of parent and grandparent food and beverage provision to children, however the samples included limit the generalisability of the findings to the wider population, particularly with a small sample of seven mothers [122]. Although Eli and colleagues' sample was large for a qualitative study (n=49), participants were primarily low-income Caucasian families with low education levels and children at risk of overweight and obesity. These results may not reflect what occurs in ethnically diverse families or those with higher income and education levels. Additionally, the sample for the beverage study [121] consisted only of mothers and maternal grandmothers and as such the potentially different dynamics of in-law relationships or relationships with grandfathers are not reflected in this study.

Other research in the United States has examined custodial grandparents caring for their grandchildren without the child's parents present. As for the research outlined above, the sample was primarily Caucasian, limiting the generalisability to culturally diverse families. Semi-structured interviews with these 23 grandparents showed differences in their nutrition practices with their grandchildren compared to when they raised their own children. Many felt that they were more nutrition and safety conscious about food with their grandchildren than they were with their own children [123].

The only paper to date that has looked at the feeding practices of grandparents who care for their grandchildren, but don't live with them has come from the U.K. [124]. The results from this research, involving a survey of 50 parents and 50 grandparents (parents and grandparents unrelated to each other) of children aged between two and eight years, showed not only differences between parents and grandparents, but differences between grandparents relative to the number of hours they cared for their grandchild. Grandparents overall allowed significantly more control and input into meals and food choice from their grandchildren and reported using food to control children's emotions significantly more often than parents. Whilst grandparents tended to have less unhealthy foods in their homes compared to parents, they did tend to model healthy eating less frequently. Interesting results were seen when comparing grandparents based on the number of hours they cared for their grandchildren. As the number of hours caring for grandchildren increased, the role of grandparents tended to become less of an 'indulgent' one and more structured and parent like, similar to what was observed by Eli and colleagues [120]. Grandparents who spent more hours caring for grandchildren tended to provide a more positive food and eating environment, spent more time teaching their grandchild about healthy eating, and modelled more healthy eating behaviours. In contrast however, they also reported using food as a reward more frequently and did not allow their grandchildren as much control over meal times and decisions about food, compared to those who cared for their grandchildren less frequently. The relatively small, homogenous sample included in this survey limits the generalisability of these findings to the wider populations particularly families that are not of Caucasian background. Additionally, there was poor internal consistency of the measures used in this study, indicating the need for these items to be further explored with grandparent populations.

To date, there are two published Australian studies exploring the influence that grandparents have on children's eating behaviours. One study reported on interview data from 39 parents and 124 children, not actually grandparents themselves [126]. Similar to findings from some of the international research presented above, parents tended to report grandparents as having a negative influence on the eating habits of their children. Grandparents frequently used food as a tool to differentiate themselves from the child's parents and some grandparents deliberately ignored rules that parents had put in place about food by sneaking some foods to children. This sample however, only included parents of 6-12-year-old children, not preschool aged children, did not report on how frequently grandparents saw their grandchildren or if they were responsible for caring for them.

In contrast, the research from Jongenelis and colleagues [127], surveyed 1,075 Australian grandparents who provided non-custodial care to children between three and 14 years of age (46% cared for children aged 3-6 years). Grandparents reported that healthiness of the food was the most important factor when they decided what to feed their grandchild, however researchers also demonstrated the influence of socio-economic status (SES) and child's age and gender. Younger children and girls trended to be provided with healthier options compared to older children and boys, whilst those in higher SES areas tended to provide healthier options compared to those in lower SES areas. Participants for this study were recruited via an online panel which enabled researchers to ensure the male/female ratio was reflective of the general Australian population. However, this may not truly reflect the gender ratio of grandparent caregivers, as the literature suggests that grandmothers are much more likely to provide care than grandfathers [128]. Additionally, the self-reported nature of the survey may have led to biased reporting of foods that grandparents feed their grandchildren.

In support of this growing area of research interest, a recent international systematic review examined the influence of grandparents on the dietary intake of 2-12-year-old grandchildren [129]. The major findings of this review demonstrated that many grandparents use unhelpful strategies, such as overt food restriction (e.g. not allowing dessert until all food is finished), to get their grandchildren to eat. They also highlighted that differences in child feeding attitudes and behaviours can lead to conflict between parents and grandparents, a finding seen in some of the international and Australian studies outlined above. Most studies included in this review focussed on children older than preschool age, reflecting the current body of research available and highlights the need for more research in younger age groups.

2.10.4 Grandparent care and oral health behaviours

The emerging field of research examining the role that grandparents play in the dietary intake of their grandchildren is in contrast to the gap in the literature on the role that grandparents may play in their grandchild's oral health. Although dietary intake is a key risk factor for the development of dental caries, much of the published research has tended to focus on the influence of dietary intake on the development of overweight and obesity, rather than dental caries. To date, only one published study has been identified which explores the potential influence of grandparents on their grandchild's oral health [130]. Two-hundred grandparents in India completed a questionnaire regarding oral health when they brought their grandchild into a dental clinic. Grandparents in this study were either living with their grandchild or regularly caring for them. Grandparents tended to have good knowledge about the influence of toothbrushing, soft drinks and sweet foods on oral health, but poorer knowledge about child specific toothpaste, when children should start brushing and when they should have their first check-up. The results from this study cannot be generalised to populations outside India, and as the sample was recruited from a dental clinic it is likely that the sample is biased towards those that know to seek dental care.

2.11 Summary

In summary, the existing literature suggests that grandparents, particularly grandmothers, influence the nutrition and dietary intake of children whom they care for. Parents' and grandparents' attitudes and behaviours towards nutrition and feeding children tend to differ, with grandparents more likely to indulge children in unhealthy behaviours, particularly the provision of unhealthy 'treat' foods. These behaviours, however, appear to be moderated by the amount of daily or weekly time grandparents spend caring for children, with more 'parent' like behaviours apparent with increasing time. There is currently a lack of research exploring nutrition in the Australian grandparent care environment, from the perspectives of both grandparents and parents. Additionally, there is little research examining the role of grandparents in child oral health and hygiene, and the influence the grandparent care environment may have on these health behaviours.

2.12 PhD Aims & Objectives

Food preferences and eating behaviours are shaped by a range of factors in early childhood. It is important that healthy preferences and behaviours are established in these early years as children are likely to carry these with them into adulthood. Evidence suggests early introduction of discretionary foods into children's diets and that consumption of these items exceeds recommendations. This has implications for the development of overweight/obesity and dental caries both in childhood and later in life. There is however, limited longitudinal evidence from diverse Australian samples tracking what children are consuming between birth and five years of age. During these formative years, many children spend a substantial amount of time in the care of people other than their parents. These care providers can influence the dietary intake and oral health and hygiene behaviours of these children. While there is existing research about the role that formal care settings may play in shaping these behaviours, there is little evidence about the role of informal care settings, particularly the most common: grandparent care.

In order to fill these evidence gaps **this thesis aims to identify influences on nutrition and oral health in early childhood.**

It will achieve this through the following objectives

1. Establish the reliability and validity of a tool used to collect dietary data in children under five years of age.
2. Examine the foods and beverages that children consume and how intake of core and discretionary items change across the first five years of life.
3. Explore the relationship between childcare and nutrition and oral health indicators in three-year-old and four-year-old children.
4. Explore the role of the grandparent care environment on nutrition and oral health behaviours in children under five years of age.

Chapter 3: Research Methodology

3.1 Theoretical Frameworks

3.1.1 Overview

This section outlines the theoretical frameworks and models that underpin the research presented in this thesis. The general concept of an ecological framework is outlined and an overview of three different ecological frameworks from Davison & Birch [131], Story and colleagues [28] and Fisher-Owens and colleagues [132] are presented. This chapter also outlines the key concepts of Family Systems Theory [133] and the ways in which it has been used to assist with the interpretation of some of the work in this thesis.

Theory can be defined as *"a set of interrelated concepts, definitions and propositions that present a systematic view of events or situations by specifying relations among variables in order to predict events or situations"* (page 26) [134]. In the field of health, theories and models are useful tools that can help explain observed behaviours and may also help us identify opportunities to change behaviours to be more health promoting.

3.1.2 Ecological models

Ecological models in public health are useful tools to show how people interact with their physical and sociocultural environment [134]. The key aspects of ecological models, when compared to other health behaviour models is their ability to consider the combination of individual level, environmental level and policy level influences on behaviour. Ecological models are not thought of as theories, but rather a framework within which specific theories about behaviour and behaviour change can sit. This allows researchers to propose and explore the influence that specific factors may have on behaviour and how multiple factors interact at different levels to influence behaviours.

Urie Bronfenbrenner's work from the 1970s provided the foundation for ecological models that exist today [135]. He describes three levels of environmental influence; the microsystem (e.g. family members, work groups), the mesosystem (e.g. physical family, school and work settings) and the exosystem (larger social systems, e.g. economics, culture and politics). Since Bronfenbrenner's work was established, this framework has been developed and adapted extensively for a multitude of health behaviours and disease states. Despite the different health foci, ecological models tend to have five common key principles; 1. there are multiple levels of influence; 2. the context of the environment plays a large role in determining behaviour; 3. factors interact across levels of the model; 4. models are most useful when tailored to specific health issues and behaviours and; 5. multi-level interventions should be the most effective for behaviour change.

3.1.3 Ecological models used to guide this PhD research

Three ecological models informed the work conducted as part of this PhD. Nutrition and oral health are inextricably linked due to the role of diet in the development of dental caries, however whilst there are some common risk factors for these issues there are also influences across many levels of an ecological framework that are unique to nutrition and unique to oral health. Thus Davison and Birch's ecological model showing predictors of childhood overweight [131], Story and colleagues ecological framework of the multiple influences on what people eat [28], and Fisher-Owens conceptual model of influences on children's oral health [132] were used to guide the current work.

3.1.4 Davison & Birch

Davison and Birch developed their ecological model of predictors of childhood overweight in response to the growing issue of childhood overweight and obesity in the 1990s (**Figure 3.1**) [131]. The authors draw on ecological systems theory, which highlights the importance of contextual factors influencing health behaviours, both directly and indirectly. Dietary intake is explicitly labelled as a risk factor in the development of overweight in this model, and its interaction with a child's gender, age, and familial susceptibility to weight gain are also linked to weight status. The model also outlines factors that contribute to dietary intake at a family or parent level, such as knowledge or food preferences, and at the community and societal level, such as socio-economic status.

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Figure 3.1 Davison and Birch's ecological model of predictors of childhood overweight. [131]

3.1.5 Story, Kaphingst, Robinson-O'Brien and Glanz

Story and colleague's 2008 ecological framework (**Figure 3.2**) focuses more specifically on factors that influence **what** people eat [28]. This model examines some of the broad dietary factors that are outlined in the Davison and Birch model but takes a closer look at the influences of environments and policy on these factors. The model examines the influence on food intake of different factors at the individual level, social environment level, physical environment level and macro-level environment level. This model highlights the multitude of factors beyond those at an individual level that are influencing food intake.

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Figure 3.2 Story and colleague's ecological framework depicting the multiple influences on what people eat.

[28]

3.1.6 Fisher-Owens et al.

In contrast to the two ecological models previously described, the conceptual model proposed by Fisher-Owens and colleagues focuses on the multiple levels of influence on children's oral health [132]. The model is displayed in **Figure 3.3** and displays child, family and community level influences on oral health, as well as taking into account the influence of time and the environment on oral health. Although diet is not the focus of this model, it is represented through its interaction with a child's teeth and the bacterial environment in their mouth (microflora) contributing to the development of dental caries.

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Figure 3.3 Fisher-Owen's Conceptual model on influences on children's oral health. [132].

3.1.7 Model application

The primary focus of this thesis was to examine factors related to nutrition and oral health in early childhood. A broad ecological approach was taken to examine nutrition and oral health in early childhood, with different aspects of each of the models outlined above informing the work Chapters 6, 7 and 8. The three ecological models outlined above examine nutrition or oral health independently, so parts of each of these were used to inform this thesis and help to generate a model that includes risk factors related specifically to nutrition or oral health as well as shared risk factors. Selected risk factors from these models were used to guide analyses in the above-mentioned chapters, whilst also exploring new factors that were not necessarily included in these models.

Of particular interest in this thesis was the childcare environment identified in Story et al's model [28]. The influence of this environment on what children are eating and drinking, as well as their oral health and hygiene behaviours are examined in detail in Chapter 7:. Moving beyond the broad field of childcare, the work presented in Chapter 8: takes an in depth look at a specific childcare environment –grandparent care. Factors outlined in each of the ecological models presented informed the interview guide in this chapter. The data collected in this study, have helped to develop a new ecological framework showing the role of grandparent care in nutrition and oral health in early childhood. The model that emerged from this work has been enhanced by including aspects of the Story et al, Fisher-Owens et al. and Davison and Birch models outlined above.

When the grandparent care environment was closely examined in Chapter 8, it became apparent that communication and general family dynamics had a large influence on influencing factors within the grandparent care environment. To assist with understanding this phenomenon, family process theory was examined.

3.1.8 Family process theory

Family process theory (also known as Family Systems theory) has its basis in psychology and family therapy. It views the family as a system, that operates in a similar way to other systems in society, but with unique characteristics which set it apart from other systems [133]. Broderick defines families as "*an example of an open, ongoing, goal-seeking, self-regulating, social system*" (page 37) [133]. Within the family system, people tend to play different roles and interact with each other in specific ways, and the actions, thoughts and feelings of one person in the family system can affect the actions, thoughts and feelings of another person [136]. Murray Bowen developed this theory for use in family therapy in the 1960s and Brown

[137] and Kerr [138] provide a useful overview of the eight concepts of the theory which are 1. Emotional Fusion and Differentiation of Self; 2. Triangles; 3. Nuclear Family Emotional System; 4. Family Projection Process; 5. Emotional Cut-off; 6. Multigenerational Transmission Process; 7. Sibling Positions and; 8. Societal Emotional Process. The three concepts relevant to research presented in this thesis are outlined below.

Emotional Fusion and Differentiation of Self: Fusion refers to situations where individuals ignore their own personal choices or preferences to sustain harmony within a relationship system. In contrast, *differentiation of self* refers to an individual's ability to operate by themselves, whilst also remaining connected to the relationship system. There are different levels of fusion and differentiation of self in all family systems, however those with high levels of fusion will tend to have trouble adapting to stress.

Triangles: Triangles are relationship systems consisting of three points (including at least two people) and are the smallest **stable** relationship unit. When tension builds in a two-person relationship, a third person or activity is generally brought in (creating a triangle) to relieve some of the tension. Triangles tend to become more apparent with increasing stress in relationships and are less visible when things are calm. Multiple triangles can be formed with increasing stress.

Societal Emotional Process: The final concept in family systems theory suggests that the complex processes that occur in family systems, also occur in other systems operating outside of families, such as workplaces, social settings and society in general. These systems go through periods of stability and instability, with potential stressors such as climate change and economic changes influencing this.

Study 3b (described below and reported in Chapter 8) explored the role that the grandparent care environment plays in nutrition and oral health in early childhood, using the qualitative methodology of grounded theory. Grounded theory allows theory to emerge from the data collected, rather than attempting to fit a pre-selected theory to the data. Although the focus of Study 3b was nutrition and oral health, the grounded theory process highlighted the way in which families operate as a unit, has a direct influence on the grandparent care environment, and that the results of this study could not be discussed without taking this into account. Although not all eight concepts of family process theory were directly relevant to the interpretation of the data, several concepts have been adapted and used in Chapter 8 to assist interpretation of the results.

3.1.9 Theoretical Framework Summary

In summary, three ecological models guided the work of this thesis. Two of these focus to some extent on factors related to nutrition, whilst one focusses on factors related specifically to oral health in children. These models helped to guide and interpret much of the research presented in this thesis. Family systems theory, a theory with its basis in family therapy, has been adapted and used to assist with the interpretation of the qualitative work that focuses on the role of grandparent care in nutrition and oral health.

3.2 Research Methods

Figure 3.4 provides a visual representation of these four studies and how they fit together as an overall piece of work. To maximise the breadth and depth of the research, a mixed-method approach was used. This included the collection and analysis of primary qualitative and quantitative data as well as secondary analysis of quantitative data from the VicGen study. The VicGen study underpins much of the research presented in this thesis and is described in Chapter Chapter 4:.

The four studies are outlined briefly below as an overarching introduction to the thesis research methods. They are then each presented in detail as distinct chapters (5, 6, 7 and 8), with the background, methods, results and discussion for each study contained within these individual chapters.

3.2.1 Study 1. Exploring the reliability and validity of a food frequency questionnaire

At the time of data collection for the VicGen study, researchers were unable to identify any existing tool that would collect the dietary data required for the study and thus developed their own food frequency questionnaire (FFQ). A small study was planned to examine the validity of the tool at the time that data were being collected for the cohort, but due to limited funding and logistical considerations, the sample size required for meaningful analysis was never reached. The reliability and validity of the tool remained unknown and a concern. This PhD provided an opportunity to examine the tool properties. Study 1 explores the reliability and validity of the VicGen FFQ, using primary data collected from 147 families who had children aged between 18 months and five years of age (see Chapter 5).

3.2.2 Study 2. Food and beverage consumption in young Victorian children.

The literature reviewed in Chapter 2 highlighted the lack of published, longitudinal Australian dietary data for children under five years of age. To understand how to positively influence children's dietary habits, we need an understanding of what they are eating and drinking. Study 2 explores the foods and beverages that a cohort of 466 Victorian children consumed across the first five years of life. This study involved secondary analysis of longitudinal data from the VicGen study, which was collected using the VicGen FFQ (referred to previously and examined in Chapter 5). Descriptive analyses and linear mixed-effects models were conducted to generate evidence about a) how young children's diets change over the first five years of life and b) identify specific factors which may influence how healthy or unhealthy dietary intake are across the first five years of life (see Chapter 6).

3.2.3 Study 3a. Oral health and nutrition in early childhood associations with formal and informal care.

Study 3 examined one of the potential influences on nutrition and oral health in early childhood, that of childcare. Cross-sectional data from three-year-old (n=272) and four-year-old (n=246) children in the VicGen study were analysed using the chi-square statistic and logistic regression. The association between the type of childcare (formal, informal, parent-only) that children experience at these ages and their dietary intake and oral health indicators was explored. This study is presented in Chapter 7 in the form of a draft manuscript that is currently under review with Public Health Nutrition.

3.2.4 Study 3b. The role of grandparent care in early childhood nutrition and oral health

Study 3b is an in-depth exploration of the role of the grandparent care environment in nutrition and oral health in early childhood. Semi-structured interviews were conducted with eight grandparents and five parents of preschool aged children (18 months to 5 years), who were cared for by their grandparents on a regular basis. Given the complexities of this environment highlighted in the small amount of published research on this topic, a qualitative approach was used for the research. Qualitative methodologies are useful as they allow an in-depth examination of the range of factors contributing to complex issues and also help to explain the context of the issue [139]. This study is presented in Chapter 8.

3.2.5 Integration

The findings from each of the studies outlined above are integrated in a broad discussion in Chapter 9. The overall contribution of the studies to research methodology, theory and health promotion is discussed, along with recommendations for research moving forward.

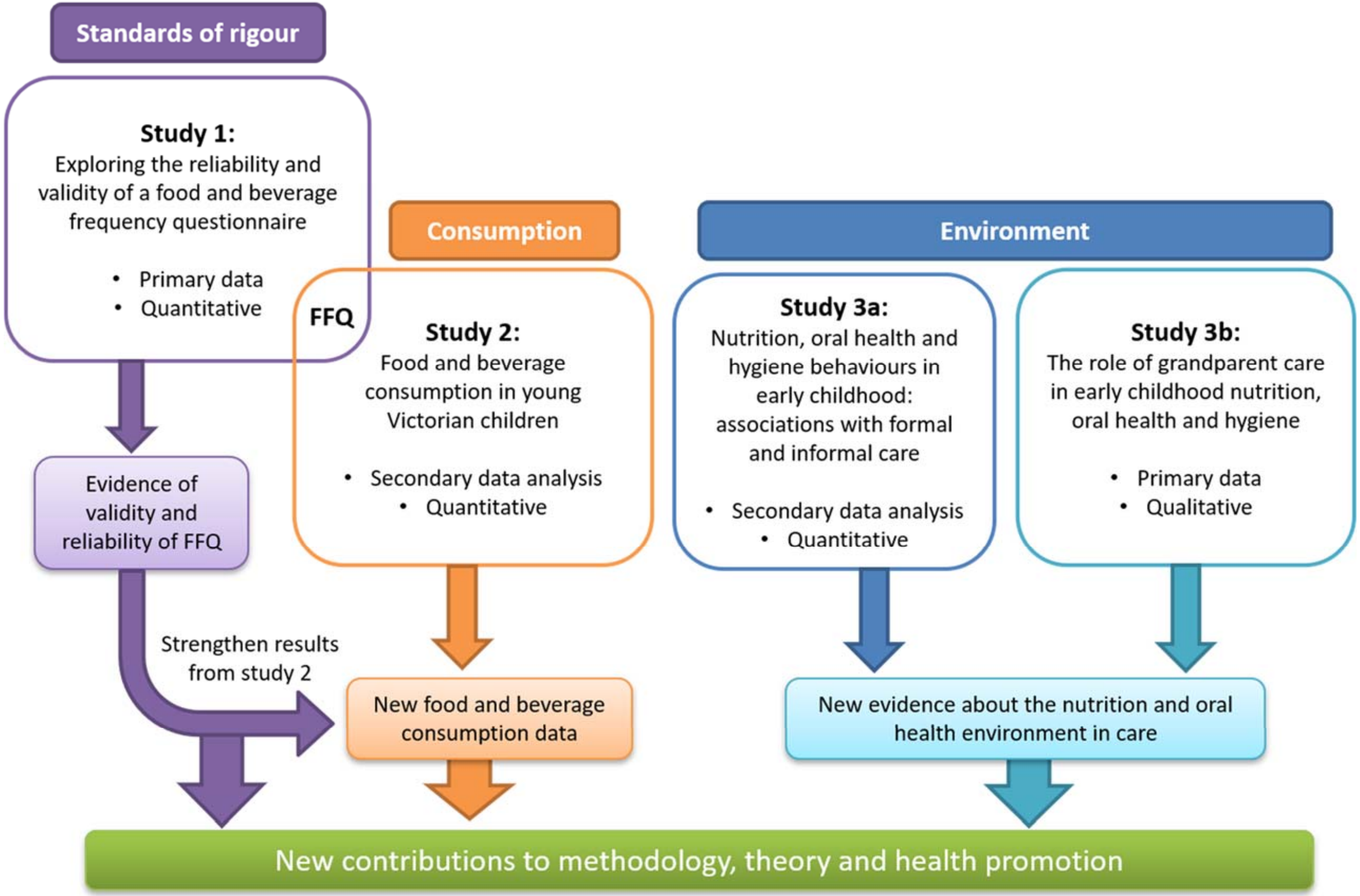


Figure 3.4. Study components in PhD thesis.

Chapter 4: The VicGen Birth cohort study

4.1 Background

The VicGen Birth cohort plays a central role in this thesis. This chapter will provide an overview of the purpose and methodology of the overall study in order to provide context for Chapters 5, 6 and 7 of this thesis.

The VicGen study (originally known as VicGeneration) was established in 2008 with the aim of exploring the relative importance of biological, social and environmental factors in the development of early childhood caries [140, 141]. Phase one of the study was established with funding from the National Health and Medical Research Council and phase two with funding from the Financial Markets Foundation for Children and the Victorian Government Department of Education and Training (formerly known as the Department of Early Childhood Education and Development). Primary investigators were from multiple institutions including: Melbourne School of Population and Global Health and the School of Dentistry at The University of Melbourne; Latrobe University; and Dental Health Services Victoria.

4.1.1 Methodology

Recruitment was purposely designed to target participants from metropolitan, regional and rural areas in Victoria, Australia, with a focus on socially disadvantaged areas. Maternal and Child Health Nurse Services from seven Local Government Areas in western metropolitan Melbourne and western regional and rural Victoria were engaged to assist with recruitment of participants into the study. The Victorian Maternal and Child Health Service is a free service providing ten health and wellness checks to children across the first 3½ years of life. The Local Government Areas were as follows: City of Brimbank, City of Maribyrnong, City of Ballarat, Northern Grampians Shire, Ararat Rural City, Central Goldfields Shire and Mt. Alexander Shire.

Maternal and Child Health Nurses within each of these services were asked to give information regarding the study to parents who were attending for their child's two or four-week health and wellness check. Contact details of those parents who were interested in hearing more about the study were provided to the research team at the University of Melbourne by these nurses. Participants were recruited between 2008 and 2011. The exact number of parents who were given information or declined to be given information on the study is unknown, however the contact details of 910 families were provided to the research team.

4.1.2 Exclusion criteria

Families excluded from being involved in the study included: those that intended to move from the local area within the next 12 months, children who required specialist paediatric care, and people with severe illness in the family or documented parental mental illness. Maternal and Child Health Nurses had knowledge of how these criteria related to many of their clients and did not give information about the study to anyone who fit this criterion.

4.1.3 Recruitment

The primary caregiver (majority mothers) were contacted by a researcher from the University of Melbourne outlining the study. In cases where the mother did not speak English, an interpreter assisted explaining the study to the potential participant over the phone. Caregivers that were not interested in taking part were thanked for their time and interest and were not contacted again. Four hundred and sixty-six (51.2%) of the 910 families for whom contact details were provided were recruited into the study.

4.1.4 Study Visits

The first phase of the study consisted of four visits at child age one month, six, 12 and 18 months (Phase I). Towards the end of the first phase, funding was sought and granted to continue the collection of data for a further three study visits at child age three, four and five years (Phase II).

All study visits across the first four waves took place in the participant's home. The majority of study visits in the final three waves also took place in the participant's home, however due to budget constraints, a small number were conducted at Maternal and Child Health Centres within the Local Government Areas. Families were contacted via phone prior to the due date of data collection to book a suitable time for the study team to visit their home. Each study visit was conducted by a research assistant and an oral health professional (dental hygienist or oral health therapist).

Each wave of data collection included; a self-completed, paper-based questionnaire; an oral examination of the child and the collection of saliva from the child. Saliva was also collected from the primary caregiver between wave one and four, and an oral examination of the primary caregiver was also conducted at two waves (majority waves two and six). The oral examination and saliva data were used for purposes other than this thesis.

4.1.5 Questionnaire

Baseline questionnaires were given to participants at the first study visit and completed whilst the researchers were at the participant's home. From wave two onwards, the questionnaire was posted to the participant once their study visit was booked and collected by the researchers at the visit. In cases where the participant had not completed the questionnaire when the study visit occurred, a reply-paid envelope was left with the participant to return the questionnaire at their convenience. The questionnaire covered a range of domains in relation to the child and family, with questionnaires growing in length across the waves. Table 4.1 shows the domains that are covered in each questionnaire wave. The food frequency questionnaire was included from wave 2 onwards.

Within the cohort, there was a group of participants whose main language was Vietnamese. The questionnaire was translated into Vietnamese by a research assistant, and a Vietnamese speaking researcher booked these participants and attended the study visit at their home. In other cases, where the participant's first language was not English, researchers assisted the participant to fill out the questionnaire.

Table 4.1 Questionnaire domains by wave for VicGen cohort

Wave	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Child age	**1m**	**6m**	**12m**	**18m**	**3yr**	**4yr**	**5yr**
Child							
weight and length	✓	✓	✓	✓	x	✓	x
general and oral health	✓	✓	✓	✓	✓	✓	✓
social and emotional health	✓	✓	✓	✓	x	✓	✓
immunisation	✓	✓	✓	✓	✓	✓	✓
child feeding habits	✓	✓	✓	✓	✓	✓	✓
breastfeeding and infant formula	✓	✓	✓	✓	✓	x	x
food and beverage frequency	x	✓	✓	✓	✓	✓	✓
oral health behaviour	x	✓	✓	✓	✓	✓	✓
oral bacteria transmission	✓	✓	✓	✓	✓	✓	✓
childcare	x	X	✓	✓	✓	✓	✓
early learning	x	x	x	x	x	✓	✓
routines	x	x	x	x	x	✓	✓
school transition	x	x	x	x	x	x	✓
child feeding habits	✓	✓	✓	✓	x	✓	x
breastfeeding and infant formula	✓	✓	✓	✓	✓	✓	✓
Parent							
demographics	✓	✓	✓	✓	✓	✓	✓
general and oral health	✓	✓	✓	✓	✓	✓	✓
social and emotional health	✓	✓	✓	✓	✓	✓	✓
diet habits	✓	✓	x	✓	✓	✓	✓
food and beverage frequency	x	✓	x	x	x	x	x
lifestyle behaviour	x	✓	✓	✓	✓	✓	✓
oral health behaviour	✓	✓	✓	✓	✓	✓	✓
oral health knowledge	x	x	✓	✓	✓	x	x
health literacy	x	x	x	x	✓	x	x
occupation	✓	✓	✓	✓	✓	✓	✓
education	✓	x	✓	✓	✓	✓	✓
Partner							
demographics	✓	✓	✓	✓	✓	✓	✓
education	✓	✓	✓	✓	✓	✓	✓
employment	✓	✓	✓	✓	✓	✓	✓
Family							
structure	✓	✓	✓	✓	✓	✓	✓
functioning	x	x	x	x	x	✓	✓
parenting confidence	x	x	x	x	x	✓	✓
parenting support	x	x	x	x	x	✓	✓
life events	x	x	x	x	✓	✓	✓
household affluence	✓	x	✓	✓	✓	✓	✓
financial stress	x	x	✓	✓	✓	✓	✓
income	✓	x	✓	✓	x	x	x
Community							
service use	x	x	x	x	x	✓	✓
service availability	x	x	x	x	x	✓	✓
community engagement	x	x	x	x	x	✓	✓
community trust	x	x	x	x	x	✓	✓

Adapted from Johnson et al 2017 [140]

4.1.6 Withdrawal and loss to follow up

Four hundred and sixty-six newborn children were recruited, including two sets of twins. The sibling of one existing participant was recruited into the study at age six months (no baseline data). Siblings of 14 other participants were recruited into the study at age 18 months. The degree to which participants completed the components of each study visit varied across the seven waves. Table 4.2 shows the number of participants who completed a questionnaire at each wave and the proportion of those originally recruited that this represents. The largest drop out was seen between waves one and two, the first six months of the child's life and the second largest drop out occurred between waves four and five. Participants were initially recruited for four waves of data collection, until their child was 18 months of age. During this time the study received extra funding to extend data collection for an additional 3 waves, until children were five years old. Participants were asked if they would like to continue in the study at the end of the wave 4 visit.

Table 4.2 Participants who completed questionnaires across waves of VicGen

	Phase I				Phase II		
	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6	Wave7
n	466	378	330	387	286	258	227
%	-	81.1	70.8	83.0	61.4	55.4	48.7

4.1.7 Data management

Questionnaires were stored at the University of Melbourne in locked filing cabinets. All questionnaire data were entered twice into SPSS [142] databases by two trained research assistants. The two entries were compared using STATA [143] and any identified discrepancies were checked against the hard copy of the questionnaire for the correct response.

4.1.8 Ethics Approval

Ethics approval for Phase I and Phase II of the VicGen study was obtained from the University of Melbourne Human Research Ethics Committee (HREC 0722543 and HREC 1137124). Approval for the study was also received from what was then known as the *Office for Children Research Coordinating Committee* which was part of the Department of Education and Early Childhood Development (now known as the Department of Education and Training) in the Victorian State Government.

4.1.9 Funding

The VicGen study was supported by the National Health and Medical Research Council, Dental Health Services Victoria, Financial Markets Foundation for Children, Jack Brockhoff Foundation, La Trobe University, Oral Health Cooperative Research Centre and the Victorian Government Department for Education and Training.

4.2 The VicGen component in this thesis

A substantial amount of dietary data was collected for children across the seven waves of the VicGen study. Whilst parts of the dietary data have been used in the larger analysis examining the development of early childhood caries, this PhD thesis provides an opportunity to take a more in depth look at the dietary data, which is covered in Chapters 5, 6 and 7 of this thesis. A small number of questions related to oral health and hygiene behaviours are also explored in Chapter 7.

Chapter 5: Validity and Reliability of a Food frequency questionnaire for use with young children

5.1 Background

Accurately assessing dietary intake is important when assessing the role that diet plays in disease development. It is difficult to accurately measure diet, and as such there are inherent errors related to every type of dietary measurement methodology [144]. The measurement of young children's diets adds an extra source of potential error to this process. Children's diets tend to change rapidly in the first few years of life, as they transition from a milk-based diet to consumption of table (complementary) foods [145]. Additionally, as young children are unable to report their own dietary intake, we are reliant on proxies to report for them – in most cases the child's parent(s) [146]. Parents tend to be good at recalling their child's food intake when the child is in the home environment, but not as good when the child is elsewhere [146].

A range of methods have been used to measure children's diets, including food diaries, weighed food records, repeated 24-hour recalls, dietary histories and food frequency questionnaires [147] and each of these have advantages and disadvantages. When deciding which tool to use to assess dietary intake it is important to consider numerous factors including the study purpose, study population and the accuracy required. The practicality of the data collection method, particularly the time (participant and researcher) and cost associated with each method and whether a retrospective or prospective design is required, also needs to be considered [148]. Food frequency questionnaires are a common method used to collect data in large population-based studies. They are practical and efficient to implement in large studies as well as having a low participant burden relative to other dietary recall methods [149].

The VicGen study, detailed in Chapter 4, included a food frequency questionnaire (FFQ) as part of the parent-completed questionnaire, in six of the seven waves of data collected (child age 6, 12 and 18 months, 3, 4 and 5 years). No FFQ was included in the baseline data collection as children were approximately one month old and were expected to be consuming only breastmilk and/or infant formula. A separate set of questions regarding breastmilk and/or infant formula consumption were included in the survey for waves 1-5 (child age 1, 6, 12, 18 months and 3 years).

The FFQ was developed specifically for the VicGen study, where the primary outcome was child oral health, particularly the development of dental caries. At the time that the study was initiated, few tools existed for collection of dietary data in this age group where the data were to be used in relation to oral health outcomes. The FFQ consisted of two components, one focussing on beverages and one on foods.

The beverage component was adapted from the tool used as part of the IOWA fluoride study, a longitudinal birth cohort study designed to examine how beverage and fluoride intake is associated with dental caries and dental fluorosis in children [150, 151]. The VicGen items included 12 beverages (water, infant formula, full fat cow's milk, low fat cow's milk, sweetened condensed milk, sweetened/flavoured milk, fruit juice/fruit drink, cordial (flavoured syrup diluted with water), soft drink (e.g. cola), tea/coffee, herbal teas/drinks, sports drinks). Parents could also list other beverages their child consumed (**Appendix A).** The questionnaire asked parents to indicate whether their child consumed the listed beverage, and if they did how frequently it was consumed (times per day/week/month). Parents were asked to indicate the extent to which they diluted any fruit juice or cordial (four options: undiluted, ¼ water, ½ water, ¾ water). Infant formula was removed as an option at the four and five-year old visit as it was no longer consumed.

The food component of the questionnaire was developed by the research team, which included a nutritionist with expertise in child health, and oral health practitioners specialising in early childhood caries, using items commonly consumed by young children [152] and thought to be protective or detrimental to oral health [153]. The FFQ used in the 6-month survey included 32 items, with a free text option to list any foods that the child consumed that were not listed (**Appendix B**). Parents were instructed to indicate how often their child consumed each item by ticking one of eight response options, ranging from 'never' to '4+ times per day'. Parents were also asked to indicate the type of cheese and yoghurt their child consumed (full fat and/or low fat). The food items were identical across each of the six waves of data collection, with the following exceptions:

Age 12 months (wave three) onwards

- Addition of a meat/fish category

Age four years (wave six) onwards

- Removal of the custard and jelly items

- Banana, other fresh fruit and stewed fruit items collapsed into one item ‘fresh/stewed fruit’
- Cakes/muffins and donut items collapsed into one item

Age five years (wave seven-final point)

- Low fat/full fat tick box options for yoghurt and cheese replaced with four separate items (low fat cheese, full fat cheese, low fat yoghurt, full fat yoghurt).

The FFQ used for the VicGen study did not include portion size, as the primary researchers wanted to focus on consumption frequency of items rather than amount. Work that followed the development of the FFQ identified an issue related to the context within which foods and drinks were being consumed by young children. The cariogenic potential of a food and/or beverage can be influenced by the combination of foods and drinks which are consumed together [4, 154, 155] and this has implications for health promotion messages given to parents. For example, if a sweetened beverage such as fruit juice is consumed in conjunction with a meal, it is likely to have a less detrimental effect on the teeth than it would if it was consumed by itself. Salivary flow increases during mealtimes, as different components of a meal and chewing stimulate saliva production, which helps to neutralise plaque acids more rapidly [4]. To address this limitation a set of new questions was developed and tested as part of this study.

When a tool is developed to assess dietary intake it is important to examine the ability of the tool to meet its purported goals, i.e. to determine the tool properties [148]. The reliability of a tool refers to how well it produces the same or similar results over multiple applications, whilst validity describes the degree to which a tool accurately measures actual consumption, by comparing it to what is believed to be a ‘superior’ tool [148]. Understanding these properties specific to the tool being used assists with the interpretation of results, ensuring that potential links between diet and disease are explained within the context of the tool used.

The body of literature surrounding very young children’s diets has grown rapidly over the last ten years, and with that so has the number of tools available for assessing diet. FFQs are commonly used, but the extent to which the reliability and validity properties of these tools has been examined varies. In a recent systematic review of 17 FFQs designed for use with young children, Lovell et al [156] concluded that semi quantitative FFQs tend to be valid when examining dietary intake at a group level, rather than individual level. It is difficult to directly compare FFQs as they are all developed and designed for specific populations, different purposes and are used to examine different disease outcomes. Some validation studies compare derived dietary scores [157-159] or measures of nutrients or energy [160, 161] against a reference value such as 24-hour recall or food record.

More comparable to the tool used in the VicGen birth cohort is research examining the reliability and/or validity of FFQs using individual or grouped foods and beverages. The comparison method for the validity component has varied across these validation studies, with some using one or multiple 24-hour recalls [152, 162, 163], 3-day food records [150, 164, 165], weighed food records [166, 167] and checklists [168]. The age of children included also varies amongst studies from specific ages (e.g. 12-month old children) to a wider range of preschool ages (e.g. 2-5 years). The statistical analyses performed in these studies also varies and makes comparisons difficult. The most common statistics reported are correlation coefficients, with most results indicating tools have poor to good correlation with the reference method [152, 162, 165, 169]. Correlation, however, is a weak statistical method because it shows the strength of a relationship between two measures but does not demonstrate the level of agreement between the two [170]. Research published over the last 10 years has started to include more informative methods that indicate the level of agreement and any bias between the two measures such as the Intracluster Correlation (ICC) statistic and Bland Altman plots [171]. Results tend to indicate good agreement at a group level rather than an individual level. Bias is also present in some of the tools tested, meaning participants tended to over or underestimate their actual intake items compared to the reference method [164, 167, 168, 172].

The reliability and validity properties of the FFQ used in the VicGen study are currently unknown and as such the aims of this study were to

a. Examine the test-retest reliability and relative validity of a food and beverage frequency questionnaire for use with children aged between 18 months and five years, including subgroup analyses by age (<3 years and ≥3 years).

b. Pilot test and examine the reliability and validity of a set of questions designed to collect information about the context of eating in young children aged between 18 months and five years.

5.2 Methods

5.2.1 Recruitment

Parents of young children were targeted for participation in this reliability and validity study. Eligible parents were those who had at least one child aged between 18 months and five years, resided in Australia and had facility with written and spoken English. A convenience sample of parents was recruited using the three strategies outlined below.

1. Social Media: A Facebook page was set up outlining what the study involved and encouraging interested parents to contact the page for more information or indicate their interest in taking part. The page went live in August 2016 and 12 recruitment posts were placed between August 2016 and March 2017. The posts were then shared by myself and my research unit's personal and professional networks. The reach of each post varied between 116 and 5,000 people, with between 13 and 333 clicks on each post (**Appendix C**).

In February 2017, an article was published in the Sunday edition of the Herald Sun, one of the two major newspapers in the state of Victoria. The article reported some previous work that I had been involved with and a request for participants for this validation study. Links to the Facebook page were provided at the end of the article.

Participants contacted me by either private messaging the Facebook page or commenting on one of the posts that appeared on the page. I responded through email.

2. University Newsletter: An advertisement was placed in the University of Melbourne staff news on three separate occasions between September 2016 and March 2017. The newsletter is distributed to the 7000-plus employees of the University.

3. Email: A flyer outlining the study was circulated to Health Promotion contacts at Dental Health Services Victoria and Merri Community Health Services. The flyer was distributed amongst the professional networks of these contacts (**Appendix D**).

5.2.2 Tools

Study participants completed the food frequency questionnaire (FFQ) twice (FFQ1, FFQ2) and a seven-day food checklist once over a five-week period. Demographic data (the age, gender, and Aboriginal and Torres Strait Islander background of both the parent and child, and parent education, place of birth and language spoken at home) were collected at the time of FFQ1.

The FFQ comprised three sections: beverage consumption; food consumption and; eating and drinking context **(Appendix E).** The food and beverage consumption questions were taken directly from the questionnaires used as part of the VicGen study (described in Chapter 4).

The eating and drinking context section consisted of eight questions and were developed specifically for this study. Three questions measured how often three different beverages were consumed with food, with five response options ranging from *always eats something when drinking this* to *never eats something when drinking this*. Five questions measured how often five different foods were consumed as part of a main meal or part of a snack, with five response options ranging from *always eats this as part of a main meal, never as a snack* to *never eats this as a main meal, always as a snack*. All eight questions in this section also had a response option to indicate that the child does not consume the food or beverage listed.

Food Frequency Questionnaire 2 (**Appendix E)** consisted of the same questions from FFQ1, except for the demographic questions which were excluded. In most cases a hard copy of the questionnaire was completed, however, an electronic PDF form was also developed for FFQ1 and FFQ2 to assist with the response rate.

The seven-day checklist was a 20 page, A5 booklet and included the same food and beverage items as the food frequency questionnaire **(Appendix F).** One beverage from the FFQ, sweetened condensed milk was excluded from the checklist due to exceptionally low consumption in the FFQ, and for ease of analysis there was no option to provide 'other' beverages. Full fat and low-fat yoghurt and cheese were listed as four separate items in the checklist, which resulted in 35 checklist food items compared to 33 in the FFQ.

The booklet had a page of instructions at the front, followed by the 35 food and 11 beverage items, repeated seven times (seven days). Each new set of items had a cover page which indicated which day it was (1-7) and space for the participant to write the date and circle the day of the week. For each item, there were nine consumption occasions listed; breakfast, morning snack, lunch, afternoon snack, dinner, dessert, evening snack, other snack one and other snack two. There was also an option to indicate that an item had not been consumed on that day. Parents were instructed to complete the checklist over seven consecutive days and indicate with a tick when items were consumed.

5.2.3 Data Collection

Food Frequency Questionnaire 1

Participants contacting the researcher were verbally provided with the plain language statement outlining what the study involved. Those indicating interest in taking part were posted a cover letter with instructions for completing FFQ1, plain language statement, consent form, the first food frequency questionnaire and a reply-paid envelope in which to return the paperwork. Participants who had multiple children in the required age range were given the option of completing the study tasks for one or more of their children. Most participants opted to complete the study materials for each of their children within the required age range. An electronic version of the survey was developed in response to requests from participants. The paper-based FFQ1 was completed by 179 participants and 27 completed the electronic version and emailed it back. An email or Facebook Messenger reminder was sent approximately two weeks after the survey was distributed if the researcher had not yet received it. Up to three further reminders (through email, Facebook messenger or text, depending on contact details provided) were sent, after which it was deemed the participant was lost to follow-up and no further contact was made.

Food Frequency Questionnaire 2

Approximately two weeks after receiving FFQ1, FFQ2 and cover letter with instructions on how to complete the questionnaire were distributed to participants, either by post or electronically. Participants receiving the questionnaire by post also received a reply-paid envelope for the return of the survey, as well as a small thankyou gift in the form of children's stickers or colouring sheets (depending on the age of their children). Participants were sent up to four reminders if the questionnaire had not been received. Participants who had not returned the questionnaire after four reminders were deemed to be lost to follow up and were not contacted again.

Seven-day checklist

A cover letter with instructions and a hard copy of the seven-day checklist was sent to all participants via post approximately one week after FFQ2 was received by the researcher. Participants were also sent a children's book as a small thank you for their participation in the study. The instructions included with the checklist informed participants that they could opt in to receive a daily reminder text to complete the checklist by sending an SMS request to the researcher on the day that they commenced completing the checklist. Two of the 149 participants opted in. Participants were asked to make a note on the cover page of the checklist for that day if they did not know what their child had eaten at a specific meal and were unable to find out (primarily due to childcare). The completed checklist was returned to the researcher in the reply-paid envelope supplied.

Participants were followed up approximately three weeks after being sent the checklist and were sent up to three further reminders after which they were deemed to be lost to follow up and were not contacted again.

Figure 5.1 shows the flow of families through the study. Of the 192 families sent FFQ1, 66 (34.3%) were lost to follow up between FFQ1 and the 7-day checklist data collection.

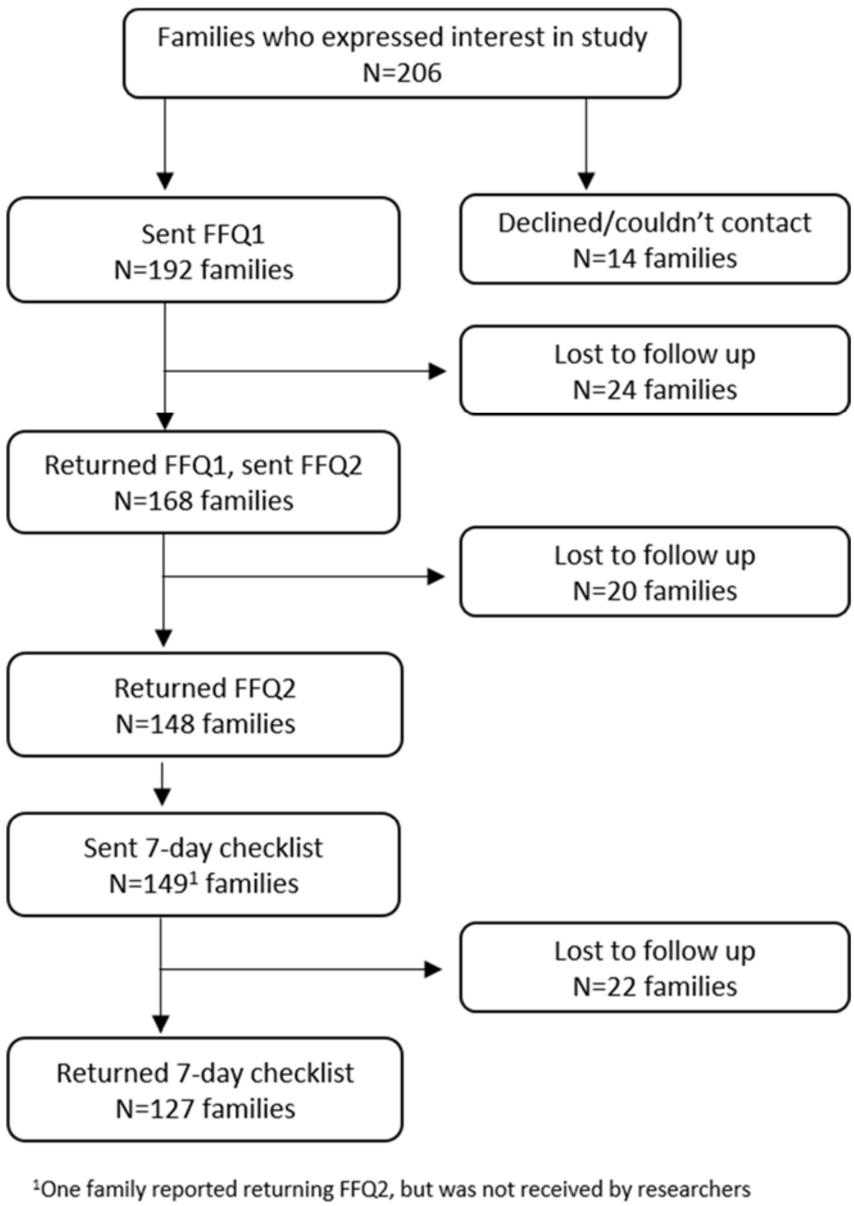


Figure 5.1 Flow of families through the validation study

5.2.4 Data Management

Administrative data

Microsoft Access was used to store all administrative data (participant contact details and information about data distribution and follow up) related to the project.

Data entry

Separate databases were set up for each FFQ and the checklist using EpiData software [173]. All data were double-entered by the researcher into EpiData and exported into Stata. The double entry of each database was compared to identify data entry errors. Errors were then corrected in Stata by referring to the original questionnaire or checklist.

Data handling

Food Frequency Questionnaire

Beverage frequency data (collected as times per day OR week OR month) were transformed into one variable per item reflecting time per week consumed. Food frequency data were converted from discrete categories to continuous values (times per week), to allow for analysis of categorical and continuous data. In cases where a range was listed as an option, the midpoint was taken to calculate the times per week value. Table 5.1 outlines the corresponding discrete and continuous values.

Table 5.1 Conversion of discrete categories to continuous values for food items

Discrete category	Continuous value
Never	0
Rarely	0.25
Once/week	1
2-3 times per week	2.5
4-6 times per week	5
Once per day	7
2-3 times per day	17.5
≥4 times per day	28

Seven Day Checklist

The number of times a food or beverage was consumed (minimum zero, maximum nine) was summed for each day of the checklist. The seven days were then summed to create a score reflecting the total times in the week the item was consumed (minimum zero, maximum 63).

Beverage Categories

Two categories were created for five of the beverages. *Sweetened beverages* consisted of fruit juice/fruit drink, soft drink and cordial whilst *plain milk* consisted of full fat and low-fat milk. All other beverages were not categorised.

Food Categories

To reduce the number of statistical tests and the inherent error that may occur with this, foods and beverages were combined into categories.

Two approaches were used. The first reflected the potential influence of foods in relation to dental caries i.e. *cariogenicity*. These were pre-existing categories developed by an accredited dietitian working on the VicGen study, and have been published [174]. Briefly, an extensive review of the evidence for cariogenic properties of different foods and nutrients was conducted. The FFQ used in VicGen did not specify specific brand or type, whether items were home-made, sweetened or unsweetened or had any additional nutritional properties. FoodWorks, a nutritional analysis software comprised of more than 20,000 commercial food products, was used to generate a nutritional profile for each food and beverage listed on the FFQ, based on the average of the products listed in FoodWorks. The food and beverage items from the VicGen FFQ were then allocated to one of six categories showing their cariogenic potential relative to each other. Factors examined included the type and number of macronutrients (fat, protein, carbohydrate (including free sugars)), processing and refinement of the food, and the relative likelihood that the item is retained in the mouth for a long period of time. The presence of protective factors such as calcium, phosphate and casein were also taken into consideration. Table 5.2 shows how the 34 foods were categorized. All foods and beverages from the FFQ were categorised (including core items), but the intention of the scale (as stated in the paper) was to use this as a tool only for discretionary foods and drinks.

Table 5.2 Cariogenic categories of foods from the FFQ

Category	Foods
Cariostatic	Eggs, Nuts, Luncheon Meats, Meat/Fish
Anticariogenic	Cheese
Low Cariogenicity	Yoghurt, vegetables, potato, noodles/pasta, rice, fresh fruit
Moderate Cariogenicity	Ice cream, custard, baked beans, soup, ready to eat baby foods, hot chips, banana, cereal, bread
High Cariogenicity	Potato chips, savoury biscuits, stewed fruit, jelly
Severe Cariogenicity	Jam/honey, peanut butter/Nutella, muesli bars/fruit sicks/rolls ups, puddings, lollies[1]/chocolates[1], cakes/muffins, dried fruit, donuts, sweet biscuits

[1]Term used in Australia for all types of confectionery/sweets.

The second approach grouped foods according to food type and nutrient profile (general category). Two items, ready-to-feed baby food and soup, could not be categorised due to the variation in the available types of these items.

Table 5.3 displays the general food categories.

Table 5.3 **General categories of foods from the FFQ**

Category	Foods
Spreads	Jam/honey, Peanut butter/Nutella
Proteins	Meat/fish, Lunch meats, Eggs, Nuts
Grains	Noodles/pasta, Rice/couscous, Bread/rolls, Cereals
Fruits and vegetables	Fresh fruit, Vegetables, Baked beans, Stewed fruit, Dried fruit, Potato, banana
Dairy	Cheese, Yoghurt
Sweet snacks	Cakes/muffins, Muesli/fruit bars, Donuts, Sweet biscuits, Lollies/chocolates
Savoury snacks	Savoury biscuits, Potato chips, Hot chips
Dessert foods	Pudding, Ice cream, Custard, Jelly
-	Ready to feed baby food
-	Soup

Context of Eating Questions

Checklist data were converted from continuous to categorical to allow comparison to FFQ responses. Table 4.4 shows the allocation of ratios to categories.

a) Beverages

A ratio was derived for juice/fruit drink, cordial and soft drink by dividing the number of times a beverage was consumed with food by the total number of occasions the beverage was drunk over the week. Data were then categorised according to the values outlined in Table 5.4

b) Foods

The potato and vegetable category were summed to generate a *total vegetables* variable, whilst fresh fruit, stewed fruit, dried fruit and banana were summed to generate a *total fruit* variable. A ratio was then derived for fruit, vegetables, lollies/chocolate, hot chips, muffins/cakes and savoury dry biscuits to show how often the item was eaten as a meal compared to a snack. The total number of times the item was eaten at a meal time (breakfast, lunch, dinner) was divided by the total number of times the item was eaten in the week. Data were then categorised according to the values outlined in Table 5.4.

Table 5.4 Allocation of ratios to FFQ categories

FFQ Category	Beverage question	Food question	Ratio
Always	Eats something when drinking this	Always eats as main meal, never a snack	1.0
Most of the time	Eats something when drinking this	Mostly eats as main meal, hardly ever a snack	0.6 to <1.0
About half the time	Eats something when drinking this	About ½ the time eats as main meal, about ½ the time as a snack	≥0.4 to ≤0.6
Hardly ever	Eats something when drinking this	Hardly ever eats as main meal, mostly eats as a snack	>0.0 to <0.04
Never	Eats something when drinking this	Never eats as main meal, always as a snack	0.0

Missing Data

FFQ1 and FFQ 2

Missing data for individual items were not replaced and were reported using descriptive statistics. Following creation of the food categories described above, two sets of variables were generated. In one set the entire food group was left as missing if one or more of the individual items were missing. In the other set, the small number of missing values were replaced with the group mean. Descriptive statistics were used to compare the mean and standard deviation values of the grouped variables when including and excluding those with missing values. To maximise the number of participants, the variables with the missing values replaced were used for analysis.

Checklist

As participants were asked to indicate whether their child did or did not consume each food and beverage for the 7 days recorded, items left blank were treated as missing. The proportion of missing rows from each checklist was calculated by dividing the number of missing rows by the total number of rows (322) in the checklist.

Mean values for weekly consumption of each food and beverage were generated, with missing data treated as zero (not consumed), and compared for three groups: 1) all participants; 2) participants missing ≥10% (≥31 rows) of checklist rows (N=9, 5.4% of sample); 3) participants missing ≥3% (≥10 rows) of checklist rows (N=21, 12.6% of sample). Similar means and standard deviations were observed between the groups missing ≥3% and ≥10% of checklist rows. Considering this, and to maximise the N available for validation analysis, participants with ≥10% of checklist rows missing were included in the analysis.

5.2.5 Data Analysis

Data were analysed both continuously and categorically, depending on how they were collected and how they could be transformed. Data were checked for non-normal distribution using the Shapiro-Wilk normality test in Stata. This test confirmed the non-normal distribution of the continuous variables and directed the analysis to be performed using non-parametric tests.

Test-Retest Reliability

Test-retest reliability was examined by comparing FFQ1 with FFQ2. Spearman correlation coefficients were calculated for continuous and categorical data with correlations ≥0.5 indicating acceptable agreement. Correlation coefficients are commonly reported in the FFQ reliability and validation studies, despite being a largely flawed method. Correlations only show the degree to which the two measures are related rather than agreement [144], however they have been calculated to allow comparison with other studies.

Intra cluster correlation coefficients were calculated for continuous data. The ICC reflects the degree of correlation and agreement between the measurements [175]. A two-way random effects model for absolute agreement was applied for all analyses. Individual and group values with 95% confidence intervals (CI) were calculated for each ICC statistic. ICC values were interpreted in the context of the 95% CI as follows: poor (<0.5); moderate (0.5-<0.75); good (0.75 - 0.90) and excellent (>0.90) [175].

The Weighted Kappa Statistic was calculated for ordinal data, using the standard Stata weights [143] which also produced the percentage agreement. Weighted Kappa values are interpreted as follows: less than chance agreement (<0); slight agreement (0.01-0.20); fair agreement (0.21- 0.40); moderate agreement (0.41-0.60); substantial agreement (0.61-0.80) and almost perfect agreement (0.81-0.99) [176].

Relative Validity

Relative validity was examined by comparing FFQ1 with the 7-day checklist. The Spearman Correlation Coefficient and ICC were calculated using the method described above. In order to assess the bias and the degree of agreement between the two methods, the mean difference (time per week) with 95% limits of agreement (LOA) was calculated and plotted for categorised foods and beverages using the Bland Altman Method [170]. Linear regression models were fitted to each plot to allow assessment of systematic bias. Bland Altman plots were produced using Graph Pad Prism 7.04 [177], all other analyses were conducted in Stata version 14.0 [143].

Individual child analysis

Reliability analyses were conducted for all families that provided complete data for FFQ1 and FFQ2. Validity analyses were conducted for all families that provided complete FFQ1 and checklist data. There were a number of cases where families had provided data for more than one child, as they fell within the designated age group. In order to be able to treat the data as independent observations, the data from one child per family were chosen at random to be included in the analyses.

Subgroup Analysis

To compare any differences between older and younger children, subgroup analyses for reliability and validity were conducted for grouped beverages and foods. Children were split into two age groups, <3 years and ≥3 years. In cases where two children from one family had data available, both were included if they fell into separate age groups. If children from one family fell into the same age group, the data for the child that was included in the initial individual analysis was included.

5.3 Results

A summary of the data used for the reliability and validity analysis is displayed in Table 5.5. A total of 148 families with 187 children completed at least two components of the study, and data for all three components were provided for 86.1% of these children.

Table 5.5 Summary of responses

	All children		Using only one child per family	
Total families, n (%)	148	(100)		
Total children, n (%)	187	(100)		
Data provided, n (%)				
Both FFQS and checklist[1]	161	(86.1)	126	(85.1)
Both FFQs no checklist[2]	24	(12.8)	21	(14.2)
1st FFQ and checklist (no FFQ 2)[3]	2		1	(0.7)
Days between completion, mean [sd]				
FFQ1 and FFQ2	34.6	[20.5]	34.7	[21.0]
FFQ 1 and checklist	61.1	[32.2]	60.9	[32.4]

[1]Data used for reliability and validity analysis; [2] Data used for reliability analysis only; [3]Data used for validity analysis only

5.3.1 Participant characteristics

Parent characteristics are displayed in Table 5.6. Parent characteristics are shown for the sample used in the reliability analysis (FFQ and FFQ2) and in the validity analysis (FFQ1 and seven-day checklist – a subsample of the reliability sample). Parents included in the reliability and validity analysis were similar across all domains. Nearly all were female, and the majority were aged between 30 and 44 years. Most parents spoke English at home and more than 80% were university educated.

Table 5.6 Parent characteristics for the reliability and validity samples

	Reliability Sample (N=147)		**Validity Sample (N=127)**	
	n	%	n	%
Gender				
Female	143	(97.3)	126	(99.2)
Male	4	(2.7)	1	(0.8)
Age (yrs)				
25-29	15	(10.2)	14	(11.0)
30-34	65	(44.2)	54	(42.5)
35-39	46	(31.3)	40	(31.5)
40-44	18	(12.2)	16	(12.6)
45-49	3	(2.0)	3	(2.4)
Identifies as Aboriginal or Torres Strait Islander				
Yes	2	(1.4)	2	(1.6)
No	145	(98.6)	125	(98.4)
Born in Australia				
Yes	125	(85.0)	109	(85.8)
No	22	(15.0)	18	(14.2)
Speaks English at home				
Yes	137	(93.2)	120	(94.5)
No	10	(6.8)	7	(5.5)
Highest Education Level				
Year 11	1	(0.7)	1	(0.8)
Year 12	4	(2.7)	3	(2.4)
Technical Apprenticeship	1	(0.7)	1	(0.8)
Diploma/Certificate	19	(12.9)	14	(11.0)
Bachelor degree	67	(45.6)	58	(45.7)
Postgraduate degree	54	(36.7)	49	(38.6)
Other	1	(0.7)	1	(0.8)

Child characteristics for the reliability and validity samples are displayed in Table 5.7. As some families had more than one child involved in the study, two sets of child characteristics are displayed. The first shows the sample characteristics when one child per family was chosen at random, and the second shows when all children are included. The mean age of children in both the validity and reliability samples was 3.1 years. There was a greater proportion of children aged <3 years across all samples, but this proportion did decline slightly when only one child per family was included. The proportion of boys was higher in both the reliability and validity samples when one child per family was included but was only higher in the validity sample when more than one child per family was included. Most children in both samples were the first-born in the family and very few identified as Aboriginal or Torres Strait Islander.

Table 5.7 Child characteristics of reliability and validity sample

	Reliability Sample		**Validity Sample**	
	One child per family[1] (n= 147)	**> One child per family (n=185)**	**One child per family[1] (n=127)**	**> One child per family (n=163)**
Child Age, mean years [SD]	3.1 [1.2]	3.1 [1.2]	3.1 [1.2]	3.1 [1.2]
Child Age Category, n (%)				
<3 years	82 (55.8)	104 (56.2)	68 (53.5)	89 (54.6)
≥3 years	65 (44.2)	81 (43.8)	59 (46.5)	74 (45.4)
Gender, n (%)				
Male	77 (52.7)	92 (50.0)	69 (54.3)	84 (51.5)
Female	69 (47.3)	92 (50.0)	58 (45.7)	79 (48.5)
Child birth order, n (%)				
1st child	111 (75.5)	119 (64.3)	98 (77.2)	105 (64.4)
2nd child	26 (17.7)	52 (28.1)	21 (16.5)	47 (28.8)
3rd child	8 (5.4)	12 (6.5)	6 (4.7)	9 (5.5)
4th child or more	2 (1.4)	2 (1.1)	2 (1.6)	2 (1.2)
Identifies as Aboriginal or Torres Strait Islander, n (%)				
Yes	2 (1.4)	2 (1.1)	2 (1.6)	2 (1.2)
No	144 (98.6)	183 (98.9)	125 (98.4)	161 (98.8)

[1]In families where more than one child was involved, one child was chosen at random

5.3.2 Reliability

Individual beverages and foods

The reported proportion and consumption frequency of each beverage for FFQ1 and FFQ2 are displayed in Table 5.8. Water, full fat milk, fruit juice and flavoured milk were commonly consumed beverages. Few children were reported to consume sweetened condensed milk, soft drink, tea/coffee and herbal drinks, and sports drinks were not consumed at all.

Strong correlations between mean consumption frequency reported in FFQ1 and FFQ 2 were observed for water, infant formula, full fat milk, low fat milk, fruit juice, tea/coffee and herbal drinks, and moderate correlations were observed for cordial, flavoured milk and soft drink.

Individual and group Intraclass Correlation Coefficients (ICC), are also presented in Table 5.8. When considering the 95% confidence intervals, good agreement was observed for low fat milk, fruit juice and tea/coffee at both the individual and group level. At the individual level, poor agreement was observed for infant formula, flavoured milk, cordial, soft drink and herbal drinks, whilst there was moderate agreement for water and full fat milk. Group ICC values indicate poor agreement remained between flavoured milk and herbal drinks, whilst the other beverages had moderate agreement.

Reported consumption frequency for individual food items from FFQ1 and FFQ2 are displayed in Table 5.9 along with the percentage agreement, weighted kappa statistic and correlation coefficient. The percentage agreement for individual food items, calculated as part of the weighted kappa analysis, ranged between 84.6% (bread/rolls) and 95.7% (custard), except for dried fruit, with a percentage agreement of 59.7%. The weighted kappa coefficients indicate moderate agreement ($K_W =$ 0.41-0.60) for 9 of the 33 food items and substantial agreement (K_W $=$ 0.61-0.80) for 24 items when comparing FFQ1 and FFQ2. Correlations ranged between 0.59 and 0.87 for each item, indicating a moderate to very strong relationship between data from FFQ1 and FFQ2.

Table 5.8 Consumption of beverages and *reliability* measures for FFQ1 and FFQ2

	FFQ1 (n=147)				FFQ 2 (n=147)				rho[2]	ICC[3]					
	Consumes beverage		Times/week consumed[1]		Consumes beverage		Times/week consumed[1]			Individual			Group		
	n	%	Mean	sd	n	%	Mean	sd		ICC	[95% CI]		ICC	[95%CI]	
Water	147	(100)	44.6	[14.5]	147	(100)	44.7	[15.5]	0.73	0.67	[0.57,	0.75]	0.81	[0.73,	0.86]
Infant formula	5	(3.4)	0.4	[2.13]	5	(3.4)	0.4	[2.5]	0.78	0.60	[0.48,	0.69]	0.75	[0.65,	0.82]
Full fat milk	111	(75.5)	8.3	[9.6]	110	(74.8)	8.5	[8.0]	0.87	0.65	[0.54,	0.73]	0.79	[0.70,	0.85]
Low fat milk	18	(12.2)	0.7	[2.3]	19	(12.9)	0.6	[2.2]	0.87	0.88	[0.84,	0.91]	0.94	[0.91,	0.96]
Sweetened condensed milk	1	(0.7)	0.03	[0.04]	1	(0.7)	0.03	[0.04]	-	-	-	-	-	-	-
Flavoured milk	33	(22.5)	0.4	[1.1]	33	(25.2)	0.5	[1.2]	0.51	0.28	[0.13,	0.43]	0.44	[0.23,	0.60]
Fruit juice	79	(53.7)	0.8	[1.8]	82	(55.8)	0.8	[1.6]	0.87	0.90	[0.86,	0.92]	0.95	[0.92,	0.96]
Cordial	12	(8.2)	0.2	[1.2]	16	(10.1)	0.1	[0.6]	0.53	0.60	[0.49,	0.70]	0.75	[0.66,	0.82]
Soft drink	8	(5.4)	0.03	[0.1]	13	(8.8)	0.03	[0.1]	0.57	0.52	[0.40,	0.63]	0.69	[0.57,	0.77]
Tea/coffee	5	(3.4)	0.03	[0.3]	8	(5.4)	0.1	[0.6]	0.61	0.81	[0.75,	0.86]	0.90	[0.86,	0.92]
Herbal drinks	8	(5.4)	0.03	[0.2]	9	(6.1)	0.1	[0.6]	0.81	0.17	[0.01,	0.32]	0.29	[0.02,	0.49]
Sports drinks	0	-	-	-	0	-	-	-	-	-	-	-	-	-	-

[1]Values for all respondents; [2]Spearman rank correlation coefficient; [3]Intracluster correlation – two-way random effects model, absolute agreement, individual (individual comparison), average (group mean comparison)

Table 5.9 Consumption of individual foods and *reliability* measures for FFQ1 and FFQ2

	FFQ1 (n=147) N	%	FFQ2 (n=147) N	%	Percentage Agreement[1]	K_w[2]	rho[3]
Peanut Butter/Nutella							
Never	35	(23.8)	39	(26.5)	92.7	0.73	0.87
Rarely	32	(21.8)	28	(19.1)			
Once/week	25	(17.0)	31	(21.1)			
2-3 times/week	36	(24.5)	29	(19.7)			
4-6 times/week	11	(7.5)	13	(8.8)			
Once/day	4	(2.7)	6	(4.1)			
2-3 times/day	1	(0.7)	-	-			
4+ times/day	-	-	-	-			
Missing	3	(2.0)	1	(0.7)			
Jam/Honey							
Never	38	(25.9)	36	(24.5)	90.1	0.62	0.77
Rarely	36	(24.5)	32	(21.8)			
Once/week	22	(15.0)	31	(21.1)			
2-3 times/week	31	(21.1)	37	(25.2)			
4-6 times/week	12	(8.2)	7	(4.8)			
Once/day	6	(4.1)	2	(1.4)			
2-3 times/day	-	-	1	(0.7)			
4+ times/day	-	-	-	-			
Missing	2	(1.4)	1	(0.7)			
Eggs							
Never	10	(6.8)	6	(4.1)	91.3	0.68	0.80
Rarely	20	(13.6)	25	(17.0)			
Once/week	37	(25.2)	35	(23.8)			
2-3 times/week	49	(33.3)	52	(35.4)			
4-6 times/week	19	(12.9)	17	(11.6)			
Once/day	9	(6.1)	8	(5.4)			
2-3 times/day	-	-	-	-			
4+ times/day	-	-	-	-			
Missing	3	(2.0)	4	(2.7)			
Nuts							
Never	29	(19.7)	32	(21.8)	91.4	0.60	0.78
Rarely	31	(21.1)	38	(25.9)			
Once/week	42	(28.6)	32	(21.8)			
2-3 times/week	22	(15.0)	28	(19.1)			
4-6 times/week	13	(8.8)	8	(5.4)			
Once/day	4	(2.7)	4	(2.7)			
2-3 times/day	1	(0.7)	-	-			
4+ times/day	1	(0.7)	-	-			
Missing	4	(2.7)	5	(3.4)			
Cheese							
Never	5	(3.4)	5	(3.4)	91.6	0.61	0.69
Rarely	9	(6.1)	6	(4.1)			
Once/week	6	(4.1)	7	(4.8)			
2-3 times/week	31	(21.1)	33	(22.5)			
4-6 times/week	44	(29.9)	44	(29.9)			

	FFQ1 (n=147) N	%	FFQ2 (n=147) N	%	Percentage Agreement[1]	K_w[2]	rho[3]
Once/day	41	(27.9)	43	(29.3)			
2-3 times/day	8	(5.4)	8	(5.4)			
4+ times/day	-	-	-	-			
Missing	3	(2.0)	1	(0.7)			
Yoghurt					90.5	0.57	0.74
Never	9	(6.1)	4	(2.7)			
Rarely	9	(6.1)	13	(8.8)			
Once/week	13	(8.8)	11	(7.5)			
2-3 times/week	31	(21.1)	42	(28.6)			
4-6 times/week	31	(21.1)	40	(27.2)			
Once/day	47	(32.0)	32	(21.8)			
2-3 times/day	5	(3.4)	2	(1.4)			
4+ times/day	1	(0.7)	1	(0.7)			
Missing	1	(0.7)	2	(1.4)			
Banana							
Never	7	(4.8)	7	(4.8)	90.6	0.64	0.77
Rarely	7	(4.8)	11	(7.5)			
Once/week	13	(8.8)	15	(10.2)			
2-3 times/week	36	(24.5)	40	(27.2)			
4-6 times/week	33	(22.5)	35	(23.8)			
Once/day	47	(32.0)	35	(23.8)			
2-3 times/day	3	(2.0)	4	(2.7)			
4+ times/day	-	-	-	-			
Missing	1	(0.7)	-	-			
Fresh fruit (not banana)							
Never	2	(1.4)	3	(2.0)	92.7	0.56	0.59
Rarely	1	(0.7)	-	-			
Once/week	-	-	-	-			
2-3 times/week	6	(4.1)	11	(7.5)			
4-6 times/week	21	(14.3)	16	(10.9)			
Once/day	31	(21.1)	41	(27.9)			
2-3 times/day	82	(55.8)	71	(48.3)			
4+ times/day	3	(2.0)	5	(3.4)			
Missing	1	(0.7)	-	-			
Dried fruit							
Never	19	(12.9)	23	(15.7)	59.7	0.61	0.75
Rarely	46	(31.3)	46	(31.3)			
Once/week	25	(17.0)	25	(17.0)			
2-3 times/week	31	(21.1)	33	(22.5)			
4-6 times/week	10	(6.8)	6	(4.1)			
Once/day	12	(8.2)	12	(8.2)			
2-3 times/day	-	-	1	(0.7)			
4+ times/day	-	-	-	-			
Missing	4	(2.7)	1	(0.7)			
Muesli Bars/Fruit sticks etc.							
Never	73	(49.7)	69	(46.9)	91.4	0.68	0.80

	FFQ1 (n=147) N	%	FFQ2 (n=147) N	%	Percentage Agreement[1]	K_w[2]	rho[3]
Rarely	37	(25.2)	36	(24.5)			
Once/week	17	(11.6)	16	(10.9)			
2-3 times/week	12	(8.2)	15	(10.2)			
4-6 times/week	4	(2.7)	7	(4.8)			
Once/day	2	(1.4)	2	(1.4)			
2-3 times/day	-	-	-				
4+ times/day	-	-	-	-			
Missing	2	(1.4)	2	(1.4)			
Stewed fruit							
Never	65	(44.2)	59	(40.1)	91.8	0.60	0.71
Rarely	64	(43.5)	65	(44.2)			
Once/week	12	(8.2)	13	(8.8)			
2-3 times/week	3	(2.0)	4	(2.7)			
4-6 times/week	-	-	3	(2.0)			
Once/day	-	-	-	-			
2-3 times/day	-	-	-	-			
4+ times/day	-	-	-	-			
Missing	3	(2.0)	3	(2.0)			
Cereal							
Never	9	(6.1)	7	(4.8)	90.9	0.65	0.78
Rarely	6	(4.1)	15	(10.2)			
Once/week	14	(9.5)	8	(5.4)			
2-3 times/week	24	(16.3)	25	(17.0)			
4-6 times/week	27	(18.4)	24	(16.3)			
Once/day	65	(44.2)	68	(46.3)			
2-3 times/day	1	(0.7)	-	-			
4+ times/day	-	-	-	-			
Missing	1	(0.7)	-	-			
Savoury biscuits							
Never	2	(1.4)	4	(2.7)	89.1	0.54	0.69
Rarely	10	(6.8)	9	(6.1)			
Once/week	7	(4.8)	11	(7.5)			
2-3 times/week	48	(32.7)	49	(33.3)			
4-6 times/week	33	(22.5)	28	(19.1)			
Once/day	38	(25.9)	38	(25.9)			
2-3 times/day	8	(5.4)	7	(4.8)			
4+ times/day	-	-	-	-			
Missing	1	(0.7)	1	(0.7)			
Bread/Rolls							
Never	5	(3.4)	5	(3.4)	84.6	0.47	0.60
Rarely	14	(9.5)	13	(8.8)			
Once/week	3	(2.0)	13	(8.8)			
2-3 times/week	30	(20.4)	22	(15.0)			
4-6 times/week	31	(21.1)	24	(16.3)			
Once/day	48	(32.7)	43	(29.3)			
2-3 times/day	13	(8.8)	24	(16.3)			
4+ times/day	-	-	-	-			
Missing	3	(2.0)	3	(2.0)			

	FFQ1 (n=147) N	%	FFQ2 (n=147) N	%	Percentage Agreement[1]	K_w[2]	rho[3]
Ice cream							
Never	29	(19.7)	27	(18.4)	94.4	0.68	0.75
Rarely	82	(55.8)	79	(53.7)			
Once/week	27	(18.4)	31	(21.1)			
2-3 times/week	6	(4.1)	6	(4.1)			
4-6 times/week	1	(0.7)	2	(1.4)			
Once/day	1	(0.7)	1	(0.7)			
2-3 times/day	-	-	-	-			
4+ times/day	-	-	-	-			
Missing	1	(0. 7)	1	(0.7)			
Pudding							
Never	104	(70.8)	98	(66.7)	93.7	0.59	0.63
Rarely	35	(23.8)	42	(28.6)			
Once/week	4	(2.7)	3	(2.0)			
2-3 times/week	-	-	1	(0.7)			
4-6 times/week	-	-	-	-			
Once/day	-	-	-	-			
2-3 times/day	-	-	-	-			
4+ times/day	-	-	-	-			
Missing	4	(2.7)	3	(2.0)			
Custard							
Never	78	(53.1)	77	(52.4)	95.7	0.75	0.78
Rarely	51	(34.7)	55	(37.4)			
Once/week	11	(7.5)	8	(5.4)			
2-3 times/week	3	(2.0)	3	(2.0)			
4-6 times/week	-	-	-	-			
Once/day	2	(1.4)	2	(1.4)			
2-3 times/day	-	-	-	-			
4+ times/day	-	-	-	-			
Missing	2	(1.4)	2	(1.4)			
Jelly							
Never	79	(53.7)	78	(53.1)	92.4	0.65	0.75
Rarely	54	(36.7)	59	(40.1)			
Once/week	9	(6.1)	6	(4.1)			
2-3 times/week	3	(2.0)	1	(0.7)			
4-6 times/week	-	-	-	-			
Once/day	-	-	-	-			
2-3 times/day	-	-	-	-			
4+ times/day	-	-	-	-			
Missing	2	(1.4)	3	(2.0)			
Donuts							
Never	87	(59.2)	83	(56.5)	91.1	0.66	0.73
Rarely	58	(39.5)	57	(38.8)			
Once/week	-	-	4	(2.7)			
2-3 times/week	-	-	-	-			
4-6 times/week	-	-	-	-			
Once/day	-	-	-	-			

	FFQ1 (n=147) N	%	FFQ2 (n=147) N	%	Percentage Agreement[1]	K_w[2]	rho[3]
2-3 times/day	-	-	-	-			
4+ times/day	-	-	-	-			
Missing	2	(1.4)	3	(2.0)			
Sweet biscuits							
Never	30	(20.4)	26	(17.7)	89.6	0.62	0.80
Rarely	54	(36.7)	54	(36.7)			
Once/week	26	(17.7)	30	(20.4)			
2-3 times/week	28	(19.1)	30	(20.4)			
4-6 times/week	5	(3.4)	1	(0.7)			
Once/day	3	(2.0)	5	(3.4)			
2-3 times/day	-	-	-	-			
4+ times/day	-	-	-	-			
Missing	1	(0.7)	1	(0.7)			
Cakes/Muffins							
Never	22	(15.0)	15	(10.2)	90.1	0.62	0.79
Rarely	58	(39.5)	59	(40.1)			
Once/week	39	(26.5)	45	(30.6)			
2-3 times/week	24	(16.3)	25	(17.0)			
4-6 times/week	3	(2.0)	1	(0.7)			
Once/day	-	-	-	-			
2-3 times/day	-	-	-	-			
4+ times/day	-	-	-	-			
Missing	1	(0.7)	2	(1.4)			
Lollies/chocolates							
Never	38	(25.9)	39	(26.5)	93.0	0.70	0.83
Rarely	51	(34.7)	47	(32.0)			
Once/week	33	(22.5)	32	(21.8)			
2-3 times/week	12	(8.2)	17	(11.6)			
4-6 times/week	9	(6.1)	6	(4.1)			
Once/day	2	(1.4)	4	(2.7)			
2-3 times/day	1	(0.7)	1	(0.7)			
4+ times/day	-	-	-	-			
Missing	1	(0.7)	1	(0.7)			
Potato chips/twisties etc.							
Never	50	(34.0)	40	(27.2)	94.3	0.65	0.75
Rarely	66	(44.9)	69	(46.9)			
Once/week	15	(10.2)	22	(15.0)			
2-3 times/week	12	(8.2)	11	(7.5)			
4-6 times/week	2	(1.4)	4	(2.7)			
Once/day	1	(0.7)	-	-			
2-3 times/day	-	-	-	-			
4+ times/day	-	-	-	-			
Missing	1	(0.7)	1	(0.7)			
Hot Chips							
Never	15	(10.2)	14	(9.5)	94.3	0.68	0.77
Rarely	80	(54.4)	83	(56.5)			
Once/week	44	(29.9)	40	(27.2)			

	FFQ1 (n=147) N	%	FFQ2 (n=147) N	%	Percentage Agreement[1]	K_w[2]	rho[3]
2-3 times/week	7	(4.8)	8	(5.4)			
4-6 times/week	-	-	1	(0.7)			
Once/day	-	-	-	-			
2-3 times/day	-	-	-	-			
4+ times/day	-	-	-	-			
Missing	1	(0.7)	1	(0.7)			
Potato							
Never	15	(10.2)	15	(10.2)	90.4	0.55	0.71
Rarely	31	(21.1)	28	(19.1)			
Once/week	39	(26.5)	51	(34.7)			
2-3 times/week	46	(31.3)	40	(27.2)			
4-6 times/week	12	(8.2)	10	(6.8)			
Once/day	3	(2.0)	1	(0.7)			
2-3 times/day	-	-	-	-			
4+ times/day	-	-	-	-			
Missing	1	(0.7)	2	(2.4)			
Vegetables							
Never	1	(0.7)	1	(0.7)	93.1	0.63	0.75
Rarely	2	(1.4)	3	(2.0)			
Once/week	1	(0.7)	1	(0.7)			
2-3 times/weesk	11	(7.5)	6	(4.1)			
4-6 times/week	26	(17.7)	27	(18.4)			
Once/day	40	(27.2)	40	(27.2)			
2-3 times/day	56	(38.1)	59	(40.1)			
4+ times/day	9	(6.1)	9	(6.1)			
Missing	1	(0.7)	1	(0.7)			
Noodles/Pasta							
Never	2	(1.4)	-	-	93.5	0.55	0.67
Rarely	7	(4.8)	9	(6.1)			
Once/week	36	(24.5)	28	(19.1)			
2-3 times/week	69	(46.9)	81	(55.1)			
4-6 times/week	26	(17.7)	18	(12.2)			
Once/day	5	(3.4)	6	(4.1)			
2-3 times/day	-	-	1	(0.7)			
4+ times/day	-	-	-	-			
Missing	2	(1.4)	4	(2.7)			
Rice/Couscous							
Never	6	(4.1)	5	(3.4)	93.0	0.63	0.78
Rarely	12	(8.2)	13	(8.8)			
Once/week	47	(32.0)	48	(32.7)			
2-3 times/week	54	(36.7)	59	(40.1)			
4-6 times/week	22	(15.0)	15	(10.2)			
Once/day	4	(2.7)	2	(1.4)			
2-3 times/day	1	(0.7)	2	(1.4)			
4+ times/day	-	-	-	-			
Missing	1	(0.7)	3	(2.0)			
Baked beans							

	FFQ1 (n=147) N	%	FFQ2 (n=147) N	%	Percentage Agreement[1]	K_w[2]	rho[3]
Never	64	(43.5)	58	(39.5)	94.2	0.77	0.86
Rarely	41	(27.9)	46	(31.3)			
Once/week	30	(20.4)	28	(19.1)			
2-3 times/week	10	(6.8)	12	(8.2)			
4-6 times/week	-	-	1	(0.7)			
Once/day	-	-	-	-			
2-3 times/day	-	-	-	-			
4+ times/day	-	-	-	-			
Missing	2	(1.4)	2	(1.4)			
Luncheon meats							
Never	24	(16.3)	19	(12.9)	91.7	0.63	0.80
Rarely	36	(24.5)	35	(23.8)			
Once/week	30	(20.4)	31	(21.1)			
2-3 times/week	42	(28.6)	48	(32.7)			
4-6 times/week	11	(7.5)	9	(6.1)			
Once/day	2	(1.4)	2	(1.4)			
2-3 times/day	-	-	1	(0.7)			
4+ times/day	-	-	-	-			
Missing	2	(1.4)	2	(1.4)			
Ready to feed baby food							
Never	118	(80.3)	116	(78.9)	95.1	0.72	0.66
Rarely	14	(9.5)	18	(12.2)			
Once/week	5	(3.4)	4	(2.7)			
2-3 times/week	3	(2.0)	2	(1.4)			
4-6 times/week	3	(2.0)	2	(1.4)			
Once/day	-	-	2	(1.4)			
2-3 times/day	2	(1.4)	1	(0.7)			
4+ times/day	-	-	-	-			
Missing	2	(1.4)	2	(1.4)			
Soup							
Never	39	(26.5)	39	(26.5)	95.1	0.75	0.87
Rarely	49	(33.3)	52	(35.4)			
Once/week	40	(27.2)	39	(26.5)			
2-3 times/week	11	(7.5)	11	(7.5)			
4-6 times/week	5	(3.4)	2	(1.4)			
Once/day	-	-	1	(0.7)			
2-3 times/day	2	(1.4)	1	(0.7)			
4+ times/day	-	-	-	-			
Missing	1	(0.7)	2	(1.4)			
Meat/Fish							
Never	3	(2.0)	2	(1.4)	93.1	0.61	0.70
Rarely	4	(2.7)	3	(2.0)			
Once/week	8	(5.4)	2	(1.4)			
2-3 times/week	21	(14.3)	32	(21.8)			
4-6 times/week	46	(31.3)	47	(32.0)			
Once/day	49	(33.3)	49	(33.3)			
2-3 times/day	13	(8.8)	9	(6.1)			
4+ times/day	1	(0.7)	1	(0.7)			

	FFQ1 (n=147) N %	FFQ2 (n=147) N %	Percentage Agreement[1]	K_w[2]	rho[3]
Missing	2 (1.4)	2 (1.4)			

[1]Percentage agreement calculated as part of weighted kappa calculation; [2]Weighted kappa; [3] Spearman correlation coefficient.

Categorized beverages and foods

Plain cow's milk and sweetened beverages had moderate to good reliability (Table 5.10). ICC values ranged between 0.62 to 0.81 for individual values and 0.77 to 0.90 for group values.

Table 5.11 shows the reliability indicators for the seven cariogenicity categories generated from the individual food variables outlined in Table 5.2. Moderate to strong correlations were observed for each of the categories. Individual ICC values indicate poor to moderate reliability for cariostatic, moderate and high cariogenicity categories, and moderate to good reliability for the anticariogenic, low and severe cariogenicity categories. The group ICC values indicate moderate to excellent reliability for all categories.

Table 5.12 shows the reliability indicators for the eight general food categories generated from the individual food variables outlined in

Table 5.3 as well as the indicators for ready to feed baby food and soup, which did not readily fit into any of the categories. Moderate to strong correlations were observed for all the categories. Individual ICC values indicated poor to moderate agreement for protein and grains, and moderate to good agreement for spreads, fruit & vegetables, dairy, sweet snacks, savoury snacks, desserts, ready to feed baby food and soup. Group ICC values indicated moderate to excellent agreement for all groups.

Table 5.10 Categorized beverage consumption and *reliability* indicators between FFQ1 and FFQ2

	FFQ1 (n=147)				FFQ 2 (n=147)				rho[2]	ICC[3]			
	Consumes beverage		Times/week consumed[1]		Consumes beverage		Times/week consumed[1]			Individual		Group	
	n	%	Mean	sd	n	%	Mean	sd		ICC	[95% CI]	ICC	[95% CI]
Plain Cow's milk[4]	121	(82.3)	9.0	[9.3]	121	(82.3)	9.1	[7.7]	0.85	0.62	[0.52, 0.72]	0.77	[0.68, 0.83]
Sweetened beverages[5]	85	(57.8)	1.0	[2.1]	89	(60.5)	1.0	[1.7]	0.88	0.81	[0.75, 0.86]	0.90	[0.86, 0.93]

[1]Values for all respondents; [2]Spearman correlation coefficient, all p<0.001; [3]Two-way random effects model, absolute agreement; [4]Full fat and low-fat cow's milk;
[5]Sweetened beverages: Fruit juice, cordial and soft drink

Table 5.11 Cariogenic food categories mean consumption and *reliability* indicators for FFQ1 and FFQ2

	FFQ1 (147)				FFQ 2 (n=147)				rho[2]	ICC[3] (n=147)			
	Consumes category		Times/week consumed[1]		Consumes category		Times/week consumed[1]			Individual		Group	
	n	%	Mean	sd	n	%	Mean	sd		ICC	95%CI	ICC	95%CI
Cariostatic	146	(99.3)	11.7	[6.3]	146	(99.3)	11.1	[5.2]	0.62	0.58	[0.47, 0.68]	0.74	[0.64, 0.81]
Anticariogenic	142	(96.6)	5.1	[3.7]	142	(96.6)	5.2	[3.7]	0.67	0.70	[0.61, 0.77]	0.82	[0.75, 0.87]
Low Cariogenicity	147	(100)	35.6	[12.5]	147	(100)	34.6	[13.3]	0.72	0.73	[0.64, 0.80]	0.84	[0.78, 0.89]
Moderate Cariogenicity	147	(100)	18.5	[7.1]	147	(100)	18.8	[7.4]	0.61	0.60	[0.49, 0.69]	0.75	[0.65, 0.82]
High Cariogenicity	146	(99.3)	6.1	[4.2]	145	(98.6)	6.0	[4.0]	0.70	0.58	[0.46, 0.68]	0.73	[0.63, 0.81]
Severe Cariogenicity	146	(99.3)	9.2	[5.5]	145	(98.6)	9.3	[5.7]	0.80	0.80	[0.74, 0.85]	0.89	[0.85, 0.92]

[1]Values for all respondent; [2]Spearman correlation coefficient, all p<0.001; 3Two-way random effects model using variables with missing values replaced, absolute agreement

Table 5.12 General food categories mean weekly consumption and *reliability* indicators for FFQ1 and FFQ2

	FFQ1 (n=147)				FFQ2 (n=147)				rho[2]	ICC[3] (n=147)			
	Consumes category		Times/week consumed[1]		Consumes category		Times/week consumed[1]			Individual		Group	
	n	%	Mean	sd	n	%	Mean	sd		ICC	95%CI	ICC	95%CI
Spreads	133	(90.5)	3.1	[2.8]	135	(91.8)	2.9	[2.6]	0.75	0.62	[0.52, 0.71]	0.77	[0.68, 0.83]
Protein	146	(99.3)	11.7	[6.3]	146	(99.3)	11.1	[5.2]	0.62	0.58	[0.47, 0.68]	0.74	[0.64, 0.81]
Grains	147	(100)	15.2	[6.5]	147	(100)	15.9	[6.8]	0.59	0.55	[0.43, 0.66]	0.71	[0.60, 0.79]
Fruits and vegetables	146	(99.3)	33.0	[12.4]	146	(99.3)	32.5	[13.4]	0.70	0.73	[0.65, 0.80]	0.84	[0.78, 0.89]
Dairy	144	(98.0)	9.9	[6.3]	145	(98.6)	9.4	[5.7]	0.72	0.76	[0.69, 0.82]	0.87	[0.81, 0.90]
Sweet snacks	140	(95.2)	4.2	[3.5]	141	(95.9)	4.4	[3.4]	0.82	0.80	[0.74, 0.85]	0.89	[0.85, 0.92]
Savoury snacks	146	(99.3)	6.2	[4.3]	146	(99.3)	6.0	[4.3]	0.72	0.61	[0.50, 0.71]	0.76	[0.67, 0.83]
Dessert foods	126	(85.7)	1.5	[1.5]	130	(88.4)	1.5	[1.5]	0.83	0.88	[0.83, 0.91]	0.93	[0.91, 0.95]
Ready to feed baby food	29	(19.7)	0.5	[2.2]	31	(21.1)	0.4	[1.8]	0.62	0.86	[0.81, 0.90]	0.92	[0.90, 0.95]
Soup	108	(73.5)	1.0	[2.2]	108	(73.5)	0.9	[1.7]	0.87	0.83	[0.77, 0.87]	0.91	[0.87, 0.93]

[1]Values for all respondents; [2]Spearman correlation coefficient, all $p<0.001$; 3Two-way random effects model using variables with missing values replaced, absolute agreement

5.3.3 Validity

Beverages

Beverage consumption frequency (individual and categorised) for FFQ1 and the seven-day checklist are displayed in Table 5.13. Moderate to strong correlations between the two assessment types were seen for all beverages except flavoured milk. Individual and group ICC values were poor for water, flavoured milk, cordial and soft drink. Moderate to good ICC values at the individual and group level were observed for infant formula, full fat milk, low fat milk, fruit juice and tea/coffee. Sports drinks were unable to be compared. The plain milk and sweetened beverage categories showed moderate to good agreement at the individual and group level.

Water, flavoured milk, sweetened beverages and plain milk were further examined for systematic bias using Bland-Altman plots and linear regression (Table 5.14 and Figure 5.2.) A large positive mean difference between the two assessment types was observed for water, whilst small, negative mean differences were observed for plain milk, flavoured milk and sweetened beverages. The limits of agreement ranged between -3.48 to 2.69 for flavoured milk and -8.81 to 7.52 for plain milk. The widest limits of agreement were observed for water (-10.00 to 37.96).

The slope of the mean bias was significantly different to zero for all beverages, indicating that the bias increased as the intake increased. For water and plain milk, the difference became greater in favour of the FFQ as intake increased, whilst for flavoured milk and sweet beverages, difference became greater in favour of the checklist as intake increased.

Table 5.13 Beverage consumption frequency and validity indicators for FFQ1 and 7-day checklist (N=121)

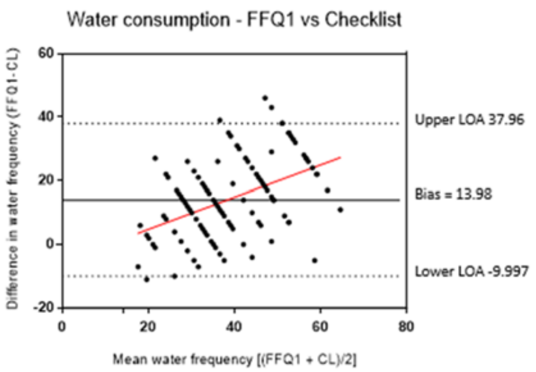
	FFQ1				Checklist				rho2	ICC3					
	Consume beverage		Times/week consumed[1]		Consume beverage		Times/week consumed[1]			Individual			Group		
	n	%	Mean	sd	n	%	Mean	sd		ICC	[95% CI]		ICC	[95% CI]	
Individual beverages															
Water	121	(100)	45.2	(14.63)	121	(100)	31.20	(9.78)	0.56	0.32	[-0.07,	0.59]	0.48	[-0.15,	0.74]
Infant formula	3	(2.5)	0.29	(1.89)	2	(1.7)	0.23	(1.79)	0.81	0.70	[0.60,	0.78]	0.82	[0.75,	0.88]
Full fat milk	91	(75.2)	7.55	(7.12)	100	(82.6)	8.07	(6.04)	0.78	0.79	[0.71,	0.85]	0.88	[0.83,	0.92]
Low fat milk	16	(13.2)	0.66	(2.12)	21	(17.4)	0.78	(2.27)	0.64	0.72	[0.62,	0.80]	0.84	[0.77,	0.89]
Flavoured milk	28	(23.1)	0.38	(1.11)	41	(33.9)	0.77	(1.50)	0.32	0.28	[0.11,	0.43]	0.44	[0.20,	0.61]
Fruit juice	67	(55.4)	0.79	(1.79)	56	(46.3)	1.19	(2.26)	0.55	0.77	[0.67,	0.84]	0.77	[0.67,	0.84]
Cordial	12	(9.9)	0.23	(1.39)	11	(9.1)	0.18	(0.71)	0.55	0.29	[0.12,	0.45]	0.45	[0.21,	0.62]
Soft drink	8	(6.6)	0.03	(0.15)	11	(9.1)	0.12	(0.44)	0.60	0.23	[0.06,	0.39]	0.37	[0.10,	0.56]
Tea/coffee	4	(3.3)	0.04	(0.29)	3	(2.5)	0.06	(0.47)	0.57	0.82	[0.75,	0.87]	0.90	[0.86,	0.93]
Herbal drinks	8	(6.6)	0.04	(0.20)	9	(7.4)	0.15	(0.61)	0.57	0.48	[0.33,	0.61]	0.65	[0.49,	0.75]
Sports drinks	0	(0)	0	(0)	2	(1.7)	0.04	(0.37)	-	-	-	-	-	-	-
Beverage categories															
Plain milk[4]	100	(82.6)	8.21	(6.80)	107	(11.6)	8.85	(5.67)	0.75	0.78	[0.69,	0.84]	0.87	[0.82,	0.91]
Sweetened beverages[5]	72	(59.5)	1.06	(2.27)	64	(52.9)	1.50	(2.59)	0.61	0.70	[0.59,	0.78]	0.82	[0.74,	0.88]

[1]Values for all respondents; [2]Spearman correlation coefficient, all p <0.001; [3]ICC two-way random effects model, absolute agreement; [4]Low fat and full milk; [5]Fruit juice, cordial and soft drink

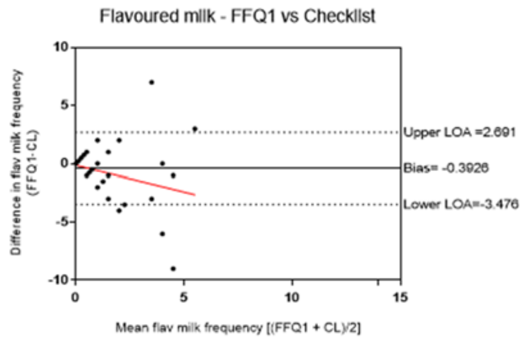
Table 5.14 Bias, 95% limits of agreement and regression values for beverage categories comparing FFQ1 and 7-day checklist

	Bias	95% LOA[1]		Slope		95% CI[2]		p
Beverages								
Water	13.98	(-10.00,	37.96)	0.50	± 0.09	[0.32,	0.68]	**<0.001**
Flavoured milk	-0.39	(-3.48,	2.69)	-0.46	± 0.13	[-0.71,	-0.2]	**<0.001**
Plain milk	-0.64	(-8.81,	7.53)	0.20	± 0.06	[0.08,	0.32]	**<0.001**
Sweetened beverages	-0.41	(-4.02,	3.19)	-0.15	± 0.07	[-0.30,	-0.01]	**0.043**

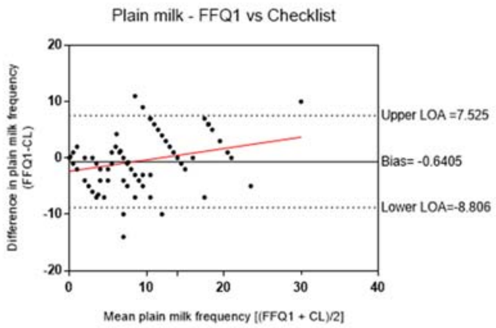
[1]LOA: Limits of agreement; [2]CI: Confidence Interval.



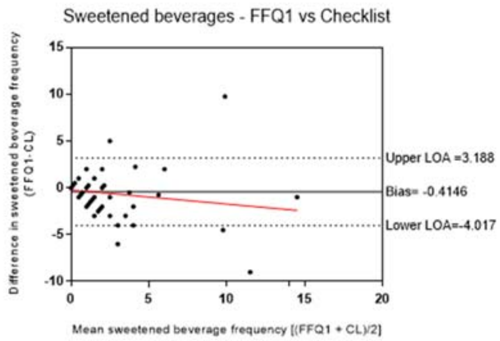
a. Slope= 0.50 ± 0.09 [95%CI: 0.32 to 0.68], p <0.001



b. Slope= -0.46 ± 0.13 [95%CI: -0.71 to -0.2], p=<0.001



c. Slope = 0.20 ± 0.06 [95%CI: 0.08 to 0.32], p<0.001



d. Slope = -0.15 ± 0.07 [95%CI: -0.30 to -0.01], p = 0.043

Figure 5.2 Bland-Altman plots assessing the validity of FFQ1 vs 7-day checklist (n=121) for water, flavoured milk, plain milk and sweetened beverages. Plots show mean difference (bias) and 95% Limits of Agreement (LOA) and the fitted regression line. Frequency measured as times per week.

Foods

Consumption frequency for the cariogenic and general food categories for FFQ 1 and the seven-day checklist are displayed in Table 5.15.

The moderate cariogenicity category (ice-cream, custard, baked beans, soup, ready to eat baby foods, hot chips, banana, cereal, bread) was the poorest performing, with poor correlation and ICC values observed. Weak to moderate correlations were observed for the five other cariogenicity categories. Poor to moderate ICC values were observed for all categories (except moderate cariogenicity) at the individual level. Values were similar at the group level, with the exception of the low and severe cariogenicity groups.

Moderate positive correlations were observed for most categories, except grains, desserts and soup. The individual ICC values indicated poor and moderate validity for soup and ready to feed baby food respectively, whilst the values for all other categories indicated poor to moderate validity. The group ICC values indicated poor to good validity for sweet snacks, poor to moderate validity for spreads, protein, grains and soup, moderate to good validity for fruit & vegetables, dairy, savoury snacks and desserts.

The cariogenic and general food categories were also examined for agreement and systematic bias between the two assessment methods using Bland Altman plots and linear regression (Table 5.16, Figure 5.4 and Figure 5.6).

The low cariogenicity category had the largest mean bias (5.38) and the widest limits of agreement (-14.44 to 25.19). The mean bias of the other cariogenicity categories ranged between -1.88 (severe) and 0.46 (high). Wide limits of agreement were also observed for each of these categories, ranging between -8.42 to 7.00 (anticariogenic) and -16.83 to 15.20 (moderate).

The slope of the mean bias was significantly different to zero for the cariostatic, low and moderate categories but not for the anticariogenic, high or severe categories. The low category had a positive bias, indicating the difference became greater in favour of the FFQ as intake increased. The bias line for the cariostatic and moderate categories crosses zero indicating that the bias varies depending on the frequency of intake. For the cariostatic and moderate categories the FFQ tends to underestimate consumption at low intakes, whilst it overestimates at high intakes.

In the general food categories, fruit and vegetables had the largest mean bias (5.34), whilst all other categories ranged between -2.28 (grains) and 0.57 (soup). The narrowest limits of agreement were observed for ready to feed baby food (-2.57 to 3.03) and desserts (-3.33 to 3.25), and the widest were observed for fruit and vegetables (-13.67 to 24.35).

The slope of the mean bias was significantly different to zero for protein, grains, fruit and vegetables, desserts, dairy, ready to feed baby food and soup but **not** spreads, sweet snacks or savoury snacks. For fruit & vegetables, ready to feed baby food and soup the difference became greater in favour of the FFQ as intake increased. For the dessert category the difference became greater in favour of the checklist as intake increased. The bias line for the protein, grains and dairy categories crosses zero indicating that the bias varies depending on the frequency of intake.

Table 5.15 Cariogenic and general food category consumption frequency and *validity* indicators for FFQ1 and 7-day checklist (N=121)

	FFQ1				**Checklist**				**rho[2]**	**ICC[3]**			
	Consume category		**Times/week consumed[1]**		**Consume category**		**Times/week consumed[1]**			**Individual**		**Group**	
	N	**%**	**Mean**	**sd**	**N**	**%**	**Mean**	**sd**		**ICC**	**[95% CI]**	**ICC**	**[95% CI]**
Cariogenic food categories													
Cariostatic	120	(99.2)	11.67	(6.42)	121	(100)	12.21	(4.12)	0.53	0.46	[0.31, 0.59]	0.63	[0.47, 0.74]
Anticariogenic	116	(95.9)	5.10	(3.61)	112	(92.6)	5.81	(3.56)	0.49	0.39	[0.23, 0.53]	0.56	[0.38, 0.69]
Low cariogenicity	121	(100)	36.15	(12.86)	121	(100)	30.78	(10.00)	0.59	0.56	[0.32, 0.71]	0.71	[0.49, 0.83]
Moderate cariogenicity	121	(100)	18.58	(7.19)	121	(100)	19.40	(5.40)	0.17	0.17	[0.00, 0.34]	0.30	[-0.01, 0.51]
High cariogenicity	121	(100)	6.25	(4.20)	117	(96.7)	5.79	(3.69)	0.47	0.40	[0.24, 0.54]	0.57	[0.39, 0.70]
Severe cariogenicity	121	(100)	9.94	(5.60)	121	(100)	11.82	(6.10)	0.53	0.54	[0.38, 0.66]	0.70	[0.55, 0.80]
General food categories													
Spreads	111	(91.7)	3.23	(2.85)	96	(79.3)	3.21	(2.96)	0.50	0.46	[0.31, 0.59]	0.63	[0.47, 0.74]
Protein	120	(99.2)	11.67	(6.42)	121	(100)	12.21	(4.12)	0.53	0.46	[0.31, 0.59]	0.63	[0.47, 0.74]
Grains	121	(100)	15.09	(6.28)	121	(100)	17.37	(4.71)	0.42	0.37	[0.19, 0.52]	0.54	[0.32, 0.68]
Fruit/vegetables	120	(99.2)	34.02	(12.78)	120	(99.2)	28.68	(11.04)	0.63	0.61	[0.37, 0.75]	0.76	[0.54, 0.86]
Dairy	118	(97.5)	9.78	(6.11)	118	(97.5)	9.86	(5.12)	0.60	0.56	[0.43, 0.67]	0.72	[0.60, 0.80]
Sweet snacks	116	(95.9)	4.53	(3.67)	115	(95.0)	6.26	(4.00)	0.53	0.51	[0.30, 0.66]	0.67	[0.47, 0.79]
Savoury snacks	121	(100)	6.26	(4.35)	118	(97.5)	5.86	(3.95)	0.62	0.53	[0.39, 0.65]	0.69	[0.56, 0.78]
Desserts	105	(86.8)	1.57	(1.56)	70	(57.9)	1.61	(1.91)	0.48	0.54	[0.40, 0.66]	0.70	[0.57, 0.79]
Ready to feed baby food	19	(15.7)	0.49	(2.35)	8	(6.6)	0.26	(1.34)	0.57	0.72	[0.62, 0.79]	0.84	[0.77, 0.89]
Soup	88	(72.7)	1.06	(2.36)	36	(29.8)	0.49	(0.92)	0.44	0.33	[0.16, 0.48]	0.49	[0.28, 0.65]

[1]Values for all respondents; [2]Spearman correlation coefficient, all $p < 0.001$; [3]ICC two-way random effects model, absolute agreement.

Table 5.16 Bias, 95% limits of agreement and regression values for food categories comparing FFQ1 and 7-day checklist

	Bias	95% LOA[1]		Slope		95% CI[2]		p
Cariogenic[3]								
Cariostatic	-0.54	(-11.53,	10.45)	0.57	± 0.10	[0.38,	0.77]	**<0.001**
Anticariogenic	-0.71	(-8.42,	7.00)	0.02	±0.12	[-0.22,	0.26]	0.858
Low	5.38	(-14.44,	25.19)	0.30	±0.09	[0.14,	0.47]	**<0.001**
Moderate	-0.81	(-16.83,	15.20)	0.48	±0.15	[0.18,	0.77]	**0.002**
High	0.46	(-8.03,	8.96)	0.18	±0.12	[-0.05,	0.42]	0.126
Severe	-1.88	(-12.62,	8.86)	-0.11	±0.10	[-0.30,	0.08]	0.254
General[4]								
Spreads	0.02	(-5.90,	5.94)	-0.05	±0.11	[-0.27,	0.17]	0.654
Protein	-0.54	(-11.53,	10.45)	0.57	±0.10	[0.38,	0.77]	**<0.001**
Grains	-2.28	(-14.25,	9.69)	0.40	±0.12	[0.17,	0.63]	**<0.001**
Fruit and vegetables	5.34	(-13.67,	24.35)	0.17	±0.08	[0.02,	0.33]	**0.031**
Dairy	-0.08	(-10.45,	10.29)	0.22	±0.10	[0.04,	0.41]	**0.020**
Sweet snacks	-1.73	(-8.80,	5.35)	-0.11	±0.10	[-0.30,	0.08]	0.263
Savoury snacks	0.40	(-7.50,	8.31)	0.12	±0.10	[-0.08,	0.32]	0.227
Desserts	-0.04	(-3.33,	3.25)	-0.26	±0.10	[-0.45,	-0.06]	**0.010**
Ready to feed baby food	0.23	(-2.57,	3.03)	0.60	±0.05	[0.50,	0.70]	**<0.001**
Soup	0.57	(-3.45,	4.60)	1.09	±0.08	[0.93,	1.25]	**<0.001**

[1]LOA: Limits of agreement; [2]CI: Confidence Interval; [3]Cariogenic food categories; [4]General food categories

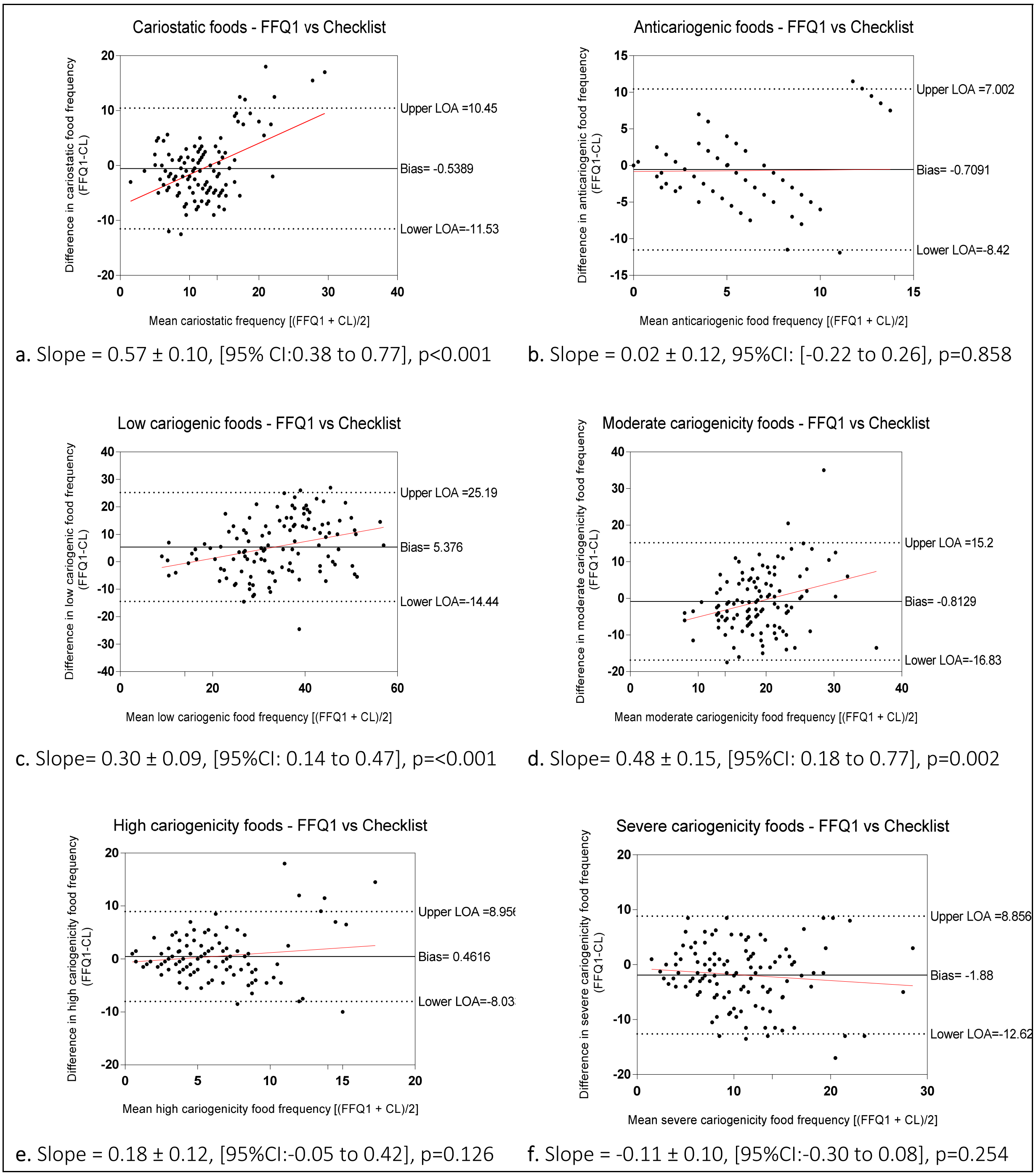


Figure 5.3. Bland-Altman plots assessing the validity of FFQ1 vs 7-day checklist (n=121) for cariogenicity food groupings. Plots show mean difference (bias) and 95% Limits of Agreement (LOA) and the fitted regression line. Frequency measured as times per week.

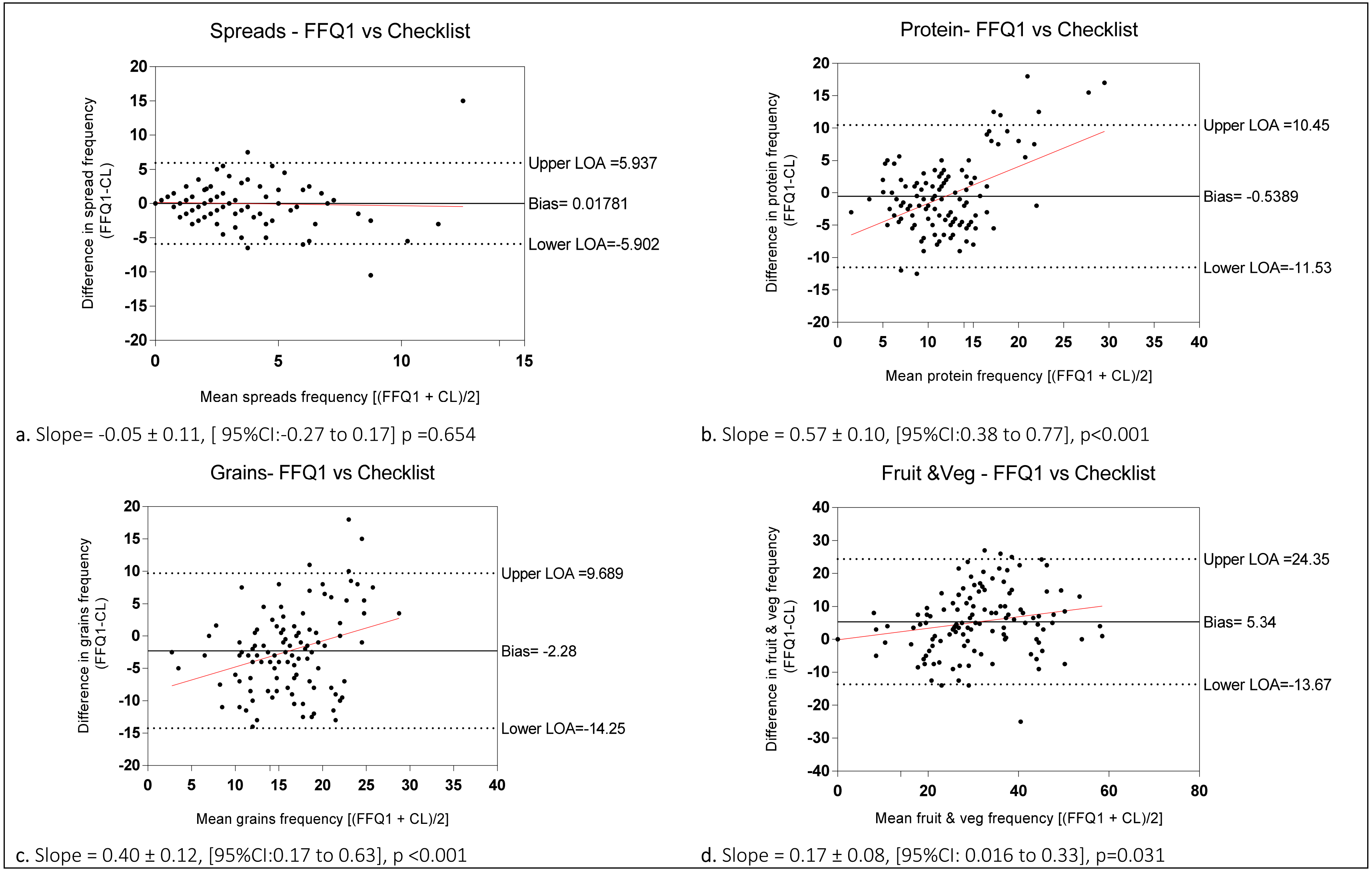
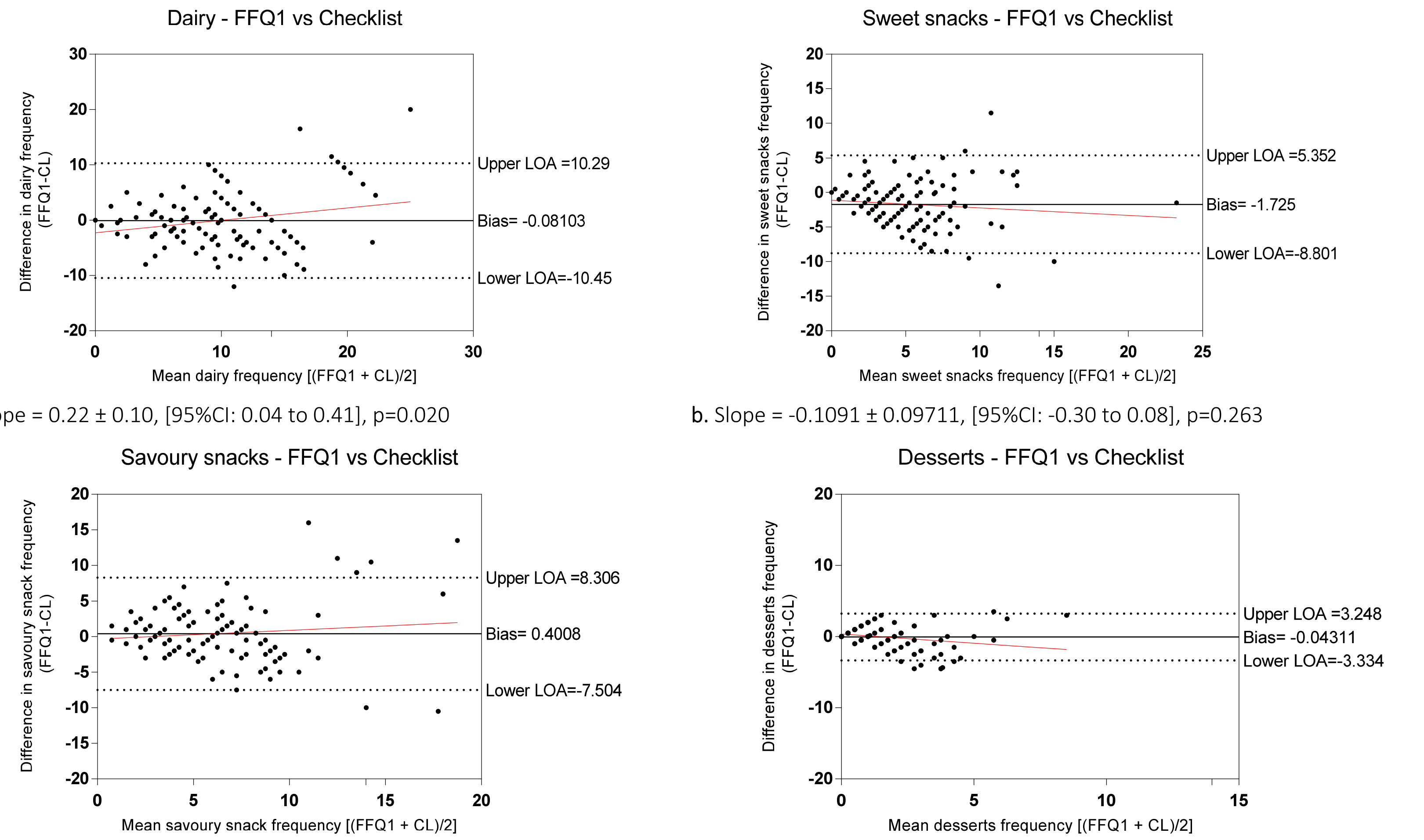


Figure 5.4 Bland-Altman plots assessing the validity of FFQ1 vs 7-day checklist (n=121) for spreads, protein, grains and fruit & vegetable groups. Plots show mean difference (bias) and 95% Limits of Agreement (LOA) and the fitted regression line. Frequency measured as times per week.



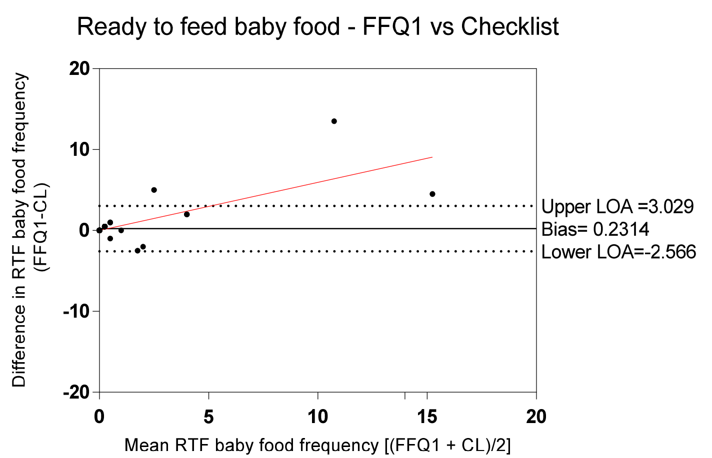
a. Slope = 0.22 ± 0.10, [95%CI: 0.04 to 0.41], p=0.020

b. Slope = -0.1091 ± 0.09711, [95%CI: -0.30 to 0.08], p=0.263

c. Slope = 0.12 ± 0.10, [95%CI: -0.08 to 0.32], p=0.227

d. Slope = -0.26 ± 0.10, [95%CI: -0.45 to -0.06], p=0.010

Figure 5.5 Bland-Altman plots assessing the validity of FFQ1 vs 7-day checklist (n=121) for dairy, sweet snacks, savoury snacks and desserts groups. Plots show mean difference (bias) and 95% Limits of Agreement (LOA) and the fitted regression line. Frequency measured as times per week.



a. Slope= 0.60 ± 0.05, [95%CI: 0.50 to 0.70], p=<0.0001

b. Slope= 1.09 ± 0.08, [95%CI: 0.93 to 1.25], p=<0.0001

Figure 5.6 Bland-Altman plots assessing the validity of FFQ1 vs 7-day checklist (n=121) for ready to feed baby food and soup. Plots show mean difference (bias) and 95% Limits of Agreement (LOA) and the fitted regression line. Frequency measured as times per week. Frequency measured as times per week.

5.3.4 Age subgroup analysis

Reliability

The following section shows the results for the reliability and validity subgroup analysis for age (<3 years, ≥3 years), for the grouped beverages and foods only. Table 5.17 shows moderate to strong correlations between FFQ1 and FFQ2 for grouped beverages at both age groups. The ICC values show flavoured milk performing poorly across both age groups, although slightly better in the older age group. Water performed better in the younger age group, whilst plain milk and sweetened beverages tended to be more reliable in the older age group.

Moderate to strong correlations were observed between FFQ1 and FFQ2 for all cariogenicity food groups at both ages, except the moderate group in the older children (Table 5.18). ICC values at the individual and group level were higher for the anticariogenic, moderate and high cariogenicity categories in younger children compared to older children, whilst the values for the cariostatic and severe cariogenicity categories were better in the older children. Similar ICC values were seen in both age groups for the low cariogenicity category.

When comparing the foods from FFQ1 to FFQ2 for general food groups across subgroups, moderate to strong correlations were observed for all groups, except ready to feed baby food in the older age group (Table 5.19). Individual ICC values indicated moderate to excellent reliability for fruits & vegetables, sweet snacks, soup, desserts and ready to feed baby food in both age groups. Grains were the worst performing group across both age groups. Group ICC values indicated moderate to excellent reliability for all items across all age groups, except for grains in the older age group.

Table 5.17 Consumption of beverages and *reliability* measures for FFQ1 and FFQ2 for age subgroups

	FFQ1				FFQ2					ICC[3]					
	Consumes beverage		Times/week consumed[1]		Consumes beverage		Times/week consumed[1]		rho[2]	Individual			Group		
	n	%	mean	sd	n	%	mean	sd		ICC	[95%CI]		ICC	[95%CI]	
<3yrs (n=101)															
Water	101	(100)	46.99	[15.54]	101	(100)	46.62	[15.00]	0.72	0.71	[0.60,	0.79]	0.83	[0.75,	0.89]
Flavoured milk	16	(15.8)	0.30	[1.08]	19	(18.81)	0.27	[0.90]	0.45	0.13	[-0.07,	0.32]	0.23	[-0.15,	0.48]
Plain milk[3]	82	(81.2)	9.99	[10.56]	80	(79.21)	9.85	[8.65]	0.83	0.60	[0.46,	0.71]	0.75	[0.63,	0.83]
Sweetened beverages[4]	46	(45.5)	0.60	[1.26]	52	(51.49)	0.69	[1.20]	0.84	0.87	[0.73,	0.87]	0.90	[0.85,	0.93]
≥ 3 years (n=72)															
Water	72	(100)	41.42	[14.04]	72	(100)	41.70	[15.31]	0.73	0.62	[0.45,	0.74]	0.76	[0.62,	0.85]
Flavoured milk	21	(29.2)	0.50	[1.27]	25	(34.72)	0.66	[1.41]	0.43	0.32	[0.09,	0.51]	0.48	[0.17,	0.67]
Plain milk[4]	62	(86.1)	7.45	[5.72]	64	(88.89)	8.29	[5.88]	0.88	0.86	[0.78,	0.91]	0.93	[0.88,	0.95]
Sweetened beverages[5]	58	(80.6)	2.00	[4.84]	58	(80.56)	1.79	[4.61]	0.84	0.84	[0.91,	0.96]	0.97	[0.95,	0.98]

[1]Values for all respondents; [2]Spearman correlation coefficient, all $p < 0.05$; [3]ICC two-way random effects model, absolute agreement; [4]Low fat and full milk; [5]Fruit juice, cordial and soft drink

Table 5.18 Consumption of cariogenic food categories and *reliability* measures for FFQ1 and FFQ2 for all children

	FFQ1				FFQ2					ICC[3]					
	Consumes category		Times/week consumed[1]		Consumes category		Times/week consumed[1]		rho[2]	Individual			Group		
	N	%	mean	sd	N	%	mean	sd		ICC	[95%CI]		ICC	[95%CI]	
<3yrs (n=101)															
Cariostatic	101	(100)	11.06	[6.12]	101	(100)	10.79	[4.86]	0.56	0.57	[0.42,	0.69]	0.73	[0.60,	0.82]
Anticariogenic	98	(97.0)	5.33	[4.20]	99	(98.0)	5.44	[3.93]	0.68	0.73	[0.62,	0.81]	0.84	[0.77,	0.89]
Low cariogenicity	101	(100)	35.30	[12.24]	101	(100)	35.24	[12.56]	0.71	0.72	[0.61,	0.80]	0.84	[0.76,	0.89]
Moderate cariogenicity	101	(100)	18.77	[6.99]	101	(100)	19.19	[7.87]	0.65	0.60	[0.45,	0.71]	0.75	[0.62,	0.83]
High cariogenicity	100	(99.0)	6.22	[4.41]	99	(98.0)	6.06	[3.99]	0.66	0.65	[0.52,	0.75]	0.79	[0.68,	0.86]
Severe cariogenicity	100	(99.0)	8.45	[5.04]	99	(98.0)	8.90	[5.40]	0.77	0.77	[0.67,	0.84]	0.87	[0.80,	0.91]
≥3yrs (n=72)															
Cariostatic	71	(98.6)	12.22	[6.29]	71	(98.6)	11.10	[5.27]	0.73	0.62	[0.46,	0.75]	0.77	[0.63,	0.85]
Anticariogenic	69	(95.3)	4.72	[3.49]	68	(94.4)	4.91	[4.24]	0.69	0.43	[0.22,	0.60]	0.60	[0.36,	0.75]
Low cariogenicity	72	(100)	34.54	[12.57]	72	(100)	33.53	[13.72]	0.67	0.72	[0.59,	0.81]	0.84	[0.74,	0.90]
Moderate cariogenicity	72	(100)	18.03	[6.27]	72	(100)	18.47	[7.19]	0.48	0.49	[0.30,	0.65]	0.66	[0.46,	0.79]
High cariogenicity	72	(100)	6.37	[4.60]	72	(100)	6.43	[4.26]	0.75	0.57	[0.40,	0.71]	0.73	[0.57,	0.83]
Severe cariogenicity	72	(100)	10.72	[5.41]	72	(100)	10.43	[5.91	0.78	0.80	[0.70,	0.87]	0.89	[0.83,	0.93]

[1]Values for all respondents; [2]Spearman correlation coefficient, all $p < 0.05$; [3]ICC two-way random effects model, absolute agreement

Table 5.19 Consumption of general food categories and *reliability* measures for FFQ1 and FFQ2 for all children

	FFQ1				FFQ2					ICC[3]					
	Consumes category		Times/week consumed[1]		Consumes category		Times/week consumed[1]		rho[2]	Individual			Group		
	N	%	mean	sd	N	%	mean	sd		ICC	[95%CI]		ICC	[95%CI]	
<3yrs (n=101)															
Spreads	89	(88.1)	2.88	[2.91]	91	(90.1)	2.86	[2.42]	0.75	0.58	[0.43,	0.69]	0.73	[0.60,	0.82]
Protein	101	(100)	11.06	[6.12]	101	(100)	10.79	[4.86]	0.56	0.57	[0.42,	0.69]	0.73	[0.60,	0.82]
Grains	101	(100)	15.00	[6.59]	101	(100)	15.67	[6.89]	0.57	0.57	[0.43,	0.69]	0.73	[0.60,	0.82]
Fruit/vegetables	101	(100)	32.86	[11.78]	101	(100)	33.38	[12.76]	0.72	0.71	[0.60,	0.80]	0.83	[0.75,	0.89]
Dairy	100	(99.0)	10.57	[6.72]	101	(100)	10.21	[5.94]	0.74	0.79	[0.71,	0.85]	0.88	[0.83,	0.92]
Sweet snacks	95	(94.1)	3.67	[2.99]	95	(94.1)	4.00	[3.17]	0.78	0.73	[0.62,	0.81]	0.84	[0.77,	0.89]
Savoury snacks	100	(99.0)	6.29	[4.59]	100	(99.0)	6.04	[4.33]	0.65	0.68	[0.55,	0.77]	0.81	[0.71,	0.87]
Desserts	80	(79.2)	1.38	[1.69]	83	(82.2)	1.38	[1.63]	0.86	0.91	[0.86,	0.94]	0.95	[0.93,	0.97]
Ready to feed baby food	26	(25.7)	0.53	[1.96]	29	(28.7)	0.42	[1.23]	0.67	0.70	[0.59,	0.79]	0.82	[0.74,	0.88]
Soup	70	(69.3)	0.90	[1.90]	76	(75.3)	0.88	[1.87]	0.86	0.94	[0.91,	0.96]	0.97	[0.95,	0.98]
≥3yrs (n=72)															
Spreads	70	(97.2)	3.66	[2.50]	69	(95.8)	3.30	[2.81]	0.77	0.71	[0.58,	0.81]	0.83	[0.73,	0.89]
Protein	71	(98.6)	12.22	[6.29]	71	(98.6)	11.10	[5.27]	0.73	0.62	[0.46,	0.75]	0.77	[0.63,	0.85]
Grains	72	(100)	15.11	[5.65]	72	(100)	15.96	[6.83]	0.60	0.48	[0.29,	0.64]	0.65	[0.45,	0.78]
Fruit/vegetables	71	(98.6)	32.09	[12.72]	71	(98.6)	31.40	[13.63]	0.66	0.73	[0.61,	0.83]	0.85	[0.76,	0.90]
Dairy	70	(97.2)	8.60	[5.39]	70	(97.2)	8.41	[5.27]	0.66	0.52	[0.33,	0.67]	0.69	[0.50,	0.80]
Sweet snacks	71	(98.6)	5.20	[3.73]	72	(100)	5.37	[3.52]	0.78	0.80	[0.69,	0.87]	0.89	[0.82,	0.93]
Savoury snacks	72	(100)	6.40	[4.65]	72	(100)	6.32	[4.23]	0.78	0.60	[0.42,	0.73]	0.75	[0.60,	0.84]
Desserts	70	(97.2)	1.97	[1.54]	71	(98.6)	1.98	[1.51]	0.78	0.84	[0.76,	0.90]	0.91	[0.86,	0.95]
Ready to feed baby food	5	(6.9)	0.27	[2.06]	5	(6.9)	0.27	[2.06]	0.38	1.00	[1.00,	1.00]	1.00	[1.00,	1.00]
Soup	57	(79.2)	1.08	[2.22]	50	(69.4)	0.74	[1.01]	0.88	0.65	[0.50,	0.77]	0.79	[0.66,	0.87]

[1]Values for all respondents; [2]Spearman correlation coefficient, all $p < 0.05$; [3]ICC two-way random effects model, absolute agreement

Validity

Beverages

Beverage consumption frequency (categorised) for FFQ1 and the seven-day checklist split by age category (<3 years and ≥ 3years) are displayed in Table 5.20. Water and flavoured milk were the poorest performing variables in both age subgroups, with poor validity for both individual and group ICC, although flavoured milk performed slightly better in the younger age group. Poor to good ICC values were observed for sweetened beverages in the younger age group and good to excellent values in the older subgroup. Plain milk had good to excellent validity in both age groups.

The beverage categories by age subgroup were also examined for agreement and systematic bias between the two assessment methods using Bland Altman plots and linear regression (Table 5.21 and Figure 5.7). Water had the largest mean bias in both age subgroups but was larger in the younger subgroup (16.94) compared to the older subgroup (9.89). The mean bias for flavoured milk, plain milk and sweetened beverages were similar between age groups, ranging from -0.66 to -0.17. The limits of agreement for all beverages were wide across all beverages and age groups, however, they were wider for flavoured milk and sweetened beverages in the older children compared to younger children.

The slope of the mean bias was significantly different from zero for each beverage except flavoured milk in the younger age group. For water, in both age groups the difference became greater in favour of the FFQ as intake increased, whilst for flavoured milk in the older age group, the difference became greater in favour of the checklist as intake increased. Sweetened beverages had a negative bias in the younger age group but a positive bias in the older age group. The bias line for plain milk crosses zero indicating that the bias varies depending on the frequency of intake.

Table 5.20 Beverage category consumption frequency and *validity* indicators by age subgroup for FFQ1 and 7-day checklist

	FFQ1				Checklist					ICC[3]					
	Consumes beverage		Times/week consumed[1]		Consumes beverage		Times/week consumed[1]		rho[2]	Individual			Group		
	N	%	mean	sd	N	%	mean	sd		ICC	[95%CI]		ICC	[95%CI]	
<3yrs (n=78)															
Water	79	(100)	48.20	[15.81]	79	(100)	31.27	[9.34]	0.42	0.19	[-0.08	0.44]	0.32	[-0.16	0.61]
Flavoured milk	13	(16.5)	0.34	[1.18]	23	(29.1)	0.68	[1.41]	0.40	0.26	[0.05	0.45]	0.42	[0.10	0.63]
Plain milk[4]	64	(81.0)	8.75	[7.22]	70	(88.6)	9.89	[6.18]	0.73	0.77	[0.65	0.85]	0.87	[0.79	0.92]
Sweetened beverages[5]	40	(50.6)	0.70	[1.39]	37	(46.8)	1.39	[2.57]	0.68	0.51	[0.32	0.67]	0.68	[0.48	0.80]
≥ 3 years (n=64)															
Water	64	(100)	41.13	[14.36]	64	(100)	31.23	[9.90]	0.65	0.46	[0.02	0.71]	0.63	[0.05	0.83]
Flavoured milk	19	(29.7)	0.43	[1.17]	31	(48.4)	1.03	[1.59]	0.10	0.13	[-0.10	0.35]	0.23	[-0.22	0.52]
Plain milk[4]	55	(85.9)	7.68	[5.84]	56	(87.5)	8.11	[4.87]	0.69	0.72	[0.57	0.82]	0.83	[0.73	0.90]
Sweetened beverages[5]	50	(78.1)	2.00	[5.05]	41	(64.0)	2.17	[3.55]	0.57	0.80	[0.69	0.87]	0.89	[0.82	0.93]

[1]Values for all respondents; [2]Spearman correlation coefficient, all p <0.001; [3]ICC two-way random effects model, absolute agreement;[4]Low fat and full milk; [5]Fruit juice, cordial and soft drink

Table 5.21 Bias, 95% limits of agreement and regression values for beverage categories by age subgroup comparing FFQ1 and 7-day checklist

	Bias	95% LOA[1]		Slope		95% CI[2]		p
<3 years (n=79)								
Water	16.94	(-12.07	45.94)	0.71	±0.14	[0.44	0.98]	**<0.001**
Flavoured milk	-0.34	(-3.42	2.74)	-0.28	±0.17	[-0.61	0.06]	0.109
Plain milk	-0.34	(-10.04	7.76)	0.17	±0.08	[0.02	0.33]	**0.032**
Sweetened beverages	-0.66	(-4.09	2.78)	-0.67	±0.08	[-0.82	-0.52]	**<0.001**
≥ 3 years (n=64)								
Water	9.89	(-11.57	31.35)	0.44	±0.11	[0.22	0.67]	**<0.001**
Flavoured milk	-0.60	(-4.1	2.99)	-0.53	±0.21	[-0.94	-0.11]	**0.015**
Plain milk	-0.43	(-8.53	7.67)	0.21	±0.10	[0.01	0.42]	**0.044**
Sweetened beverages	-0.17	(-5.57	5.22)	0.38	±0.07	[0.24	0.51]	**<0.001**

[1]LOA: Limits of agreement; [2]CI: Confidence Interval

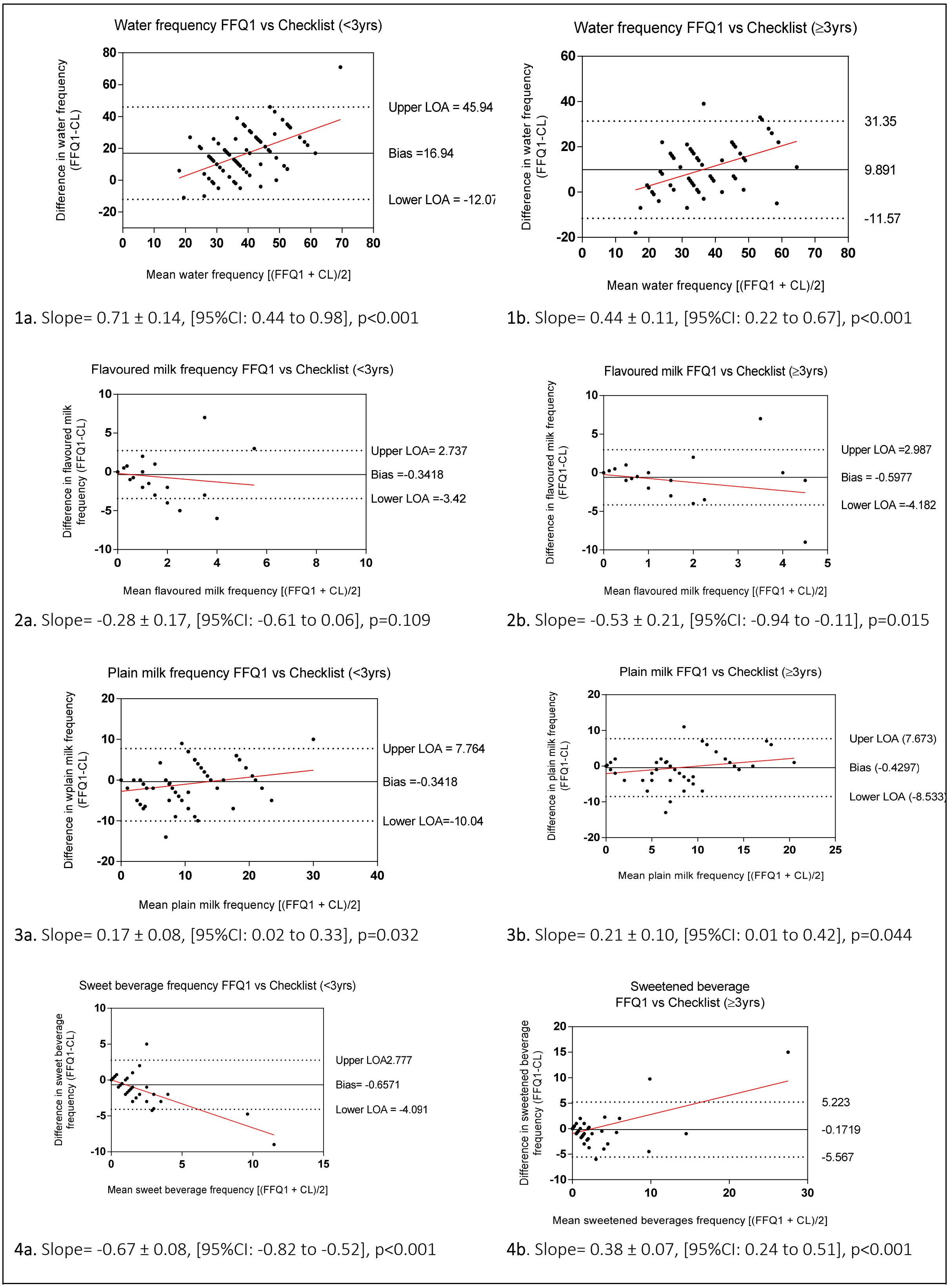


Figure 5.7 Bland-Altman plots assessing the validity of FFQ1 vs 7-day checklist by age (<3yrs, n=79; ≥3 years, n=64) for beverage groups. Plots show mean difference (bias) and 95% Limits of Agreement (LOA) and the fitted regression line. Frequency measured as times per week**.**

Cariogenic food categories

Consumption frequency for the cariogenic food categories for FFQ1 and the 7-day checklist, by age subgroup are displayed in Table 5.22. The moderate category was the poorest performing across both age subgroups, with poor ICC values observed. Individual ICC values indicated poor to moderate validity for all other categories in both age subgroups. The group ICC values indicate the poor to moderate rating remained, except for the low cariogenicity category and the severe cariogenicity category (older age group only) which improved to moderate to good.

Mean bias and limits of agreement were similar across age subgroups for the cariostatic, anticariogenic and severe categories (Table 5.23, Figure 5.8 and Figure 5.9). The moderate and high categories differed between age subgroups, the mean bias was slightly higher for the moderate category in the older children (-2.12) compared to younger children (-0.91), whilst the opposite was observed for the high category.

The slope of the mean bias was significantly different to zero in the cariostatic and the low categories and both had a positive bias. For the low category the difference became greater in favour of the FFQ as intake increased. The slope crosses zero for the cariostatic category indicating that the bias varies depending on frequency of intake. The slope of the mean bias was significantly different to zero for the moderate and high categories only in older children, and the difference became greater in favour of the FFQ as intake increased.

Table 5.22 Cariogenic food category consumption frequency and *validity* indicators by age subgroup for FFQ1 and 7-day checklist

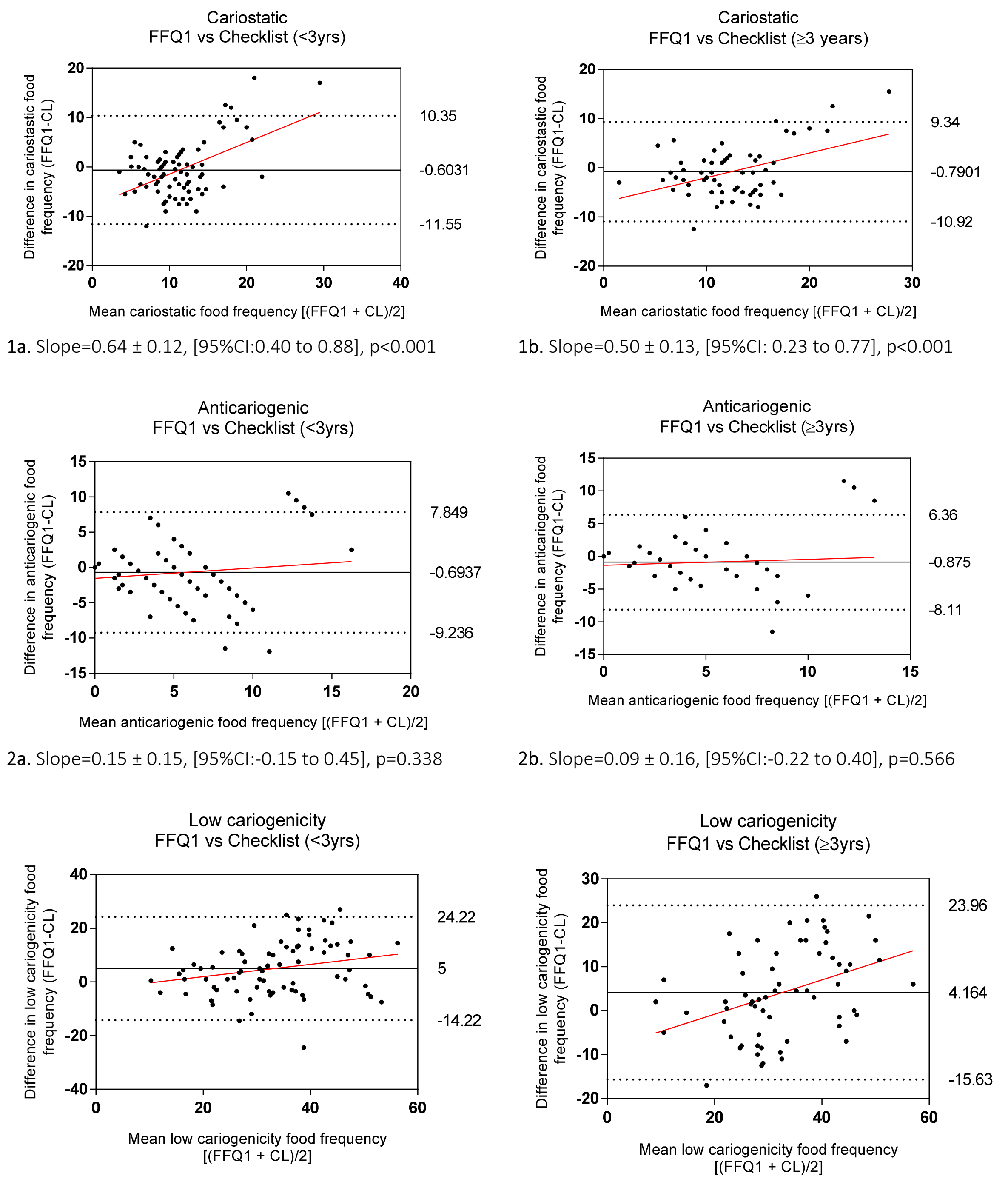
	FFQ1				Checklist					ICC[3]			
	Consumes category		Times/week consumed[1]		Consumes category		Times/week consumed[1]		rho[2]	Individual		Group	
	N	%	mean	sd	N	%	mean	sd		ICC	[95%CI]	ICC	[95%CI]
<3yrs (n=79)													
Cariostatic	79	(100)	11.02	[6.41]	79	(100)	11.62	[3.88]	0.50	0.44	[0.25, 0.60]	0.62	[0.40, 0.75]
Anticariogenic	76	(96.2)	5.39	[4.13]	74	(93.7)	6.09	[3.73]	0.42	0.38	[0.18, 0.55]	0.55	[0.31, 0.71]
Low cariogenicity	79	(100)	35.63	[12.69]	79	(100)	30.63	[10.48]	0.66	0.59	[0.36, 0.74]	0.74	[0.53, 0.85]
Moderate cariogenicity	79	(100)	18.86	[6.97]	79	(100)	19.77	[5.79]	0.19[4]	0.19	[-0.03, 0.40]	0.32	[-0.06, 0.57]
High cariogenicity	79	(100)	6.23	[4.05]	76	(96.2)	6.19	[3.91]	0.53	0.49	[0.30, 0.64]	0.66	[0.46, 0.78]
Severe cariogenicity	79	(100)	9.31	[5.11]	79	(100)	11.52	[5.92]	0.52	0.49	[0.29, 0.65]	0.66	[0.44, 0.79]
≥3yrs (n=64)													
Cariostatic	63	(98.4)	12.01	[6.02]	64	(100)	12.80	[4.06]	0.56	0.49	[0.28, 0.66]	0.66	[0.44, 0.79]
Anticariogenic	61	(95.3)	4.77	[3.64]	60	(93.8)	5.64	[3.41]	0.63	0.44	[0.23, 0.62]	0.61	[0.37, 0.76]
Low cariogenicity	64	(100)	34.80	[12.96]	64	(100)	30.64	[9.38]	0.54	0.57	[0.35, 0.72]	0.72	[0.52, 0.84]
Moderate cariogenicity	64	(100)	17.99	[6.61]	64	(100)	20.11	[4.74]	0.17[5]	0.14	[-0.09, 0.36]	0.25	[-0.20, 0.53]
High cariogenicity	64	(100)	6.46	[4.81]	62	(96.9)	5.75	[3.55]	0.47	0.34	[0.11, 0.54]	0.51	[0.20, 0.70]
Severe cariogenicity	64	(100)	11.04	[5.58]	64	(100)	13.05	[6.58]	0.59	0.57	[0.36, 0.72]	0.72	[0.53, 0.83]

[1]Values for all respondents; [2]Spearman correlation coefficient, p <0.001 except moderate cariogenicity variable; [3]ICC two-way random effects model, absolute agreement; [4]p=0.096; [5]p=0.182

Table 5.23 Bias, 95% limits of agreement and regression values for cariogenic food categories by age subgroup comparing FFQ1 and 7-day checklist

	Bias	95% LOA[1]		Slope		95% CI[2]		p
<3 years (n=79)								
Cariostatic	-0.60	(-11.55	10.35)	0.64	±0.12	[0.40	0.88]	**<0.001**
Anticariogenic	-0.69	(-9.24	7.85)	0.15	±0.15	[-0.15	0.45]	0.338
Low	5.00	(-14.22	24.22)	0.23	±0.10	[-0.03	0.43]	**0.028**
Moderate	-0.91	(-16.86	15.04)	0.30	±0.18	[-0.06	0.67]	0.099
High	0.04	(-7.88	7.96)	0.05	±0.13	[-0.22	0.32]	0.710
Severe	-2.21	(-12.72	8.30)	-0.19	±0.12	[-0.44	0.06]	0.128
≥ 3 years (n=64)								
Cariostatic	-0.79	(-10.92	9.34)	0.50	±0.13	[0.23	0.77]	**<0.001**
Anticariogenic	-0.88	(-8.11	6.36)	0.09	±0.16	[-0.22	0.40]	0.566
Low	4.16	(-15.6	24.0)	0.39	±0.12	[0.16	0.62]	**0.001**
Moderate	-2.12	(-16.83	12.59)	0.56	±0.21	[0.14	0.97]	**0.009**
High	0.71	(-8.77	10.19)	0.44	±0.17	[0.10	0.76]	**0.012**
Severe	-2.01	(-12.79	8.78)	-0.21	±0.13	[-0.46	0.05]	0.107

[1]LOA: Limits of agreement; [2]CI: Confidence Interval



1a. Slope=0.64 ± 0.12, [95%CI:0.40 to 0.88], p<0.001

1b. Slope=0.50 ± 0.13, [95%CI: 0.23 to 0.77], p<0.001

2a. Slope=0.15 ± 0.15, [95%CI:-0.15 to 0.45], p=0.338

2b. Slope=0.09 ± 0.16, [95%CI:-0.22 to 0.40], p=0.566

3a. Slope=0.23 ± 0.10, [95%CI:0.026 to 0.43], p=0.028

3b. Slope=0.39 ± 0.12, [95%CI:0.16 to 0.62], p=0.001

Figure 5.8 Bland-Altman plots assessing the validity of FFQ1 vs 7-day checklist by age (<3yrs, n=79; ≥3 years, n=64) for cariostatic, anticariogenic and low cariogenicity groups. Plots show mean difference (bias) and 95% Limits of Agreement (LOA) and the fitted regression line.

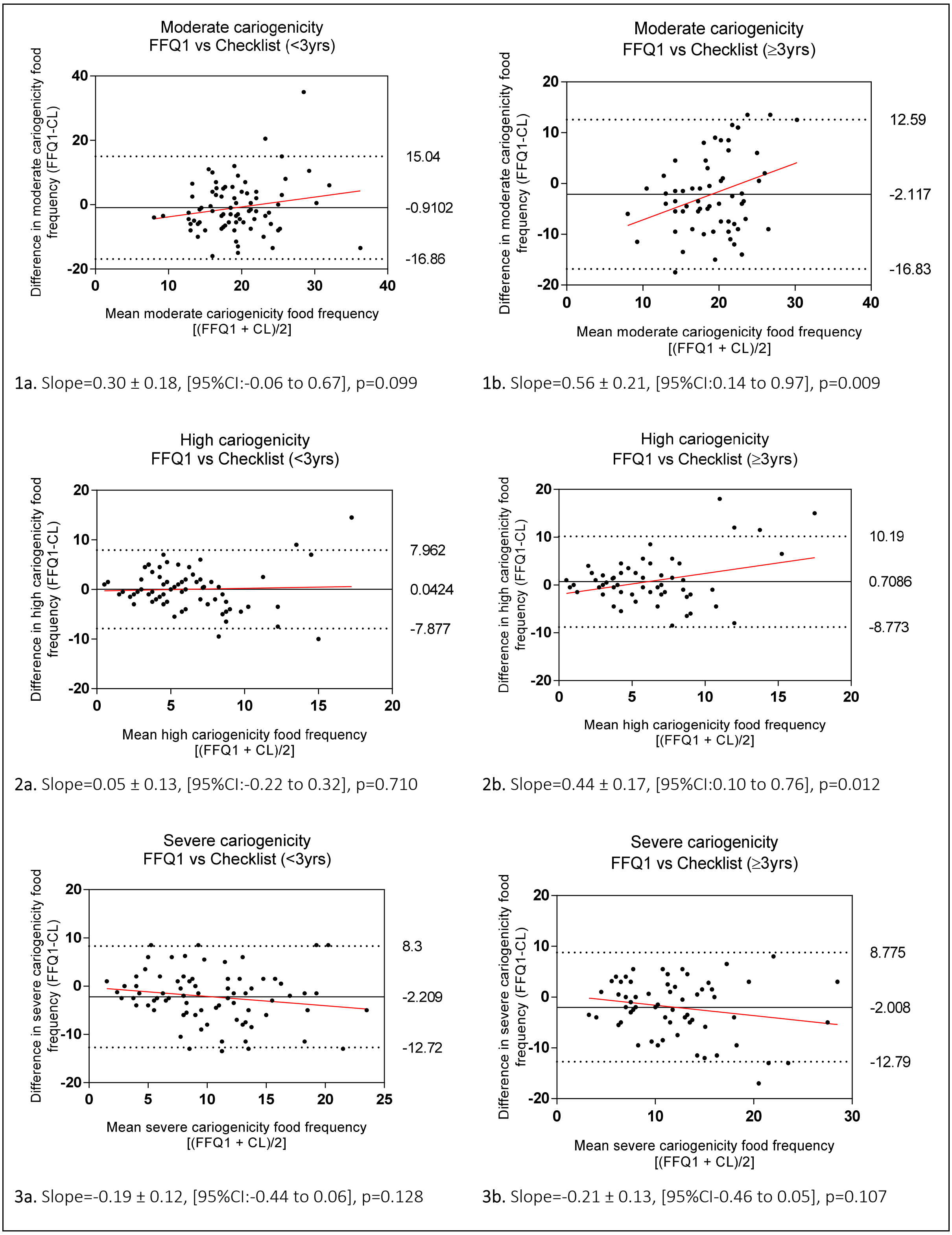


Figure 5.9 Bland-Altman plots assessing the validity of FFQ1 vs 7-day checklist by age (<3yrs, n=79; ≥3 years, n=64) for moderate, high and severe cariogenicity groups. Plots show mean difference (bias) and 95% Limits of Agreement (LOA) and the fitted regression line.

General food categories

Consumption frequency for the general food categories for FFQ1 and the 7-day checklist, by age subgroup are displayed in Table 5.24. Poor individual ICC values were observed for soup in the younger age group and grains in the older group, with all other groups showing poor to moderate validity. The group ICC values in the younger age group indicate poor to moderate validity for sweet snacks and soup, moderate to good validity for fruit/vegetables and dairy and poor to good validity for all other groups. In the older age group, the group ICC indicates moderate to good validity for spreads, poor to moderate validity for soup and grains and poor to good validity for all other groups. Individual and group ICC values indicate excellent validity for ready to feed baby food in the older age group.

Mean bias for each general category was similar in each age group (Table 5.25, Figure 5.10 and Figure 5.11) with the largest bias observed for fruit and vegetables. The limits of agreement were also similar across age subgroups, with the narrowest observed for desserts (< 3 years: -3.36 to 3.43; ≥3 years: -3.83 to 3.51) and the widest observed for fruit and vegetables (< 3 years: -15.15 to 24.14; ≥3 years: -14.23 to 22.6). The slope of the mean bias was significantly different to zero for protein in both age groups; dairy in the younger age group; and spreads, grains, fruit and vegetables, savoury snacks and desserts in the older age group. In older children the difference became greater in favour of the checklist as intake increased for desserts and spreads. The bias varied depending on frequency of intake for protein in older and younger children; grains and fruit and vegetables in older children and dairy in younger children.

Table 5.24 General food category consumption frequency and *validity* indicators by age subgroup for FFQ1 and 7-day checklist

	FFQ1				Checklist					ICC[3]					
	Consumes category		Times/week consumed[1]		Consumes category		Times/week consumed[1]		rho[2]	Individual			Group		
	N	%	mean	sd	N	%	mean	sd		ICC	[95%CI]		ICC	[95%CI]	
<3yrs (n=79)															
Spreads	71	(89.9)	3.08	[3.04]	63	79.8	3.28	[2.84]	0.52	0.45	[0.26,	0.61]	0.62	[0.41,	0.76]
Protein	79	(100)	11.02	[6.41]	79	(100)	11.62	[3.88]	0.50	0.44	[0.25,	0.60]	0.62	[0.40,	0.75]
Grains	79	(100)	14.67	[6.08]	79	(100)	16.92	[5.14]	0.46	0.45	[0.24,	0.61]	0.62	[0.39,	0.76]
Fruit/vegetables	79	(100)	33.71	[12.16]	79	(100)	29.22	[11.58]	0.60	0.60	[0.40,	0.74]	0.75	[0.57,	0.85]
Dairy	78	(98.7)	10.68	[6.73]	77	(97.5)	10.56	[5.29]	0.54	0.52	[0.33,	0.66]	0.68	[0.50,	0.80]
Sweet snacks	75	(94.9)	4.01	[3.12]	73	(92.4)	5.73	[3.74]	0.49	0.41	[0.18,	0.59]	0.58	[0.30,	0.74]
Savoury snacks	79	(100)	6.29	[4.20]	78	(98.7)	6.29	[4.08]	0.61	0.56	[0.39,	0.70]	0.72	[0.56,	0.82]
Desserts	63	(79.8)	1.52	[1.86]	42	(53.2)	1.49	[1.89]	0.53	0.58	[0.41,	0.71]	0.73	[0.58,	0.83]
Ready to feed baby food	18	(22.8)	0.55	[2.18]	6	(7.6)	0.19	[0.74]	0.49	0.46	[0.27,	0.61]	0.63	[0.42,	0.76]
Soup	56	(70.9)	0.91	[2.05]	25	(31.7)	0.52	[0.97]	0.49	0.30	[0.09,	0.48]	0.46	[0.16,	0.65]
≥3yrs (n=64)															
Spreads	62	(96.9)	3.62	[2.51]	53	(82.2)	3.52	[3.29]	0.56	0.58	[0.39,	0.72]	0.74	[0.56,	0.84]
Protein	63	(98.4)	12.01	[6.02]	64	(100)	12.80	[4.06]	0.56	0.49	[0.28,	0.66]	0.66	[0.44,	0.79]
Grains	64	(100)	15.10	[5.85]	64	(100)	18.06	[3.89]	0.36	0.24	[0.01,	0.45]	0.39	[0.03,	0.62]
Fruit/vegetables	63	(98.4)	32.51	[13.28]	63	(98.4)	28.34	[9.74]	0.64	0.64	[0.43,	0.78]	0.78	[0.60,	0.87]
Dairy	62	(96.9)	8.52	[5.26]	63	(98.4)	9.19	[4.85]	0.60	0.52	[0.32,	0.68]	0.68	[0.48,	0.81]
Sweet snacks	63	(98.4)	5.52	[3.88]	64	(100)	7.45	[4.33]	0.53	0.53	[0.27,	0.71]	0.70	[0.43,	0.83]
Savoury snacks	64	(100)	6.42	[4.87]	62	(96.9)	5.78	[3.72]	0.69	0.50	[0.30,	0.66]	0.67	[0.46,	0.80]
Desserts	62	(96.9)	2.00	[1.59]	46	(71.9)	2.16	[2.09]	0.45	0.49	[0.28,	0.66]	0.66	[0.44,	0.79]
Ready to feed baby food	3	(4.7)	0.29	[2.19]	2	(3.1)	0.25	[1.66]	0.82	0.94	[0.91,	0.97]	0.97	[0.95,	0.98]
Soup	49	(76.6)	1.08	[2.34]	17	(26.6)	0.44	[0.87]	0.38	0.36	[0.13,	0.55]	0.53	[0.23,	0.71]

[1]Values for all respondents; [2]Spearman correlation coefficient, all $p < 0.001$; [3]ICC two-way random effects model, absolute agreement

Table 5.25 Bias, 95% limits of agreement and regression values for beverage and food categories comparing FFQ1 and 7-day checklist by age category

	Bias	95% LOA[1]		Slope		95% CI[2]		p
<3 years (n=79)								
Spreads	-0.20	(-6.23	5.83)	-0.09	±0.14	[-0.18	0.37]	0.503
Protein	-0.60	(-11.55	10.35)	-0.64	±0.12	[0.40	0.88]	**<0.001**
Grains	-2.25	(-13.5	9.00)	-0.23	±0.13	[-0.05	0.49]	0.094
Fruit and vegetables	4.50	(-15.15	24.14)	-0.06	±0.11	[-0.15	0.27]	0.590
Dairy	0.12	(-11.59	11.84)	-0.31	±0.12	[0.06	0.56]	**0.014**
Sweet snacks	-1.93	(-9.25	5.38)	-0.25	±0.14	[-0.52	0.02]	0.073
Savoury snacks	0.00	(-7.64	7.64)	-0.04	±0.12	[-0.20	0.28]	0.760
Desserts	0.03	(-3.36	3.43)	-0.03	±0.12	[-0.26	0.21]	0.826
≥ 3 years (n=64)								
Spreads	0.10	(-5.17	5.38)	-0.34	±0.12	[-0.59	-0.09]	**0.009**
Protein	-0.79	(-10.92	9.34)	0.50	±0.13	[0.23	0.77]	**<0.001**
Grains	-2.96	(-14.6	8.69)	0.60	±0.17	[0.25	0.94]	**0.001**
Fruit and vegetables	4.17	(-14.23	22.6)	0.36	±0.10	[0.15	0.56]	**<0.001**
Dairy	-0.66	(-10.39	9.06)	0.10	±0.14	[-0.18	0.39]	0.454
Sweet snacks	-1.93	(-9.25	5.38)	-0.14	±0.13	[-0.39	0.12]	0.295
Savoury snacks	0.64	(-7.82	9.10)	0.35	±0.14	[0.07	0.63]	**0.015**
Desserts	-0.16	(-3.83	3.51)	-0.36	±0.14	[-0.65	-0.08]	**0.012**

[1]LOA: Limits of agreement; [2]CI: Confidence Interval

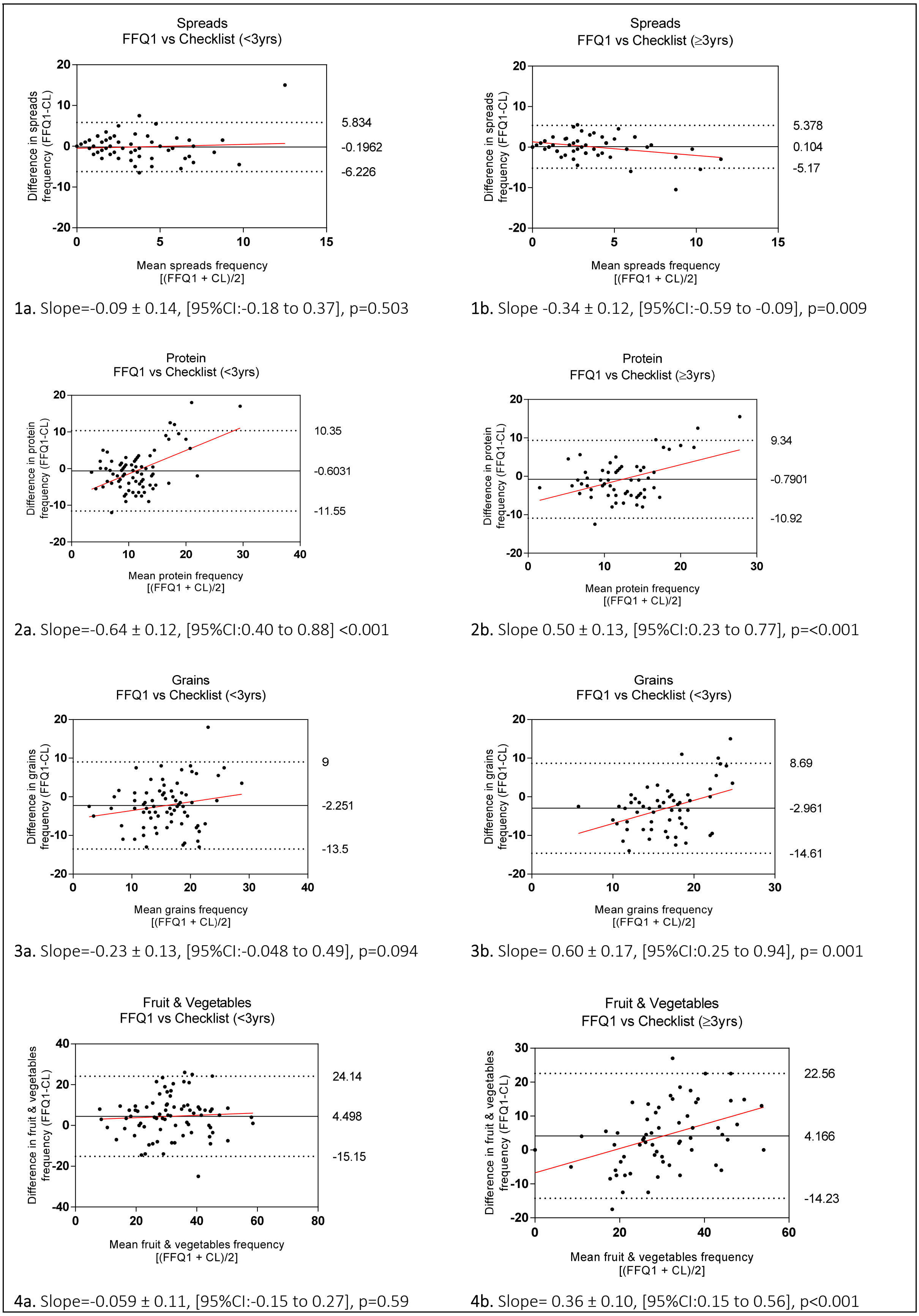
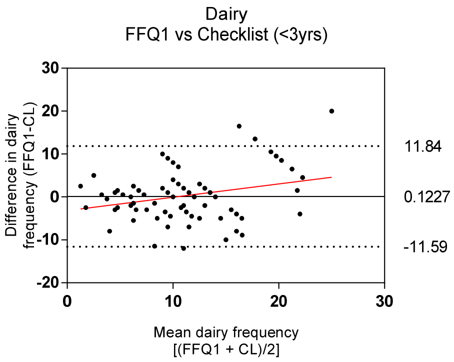
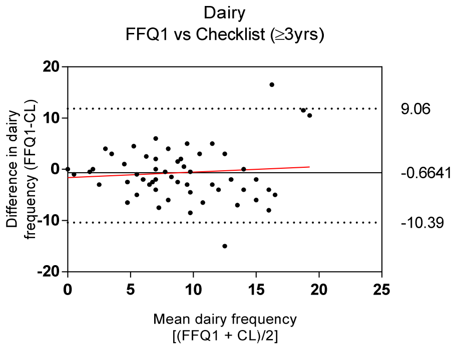


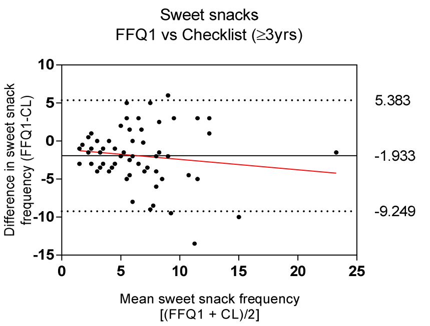
Figure 5.10 Bland-Altman plots assessing the validity of FFQ1 vs 7-day checklist by age (<3yrs, n=79; ≥3 years, n=64) for spreads, proteins, grains and fruits & vegetables. Plots show mean difference (bias) and 95% Limits of Agreement (LOA) and the fitted regression line.



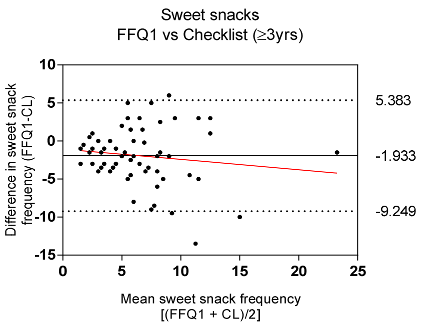
1a. Slope=-0.31 ± 0.12, [95%CI:0.06 to 0.56], p=0.014



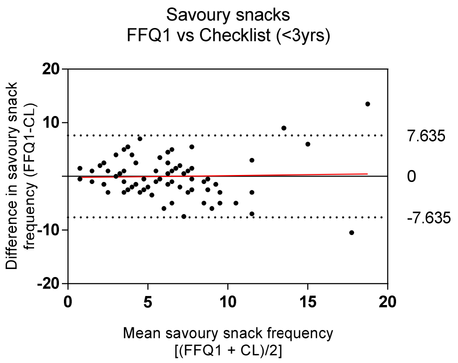
1b. Slope=0.10 ± 0.14, [95%CI:-0.18 to 0.39], p=0.454



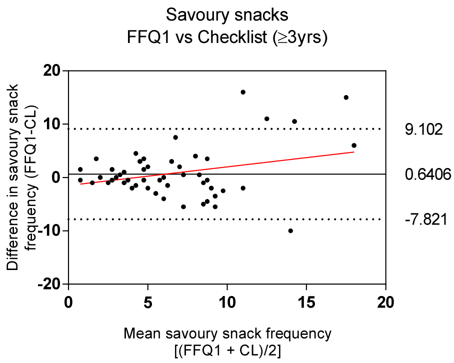
2a. Slope=--0.25 ± 0.14, [95%CI:-0.52 to 0.02], p=0.073



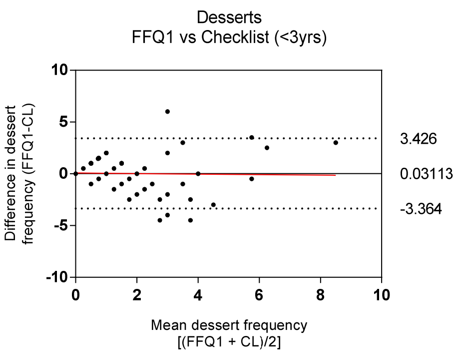
2b. Slope=-0.14 ± 0.13, [95%CI:-0.39 to 0.12], p= 0.295



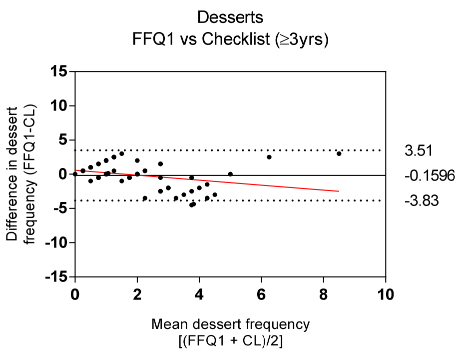
3a. Slope=-0.04 ± 0.12, [95%CI:-0.20 to 0.28], p=0.760



3b. Slope=0.35 ± 0.14, [95%CI:0.07 to 0.63], p=0.015



4a. Slope=--0.03 ± 0.12, [95%CI:-0.26 to 0.21], p=0.826



4b. Slope=-0.36 ± 0.14, [95%CI:-0.65 to -0.08], p=0.0121

Figure 5.11. Bland-Altman plots assessing the validity of FFQ1 vs 7-day checklist by age (<3yrs, n=79; ≥3 years, n=64) for spreads, proteins, grains and fruits & vegetables. Plots show mean difference (bias) and 95% Limits of Agreement (LOA) and the fitted regression line.

5.3.5 Context of Eating

Parent reported frequency with which children consume food with fruit juice, cordial and soft drink from FFQ1 and FFQ2 is displayed in Table 5.26. High percentage agreement was seen between the two timepoints, with fair to moderate agreement. Moderate to strong correlations were seen between responses to FFQ1 and FFQ2.

Table 5.27 shows the reported frequency with which children consume foods as part of a main meal and/or as a snack. High percentage agreement was seen between both timepoints, with fair to moderate agreement. Moderate to strong correlations were observed.

Table 5.28 and Table 5.29 display parents' reported child consumption of beverages and foods by context in FFQ1 and the 7-day checklist. There was moderate to high percentage agreement for beverages, with fair to moderate agreement between the two methods and weak to moderate correlation. The percentage agreement was good for most foods except hot chips. There was slight to moderate agreement between the two methods but weak correlation.

Table 5.26 Parent reported child usual beverage consumption with food for FFQ1 and FFQ2

	FFQ1 (N=146) N	%	FFQ2 (N=146) N	%	Percentage Agreement[1]	K_w[2]	rho[3]
Fruit juice/fruit drink							
Doesn't drink	66	(45.2)	60	(41.1)	87.8%	0.71	0.74
Always	30	(20.6)	35	(24.0)			
Most of the time	20	(13.7)	24	(16.4)			
About half the time	15	(10.3)	14	(9.6)			
Hardly ever	13	(8.9)	10	(6.9)			
Never	2	(1.4)	3	(2.1)			
Cordial							
Doesn't drink	130	(89.0)	127	(87.0)	94.9%	0.50	0.59
Always	4	(2.7)	9	(6.2)			
Most of the time	5	(3.4)	4	(2.7)			
About half the time	2	(1.4)	3	(2.1)			
Hardly ever	3	(2.1)	2	(1.4)			
Never	2	(1.4)	1	(0.7)			
Soft drink							
Doesn't drink	134	(91.8)	129	(89.0)	96.0%	0.59	0.69
Always	5	(3.4)	8	(5.5)			
Most of the time	1	(0.7)	3	(2.1)			
About half the time	3	(2.1)	3	(2.1)			
Hardly ever	2	(1.4)	1	(0.7)			
Never	1	(0.7)	1	(0.7)			

[1]Percentage agreement calculated as part of weighted kappa calculation; [2]Weighted kappa; [3]Spearman correlation coefficient

Table 5.27 Parent report of child's usual consumption of foods as a meal or snack for FFQ1 and FFQ2

	FFQ1 (N=146) N	%	FFQ2 (N=146) N	%	Percentage Agreement[1]	K_w[2]	rho[3]
Fruit							
Doesn't eat	2	(1.4)	2	(1.4)	92.6%	0.67	0.68
Always meal, never snack	0	(0.0)	0	(0.0)			
Mostly meal, hardly ever snack	3	(2.1)	2	(1.4)			
About ½ time meal, ½ time snack	40	(27.4)	39	(26.7)			
Hardly ever meal, mostly snack	77	(52.7)	79	(54.1)			
Never meal, always snack	24	(16.4)	24	(16.4)			
Vegetables							
Doesn't eat	2	(1.4)	1	(0.7)	88.1%	0.56	0.56
Always meal, never snack	31	(21.2)	38	(26.2)			
Mostly meal, hardly ever snack	75	(51.4)	69	(47.6)			
About ½ time meal, ½ time snack	38	(26.0)	37	(25.5)			
Hardly ever meal, mostly snack	0	(0.0)	0	(0.0)			
Never meal, always snack	0	(0.0)	0	(0.0)			
Lollies/Chocolates							
Doesn't eat	42	(28.8)	42	(29.0)	89.0%	0.75	0.72
Always meal, never snack	1	(0.7)	1	(0.7)			
Mostly meal, hardly ever snack	0	(0.0)	0	(0.0)			
About ½ time meal, ½ time snack	2	(1.4)	3	(2.1)			
Hardly ever meal, mostly snack	6	(4.1)	4	(2.8)			
Never meal, always snack	95	(65.1)	95	(65.5)			
Hot Chips							
Doesn't eat	20	(13.8)	21	(14.4)	87.3%	0.63	0.65
Always main meal, never snack	61	(42.1)	61	(41.8)			
Mostly meal, hardly ever snack	32	(22.1)	28	(19.2)			
About ½ time meal, ½ time snack	7	(4.8)	18	(12.3)			
Hardly ever meal, mostly snack	15	(10.3)	10	(6.9)			
Never main meal, always snack	10	(6.9)	8	(5.5)			
Muffins/Cakes							
Doesn't eat	22	(15.1)	21	(14.5)	87.9%	0.63	0.51
Always meal, never snack	0	(0.0)	0	(0.0)			
Mostly meal, hardly ever snack	1	(0.7)	0	(0.0)			
About ½ time meal, ½ time snack	2	(1.4)	5	(3.5)			
Hardly ever meal, mostly snack	19	(13.0)	16	(11.0)			
Never meal, always snack	102	(69.9)	103	(71.0)			
Savoury biscuits							
Doesn't eat	4	(2.7)	5	(3.5)	89.1%	0.45	0.52
Always meal, never snack	0	(0.0)	1	(0.7)			
Mostly meal, hardly ever snack	2	(1.4)	4	(2.8)			
About ½ time meal, ½ time snack	15	(10.3)	17	(11.9)			
Hardly ever meal, mostly snack	37	(25.3)	29	(20.3)			
Never meal, always snack	88	(60.3)	87	(60.8)			

[1]Percentage agreement calculated as part of weighted kappa calculation; [2]Weighted kappa; [3]Spearman correlation coefficient

Table 5.28 Parent reported child usual beverage consumption with food for FFQ1 and checklist

	FFQ1 (N=127) N	%	Checklist (N=127) N	%	Percentage Agreement[1]	K_w[2]	rho[3]
Fruit juice/fruit drink							
Doesn't/didn't drink[4]	55	(43.3)	70	(55.1)	60.3	0.33	0.39
Always	27	(21.3)	47	(37.0)			
Most of the time	20	(15.8)	6	(4.7)			
About half the time	12	(9.5)	1	(0.8)			
Hardly ever	12	(9.5)	0	(0.0)			
Never	1	(0.8)	3	(2.4)			
Cordial							
Doesn't/didn't drink[4]	111	(87.4)	114	(89.8)	87.2	0.38	0.51
Always	5	(3.9)	12	(9.5)			
Most of the time	5	(3.9)	0	(0.0)			
About half the time	2	(1.6)	1	(0.8)			
Hardly ever	3	(2.4)	0	(0.0)			
Never	1	(0.8)	0	(0.0)			
Soft drink							
Doesn't/didn't drink[4]	114	(89.8)	116	(91.3)	90.8	0.48	0.54
Always	6	(4.7)	10	(7.9)			
Most of the time	1	(0.8)	0	(0.0)			
About half the time	3	(2.4)	1	(0.8)			
Hardly ever	2	(1.6)	0	(0.0)			
Never	1	(0.8)	0	(0.0)			

[1]Percentage agreement calculated as part of weighted kappa calculation; [2]Weighted kappa; [3] Spearman correlation coefficient; [4] Doesn’t drink (FFQ), Didn’t drink during week (7-day checklist)

Table 5.29 Parent report of child's usual consumption of foods as a meal or snack for FFQ1 and checklist.

	FFQ1 (N=127) N	%	Checklist (N=127) N	%	Percentage Agreement[1]	K_w[2]	rho[3]
Fruit							
Doesn't/didn't eat[4]	2	(1.6)	3	(2.4)	88.4	0.46	0.42
Always meal, never snack	0	(0.0)	0	(0.0)			
Mostly meal, hardly ever snack	3	(2.4)	8	(6.3)			
About ½ time meal, ½ time snack	36	(28.4)	24	(18.9)			
Hardly ever meal, mostly snack	69	(54.3)	72	(56.7)			
Never meal, always snack	17	(13.4)	20	(15.8)			
Vegetables							
Doesn't/didn't eat[4]	2	(1.6)	2	(1.6)	86.3	0.21	0.36
Always meal, never snack	25	(19.7	58	(45.7)			
Mostly meal, hardly ever snack	68	(53.5)	66	(52.0)			
About ½ time meal, ½ time snack	32	(25.2)	1	(0.8)			
Hardly ever meal, mostly snack	0	(0.0)	0	(0.0)			
Never meal, always snack	0	(0.0)	0	(0.0)			
Lollies/Chocolates							
Doesn't/didn't eat[4]	32	(25.2)	54	(42.5)	69.0	0.38	0.36
Always meal, never snack	1	(0.8)	3	(2.4)			
Mostly meal, hardly ever snack	0	(0.0)	1	(0.8)			
About ½ time meal, ½ time snack	2	(1.6)	1	(0.8)			
Hardly ever meal, mostly snack	6	(4.7)	2	(1.6)			
Never meal, always snack	86	(67.7)	66	(52.0)			
Hot Chips							
Doesn't/didn't eat[4]	15	(11.8)	63	(49.6)	46.6	0.15	0.17
Always main meal, never snack	53	(41.7)	58	(45.7)			
Mostly meal, hardly ever snack	31	(24.4)	3	(2.4)			
About ½ time meal, ½ time snack	7	(5.5)	0	(0.0)			
Hardly ever meal, mostly snack	13	(10.2)	0	(0.0)			
Never main meal, always snack	8	(6.3)	3	(2.4)			
Muffins/Cakes							
Doesn't/didn't eat[4]	17	(13.4)	31	(24.4)	67.2	0.21	0.08
Always meal, never snack	0	(0.0)	5	(3.9)			
Mostly meal, hardly ever snack	1	(0.8)	2	(1.6)			
About ½ time meal, ½ time snack	1	(0.8)	7	(5.5)			
Hardly ever meal, mostly snack	19	(15.0)	5	(3.9)			
Never meal, always snack	89	(70.1)	77	(60.6)			
Savoury biscuits							
Doesn't/didn't eat[4]	3	(2.4)	9	(7.1)	75.4	0.13	0.06
Always meal, never snack	0	(0.0)	3	(2.4)			
Mostly meal, hardly ever snack	3	(2.4)	7	(5.5)			
About ½ time meal, ½ time snack	14	(11.0)	8	(6.3)			
Hardly ever meal, mostly snack	31	(24.4)	34	(26.8)			
Never meal, always snack	76	(59.8)	66	(52.0)			

[1]Percentage agreement calculated as part of weighted kappa calculation; [2]Weighted kappa; [3] Spearman correlation coefficient; [4] Doesn't eat (FFQ), Didn't eat during week (7-day checklist)

5.4 Discussion

This study has examined the test-retest reliability and relative validity of a food frequency questionnaire for use with children aged between 18 months and five years. The FFQ contains items commonly found in young children's diets and which are known to play a role in oral health. Beverages were tested individually, and sweetened beverages and plain milks were grouped into two categories and tested. Foods were tested individually and grouped into two types of categories (cariogenic and general) and tested. In summary good test-retest reliability was demonstrated for all individual foods, individual beverages and food/beverage categories in the FFQ across all age groups, except for flavoured milk which was poor. Acceptable relative validity was demonstrated for most food and beverage categories, when the tool is used at a group rather than individual level.

Test-retest reliability was examined by parents completing the FFQ twice with an average 34 days between completions. Moderate to strong correlations, and acceptable weighted kappa values for individual and categorised foods and beverages for each completion of the questionnaire. Weighted kappa values for comparable reliability studies have ranged 0.37 to 0.85 in two to five year old Australian children [164], whilst in Flemish one year old children, unweighted kappa values ranged from 0.40 to 1.0 for beverages and 0.32 to 0.78 for foods [178]. The correlations are similar to those seen in studies of very young children from Norway, Australia and Belgium using food and/or beverage groupings [164, 165, 178]. Correlation coefficients for most food and beverage groups in these studies were larger than 0.50, indicating acceptable reliability. Whilst correlation coefficients are useful for comparing across studies, they are not the strongest measure of reliability, as they only give an indication of association, rather than agreement.

Examining the intra-cluster correlation is more indicative of agreement between two measures. In this study acceptable reliability was observed for most individual beverages (exceptions were flavoured milk and herbal drinks), and all categorised beverages and foods, with the group ICC ranging between 0.69 (soft drink) and 0.95 (fruit juice), with a mean ICC of 0.79. These trends remained when examining the reliability in younger and older age groups. There are few published studies that examine the reliability of food and/or beverage groups in a similar age group using the ICC statistic. The studies that have used these methods report similar results to the current study. Flood et al [164] observed ICC values between 0.29 (red meat) and 0.83 (confectionery) when examining the repeatability of a 17-item FFQ in 77, 2-5 year old Australian children. Beverages, fruit and vegetables were measured by cups or servings, whilst seven other food items were measured by usual consumption frequency. Another Australian study reported on the reliability of a 38 item FFQ, with foods and beverages collapsed into 7 categories aligning with the Australian dietary guidelines [159]. ICC values for reliability ranged between 0.58 (breads and cereals) and 0.94 (beverages), similar to observations in the present study, despite having a smaller sample size (n=68) and a wider age range (4-11 years, mean 7.1 years). Internationally, ICC values between 0.53 (sweet spreads, snacks) to 0.79 (sugared drinks, cheese) were observed when examining the reliability of categorised foods and beverages from a 47-item semi-quantitative FFQ completed by parents of 124 Flemish pre-schoolers [165].

Poor agreement was observed for flavoured milk and herbal drinks in the present study. Herbal drinks were reported to be consumed by approximately 5% respondents, so it is likely this low proportion of consumers contributed to the poor reliability. Flavoured milk however, was reported to be consumed by just under ¼ of children at both timepoints. These results may indicate that children's consumption of flavoured milk does not remain stable over a relatively short period of time. Another potential reason could be changes in parents' perceptions of flavoured milk between completions of each questionnaire. Australian research by Bennet et al [152] indicated that parents of 2-5-year-old children have difficulty reporting the amount of flavoured milk their child consumes as they tend to not report the addition of sweeteners to plain milk. It is possible that completion of the first FFQ gave parents a heightened awareness of their child's consumption habits and when they completed the second FFQ they considered different types of 'flavoured' milk that they had not before. The age-subgroup analysis tends to support the first explanation, with flavoured milk performing much worse in the younger age group (<3 years) compared with the older age group (>3 years). This suggests that consumption frequency of flavoured milk is more stable in children aged 3 years and older than those aged less than 3 years.

In the absence of a 'gold-standard' reference measure for dietary measurement, a seven-day checklist was used in the present study to examine the relative validity of the FFQ. The checklist relied on parents accurately reporting the foods and beverages that their child consumed each day on seven consecutive days. The checklist was completed at the time of consumption, not retrospectively. As such, it was not reliant on parent memory and may be considered the closest measure to true consumption frequency. Correlation coefficients, ICC and the Bland Altman method with linear regression were used to compare responses from

FFQ1 and the seven-day checklist, to ensure that the agreement and bias could be examined whilst also allowing for comparison with other published research.

Correlation coefficients were ≥0.50 for all beverage and beverage categories except flavoured milk, indicating acceptable validity. Child age influenced the accuracy of reporting water and flavoured milk, with stronger correlations for water (0.65 vs 0.42) and weaker correlations for flavoured milk (0.10 vs 0.40) observed in older children. Categorised foods performed worse than beverages with correlation coefficients <0.50 observed in the anticariogenic, moderate and high cariogenicity categories as well as the grain, desserts and soup categories. Similar results were seen when comparing age groups except for the anticariogenic category, for which the correlation coefficient was much higher for older children than younger children.

The correlations observed in this study were generally higher than the ranges observed in other research. Comparison of a semi-quantitative FFQ (SFFQ) with seven-day weighed food records from 64, 12-month-old Norwegian infants produced correlations ranging between 0.28 (sweet drinks) and 0.83 (commercial baby cereal) [166] whilst in Flemish preschool children, comparison of a SFFQ with 3-day estimated diet records produced correlations between 0.23 (meat) and 0.61 (fruit juice) [165]. In one Australian study of 77, 2-5-year-old children, correlations were low when comparing an FFQ with 3-day food records. Red meat, processed meat, high fat potatoes and salty snacks all had correlations less than 0.20, whilst beverages varied from 0.29 (soft drink) and 0.35 (water) to 0.59 (fruit juice) and 0.67 (diet soft drink) [164]. In contrast, another Australian study of 90, 3-5 year old children observed correlations between 0.59 (water) and 0.88 (fruit juice), for a ten item FFQ compared to a single 24-hour recall [152]. This same study is the only one to have examined flavoured milk as a separate category, and in contrast to the results of the present study, a correlation of 0.74 was observed between the two assessment methods.

The beverage items used in the current study were adapted from the tool that was used to collect beverage information in the IOWA fluoride study [150]. The IOWA team examined the validity of their tool by comparing the beverage frequency data with 3-day food records of 240 children at four ages (six months, 12 months, three years and four years). Correlations between serves estimated from the two tools ranged between 0.59 (soft drink) and 0.76 (cow's milk) at age three, and 0.54 (juice) and 0.70 (water) at age five years. The correlations for sweetened beverages and water are similar to those observed in the corresponding age sub-groups of the current study. It was not possible to compare flavoured and plain milk as Marshall et al (2003) had one category ‘cow’s milk’ which incorporated both plain and flavoured milk.

Although the correlation coefficients can be useful for comparing results with other studies, they fail to indicate the degree of agreement between the FFQ and the seven-day checklist. To assess agreement, the ICC was calculated for beverages (individual (11) and categorized (2)) and six cariogenicity and, 10 general food categories. The mean bias (with associated 95% limits of agreement) was also calculated for two individual beverages (water and flavoured milk) and two beverage categories (sweetened drinks and plain milk) and the 16 food categories using the Bland-Altman method. The mean bias is the average difference in estimates provided by the FFQ and the checklist. A positive mean bias indicates that on average the FFQ provides a higher estimate compared to the checklist, whist a negative mean bias indicates the checklist provides a higher estimate compared to the FFQ. A linear regression model was fitted to this to identify any systematic bias between the FFQ and seven-day checklist.

The ICC indicated acceptable agreement between the FFQ and checklist for beverages except water, flavoured milk, cordial and soft drink. However, the ICC for sweetened beverages, which included cordial, soft drink and fruit juice was 0.82. The low values observed for the individual beverages are likely due to the small numbers of children consuming these drinks, suggesting that in this age group, combining sweetened beverages is more informative than looking at them individually. This FFQ was designed to be used in relation to oral health, where these types of beverages have a similar impact on disease status, and thus it is rational to combine them.

The mean bias for 14 of the 20 categories examined fell between -1 and +1, indicating that at a group level the FFQ tended to underestimate or overestimate consumption frequency by less than once per week for these categories compared with the checklist. The FFQ, on average, underestimated consumption frequency of the severe cariogenicity, sweet snacks and grains categories by about twice a week. Fruits and vegetables, and the low cariogenicity category were overestimated by about five times per week, and water had the largest mean bias, with the FFQ on average, overestimating consumption frequency by about 14 times per week compared with the checklist. These results were consistent across both age groups examined, although the bias for water was approximately six times a week lower in the older children compared to the younger children. Wide limits of agreement were observed for most categories, suggesting the tool is not valid for use at an individual level, but the relatively small mean biases observed in most categories suggest that it is valid for use at a group or population level.

The regression analysis showed significant differences between the slope of the bias line and zero for 14 of the 20 categories examined, indicating the bias changes depending on how frequently items are consumed. The bias did not vary by consumption frequency for three of the cariogenicity categories (anticariogenic, high and severe) and two of the general categories (sweet snacks and savoury snacks). As consumption increased, the FFQ provided a greater estimate compared to the checklist for milk, water, the low cariogenicity category and the fruit/vegetables, ready to feed baby foods and soup categories. In contrast, the checklist provided a greater estimate for sweet drinks, flavoured milk and desserts as consumption increased. This may reflect a common bias in dietary studies, where participants overreport the healthy aspects of their diet, but underreport those which are less healthy [159, 179]. Additionally, the checklist was recorded in real time without reliance on memory, whereas the FFQ required participants to recall usual consumption. This may indicate an error with recall rather than what participants are reporting. The bias however, varied across consumption for the cariostatic, moderate cariogenicity, protein, grains and dairy categories with the FFQ providing a higher estimate at higher consumption, whilst the checklist provided a higher estimate at lower consumption. The presence of systematic bias is less easy to control for in analyses using data collected with the tool compared to controlling for bias that is the same across many levels of consumption frequency. This will need to be taken into account when analysing data collected by this FFQ. For many of the categories examined, the bias between the FFQ and checklist was closest to zero when consumption ranged between approximately 10 and 25 times a week (around 1-3 times a day). Parents may be better at recalling items that are consistently consumed (e.g. always having cereal and fruit for breakfast, always having vegetables with dinner) compared to foods or drinks for which consumption varies from day to day.

The presence of systematic bias for food and beverage categories differed by age group. Systematic bias was observed for all beverages in the older age group, but no systematic bias was observed for flavoured milk in the younger age group. As consumption of sweetened beverages increased, the bias increased in favour of the FFQ for the older age group but increased in favour of the checklist in the younger age group. This may be related to the social desirability of sweetened beverage consumption and it perhaps being seen as less 'acceptable' for children younger than three years to be consuming sweetened beverages compared to older children. Systematic bias was observed for 10 of the 14 food categories for the older children compared to four categories for the younger children.

Few published studies have included results related to agreement, such as the bias and limits of agreement. Where these have been included, it is difficult to directly compare between studies and with the current study because of the wide variety of measurements (e.g. serves, cups, nutrients, energy) and the range of detail provided. Australian research with 4-11-year-olds indicated that a short food frequency questionnaire tended to overestimate consumption of all seven food groups examined, with wide limits of agreement and proportional bias in all categories except vegetables and extra foods when compared with three, 24 hour recalls [159]. In contrast, Flood et al [164] reported that a FFQ gave a higher mean estimate between 0.18 and 1.15 serves of vegetables, fruit, water and milk when compared to a 3-day food record, however the mean estimates did not vary according to consumption.

A set of new questions examining combinations of consumed food and beverages and snack or mealtime consumption were examined. Both these factors can influence the cariogenic effect of particular items [180], however there is a lack of simple items that could be included in a questionnaire to measure this. The questions had good reliability when comparing responses in FFQ1 and FFQ2, however performed poorly when comparing FFQ1 to the checklist. A number of factors may have contributed to this poor performance. Firstly, for items that are infrequently consumed, the one week period in which the checklist was recorded may not have been long enough to get an accurate measure of consumption context to compare to the FFQ. For example, a parent may have indicated that their child consumes fruit juice ½ the time with a meal and ½ the time without a meal. If this child only consumed fruit juice once during the week of the checklist and it wasn't with a meal, they would have been classified as 'never' consuming fruit juice with a meal. If the checklist had been collected for two weeks and on the second week the child did consume fruit juice with a meal, then their classification would have matched the FFQ. Additionally, the description of 'mostly' may be ambiguous to some parents or some parents may just not know how frequently the eating contexts asked about actually do occur. Development of these questions would benefit from qualitative research with parents to explore these issues further and understand how this information could be accurately collected in a questionnaire.

5.4.1 Strengths and Limitations

A major strength of the present study is the FFQ has been designed to examine foods and beverages that are known to be consumed in early childhood and play a role in oral health. There are very few tools in existence for this purpose and fewer that have had the reliability and validity properties examined. Additionally, the present study included a large sample size across a wide range of ages which allowed for comparison across different age groups.

There are also a number of limitations related to this study. A convenience sample of participants was included, and they tended to be English-speaking with high levels of education. This may limit the generalisability of the results in populations that do not mirror these criteria. Additionally, only the relative validity of the FFQ was examined in this study and the comparison method (checklist) will also have some limitations on how accurately it measures dietary intake. The length of time between completions of each component of the study was unable to be standardized across participants and the study assumed that children's consumption of foods and beverages is stable from week to week, which it is not likely to be. A range of factors such as weather, health, parent and child activities and financial considerations can vary from week to week and are likely to influence what foods and drinks children consume. The reliance on parents to report what their child was consuming is also a limitation. Parents may have not been present at all eating occasions and may have relied on second hand information (such as that from child care providers) to describe what their child ate or drank for particular time periods.

5.4.2 Conclusion

The food frequency questionnaire has displayed acceptable test-retest reliability for all items except flavoured milk. The tool has also shown acceptable relative validity for most food and beverage groups, when used at a population, rather than individual level. For many food and beverage categories, the FFQ provides a larger estimate as consumption frequency increases. The differences in results based on consumption frequency levels must be taken into account when analysing data collected with this FFQ.

Chapter 6: Exploring children's diets across the first five years of life

6.1 Introduction

There is limited evidence about what Australian children aged less than five years are consuming, from longitudinal studies with diverse samples as outlined in the literature review in Chapter 2. The dietary data that were collected as part of the VicGen birth cohort, which was outlined in Chapter 4, can fill some of these gaps. The VicGen dietary data has been previously explored at ages one, six, 12, and 18 months of age, with the top ten most frequently consumed core and discretionary foods at age six, 12 and 18 months published [96]. At the time of this publication, data for children at ages 3, 4 and 5 years was not available for analysis. Additionally, the published study did not incorporate all the dietary data that had been collected, instead focussing on the most common core and discretionary foods and beverages that children were transitioning onto in the first two years of life. This chapter reports on all the dietary data collected from the VicGen cohort at six points between six months and five years of age.

The aims of this study were to

a. Describe the consumption frequency of a range of core and discretionary foods and beverages at six points between age six months and five years.
b. Describe the relative contribution of a range of core and discretionary foods and beverages to children's diets at six- points between age six months and five years.
c. Create models to explore, longitudinally, the influence of socio-demographic factors on the relative contribution of core and discretionary foods and beverages to children's diets between six months and five years of age.

6.2 Methods

This study involved secondary analysis of questionnaire data collected as part of the VicGen study described in Chapter 4. Parents participated in study visits when their children were approximately one month, six months, 12 months, 18 months, three years, four years and five years of age. Prior to each study visit, parents were asked to complete a paper-based questionnaire and return it to the research assistants at the study visit or via the post in a reply-paid envelope. The child's primary caregiver, of whom the majority were mothers, completed the questionnaire at each wave.

6.2.1 Data Handling

Questionnaire data were double entered into SPSS [142] by independent research assistants. The two entries were compared to each other using STATA [143]. Where discrepancies between the two entries were observed, the original survey was checked, and the error corrected. All seven waves of data were merged into one STATA dataset, in both the long and wide format.

6.2.2 Outcome Variables

Child food and beverage consumption

A food frequency questionnaire (FFQ) was included as part of the study questionnaire from wave two (age six months) onwards. The FFQ was split into two parts, with one asking about food intake and the other about beverage intake (Appendices A and B). The reliability and validity properties of the FFQ are described in Chapter 5. The tool is acceptable for use at a group rather than individual level.

Food

Parents were asked to report how often their child consumed a list of foods in a usual week using a categorical scale. There were eight response options to choose from: *never, rarely, once a week, 2-3 times per week, 4-6 times per week, once per day, 2-3 times per day; and 4+ times per day.* A serving size was not specified. A wide range of foods commonly consumed by this age group were included in the FFQ. At wave two (age six months) there were 32 food items listed, and these remained the same at subsequent waves with the exceptions outlined in Chapter 5.

At each wave parents could add any other foods their child consumed that were not listed. Data were converted from categorical to continuous (times per week) using the values outlined in Table 6.1.

Table 6.1 Categorical and continuous values assigned to FFQ

FFQ Category	Continuous value
Never	0
Rarely	0.5
Once per week	1
2-3 times per week	2.5
4-6 times per week	5
Once per day	7
2-3 times per day	17.5
4+ times per day	28

Missing values were treated as zero. Foods were assigned to be either 'core' or 'discretionary' according to the Australian Dietary Guidelines (Table 6.2) [9]. Ready-to-feed baby foods were included as single item in the FFQ. It was not possible to determine if children were consuming core (e.g. vegetable/fruit based) and/or discretionary (e.g. flavoured custards/puddings) varieties of ready-to-feed baby foods, so this item was excluded from analysis. As these were unable to be classified with certainty, they were excluded from the analysis. The peanut butter/Nutella group were also excluded from classification as it was not possible to distinguish between the two spreads in this group.

An overall 'consumption frequency' score was generated by summing the continuous value of all foods listed. Similarly, separate 'consumption frequency' scores were generated for the subsets of core foods and discretionary foods and the percent of total food items consumed from each of these subsets determined.

Table 6.2 Categorization of foods as core (C) and discretionary (D) or not available (NA) across each wave of data collection

	Wave 2 (6m)	Wave 3 (12m)	Wave 4 (18m)	Wave 5 (3yr)	Wave 6 (4yr)	Wave 7 (5yr)
Eggs	C	C	C	C	C	C
Nuts	C	C	C	C	C	C
Cheese[1]	C	C	C	C	C	C
Yoghurt[1]	C	C	C	C	C	C
Banana	C	C	C	C	NA	NA
Fresh fruit	C	C	C	C	NA	NA
Dried fruit	C	C	C	C	C	C
Stewed fruit	C	C	C	C	NA	NA
Fresh or stewed fruit	NA	NA	NA	NA	C	C
Cereal[4]	C	C	C	C	C	C
Bread/rolls	C	C	C	C	C	C
Potato	C	C	C	C	C	C
Vegetables (not potato)	C	C	C	C	C	C
Pasta/noodles	C	C	C	C	C	C
Rice/couscous	C	C	C	C	C	C
Baked beans	C	C	C	C	C	C
Soup	C	C	C	C	C	C
Meat/fish	NA	C	C	C	C	C
Jam	D	D	D	D	D	D
Muesli bars/ fruit sticks/roll	D	D	D	D	D	D
Dry biscuits/crackers	D	D	D	D	D	D
Ice cream	D	D	D	D	D	D
Pudding	D	D	D	D	D	D
Custard	D	D	D	D	NA	NA
Jelly	D	D	D	D	NA	NA
Donuts	D	D	D	D	NA	NA
Sweet biscuits	D	D	D	D	D	D
Cakes/muffins[1]	D	D	D	D	NA	NA
Cakes/muffins/donuts	NA	NA	NA	NA	D	D
Chocolate/lollies	D	D	D	D	D	D
Hot chips	D	D	D	D	D	D
Potato chips/Twisties/Cheezels	D	D	D	D	D	D
Luncheon meats	D	D	D	D	D	D
Ready to feed baby food[3]	NA	NA	NA	NA	NA	NA

[1]Listed as one item with a full fat/low fat tick box from wave 2-6, listed as separate low fat/full fat items in wave 7; [2]Combined into cakes/muffins/donuts category waves 6 and 7; [3]Unable to determine whether core or discretionary; [4]Refers to baby or breakfast cereals.

Beverages

Parents reported their child's beverage intake as for foods described above. Twelve beverages were listed at wave two and these remained the same across the next five waves, except for infant formula being removed from wave six (age four years) onwards and different milk options (soy, lactose free, almond/rice) added in the final wave (child age five years). At each wave parents could add any other beverages their child consumed that were not listed. The different milk options included in the Wave seven questionnaire were excluded from this analysis, as they were not specified in the previous waves of data collection and were infrequently consumed.

Questions related to breast milk were collected in addition to the beverage questions outlined above. However, as this information was collected separately to the other food and beverage questions, accurate consumption frequency could not be determined. Therefore, breastmilk was not included in this analysis.

A variable reflecting the total times per week each beverage was consumed was derived from the reported data. Beverages were categorised as either core or discretionary (Table 6.3). Infant formula was included as a core beverage in waves two and three, and then excluded as the Infant Feeding Guidelines [39] recommend consumption of cow's milk from age 12 months. The fruit juice/fruit drink beverage category was classified as discretionary for the purposes of this study. Although the Australian Dietary Guidelines define ½ a cup of no added sugar fruit juice as 1 serve of fruit, it is recommended that this is only consumed occasionally [181]. This factor, along with the links between fruit juice and dental caries [182] and the inability to distinguish between 100% fruit juice and sweetened fruit juices and drinks, informed this decision.

An overall beverage consumption frequency score was generated by summing consumption frequency of each beverage. Missing values were treated as zero. A total consumption score for each of core and discretionary beverages was also generated and the percentage of total beverage consumption from each of these sub-groups calculated.

Table 6.3 Categorization of beverages as core (C) and discretionary (D) or not available (NA) across each wave of data collection

	Wave 2 (6m)	**Wave 3 (12m)**	**Wave 4 (18m)**	**Wave 5 (3yr)**	**Wave 6 (4yr)**	**Wave 7 (5yr)**
Water	C	C	C	C	C	C
Infant formula	C	C	NA	NA	NA	NA
Full fat cow's milk	C	C	C	C	C	C
Low fat cow's milk	C	C	C	C	C	C
Tea/coffee	C	C	C	C	C	C
Herbal teas/drinks	C	C	C	C	C	C
Sweetened condensed milk	D	D	D	D	D	D
Sweetened/flavoured milk	D	D	D	D	D	D
Fruit juice/fruit drink	D	D	D	D	D	D
Cordial	D	D	D	D	D	D
Soft drink	D	D	D	D	D	D
Sports drinks	D	D	D	D	D	D

Outcome Variables

The percentage of total food consumption occasions that were core foods (core food percentage) and the percentage of total beverage consumption occasions that were core beverages (core beverage percentage) were the outcome variables used in further analyses.

Predictor Variables

Variables of interest were selected based on existing literature and the socio-ecological model outlined in Chapters 2 and 3.

Child variables

Child gender was reported in the baseline questionnaire. *Child age*, in months, was generated for each wave, using birthdate and the date the questionnaire was completed. The study was designed so that each wave of data collection occurred at a specific age (Wave one: one month, Wave two: six months, wave three: 12 months, wave four: 18 months, wave five: three years, wave six: four years, wave seven: five years). Although every effort was made to see children as close to this age as possible, logistical factors resulted in variance in actual age when the study visit occurred. In such young age groups, a difference of a couple of months can influence the foods and beverages that children are consuming, so this factor needed to be accounted for in the analytic models. To account for any influence of this on the outcome, a *child age/wave difference* variable was generated by calculating how much older or younger the child was than the designated age at each wave of data collection.

Child care: The types of out of parent care that children participated in was collected in waves three through seven. At wave three, four and five parents were asked: *Please indicate which of the following forms of childminding or childcare, if any, you have used for this child in the last month?* Response options were: family day care, childcare centre, paid babysitter/nanny, relative caring for your child, friend/neighbour caring for your child, some other form of childcare, none of these options, don't know. The question was expanded at waves six and seven, asking participants: *In the last month, during a typical week did your child spend any time out of their parent (s) care? If yes, was it with grandparents, another relative, friend/another adult, childcare centre, family day care, nanny.* Parents were also asked to report the number of hours that their child had spent in care. A binary variable was derived for each wave indicating whether the child had spent any time out of their parent's care. The number of hours out of their parent's care was not included, as this was only collected in the final two waves of data collection.

Primary caregiver variables

Parent age at baseline: The child's primary caregiver (primarily mothers) reported their age in years at baseline data collection.

Education: At wave one, primary caregivers reported the highest level of schooling that they had completed through two questions. One related to secondary education, with three response options: year 10 or less, year 11 or year 12 (completed secondary school). The second question related to the highest post-school qualification they had received, with nine response options: none, certificate, technical apprenticeship, graduate diploma/certificate, advanced diploma/diploma, degree (bachelor level), post-graduate degree, other, and don't know. These two variables were combined to create one education variable with six levels: ≤ year 10, year 11, year 12, apprenticeship/certificate/diploma, bachelor degree, postgraduate degree. In subsequent waves of data collection, caregivers were asked to indicate if their highest education level had changed since completing the last questionnaire, and if it had, what it now was.

Fruit and vegetable intake: Caregivers were asked to indicate their fruit and vegetable consumption at waves two, four, five, six and seven. The question at wave two was different from that used in later waves and as such caregiver fruit and vegetable intake is only included for waves four through seven. Caregivers were asked how many serves of fruit and how many serves of vegetables they usually eat in a day. Examples were provided of a serve of fruit (one medium piece or two small pieces or one cup of diced pieces) and a serve of vegetables (½ a cup of cooked vegetables or one cup of salad vegetables). These two questions were summed to create a variable indicating the primary caregiver's usual daily serves of fruit and vegetables.

Family variables

Household region (metropolitan, regional and rural) and the *SEIFA disadvantage decile* were allocated based on the family's residential postcode at wave one of data collection. SEIFA (Socio-Economic Indexes for Areas) is produced by the ABS from data collected as part of the National Census [183]. There are several indices produced in SEIFA that indicate the relative advantage or disadvantage of an area. The disadvantage decile was included in this analysis, with a lower score indicating an area is relatively disadvantaged compared to an area with a higher score. Household postcode was only collected at wave one of data collection, and as such the variables included in this model reflect the household region and SEIFA at the time of the child's birth.

Health Care card: Primary caregivers were asked at each wave whether they or their partner had a health care card. A health care card is means tested card provided by the Australian Federal Government to people receiving certain government payments. It allows holders to receive cheaper medicine and other discounts and is used as an indicator of low income.

6.2.3 Data analysis

All analyses were conducted using STATA 14 [143]. Descriptive statistics were produced for individual foods and beverages as well as each of the outcome and predictor variables. Across each wave of data collection there were differing percentages of children who reported not consuming different items. To enable comparison across children and waves, median and mean weekly intake was generated for all children and consumers only, respectively. Histograms were examined for the outcome variables to assess the presence of a normal distribution and all met this condition. Linear mixed-effects models were produced for each outcome (percentage of core foods and percentage of core beverages) using the 'mixed' command in STATA. Mixed models are useful for analysing longitudinal data as they allow participants with some waves of missing data to be included in the analysis [184]. Stepwise selection was used to select appropriate predictors for each model. In each model, participant ID was included as a random effect and data collection wave included as a fixed effect. Each predictor variable was added sequentially as a fixed effect, with the significance level set at $p < 0.05$.

The most appropriate way to include child age in the model was examined. Child age was not directly included in the model. As it was highly correlated with data collection wave, data collection wave was used as a proxy for child age. As previously mentioned however, there was a discrepancy between the age children were intended to be at each wave and their actual age. To account for this in the modelling, the difference between intended age and actual age was calculated (child age/wave difference). This variable was included by itself and as part of an interaction term (child age/wave difference*wave) in the models, because an age difference of a few months was likely to have more of an effect at earlier waves when children were younger compared to later waves.

Several models were tested for core food percentage and core beverage percentage. The first model included child age, child birth order, wave, wave/age difference, wave/age difference interaction, household region, SEIFA disadvantage decile, primary caregiver education, primary caregiver age and health care card status as fixed effects and participant ID as a random effect. This model included variables that were available across most data collection waves.

Two predictor variables selected for these analyses; primary caregiver fruit and vegetable intake and use of childcare, were only collected consistently from wave five onwards, and as such could not be included in the model described above. A second model was fitted which included child age, child birth order, wave, wave/age difference, wave/age difference interaction, household region, SEIFA disadvantage decile, primary caregiver education, primary caregiver age, health care card status, primary caregiver fruit and vegetable intake and childcare use as fixed effects and participant ID as a random effect. This model included fewer waves resulting in a smaller n.

Akaike Information Criterion (AIC) was calculated and models were compared sequentially to determine the quality of each subsequent model to the last. These values are displayed in Appendix G.

6.3 Results

6.3.1 Sample characteristics

The VicGen study recruited 466 children at wave one, which included two sets of twins. At wave two the sibling of an existing participant was also recruited into the study and at wave four, 14 siblings of existing participants were recruited into the study.

To ensure the independence of observations, only one child from each family was included for this analysis. Those without wave one data were excluded (n=14 enrolled at wave four, n=1 enrolled at wave two). There were seven cases where two children in the same family had data from wave one available. Two of these cases were the sets of twins, in which case the data from one twin of each pair was chosen at random to be included in the analysis. The other five cases related to older/younger siblings from the same family. In these cases, the data of the older child was included in the analysis as they would have been the first child to be enrolled in the cohort.

The number of respondents with valid data at each wave is displayed in Table 6.4. Only children who had at least two waves of data collected (including wave one) were included in the analysis, resulting in a final sample of 412 children.

Table 6.4 Number of respondents at each wave of VicGen data collection.

Wave	Approximate age	n
Wave 1	1 month	412
Wave 2	6 months	369
Wave 3	12 months	323
Wave 4	18 months	366
Wave 5	3 years	267
Wave 6	4 years	244
Wave 7	5 years	214

The baseline characteristics of participants included and excluded in analyses are displayed in Table 6.5. Primary caregivers were around two years younger in the sample excluded from analysis. Compared to those included, families excluded from the analysis (n=55) tended to: be from metropolitan areas; have lower education levels; have higher health care card possession rates; and live in an area with a lower mean SEIFA score. There were small differences in child gender and their position in the family, with a slightly higher proportion of girls and first-born children (3-4%) in the sample excluded from analysis.

Table 6.5 Baseline characteristics of VicGen participants included and excluded from analysis.

	Included n=412		Excluded n=55[3]	
Child Gender[1]				
Female	198	(48.1)	29	(52.7)
Male	214	(51.9)	26	(47.3)
Health care card[1]				
Yes	149	(36.2)	29	(52.7)
No	263	(63.8)	26	(47.3)
Position in family[1]				
1st child	183	(44.4)	26	(47.3)
2nd child	152	(36.9)	16	(29.1)
3rd child	56	(13.6)	9	(16.4)
4th or more	21	(5.1)	7	(7.3)
Household location[1]				
Metro	261	(63.4)	42	(76.4)
Regional	51	(12.4)	2	(3.6)
Rural	100	(24.3)	11	(20.0)
SEIFA disadvantage decile[2]	3.0	[2.3]	2.7	[2.0]
Highest education level[1]				
≤ Year 10	22	(5.3)	8	(14.6)
Year 11	15	(3.6)	1	(1.8)
Year 12	45	(10.9)	10	(18.2)
Apprenticeship, certificate or diploma	164	(39.8)	22	(40.0)
Bachelor's degree	117	(28.4)	12	(21.8)
Postgraduate degree	49	(11.9)	2	(3.6)
Primary carer age at baseline[2]	30.5	[5.2]	28.3	[5.2]

[1]n (%); [2]mean [sd]; [3]n=55, baseline characteristics not available for 14 children enrolled at wave 4 (18 months).

Summary statistics for the variables included in the mixed model are displayed in Table 6.6. At each wave there were more male than female children, and the proportion of children who were first-born was higher in the final three waves compared to the first three waves. Children were slightly older than the intended age at each wave of data collection, with the largest discrepancy occurring at wave five, where children were, on average, three months older than the intended age of three years. The mean age of primary caregivers included in the sample at wave seven was approximately one year older than wave two. The proportion of children receiving some sort of childcare increased between wave two and wave five, and then decreased from wave five to wave seven.

The proportion of families who possessed a health care card decreased steadily from 36.4% at wave two to 19.8% at wave seven. The proportion of primary caregivers who were university-educated increased over the course of the study, whilst those that had completed year 12 or less decreased from 20.0% at wave two to 6.9% at wave seven. The proportion of families living in metropolitan areas at baseline decreased across the waves, whilst the proportion of families in rural and regional areas increased. The SEIFA index of disadvantage (assigned based on residential location at baseline) was low (<4.0) at all waves but did increase slightly across waves.

Table 6.6 Summary statistics for child, primary caregiver and family variables from wave 2 to 7 in the VicGen birth cohort

	Wave 2 (6m) (n=365)		Wave 3 (12m) (n=323)		Wave 4 (18m) (n=366)		Wave 5 (3yr) (n=267)		Wave 6 (4yr) (n=243)		Wave 7 (5yr) (n=214)	
Child Gender[1]												
Female	175	(48.0)	151	(46.8)	172	(47.0)	126	(47.1)	113	(46.5)	99	(46.3)
Male	190	(52.1)	172	(53.3)	194	(53.0)	141	(52.8)	130	(53.5)	115	(53.7)
Child Age (months)[2]	7.6	[1.3]	13.1	[1.3]	19.8	[2.3]	39.1	[2.9]	48.7	[1.7]	60.4	[1.4]
Wave/age difference (months)	1.6	[1.3]	1.1	[1.3]	1.8	[2.3]	3.1	[2.9]	0.7	[1.7]	0.4	[1.4]
Health care card[1]												
Yes	133	(36.4)	110	(34.6)	107	(29.4)	64	(24.1)	58	(24.0)	42	(19.8)
No	232	(63.6)	208	(65.4)	257	(70.6)	202	(75.9)	184	(76.0)	170	(80.2)
Position in family[1]												
1st child	168	(46.0)	147	(45.5)	162	(44.3)	131	(49.1)	120	(49.4)	104	(48.6)
2nd child	133	(36.4)	118	(36.5)	134	(36.6)	90	(33.7)	83	(34.2)	75	(35.1)
3rd child	45	(12.3)	44	(13.6)	50	(13.7)	31	(11.6)	25	(10.3)	25	(11.7)
4th or more	19	(5.2)	14	(4.3)	20	(5.5)	15	(5.6)	15	(6.2)	10	(4.7)
Household location[1,3]												
Metro	235	(64.4)	190	(58.8)	228	(62.3)	154	(57.7)	138	(56.8)	112	(52.3)
Regional	46	(12.6)	46	(14.2)	48	(13.1)	44	(16.5)	41	(16.9)	41	(19.2)
Rural	84	(23.0)	87	(26.9)	90	(24.6)	69	(25.8)	64	(26.3)	61	(28.5)
SEIFA disadvantage decile[2]	3.0	[2.3]	3.1	[2.3]	3.1	[2.4]	3.2	[2.4]	3.2	[2.4]	3.4	[2.5]

	Wave 2 (6m) (n=365)	Wave 3 (12m) (n=323)	Wave 4 (18m) (n=366)	Wave 5 (3yr) (n=267)	Wave 6 (4yr) (n=243)	Wave 7 (5yr) (n=214)
Highest education level[1,3]						
≤ Year 10	19 (5.2)	15 (4.8)	20 (5.6)	8 (3.2)	5 (2.2)	2 (1.0)
Year 11	14 (3.8)	12 (3.8)	7 (2.0)	3 (1.2)	3 (1.3)	2 (1.0)
Year 12	40 (11.0)	31 (9.9)	36 (10.1)	16 (6.5)	12 (5.3)	10 (4.9)
Apprenticeship, certificate or diploma	149 (40.8)	128 (40.8)	151 (42.3)	98 (39.5)	94 (41.4)	80 (39.2)
Bachelor's degree	100 (27.4)	91 (29.0)	104 (29.1)	87 (35.1)	77 (33.9)	74 (36.3)
Postgraduate degree	43 (11.8)	37 (11.8)	39 (10.9)	36 (14.5)	36 (15.9)	36 (17.7)
Primary carer age at baseline[2]	30.4 [5.2]	30.5 [5.2]	30.8 [5.0]	31.4 [5.0]	31.5 [4.9]	31.4 [4.9]
Primary carer daily fruit & vegetable serves[2]	NA	NA	4.1 [1.7]	4.4 [1.7]	4.5 [1.7]	4.7 [1.8]
Any childcare[1]						
Yes	NA	251 (80.7)	297 (81.6)	229 (86.1)	194 (80.5)	164 (77.7)
No	NA	60 (19.3)	67 (18.4)	37 (13.9)	47 (19.5)	47 (22.3)

[1]n (%); [2] mean [sd]; [3] measure taken at baseline only

6.3.2 Missing values

The number and percent of missing values for foods and beverages between waves two and seven are displayed in Table 6.7 and Table 6.8. Less than 4% of values for each food were missing. Less than 3% of values for each beverage were missing, except for water which ranged between 3% and 7% across the waves. As described in Chapter 5 parents find it difficult to accurately report the frequency with which their child consumes water, particularly when it is available to them all day via a bottle.

Table 6.7 The number and percent of missing values for each food in the VicGen cohort between wave 2 and wave 7

	Wave 2 (6m) n=369		Wave 3 (12m) n=323		Wave 4 (18m) n=366		Wave 5 (3yr) n=267		Wave 6 (4yr) n=244		Wave 7 (5yr) n=214	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Jam/honey	8	2.2	3	0.9	7	1.9	5	1.9	7	2.9	6	2.8
Eggs	8	2.2	1	0.3	5	1.4	7	2.6	5	2.1	2	0.9
Nuts	9	2.4	3	0.9	11	3.0	9	3.5	8	3.3	6	2.8
Cheese	8	2.2	1	0.3	6	1.6	3	1.1	2	0.8	2	0.9
Yoghurt	6	1.6	4	1.2	5	1.4	3	1.1	3	1.2	2	0.9
Banana	8	2.2	2	0.6	7	1.9	4	1.5	NA	NA	NA	NA
Fresh fruit (not banana)	8	2.2	3	0.9	5	1.4	5	1.9	NA	NA	NA	NA
Fruit (fresh or stewed)	NA	NA	NA	NA	NA	NA	NA	NA	3	1.2	2	0.9
Dried fruit	10	2.7	2	0.6	7	1.9	5	1.9	10	4.1	9	4.2
Muesli bars	7	1.9	3	0.9	7	1.9	4	1.5	8	3.3	6	2.8
Stewed fruit	8	2.2	5	1.6	8	2.2	8	3.0	NA	NA	NA	NA
Cereal	10	2.7	3	0.9	4	1.1	6	2.3	4	1.6	2	0.9
Dry biscuits	8	2.2	5	1.6	6	1.6	6	2.3	2	0.8	2	0.9
Bread/rolls	8	2.2	2	0.6	10	2.7	3	1.1	5	2.1	0	0
Ice cream	5	1.7	2	0.6	7	1.9	1	0.4	3	1.2	1	0.5
Pudding	7	1.9	3	0.9	11	3.0	4	1.5	8	3.3	3	1.4
Custard	7	1.9	3	0.9	6	1.6	5	1.9	NA	NA	NA	NA
Jelly	6	1.6	2	0.6	7	1.9	4	1.5	NA	NA	NA	NA
Donuts	7	1.9	3	0.9	7	1.9	2	0.8	NA	NA	NA	NA
Sweet biscuits	6	1.6	2	0.6	7	1.9	4	1.5	5	2.1	1	0.5
Cakes/muffins	7	1.9	2	0.6	8	2.2	4	1.5	5	2.1	2	0.9

	Wave 2 (6m) n=369		Wave 3 (12m) n=323		Wave 4 (18m) n=366		Wave 5 (3yr) n=267		Wave 6 (4yr) n=244		Wave 7 (5yr) n=214	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Lollies/chocolates	7	1.9	2	0.6	6	1.6	2	0.8	2	0.8	2	0.9
Potato chips	8	2.2	2	0.6	6	1.6	3	1.1	3	1.2	1	0.5
Hot chips	9	2.4	1	0.3	7	1.9	2	0.8	3	1.2	2	0.9
Potato	6	1.6	3	0.9	6	1.6	1	0.4	7	2.9	1	0.5
Vegetables	8	2.2	2	0.6	7	1.9	1	0.4	2	0.8	4	1.9
Noodles/Pasta	6	1.6	2	0.6	4	1.2	2	0.8	1	0.4	4	1.9
Rice/Couscous	6	1.6	2	0.6	6	1.6	1	0.4	1	0.4	2	0.9
Baked beans	7	1.9	4	1.2	10	2.7	3	1.1	4	1.6	3	1.4
Luncheon meats	7	1.9	1	0.3	9	2.5	3	1.1	2	0.8	1	0.5
RTF baby food	6	1.6	1	0.3	6	1.6	2	0.8	NA	NA	NA	NA
Soup	9	2.4	2	0.6	8	2.2	4	1.5	4	1.6	4	1.9
Meat/fish	NA	NA	1	0.3	3	0.8	1	0.4	1	0.4	1	0.5

NA: data not collected at this wave

Table 6.8 The number and percent of missing values for each beverage in the VicGen cohort between wave 2 and wave 7

	Wave 2 (6m) n=369		**Wave 3 (12m) n=323**		**Wave 4 (18m) n=366**		**Wave 5 (3yr) n=267**		**Wave 6 (4yr) n=244**		**Wave 7 (5yr) n=214**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Water	11	3.0	21	7.0	18	4.9	17	6.4	16	6.6	12	5.6
Infant formula	7	1.9	5	1.6	NA	NA	NA	NA	NA	NA	NA	NA
Full fat cow's milk	0	-	4	1.2	8	2.2	3	1.1	3	1.2	2	0.9
Low fat cow's milk	0	-	2	0.6	4	1.1	1	0.4	3	1.2	2	0.9
Flavoured milk	0	-	2	0.6	4	1.1	2	0.8	2	0.8	3	1.4
Fruit juice/fruit drink	5	1.4	8	2.5	2	0.6	4	1.5	4	1.6	2	0.9
Cordial	0	-	1	0.3	3	0.8	5	1.9	7	2.9	5	2.3
Soft drink	0	-	1	0.3	1	0.3	2	0.8	3	1.2	2	0.9
Tea/coffee	1	0.3	1	0.3	0	-	1	0.4	2	0.8	2	0.9
Herbal drinks	1	0.3	1	0.3	0	-	1	0.4	2	0.8	2	0.9
Sports drinks	0	-	1	0.3	0	-	1	0.4	2	0.8	2	0.9

NA: data not included for this wave

6.3.3 Consumption of core and discretionary foods and beverages

The results in this section describe the percentage of consumers of foods and beverages over time, followed by the median weekly consumption for the whole sample. Mean weekly consumption is also presented, but only for children who reported consuming the item.

Core and discretionary food and beverage consumption rates

The percentage of children reported to consume in a usual week any core and discretionary foods and beverages between waves two and seven are shown in Figure 6.1 to Figure 6.3. The greatest increase in the percentage of children consuming most core foods was observed between six and 18 months of age, after which the percentage of consumers remained relatively stable, at more than 95% for most core foods (Figure 6.1). More than 40% of children were consuming at least one discretionary food at around six months of age, and there were large increases in the percentage of children consuming discretionary foods between six and 18 months of age. At 12 months of age more than 50% of children were consuming cakes and muffins, jam/honey, ice cream, sweet biscuits, custard, dry biscuits/crackers and hot chips (Figure 6.2).

Water was the most common beverage consumed between six months and five years of age (Figure 6.3). Around 9% of children were consuming full fat cow's milk at six months of age, which increased to 71.4% at 12 months, and then peaked at 18 months (84.2%). The largest increase in consumption of low-fat cow's milk and flavoured milk was reported between 18 months and three years of age, with the highest percentage of consumers reported at four years of age for these beverages (low fat cow's milk: 22.2%, flavoured milk: 49.2%). Tea/coffee, herbal teas and sports drinks were consumed by less than 10% of the sample across all ages.

The most commonly consumed sweet beverage was fruit juice/fruit drink, with 19% of children consuming this at six months age. Large increases in the percentage of children consuming fruit juice were observed from this age, until age three years (77.4%). Between age three and four years, the proportion of consumers increased slightly, and then between four and five years it decreased. Similar patterns were also observed in the proportion of children consuming cordial between six months and four years of age (3.6 % to 33.9%). Soft drinks were not reported in children's diets until around 12 months of age, when 7.1% of children were consuming them and this proportion increased markedly in later ages (three years; 45.1%, four years: 47.5%, five years: 50.9%), a pattern similar to that for cordial and fruit juices.

Core and discretionary food and beverage consumption frequency

The median weekly consumption frequency of foods and beverages for all children, along with the mean and median for children consuming the items, are displayed in Table 6.9 to Table 6.17. Cereal was the most frequently consumed grain food in the early years, with a median consumption frequency of seven times per week between six and 18 months of age. From 18 months of age onwards, median weekly consumption of cereal ranged between five and seven times per week, whilst bread and rolls had a median consumption frequency of seven times per week. Yoghurt was consumed more frequently than cheese between six and 18 months of age with a median weekly consumption frequency of 0.5 (IQR 0.0 to 2.5) at 6 months, increasing to 5.0 by 18 months (IQR 2.5 to 7.0). Median consumption frequency of cheese was lower than yoghurt in the early years (0.0 at 6 months, 2.5 at 12 months) but increased to 5.0 (IQR 2.5 to 7.0) at 18 months of age and remained at this frequency to five years of age. Meat/fish consumption frequency was only collected from 12 months of age onwards. At 12 months of age median weekly consumption frequency of meat was 5.0 (IQR 2.5 to 7.0) and remained at this frequency to five years of age.

The median weekly consumption frequency of vegetables (not potato) was 7.0 at all ages. For consumers only, the mean weekly consumption was slightly higher, 7.5 (±5.2) times per week at six months of age and 7.8 (±5.6) times per week at 5 years of age with little variation between these ages. A different pattern was observed for fresh fruit (not banana), with a median weekly consumption frequency of 2.5 (IQR 0.5 to 7.0) at age 6 months, increasing to 7.0 (IQR 2.5 to 7.0) at 12 months and then remaining at this frequency to three years of age. Mean weekly fruit consumption frequency for consumers was 5.2 (±4.8) at six months of age, increasing steadily to 10.0 (±6.7) at three years of age. At age four and five years, the fresh fruit category was combined with stewed fruit and banana. Median weekly consumption frequency was 17.5 (IQR 7.0 to 7.5) at ages four and five years, however mean weekly consumption for consumers was 12 to 13 times per week at these ages.

The most frequently consumed discretionary food between six months and five years of age were dry biscuits/crackers (Table 6.12, Table 6.13 and Table 6.14). Although the median weekly consumption frequency at 6 months of age was 0.0 (IQR 0.0 to 2.5), the 46% of children who were consuming did so on average 4.6 (±4.5) times a week. Between 12 months and five years of age the median consumption frequency varied from 2.5 to 5.0 times per week. For those who were consumers of dry biscuits (>94% of children between 12 months and five years of age), the mean weekly consumption frequency was four to six times a week.

Sweet biscuits were the second most frequently consumed discretionary food between six months and five years of age. Similarly, to dry biscuits, the median weekly consumption frequency was 0.0 (IQR 0.0 to 0.0) at six months of age, however the 15% of children who were consuming them did so on average 2.9 (±3.7) times each week. Median consumption frequency for all children increased to 1.0 (IQR 0.5 to 2.5) by 18 months of age, remaining at this rate to five years of age. The average consumption frequency for children who were consuming sweet biscuits ranged between 2-3 times per week between six months and five years of age.

Between six months and three years of age, increases in median consumption frequency were reported for potato chips, hot chips, luncheon meats, ice cream, cakes and muffins, and chocolates and lollies. By three years of age the median consumption frequency for these items, for all children was between 0.5 and 1.0 times per week. Between three and five years, the median weekly consumption frequency for all children remained between 0.5 to 1.0, but more items had a median value 1.0 compared to earlier ages. The median weekly consumption frequency of muesli bars/fruit sticks was 0.0 between six and 18 months of age, increasing to 0.5 between three and five years of age. Although, only a small proportion (~3%) of children were consuming muesli bars at six months of age, those who did eat them were having them on average 5.0 (±5) times per week. From age 12 months onwards, they were consumed, on average, one to two times per week.

The median weekly consumption frequency of water increased from 14.0 at six months of age to 35.0 at three years of age, and then remained at this rate through five years. Consumption frequency of infant formula decreased in this time frame, as expected. Weekly consumption frequency of full fat cow's milk for the whole sample peaked at 18 months of age (median: 14.0, IQR 7.0 to 21.0) and then decreased to 7.0 (IQR 0, 14.0) at five years of age. The median weekly consumption frequency of flavoured milk for the whole sample was 0.0 at every age. The 1.6% of children who did consume flavoured milk at 6 months of age, did so frequently (10-15 times/week). From age 18 months 14.5% to 49.2% of the sample were consuming flavoured milk on average 3-4 times a week.

The median weekly consumption frequency of fruit juice for the whole sample was 0.0 in the first years of life, increasing to 1.0 to 2.0 from age 18 months onwards. However, fruit juice was the most commonly consumed discretionary beverage, and those who did consume it (19% at six months, increasing to 80.2% at four years) did so on average five times per week between six months and four years of age. There was a slight decrease in consumption frequency for consumers between four and five years of age from 4.8 (±6.2) times per week to 3.4 (±4.0) times per week. The median weekly consumption frequency of soft drink for all children was 0.0 for all ages until five years when it was 0.3 (IQR 0 to 0.8). Consumption frequency of soft drink was relatively stable between 18 months and five years of age, with those who did consume it, drinking it 1-2 times per week on average.

In summary, the percentage of children consuming core foods increased until 18 months of age, after which it remained steady. The greatest changes in the median weekly consumption frequency of core foods for the whole sample were observed between six and 18 months of age, and thereafter there was little to no change. In contrast there were large increases in the proportion consuming discretionary foods between six months and three years of age, with rates steadying between three and five years. Similar patterns were observed for the median consumption frequency of discretionary foods for the whole sample and mean consumption frequency of consumers. The proportion of children consuming discretionary beverages increased steadily until age three years and steadied thereafter. The median consumption weekly frequency of discretionary beverages did not change substantially during this time.

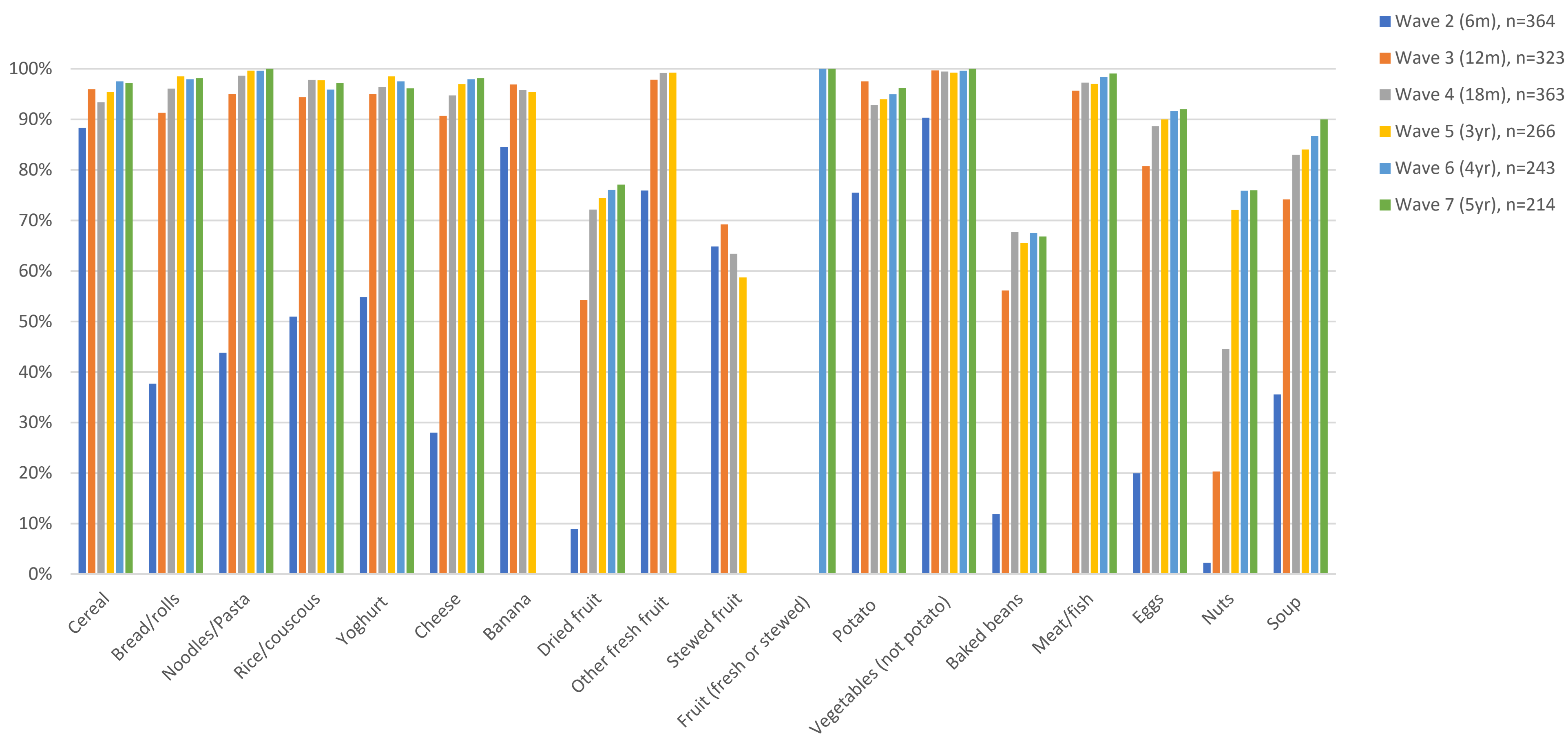


Figure 6.1 Percentage of VicGen children consuming core foods between wave 2 and wave 7

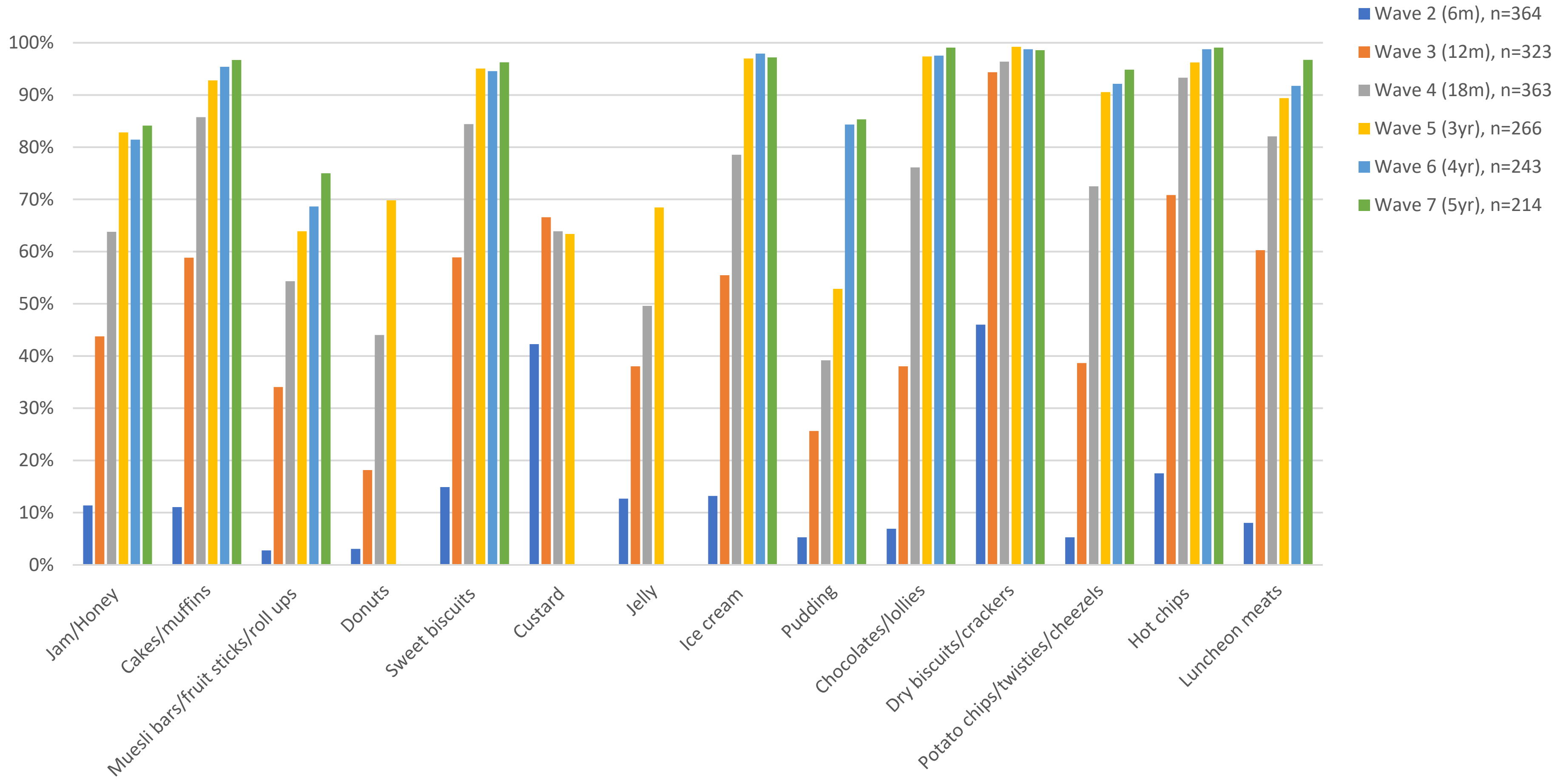


Figure 6.2 Percentage of VicGen children consuming discretionary foods between wave 2 and wave 7

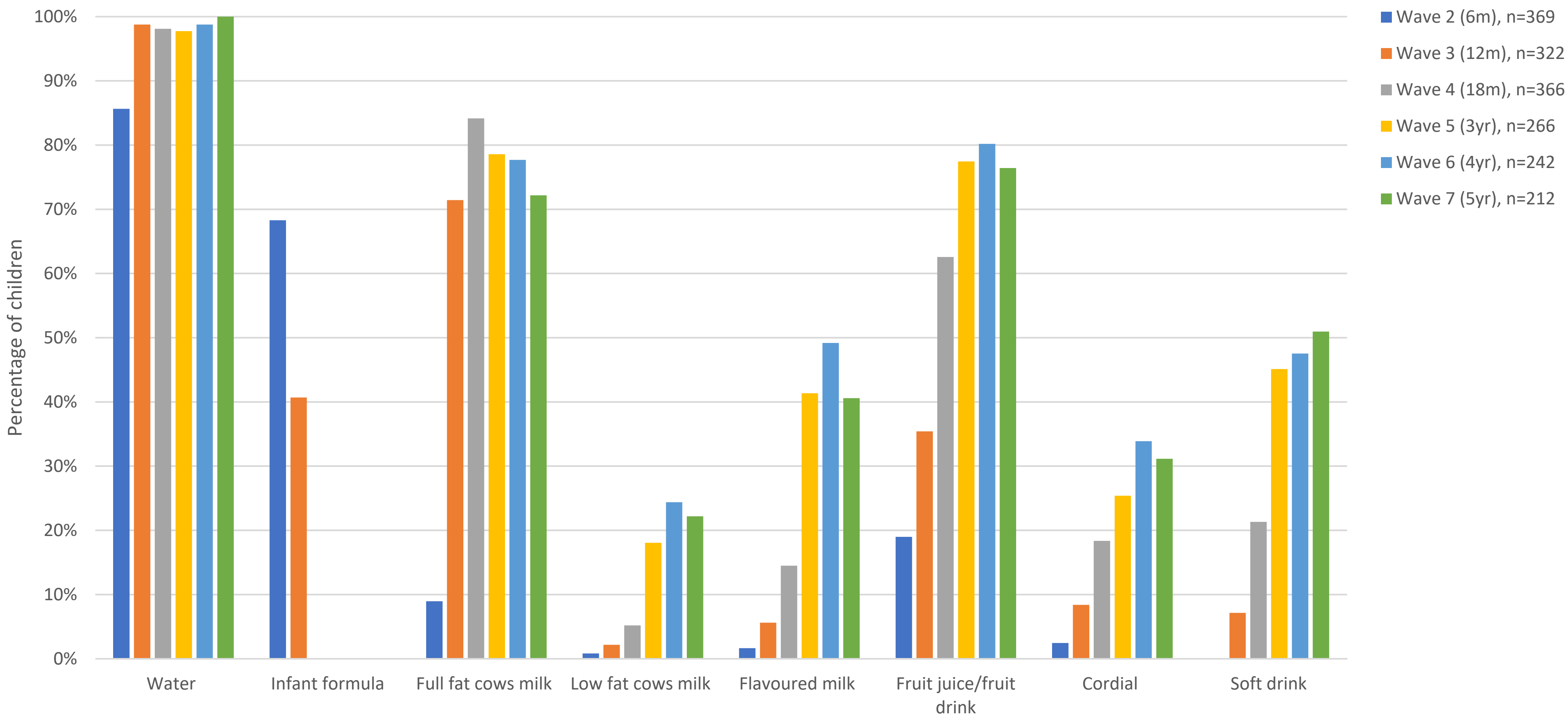


Figure 6.3 Percentage of VicGen children consuming beverages between wave 2 and wave 7

Table 6.9 Core and unclassified food consumption in the VicGen study between waves 2 and 3: Median weekly consumption frequency of whole sample, mean and median weekly consumption frequency of consumers only

	Wave 2 (6m), N = 364						Wave 3 (12m), N = 322					
	Whole sample		Consumers only				Whole sample		Consumers only			
	Mdn[1]	IQR[2]	Mean	SD[3]	Mdn[1]	IQR[2]	Mdn[1]	IQR[2]	Mean	SD[3]	Mdn[1]	IQR[2]
Potato	2.5	0.5, 5.0	3.7	[3.5]	2.5	1.0, 5.0	2.5	1.0, 5.0	3.3	[2.3]	2.5	2.5, 5.0
Vegetables (not potato)	7.0	2.5, 7.0	7.5	[5.2]	2.5	1.0, 5.0	7.0	5.0, 7.0	8.2	[5.1]	7.0	5.0, 7.0
Noodles/Pasta	0	0, 1.0	2.7	[2.6]	2.5	1.0, 5.0	2.5	1.0, 5.0	3.3	[2.7]	2.5	2.5, 5.0
Rice/couscous	0.5	0, 2.5	3.6	[4.7]	2.5	1.0, 5.0	2.5	1.0, 5.0	3.5	[3.9]	2.5	1.0, 5.0
Meat/fish	-		-		-		5.0	2.5, 7.0	5.4	[4.0]	5.0	2.5, 7.0
Banana	2.5	0.5, 2.5	2.9	[2.6]	2.5	1.0, 5.0	2.5	2.5, 7.0	4.2	[2.9]	5.0	2.5, 7.0
Other fresh fruit	2.5	0.5, 7.0	5.2	[4.8]	5.0	2.5, 7.0	7.0	2.5, 7.0	7.4	[5.5]	7.0	2.5, 7.0
Fruit (fresh or stewed)	-		-		-		-		-		-	
Stewed fruit	2.5	0, 7.0	5.4	[4.6]	5.0	2.5, 7.0	0.5	0, 2.5	2.8	[3.0]	2.5	0.5, 5.0
Bread/rolls	0	0, 1.0	4.1	[4.3]	2.5	1.0, 6.0	5.0	2.5, 7.0	5.9	[4.6]	5.0	2.5, 7.0
Cheese	0	0, 0.5	2.6	[3.0]	2.5	0.5, 2.5	2.5	2.5, 7.0	4.0	[3.6]	2.5	1.8, 5.0
Cereal	7.0	2.5, 7.0	6.6	[3.9]	7.0	5.0, 7.0	7.0	5.0, 7.0	6.1	[2.8]	7.0	2.5, 7.0
Yoghurt	0.5	0, 2.5	4.1	[3.8]	2.5	2.5, 7.0	5.0	2.5, 7.0	5.2	[3.8]	5.0	2.5, 7.0
Baked beans	0	0, 0	1.6	[1.7]	1.0	0.5, 2.5	0.5	0, 1.0	1.2	[1.7]	0.5	0.5, 1.0
Eggs	0	0, 0	1.3	[1.5]	0.5	0.5, 1.8	0.5	0.5, 1.0	1.3	[1.3]	1.0	0.5, 1.0
Nuts	0	0, 0	1.1	[0.9]	0.5	0.5, 1.8	0	0, 0	1.5	[2.5]	0.5	0.5, 1.0
Dried fruit	0	0, 0	1.9	[2.1]	0.5	0.5, 2.5	0.5	0, 2.5	2.5	[2.7]	1.0	0.5, 5.0
Soup	0	0, 0.5	2.4	[2.9]	1.0	0.5, 2.5	0.5	0, 1.0	1.9	[2.3]	1.0	0.5, 2.5
RTF baby food	1	0, 5.0	4.5	[5.4]	2.5	1.0, 5.0	0.5	0, 2.5	2.3	[3.2]	1.0	0.5, 2.5

[1]Median; [2]Interquartile range; [3]Standard deviation

Table 6.10 Core and unclassified food consumption in the VicGen study between waves 4 and 5: Median weekly consumption frequency of whole sample, mean and median weekly consumption frequency of consumers only

	Wave 4 (18m), N=363						**Wave 5 (3yr), N=266**					
	Whole sample		**Consumers only**				**Whole sample**		**Consumers only**			
	Mdn[1]	**IQR**[2]	**Mean**	**SD**[3]	**Mdn**[1]	**IQR**[2]	**Mdn**[1]	**IQR**[2]	**Mean**	**SD**[3]	**Mdn**[1]	**IQR**[2]
Potato	2.5	1.0, 5.0	2.9	[2.5]	2.5	1.0, 5.0	2.5	1.0,2.5	2.5	[1.7]	2.5	1.0, 2.5
Vegetables (not potato)	7.0	5.0, 7.0	7.7	[5.3]	7.0	5.0, 7.0	7.0	5.0, 7.0	7.4	[5.1]	7.0	5.0, 7.0
Noodles/Pasta	2.5	1.0, 5.0	3.2	[2.8]	2.5	1.0, 5.0	2.5	1.0, 2.5	2.7	[1.6]	2.5	1.0, 2.5
Rice/couscous	2.5	1.0, 5.0	3.7	[4.5]	2.5	1.0, 5.0	1.0	1.0, 2.5	3.0	[3.9]	1.0	1.0, 2.5
Meat/fish	5.0	2.5, 7.0	6.1	[4.5]	5.0	2.5, 7.0	5.0	2.5, 7.0	5.7	[3.6]	5.0	5.0, 7.0
Banana	2.5	1.0, 5.0	3.7	[2.6]	2.5	2.5, 5.0	2.5	2.5, 5.0	3.9	[3.4]	2.5	2.5, 5.0
Other fresh fruit	7.0	5, 17.5	8.5	[6.3]	7.0	5.0, 17.5	7.0	5.0, 17.5	10.0	[6.7]	7.0	5.0, 17.5
Fruit (fresh or stewed)	-		-		-		-		-		-	
Stewed fruit	0.5	0, 0.5	1.6	[2.4]	0.5	0.5, 1.0	0.5	0, 0.5	1.1	[2.4]	0.5	0.5, 1.0
Bread/rolls	5.0	2.5, 7.0	5.9	[4.6]	5.0	2.5, 7.0	7.0	2.5, 7.0	6.3	[4.6]	7.0	2.5, 7.0
Cheese	5.0	2.5, 7.0	5.0	[4.0]	5.0	2.5, 7.0	5.0	2.5, 7.0	4.9	[3.8]	5.0	2.5, 7.0
Cereal	7.0	2.5, 7.0	5.3	[2.8]	7.0	2.5, 7.0	5.0	2.5, 7.0	5.1	[2.7]	7.0	2.5, 7.0
Yoghurt	5.0	2.5, 7.0	4.8	[3.4]	5.0	2.5, 7.0	2.5	2.5, 7.0	4.3	[3.4]	2.5	2.5, 7.0
Baked beans	0.5	0, 1.0	1.3	[2.3]	0.5	0.5, 1.0	0.5	0, 1.0	1.0	[1.0]	0.5	0.5, 1.0
Eggs	1.0	0.5, 2.5	1.6	[1.4]	1.0	0.5, 2.5	1.0	0.5, 2.5	1.8	[1.5]	1.0	1.0, 2.5
Nuts	0	0, 0.5	1.2	[1.8]	0.5	0.5, 1.0	0.5	0, 1.0	1.4	[2.1]	0.5	0.5, 1.0
Dried fruit	0.5	0, 2.5	2.5	[2.7]	1.0	0.5, 5.0	0.5	0, 1.0	1.6	[1.8]	1.0	0.5. 2.5
Soup	1.0	0.5, 1.0	1.8	[2.6]	1.0	0.5, 2.5	1.0	0.5, 1.0	1.3	[1.3]	1.0	0.5, 1.0
RTF baby food	0	0, 0.5	1.5	[2.6]	0.5	0.5, 1.0	0.0	0, 0	0.6	[0.4]	0.5	0.5, 0.5

[1]Median; [2]Interquartile range; [3]Standard deviation

Table 6.11 Core and unclassified food consumption in the VicGen study between waves 6 and 7: Median weekly consumption frequency of whole sample, mean and median weekly consumption frequency of consumers only

	Wave 6 (4yr), N=243						Wave 7 (5yr), N=214					
	Whole sample		Consumers only				Whole sample		Consumers only			
	Mdn[1]	IQR[2]	Mean	SD[3]	Mdn[1]	IQR[2]	Mdn[1]	IQR[2]	Mean	SD[3]	Mdn[1]	IQR[2]
Potato	2.5	1.0, 2.5	2.6	[2.3]	2.5	1.0, 2.5	2.5	1.0, 2.5	2.3	[1.7]	2.5	1.0, 2.5
Vegetables (not potato)	7.0	5.0, 7.0	8.0	[5.8]	7.0	5.0, 7.0	7.0	5.0, 7.0	7.8	[5.6]	7.0	5.0, 7.0
Noodles/Pasta	2.5	1.0, 2.5	2.5	[1.6]	2.5	1.0, 2.5	2.5	1.0, 2.5	2.4	[1.4]	2.5	1.0, 2.5
Rice/couscous	1.0	1.0, 2.5	2.7	[3.6]	1.0	1.0, 2.5	1.0	1.0, 2.5	2.5	[2.7]	1.8	1.0, 2.5
Meat/fish	5.0	2.5, 7.0	5.4	[3.0]	5.0	5.0, 7.0	5.0	5.0, 7.0	5.6	[3.5]	5.0	5.0, 7.0
Banana		-				-		-	-			-
Other fresh fruit		-				-		-	-			-
Fruit (fresh or stewed)	17.5	7.0, 17.5	12.0	[6.8]	17.5	7.0, 17.5	17.5	7.0, 17.5	12.9	[6.4]	17.5	7.0, 17.5
Stewed fruit		-				-		-	-			-
Bread/rolls	7.0	2.5, 7.0	6.6	[5.0]	7.0	2.5, 7.0	7.0	3.0, 7.5	7.2	[6.2]	5.0	2.5, 7
Cheese	5.0	2.5, 7.0	4.9	[4.0]	5.0	2.5, 7.0	5.0	2.5, 6	4.7	[3.3]	2.5	2.5, 7
Cereal	7.0	2.5, 7.0	5.2	[2.5]	7.0	2.5, 7.0	5.0	2.5, 7	5.3	[3.1]	3.0	2.5, 5.5
Yoghurt	2.5	2.5, 5.0	4.4	[3.4]	2.5	2.5, 7.0	2.5	2.0, 5.5	4.1	[2.9]	7.0	3.0, 7.5
Baked beans	0.5	0, 0.5	0.8	[0.7]	0.5	0.5, 1.0	0.5	0, 0.5	0.7	[0.4]	0.5	0.5, 1.0
Eggs	1.0	0.5, 2.5	1.7	[1.4]	1.0	1.0, 2.5	1.0	1.0, 2.5	1.8	[1.8]	1.0	1.0, 2.5
Nuts	0.5	0.5, 1	1.4	[1.8]	1.0	0.5, 2.5	0.5	0.5, 1.0	1.4	[1.8]	0.5	0.5, 2.5
Dried fruit	0.5	0.5, 1	1.8	[2.3]	1.0	0.5, 2.5	0.5	0.5, 1.0	1.8	[2.3]	1.0	0.5, 2.5
Soup	0.5	0.5, 1	1.2	[1.3]	1.0	0.5, 1.0	0.5	0.5, 1.0	1.2	[1.6]	1.0	0.5, 1.0
RTF baby food		-				-		-	-			-

[1]Median; [2]Interquartile range; [3]Standard deviation

Table 6.12 Discretionary food consumption in the VicGen study between waves 2 and 3: Median weekly consumption frequency of whole sample, mean and median weekly consumption frequency of consumers only

	Wave 2 (6m), N = 364						**Wave 3 (12m), N = 322**					
	Whole sample		**Consumers only**				**Whole sample**		**Consumers only**			
	Mdn[1]	**IQR**[2]	**Mean**	**SD**[3]	**Mdn**[1]	**IQR**[2]	**Mdn**[1]	**IQR**[2]	**Mean**	**SD**[3]	**Mdn**[1]	**IQR**[2]
Muesli bars/fruit sticks/roll ups	0	0, 0	5.0	[5.0]	3.8	2.5, 7.0	0	0, 0.5	1.9	[2.3]	1.0	0.5, 2.5
Jam/Honey	0	0, 0	1.4	[1.8]	0.5	0.5, 1.0	0	0, 0.5	1.3	[1.6]	0.5	0.5, 1
Ice cream	0	0, 0	0.9	[1.1]	0.5	0.5, 0.8	0.5	0, 0.5	0.9	[1.0]	0.5	0.5, 1
Pudding	0	0, 0	1.8	[2.0]	0.5	0.5, 2.5	0	0, 0.5	1.0	[1.4]	0.5	0.5, 0.5
Sweet biscuits	0	0, 0	2.9	[3.7]	1.0	0.5, 2.5	0.5	0, 1.0	2.0	[2.2]	1.0	0.5, 2.5
Cakes/muffins	0	0, 0	0.6	[0.5]	0.5	0.5, 0.5	0.5	0, 0.5	0.8	[0.7]	0.5	0.5, 0.5
Chocolates/lollies	0	0, 0	0.8	[0.6]	0.5	0.5, 1.0	0	0, 0.5	0.8	[1.0]	0.5	0.5, 0.5
Custard	0	0, 1.0	2.6	[2.6]	2.5	1.0, 2.5	0.5	0, 1.0	1.9	[1.9]	1.0	0.5, 2.5
Donuts	0	0, 0	0.9	[0.8]	0.5	0.5, 1.0	0	0, 0	0.6	[0.3]	0.5	0.5, 0.5
Jelly	0	0, 0	1.6	[1.4]	1.0	0.5, 2.5	0	0, 0.5	0.9	[0.7]	0.5	0.5, 1
Dry biscuits/crackers	0	0, 2.5	4.6	[4.5]	0.5	0.5, 0.5	5	2.5, 7	6.0	[4.8]	5.0	2.5, 7.0
Potato chips / twisties/ cheezels	0	0, 0	0.7	[0.6]	0.5	0.5, 1.0	0	0, 0.5	0.9	[0.9]	0.5	0.5, 1
Hot chips	0	0, 0	0.8	[0.8]	0.5	0.5, 1.0	0.5	0, 1.0	1.0	[1.0]	0.5	0.5, 1
Luncheon meats	0	0, 0	1.3	[1.6]	0.5	0.5, 1.0	0.5	0, 1.0	1.8	[2.6]	1.0	0.5, 2.5

[1]Median; [2]Interquartile range; [3]Standard deviation

Table 6.13 Discretionary food consumption in the VicGen study between waves 4 and 5: Median weekly consumption frequency of whole sample, mean and median weekly consumption frequency of consumers only

	Wave 4 (18m), N=363						Wave 5 (3yr), N=266					
	Whole sample		**Consumers only**				**Whole sample**		**Consumers only**			
	Mdn[1]	**IQR[2]**	**Mean**	**SD[3]**	**Mdn[1]**	**IQR[2]**	**Mdn[1]**	**IQR[2]**	**Mean**	**SD[3]**	**Mdn[1]**	**IQR[2]**
Muesli bars/fruit sticks/roll ups	0.5	0, 1.0	2.0	[2.5]	1.0	0.5, 2.5	0.5	0, 1.0	1.5	[1.5]	1.0	0.5, 2.5
Jam/Honey	0.5	0, 1.0	1.5	[1.7]	0.5	0.5, 2.5	1.0	0.5, 2.5	2.0	[2.1]	1.0	0.5, 2.5
Ice cream	0.5	0.5, 1.0	1.1	[1.5]	0.5	0.5, 1	0.5	0.5, 1	1.3	[1.7]	0.5	0.5, 1.0
Pudding	0	0, 0.5	0.7	[0.5]	0.5	0.5, 0.5	0.5	0, 0.5	0.6	[0.5]	0.5	0.5, 0.5
Sweet biscuits	1.0	0.5, 2.5	2.2	[2.6]	1.0	0.5, 2.5	1.0	0.5, 2.5	2.2	[2.3]	1.0	0.5, 2.5
Cakes/muffins	0.5	0.5, 1	1.0	[1.0]	0.5	0.5, 1	1.0	0.5, 2.5	1.3	[1.0]	1.0	0.5, 2.5
Chocolates/lollies	0.5	0.5, 1	1.5	[1.5]	0.5	0.5, 2.5	1.0	0.5, 2.5	2.4	[2.8]	1.0	0.5, 2.5
Custard	0.5	0, 0.5	1.2	[1.7]	0.5	0.5, 1	0.5	0, 0.5	0.8	[0.9]	0.5	0.5, 1.0
Donuts	0	0, 0.5	0.6	[0.4]	0.5	0.5, 0.5	0.5	0, 0.5	0.7	[0.7]	0.5	0.5, 0.5
Jelly	0	0, 0.5	0.9	[1.4]	0.5	0.5, 0.5	0.5	0, 0.5	0.8	[0.8]	0.5	0.5, 0.5
Dry biscuits/crackers	5.0	2.5, 7.0	5.3	[4.9]	5.0	2.5, 7.0	2.5	2.5, 7.0	4.5	[4.1]	2.5	2.5, 7.0
Potato chips/ twisties/ cheezels	0.5	0, 1.0	1.1	[1.1]	0.5	0.5, 1	0.8	0.5, 1	1.4	[1.5]	1.0	0.5, 2.5
Hot chips	0.5	0.5, 1	1.2	[1.1]	1.0	0.5, 1	1.0	0.5, 1	1.2	[1.1]	1.0	0.5, 1.0
Luncheon meats	1.0	0.5, 2.5	2.0	[2.2]	1.0	0.5, 2.5	1.0	0.5, 2.5	2.4	[2.3]	2.5	1.0, 2.5

[1]Median; [2]Interquartile range; [3]Standard deviation

Table 6.14 Discretionary food consumption in the VicGen study between waves 6 and 7: Median weekly consumption frequency of whole sample, mean and median weekly consumption frequency of consumers only

	Wave 6 (4yr), N=243						Wave 7 (5yr), N=214					
	Whole sample		Consumers only				Whole sample		Consumers only			
	Mdn[1]	IQR[2]	Mean	SD[3]	Mdn[1]	IQR[2]	Mdn[1]	IQR[2]	Mean	SD[3]	Mdn[1]	IQR[2]
Muesli bars/fruit sticks/roll ups	0.5	0, 2.5	1.7	[1.7]	1.0	0.5, 2.5	0.5	0.3, 2.5	1.9	[2.8]	6.0	2.5, 7.0
Jam/Honey	1.0	0.5, 2.5	1.9	[2.1]	1.0	0.5, 2.5	1.0	0.5, 2.5	2.1	[1.9]	1.0	0.5, 2.5
Ice cream	1.0	0.5, 2.5	1.6	[1.8]	1.0	0.5, 2.5	1.0	0.5, 2.5	1.4	[1.3]	1.0	0.5, 2.5
Pudding	0.5	0.5, 1.0	1.0	[1.1]	0.5	0.5, 1.0	0.5	0.5, 1.0	1.0	[1.0]	0.5	0.5, 1.0
Sweet biscuits	1.0	0.5, 2.5	2.5	[3.0]	2.5	0.5, 2.5	1.0	0.5, 2.5	2.2	[2.1]	2.5	0.5, 2.5
Cakes/muffins	1.0	0.5, 1.0	1.3	[1.2]	1.0	0.5, 2.5	1.0	0.5, 2.5	1.4	[1.1]	1.0	0.5, 2.5
Chocolates/lollies	1.0	0.5, 2.5	1.9	[1.6]	1.0	0.8, 2.5	1.0	0.5, 2.5	2.0	[2.1]	1.0	1.0, 2.5
Custard		-	-			-		-	-			-
Donuts		-	-			-		-	-			-
Jelly		-	-			-		-	-			-
Dry biscuits/crackers	5.0	2.5, 7.0	4.7	[3.7]	5.0	2.5, 7.0	2.5	2.5, 7.0	4.5	[4.2]	5.0	0.5, 7.0
Potato chips/ twisties/cheezels	1.0	0.5, 1.0	1.2	[1.1]	1.0	0.5, 1.0	1.0	0.5, 2.5	1.4	[1.3]	1.0	0.5, 2.5
Hot chips	1.0	0.5, 1.0	1.1	[1.0]	1.0	0.5, 1.0	1.0	0.5, 1.0	1.2	[1.0]	1.0	0.5, 1.0
Luncheon meats	2.5	0.5, 2.5	2.5	[2.4]	2.5	1.0, 2.5	2.5	1.0, 5.0	2.8	[2.3]	2.5	1.0, 5.0

[1]Median; [2]Interquartile range; [3]Standard deviation

Table 6.15 Beverage consumption in the VicGen study between waves 2 and 3: Median weekly consumption frequency of whole sample, mean and median weekly consumption frequency of consumers only

	Wave 2 (6m), N=369						**Wave 3 (12m), N=322**					
	Whole sample		**Consumers only**				**Whole sample**		**Consumers only**			
	Mdn[1]	**IQR**[2]	**Mean**	**SD**[3]	**Mdn**[1]	**IQR**[2]	**Mdn**[1]	**IQR**[2]	**Mean**	**SD**[3]	**Mdn**[1]	**IQR**[2]
Water	14.0	4.0, 21.0	17.5	[12.2]	14.0	7.0, 21.0	28	21.0, 35.0	29.6	[18.1]	28	21.0, 35.0
Infant formula	21.0	0, 28.0	26.5	[10.8]	28.0	21.0, 35.0	0	0, 21.0	20.7	[9.1]	21.0	14.0, 28.0
Full fat cow's milk	0.0	0, 0	12.6	[15.8]	7.0	3.0, 14.0	7	0, 21.0	15.8	[9.1]	14.0	7.0, 21.0
Low fat cow's milk	0	0, 0	5.7	[2.31]	7.0	3.0, 7.0	0	0, 0	9.2	[10.4]	5.0	2.0, 14.0
Flavoured milk	0	0, 0	11.5	[13.7]	5.0	2.5, 21.0	0	0, 0	3.0	[3.7]	1.0	0.5, 5.0
Fruit juice/fruit drink	0	0, 0	4.9	[4.5]	3.0	1.0, 7.0	0	0, 1.0	4.3	[4.6]	2.0	1.0, 7.0
Cordial	0	0, 0	3.6	[2.7]	2.0	2.0, 7.0	0	0, 0	7.7	[7.9]	7.0	2.0, 7.0
Soft drink	-		-		-		0	0, 0	1.1	[0.8]	1.0	0.3, 2.0

[1]Median; [2]Interquartile range; [3]Standard deviation

Table 6.16 Beverage consumption in the VicGen study between waves 4 and 5: Median weekly consumption frequency of whole sample, mean and median weekly consumption frequency of consumers only

	Wave 4 (18m), N=366						**Wave 5 (3yr), N=266**					
	Whole sample		**Consumers only**				**Whole sample**		**Consumers only**			
	Mdn[1]	**IQR**[2]	**Mean**	**SD**[3]	**Mdn**[1]	**IQR**[2]	**Mdn**[1]	**IQR**[2]	**Mean**	**SD**[3]	**Mdn**[1]	**IQR**[2]
Water	28.0	21.0, 42.0	33.6	[18.9]	28.0	21.0, 42.0	35	21.0, 42.0	37.3	[18.4]	35.0	26.3, 42.0
Infant formula	0	0, 0	17.7	[8.2]	14.0	14.0, 21.0	0	0, 0	10.3	[6.8]	7.0	7.0, 14.0
Full fat cow's milk	14.0	7.0, 21.0	15.8	[7.5]	14.0	14.0, 21.0	12.3	3.3, 14.0	13.0	[6.3]	14.0	7.0, 14.0
Low fat cow's milk	0	0, 0	10.1	[8.7]	7.0	2.0, 17.5	0	0, 0	10.6	[6.7]	7.0	7.0, 14.0
Flavoured milk	0	0, 0	4.3	[5.2]	2.0	0.5, 7.0	0	0, 1.0	3.4	[3.8]	2.0	1.0, 4.0
Fruit juice /fruit drink	1.0	0, 4.5	5.1	[5.2]	3.0	1.0, 7.0	2	0.3, 7.0	5.3	[6.5]	3.0	1.0, 7.0
Cordial	0	0, 0	5.1	[7.6]	2.0	1.0, 7.0	0	0, 0	4.2	[5.5]	2.0	1.0, 7.0
Soft drink	0	0, 0	1.9	[3.5]	1.0	0.5, 2.0	0	0, 1.0	1.7	[1.8]	1.0	0.5, 2.0

[1]Median; [2]Interquartile range; [3]Standard deviation

Table 6.17 Beverage consumption in the VicGen study between waves 6 and 7: Median weekly consumption frequency of whole sample, mean and median weekly consumption frequency of consumers only

	Wave 6 (4yr), N=242						**Wave 7 (5yr), N=212**					
	Whole sample		**Consumers only**				**Whole sample**		**Consumers only**			
	Mdn[1]	**IQR[2]**	**Mean**	**SD[3]**	**Mdn[1]**	**IQR[2]**	**Mdn[1]**	**IQR[2]**	**Mean**	**SD[3]**	**Mdn[1]**	**IQR[2]**
Water	35.0	28.0, 49.0	38.3	[18.1]	35.0	28.0, 49.0	35.0	28.0, 42.0	38.0	[16.9]	35.0	28.0, 42.0
Infant formula	-		-		-		-		-		-	
Full fat cow's milk	7.0	2.0, 14.0	11.2	[5.7]	14.0	7.0, 14.0	7.0	0 14.0	10.4	[6.9]	7.0	7.0, 14.0
Low fat cow's milk	0	0, 0	10.6	[7.2]	10.5	7.0, 14.0	0	0, 0	10.1	[5.9]	7.0	7.0, 14.0
Flavoured milk	0	0, 2.0	3.4	[4.2]	2.0	1.0, 4.0	0	0, 1.0	2.5	[2.5]	2.0	1.0, 3.0
Fruit juice/fruit drink	1	0.3, 5.0	4.8	[6.2]	2.0	1.0, 7.0	1.0	0.3, 3.0	3.6	[4.0]	2.0	0.8, 5.0
Cordial	0	0, 1.0	4.1	[5.3]	2.0	1.0, 7.0	0	0, 0.5	4.3	[6.2]	2.0	1.0, 7.0
Soft drink	0	0, 1.0	1.7	[1.9]	1.0	0.5, 2.0	0.3	0, 0.8	1.3	[1.9]	0.8	0.5, 1.0

[1]Median; [2]Interquartile range; [3]Standard deviation

6.3.4 Contribution of core and discretionary foods and beverages to consumption frequency

The mean percentage that core foods and beverages contribute to overall weekly consumption frequency was generated for each wave and is displayed in Figure 6.4 and Figure 6.5. The contribution of core foods decreased steadily from 88.8% at age six months to 74.0% at age five years. The percentage that core beverages contributed to overall beverage consumption frequency decreased from 97.2% at age six months to 85.0% at age three years, then remained stable at age four years, before increasing to 87.9% at age five years.

Linear Mixed Effects Models

Several linear mixed effects models were tested with 1) the mean percentage consumption frequency contributed by core foods and 2) the mean percentage consumption frequency contributed by core beverages as separate outcomes. Covariates were added sequentially and the models from each step are displayed in Appendix G (Table 9.5 to Table 9.8). Two final models are presented for each outcome. The first model includes the covariates child birth order, data collection wave, child age/wave difference, child age/wave difference interaction, household region, SEIFA disadvantage decile, primary carer education, primary carer age, child gender and health care card status. The second model includes the previous covariates as well as parent fruit/vegetable intake and use of childcare.

Adjusted mean change in percentage contribution between waves

The mean change between sequential waves for 1) the mean percentage consumption frequency contributed by core foods 2) the mean percentage consumption frequency contributed by core beverages was also examined with the final linear mixed models using pairwise comparisons. The mean change between waves, adjusted for child birth order, data collection wave, child age/wave difference, child age/wave difference interaction, household region, SEIFA disadvantage decile, primary carer education, primary carer age, child gender and health care card status (model one) and then parent fruit/vegetable intake and use of childcare (model two) are presented in Table 6.18. For foods, the largest difference was seen between age six and 12 months with a 9.3% decrease (95%CI: 7.3 to 11.2%, p <0.001) in the mean percentage consumption frequency contributed by core foods. For beverages, the largest difference was seen between waves four and five, with a 6.9% decrease (95%CI: 4.1% to 9.7%, p<0.001) in the mean percentage consumption frequency contribute by core beverages. No significant differences were observed for foods or beverages between ages three, four or five years when adjusting for the variables in model one. This remained for beverages with the addition of parent fruit and vegetable daily serves and childcare into model two, however for foods a small, but significant difference was observed between age four and five years (mean difference -1.1% 95%CI: 0.1% to 2.7%, p 0.038).

Mean percentage consumption frequency contributed by core foods.

The association between covariates and the mean percentage consumption frequency contributed by core foods between six months and five years of age are displayed in Table 6.19 and Table 6.20. Household location and the primary caregiver's age were associated with an increase in the mean percentage consumption frequency contributed by core foods between the age of six months and five years. The mean percentage consumption frequency contributed by core foods was 2.7% higher (95%CI: 0.2% to 5.2%, p =0.031) for children born in regional areas than children in metropolitan areas. There was no association with residing in a rural area. Although a significant association, the mean percentage increase associated with primary caregiver age was very small. A one-year increase in primary caregiver age was associated with a 0.2% increase (95%CI: 0.1% to 0.4%, p =0.005) in the mean percentage consumption frequency contributed by core foods.

The mean percentage consumption frequency contributed by core foods was 2.3% lower (95%CI: 0.5% to 4.0%, p=0.012) in second born and 3.2% lower (95%CI: 0.6% top 0.57%, p=0.014) in third born children compared to first born children. Being born fourth or later into the family was not associated with core foods. No associations were observed between SEIFA decile, child gender or health care card possession and the mean percentage consumption frequency contributed by core foods.

The number of observations dropped from 1673 from 410 individuals to 994 from 356 individuals when primary caregivers' daily fruit and vegetable serves, and childcare were added (Table 6.20). Between age 18 months and five years, a one serve increase in primary caregivers' daily fruit and vegetable intake was associated with a 0.8% increase in the mean percentage consumption frequency contributed by core foods (95%CI: 0.4% to 1.1%, p<0.001). No association was observed between childcare and percentage contribution of core foods.

Mean percentage consumption frequency contributed by core beverages.

The association between covariates and the mean percentage consumption frequency contributed by core beverages is displayed in Table 6.21 and Table 6.22. Similarly to core foods, household region, and primary caregiver age were all associated with core beverages contributing a greater mean percentage to overall beverage consumption frequency between child age six months and five years. Unlike core foods, an association between parent education was also observed. The mean percentage consumption frequency that core beverages contributed to overall intake was 4% higher (95% CI: 0.6 to 7.4%, p =0.021) in children who were born in a regional area compared to those born in a metropolitan area. As with core foods, there was no association with being born in a rural area.

Compared to children with primary caregivers who had not completed any schooling higher than year 10, the mean percentage consumption frequency contributed by core beverages was 5.6% (95%CI: 0.9% to 10.3%, p=0.020) higher for children whose primary caregiver held a bachelor's degree and 7.9% higher (95%CI: 2.7% to 13.2%, p=0.003) where a postgraduate degree was held. No associations were observed between the three other education categories and mean percentage consumption frequency contributed by core beverages.

A significant positive association was observed between increased primary caregiver age at the time of the child's birth and the mean percentage consumption frequency contributed by core beverages. Despite its significance, the magnitude of this association was quite small, with a one-year increase in caregiver age associated with a 0.3% increase (95%CI: <0.001% to 0.5%, p 0.029) in the mean percentage consumption frequency contributed by core beverages.

In contrast, child birth order was associated with a decrease in the mean percentage consumption frequency contributed by core beverages. Compared to being first born, the contribution of core beverages was lower in children who were born second or later into their family. This observation was only significant with children who were fourth (or later) born in to their family. On average these children had an 8.9% decrease (95%CI:3.6%, to 14.2% p=0.001) in the mean percentage consumption frequency contributed by core beverages compared to first born children.

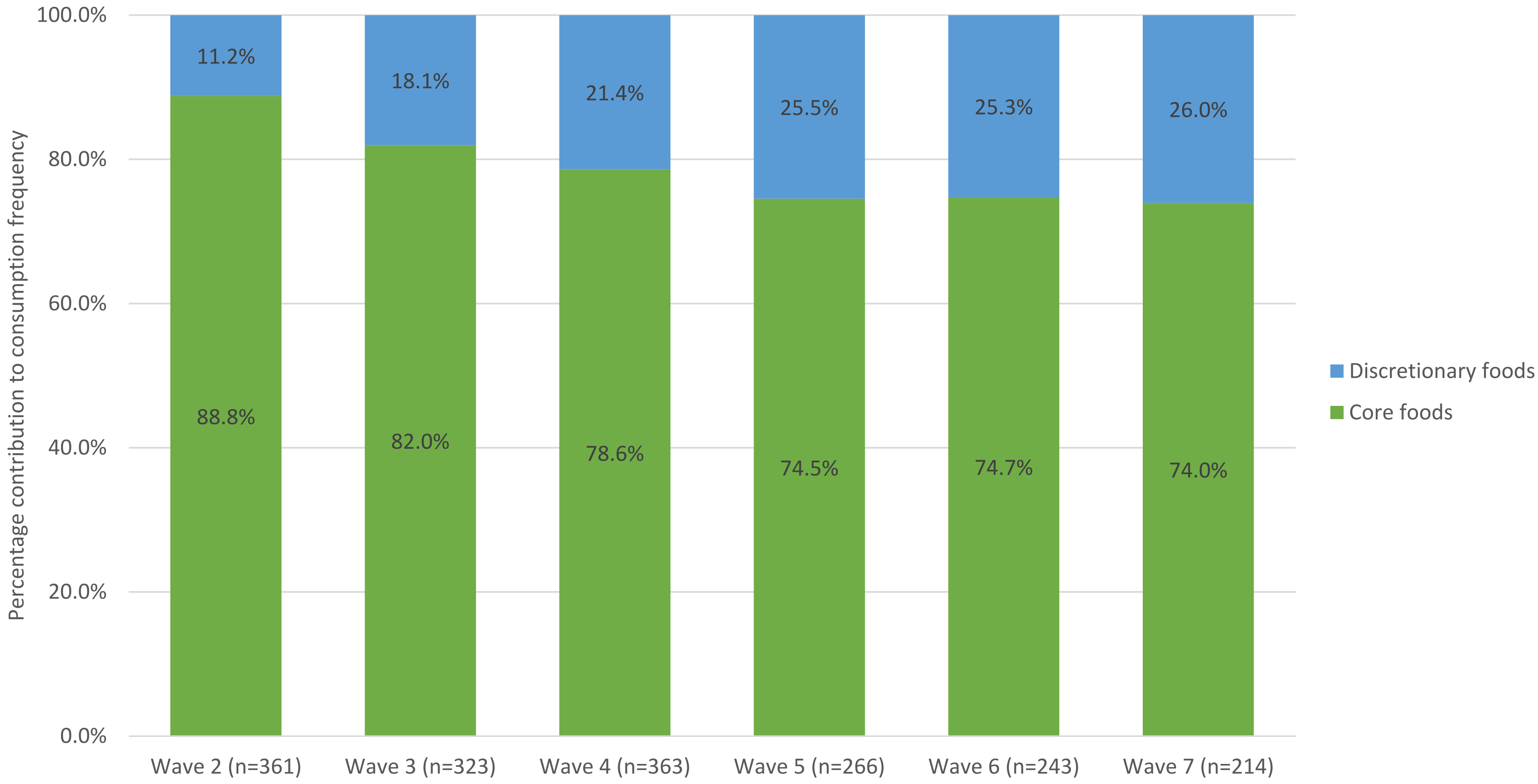


Figure 6.4 Mean percentage contribution of core and discretionary foods to overall food consumption frequency from wave 2 to wave 7 of the VicGen study

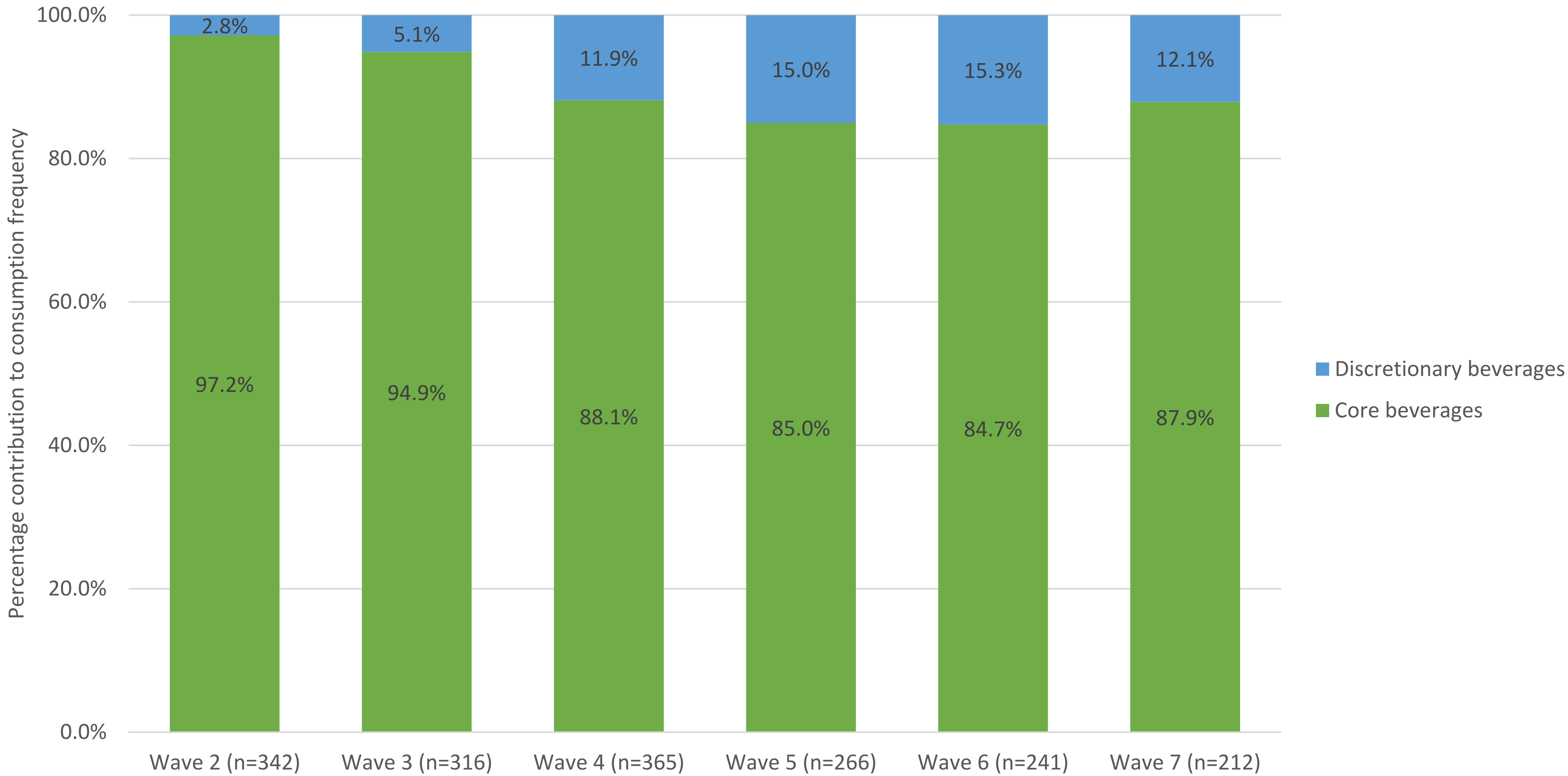


Figure 6.5 Mean percentage contribution of core and discretionary beverages to overall beverage consumption frequency from wave 2 to wave 7 of the VicGen study

Table 6.18 Adjusted change in mean percentage consumption frequency contributed by core foods and beverages between sequential waves of the VicGen study

	Model 1[1]			Model 2[2]		
	Mean % change	**95%CI**	**p**	**Mean % change**	**95%CI**	**p**
Core foods[3]						
Wave 3 to 2	-9.3	[-11.2 -7.3]	**<0.001**			
Wave 4 to 3	-4.1	[-5.8 -2.4]	**<0.001**			
Wave 5 to 4	-4.2	[-6.2 -2.3]	**<0.001**	-4.5	[-6.1 -3.0]	**<0.001**
Wave 6 to 5	-0.7	[-2.7 1.3]	0.48	-0.6	[-2.1 1.0]	0.48
Wave 7 to 6	-1.1	[-2.8 0.6]	0.19	-1.4	[-2.7 -0.1]	**0.038**
Core beverages[4]						
Wave 3 to 2	-3.0	[-6.0 -0.1]	**0.045**			
Wave 4 to 3	-4.9	[-7.3 -2.4]	**<0.001**			
Wave 5 to 4	-6.9	[-9.7 -4.1]	**<0.001**	-7.4	[-10.2 -4.6]	**<0.001**
Wave 6 to 5	-0.2	[-3.0 2.7]	0.91	-0.4	[-3.3 2.4]	0.76
Wave 7 to 6	2.2	[-0.2 4.6]	0.08	1.6	[-0.9 4.0]	0.20

[1]Adjusted for: child gender, household region, SEIFA disadvantage decile, primary carer education, age and health care card status, child age/wave difference, child age/wave interaction; [2]Adjusted for variables in model 1 plus primary carer daily fruit/veg serves and child care; [3]Model 1: 1673 observations from 410 individuals, Model 2: 994 observations from 356 individuals; [4]Model 1: 1646 observations from 407 individuals, Model 2: 993 observations from 357 individuals.

Table 6.19 Final mixed model for proportion of frequency of consumption as core food, excluding parent age and childcare (1673 observations from 410 individuals)

	Coefficient	95% CI	p
Child birth order[1]			
2nd	-2.3	[-4.0 -0.5]	**0.012**
3rd	-3.2	[-5.7 -0.6]	**0.014**
4th or more	-2.6	[-6.5 1.2]	0.18
Wave[2]			
Wave 3	-9.3	[-11.2 -7.3]	**<0.001**
Wave 4	-13.4	[-15.2 -11.5]	**<0.001**
Wave 5	-17.6	[-19.8 -15.4]	**<0.001**
Wave 6	-18.3	[-20.2 -16.3]	**<0.001**
Wave 7	-19.4	[-21.3 -17.4]	**<0.001**
Child age/wave difference	-1.7	[-2.4 -0.9]	**<0.001**
Child age/wave difference interaction[2]			
Wave 3	0.7	[-0.3 1.8]	0.18
Wave 4	1.6	[0.8 2.4]	**<0.001**
Wave 5	1.5	[0.7 2.3]	**<0.001**
Wave 6	1.2	[0.1 2.2]	**0.030**
Wave 7	1.3	[0.2 2.5]	**0.018**
Household region at baseline[3]			
Regional	2.7	[0.2 5.2]	**0.031**
Rural	0.8	[-1.1 2.6]	0.44
SEIFA disadvantage decile	0.02	[-0.4 0.3]	0.91
Primary carer education[4]			
Year 11	-2.8	[-7.2 1.6]	0.205
Year 12[7]	-1.7	[-5.3 1.9]	0.351
Apprenticeship, Certificate or Diploma	-1.0	[-4.1 2.1]	0.517
Bachelor's degree	0.01	[-3.3 3.3]	0.997
Postgraduate degree	1.2	[-2.5 4.9]	0.539
Primary carer age at baseline (years)	0.2	[0.07 0.4]	**0.005**
Child gender[5]			
Male	0.9	[-0.7 2.4]	0.279
Health care card[6]			
Yes	-1.2	[-2.5 0.2]	0.092
Constant	85.7	[79.9 91.5]	**<0.001**

Reference categories: [1] 1st born, [2]Wave 2 [3]Metropoliton; [4]Year 10; [5]Female [6] Health care card; [7]Final year of high school in Victoria

Table 6.20 Final mixed model for proportion of frequency of consumption as core food, including parent age and childcare, (994 observations from 356 individuals)

	Coefficient	95% CI	p
Child birth order[1]			
2nd	-2.0	[-3.9, 0.01]	0.05
3rd	-2.7	[-5.5, 0.1]	0.06
4th or more	-1.8	[-6.0, 2.4]	0.41
Wave[2]			
Wave 5	-4.5	[-6.1, -3.0]	**<0.001**
Wave 6	-5.1	[-6.4, -3.8]	**<0.001**
Wave 7	-6.5	[-7.8, -5.1]	**<0.001**
Child age/wave difference	-0.2	[-0.6, 0.1]	0.22
Child age/wave difference interaction[2]			
Wave 5	0.1	[-0.3, 0.6]	0.54
Wave 6	-0.1	[-0.8, 0.7]	0.84
Wave 7	-0.1	[-0.8, 0.7]	0.84
Household region at baseline[3]			
Regional	2.4	[-0.3, 5.1]	0.08
Rural	0.03	[-2.1, 2.2]	0.98
SEIFA disadvantage decile	-0.1	[-0.5, 0.3]	0.53
Primary carer education[4]			
Year 11	-7.0	[-14.3, 0.4]	0.06
Year 12[7]	-2.0	[-6.6, 2.7]	0.41
Apprenticeship, Certificate or Diploma	-2.3	[-6.3, 1.6]	0.25
Bachelor's degree	-0.7	[-4.8, 3.3]	0.73
Postgraduate degree	1.3	[-3.2, 5.8]	0.57
Primary carer age at baseline (years)	-0.04	[-0.2, 0.1]	0.65
Child gender[5]			
Male	0.1	[-1.6, 1.8]	0.90
Health care card[6]			
Yes	-0.7	[-2.3, 0.9]	0.38
Parent fruit and veg serves	0.8	[0.4, 1.1]	**<0.001**
Any out of parent care[7]			
Yes	-0.6	[-2.1, 0.8]	0.38
Constant	80.4	[73.7, 87.2]	<0.001

Reference categories: [1] 1st born, [2]Wave 4 [3]Metropoliton; [4]Year 10; [5]Female [6] Health care card; [7]No out of parent care

Table 6.21. Final mixed model for proportion of frequency of consumption as core beverage, excluding parent age and childcare (1646 observations from 407 individuals)

	Coefficient	95% CI	p
Child birth order[1]			
2nd	-1.7	[-4.1, 0.8]	0.18
3rd	-1.3	[-4.8, 2.2]	0.47
4th or more	-8.9	[-14.2, -3.6]	**0.001**
Wave[2]			
Wave 3	-3.0	[-6.0, -0.07]	**0.045**
Wave 4	-7.9	[-10.7, -5.0]	**<0.001**
Wave 5	-14.8	[-18.0, -11.5]	**<0.001**
Wave 6	-14.9	[-17.8, -12.0]	**<0.001**
Wave 7	-12.7	[-15.7, -9.8]	**<0.001**
Child age/wave difference	-0.7	[-1.8, 0.4]	0.22
Child age/wave difference interaction[2]			
Wave 3	-0.5	[-2.1, 1.6]	0.57
Wave 4	-0.9	[-2.1, 0.4]	0.18
Wave 5	0.7	[-0.5, 2.0]	0.25
Wave 6	0.5	[-1.1, 2.0]	0.57
Wave 7	0.5	[-1.2, 2.1]	0.56
Household region at baseline[3]			
Regional	4.0	[0.6, 7.4]	**0.02**
Rural	0.6	[-2.0, 3.2]	0.65
SEIFA disadvantage decile	-0.5	[-1.0, <0.001]	0.05
Primary carer education[4]			
Year 11	-1.7	[-7.9, 4.5]	0.59
Year 12[7]	3.8	[-1.4, 9.0]	0.15
Apprenticeship, Certificate or Diploma	2.1	[-2.3, 6.6]	0.35
Bachelor's degree	5.6	[0.9, 10.3]	**0.020**
Postgraduate degree	7.9	[2.7, 13.2]	**0.003**
Primary carer age at baseline (years)	0.3	[0.03, 0.5]	**0.029**
Child gender[5]			
Male	0.7	[-1.4, 2.8]	0.53
Health care card[6]			
Yes	-1.1	[-03.0, 0.9]	0.29
Constant	89.2	[81.0, 97.4]	<0.001

Reference categories: [1] 1st born, [2]Wave 2 [3]Metropoliton; [4]Year 10; [5]Female [6] Health care card; [7]Final year of high school in Victoria

Table 6.22. Final mixed model for proportion of frequency of consumption as core beverage including parent age and childcare, (993 observations from 357 individuals)

	Coefficient	95% CI	p
Child birth order[1]			
2nd	-2.4	[-5.8, 1.0]	0.17
3rd	-2.0	[-6.9, 2.9]	0.42
4th or more	-9.2	[-16.5, -1.9]	0.01
Wave[2]			
Wave 5	-7.4	[-10.2, -4.5]	**<0.001**
Wave 6	-7.8	[-10.3, -5.4]	**<0.001**
Wave 7	-6.2	[-8.8, -3.7]	**<0.001**
Child age/wave difference	-1.6	[-2.3, -1.0]	<**0.001**
Child age/wave difference interaction[2]			
Wave 5	1.5	[0.7, 2.4]	**<0.001**
Wave 6	1.2	[-0.1, 2.6]	0.07
Wave 7	1.7	[0.3, 3.1]	**0.017**
Household region at baseline[3]			
Regional	4.8	[0.1, 9.4]	0.04
Rural	-0.03	[-3.7, 3.6]	0.99
SEIFA disadvantage decile	-0.6	[-1.3, 0.1]	0.08
Primary carer education[4]			
Year 11	-1.6	[-14.5, 11.3]	0.81
Year 12	6.9	[-1.3, 15.0]	0.10
Apprenticeship, Certificate or Diploma	4.9	[-2.1, 11.9]	0.17
Bachelor's degree	9.0	[1.8, 16.2]	**0.014**
Postgraduate degree	11.2	[3.3, 19.0]	**0.005**
Primary carer age at baseline (years)	0.1	[-0.2, 0.4]	0.49
Child gender[5]			
Male	0.9	[-2.1, 3.8]	0.57
Health care card[6]			
Yes	-1.7	[-4.6, 1.1]	0.23
Parent fruit and veg serves	0.7	[0.1, 1.4]	**0.022**
Any out of parent care[7]			
Yes	1.5	[-1.2, 4.1]	0.28
Constant	80.2	[68.3, 92.1]	<0.001

Reference categories: [1] 1st born, [2]Wave 4 [3]Metropoliton; [4]Year 10; [5]Female [6] Health care card; [7]No out of parent care

6.4 Discussion

This research aimed to describe the consumption frequency and relative contribution of core and discretionary foods over the first five years of life, as well as exploring socio-demographic factors which may influence these intakes. The results demonstrate that whilst core foods make up the majority of dietary intake, discretionary foods and beverages are appearing in the diets of children as early as six months of age. Between six months and three years of age, the contribution of discretionary items to overall intake increases steadily and then tends to stabilise to five years of age. Parent age, residential area, parent education level and parent dietary intake were all associated with a greater contribution of core items to overall consumption frequency, whilst later child birth order was associated with a decrease in the contribution of core items. No associations were observed between childcare attendance, health care card status or socio-economic index for areas and the contribution of core and discretionary foods to overall diet.

6.4.1 Core food intake over time

Cereal, banana and vegetables were the most commonly consumed core foods at six months of age, reflecting some of the typical foods that children are introduced to when they commence solids. Meat is also a common food for children to be introduced to, however consumption of meat was not included in the FFQ until 12 months of age. Most core foods (except stewed fruit, baked beans, eggs, nuts and soup) were consumed by more than 90% of children by the time they were 12 months old. It is important to note that breastmilk is likely a contributor of core food intake during this time period as well but was excluded from the analysis because of the different data collection method. The high percentage of children consuming grain-based core foods are similar to the rates seen in the FITS study in the United States [53] as well as the SAIDI/NOURISH and INFANT studies in Australia [76, 95, 97]. In the early years, cereal was the most frequent grain product consumed (median intake of once per day), however as children got older bread and rolls became the frequent (median intake of once per day), a trend also observed in the SAIDI and NOURISH [97]. This is likely due to the convenience and ease of serving bread or rolls, compared to cereal as well as reflecting children's developmental stages.

Meat was reported to be consumed by 95% to 99% of children between 12 months and five years of age. This is higher than what has been observed in other Australian studies with children of a similar age, which have shown rates of consumption between 69% to 79% [89, 95]. The discrepancy in rates is likely due to the use of a food frequency questionnaire in the current study compared to 24-hour recall in those with lower rates. In the current study, if parents reported their child ate meat/fish infrequently (less than once a week), they were still counted as being consumers, whereas in studies where a 24-hour recall was used, it is likely that children who only consume meat once a week would not have been identified as consumers.

The difference in data collection method is also likely to explain the higher consumption rates of cheese and yoghurt observed in the current study compared to other Australian research. Cheese and yoghurt were consumed by 28% and 55% of VicGen children respectively at six months of age, which then increased to more than 90% of children from 12 months onwards. Less than 35% of 14 month old children consumed yoghurt in the NOURISH/SAIDI studies, and 62% were consuming cheese [97], whilst nationally representative data of 2-5 year old children suggests consumption rates of 25% for yoghurt and 40% for cheese [89].

Nearly all children were consuming fruits and vegetables by the time they were 12 months old and this remained stable until five years of age. The median fresh fruit consumption frequency was 7 times per week (once a day) between 12 months and three years of age and banana and stewed fruit had a median intake of 2.5 times a week between these ages. At age four and five years, fruit consumption was measured differently, with stewed fruit, banana and fresh fruit becoming one category, with a median intake of 17.5 times a week (~2.5 times/day). The median intake of vegetables for all children was seven times per week, with little change in consumption frequency between six months and five year of age. The consumption rates for fruits and vegetable are higher than those seen in the most recent Feeding Infants and Toddlers Study, where only 70-75% of children under two years of age were reported to have consumed fruits and vegetables on the previous day [52]. It is difficult to directly compare these results though, as FITS used one, 24-hour recall collecting actual consumption compared to the FFQ used in VicGen which measured usual consumption. Comparable research in the Australian context has demonstrated that fruit consumption rates in young children measured by 24-hour recall can vary from 80-90% [89, 95, 98], but those that are consuming tend to be having the recommended number of serves [185]. Vegetable consumption rates tend to be lower than for fruit [95, 99, 185] and children are generally not consuming their recommended daily serves [185].

In the current study only consumption frequency was measured, without the inclusion of portion size, however published data on portion size information can be useful for filling this gap. Existing research in children of a similar age suggests that median portion sizes for children at 14 months of age range are no larger than 30g for vegetables, 15g for meat, 45g for grains, 53g for fruit and 130g for dairy [97]. There is little change in portion sizes by 24 months of age, however when increases occur they tend to be small (~10-20g). In older children, the Australian Health Survey reports that on average 2-3yr old children consume 373g of dairy, 110g of grains, 185g of fruit, 68g of vegetables and 70g of meat. In 4-8 year old children fruit intake does not change, whilst dairy reduces to 313g. Daily grain, vegetable and meat intake increases by 20- 50g [88].

It is difficult to ascertain whether recommended daily serves of grains, meat and alternatives and dairy are being met for children, as there are numerous items from each of these groups listed in the FFQ. However, fruit and vegetables are treated separately. The Australian Dietary Guidelines recommend that children aged 1-2 years consume ½ a serve (75 grams) of fruit each day, which increases to 1 serve (150g) and 1½ serves (225g) for 2-3-year-old children and 4-8-year-old children respectively [9]. The results from the present study suggest that while many children were likely to be meeting the guidelines when aged three and under, they were less likely to be doing so when aged 4-5 years. The dietary guidelines recommend 1-2-year-old children consume 2-3 serves (150-225g) of vegetables each day, whilst 2-3-year-old and 4-8-year-old children should consume 2½ (188g) and 4½ serves (338g) respectively [9]. In the present study, vegetables had a median consumption frequency of once per day. Given that the median portion size of vegetables for two year olds can be estimated at approximately 30g [97], children would need to be consuming more than once a day to be meeting the dietary guidelines. It is unlikely that children will make up any deficit in daily intake on other days of a usual week, particularly given that the recommended daily serves of vegetables are quite high.

6.4.2 Discretionary food intake over time

It is recommended that children aged two years and under avoid consuming discretionary foods and drinks. Similarly for children up to eight years old, however if consumed, intake should be limited to ½ a serve per day [41]. In the present study, discretionary foods appear in children's diets as early as six months of age. The proportion consuming these foods increases considerably from this age such that by three years, more than 80% of children were consuming many of the discretionary items measured, with most of these items having a median consumption between once a fortnight to once a week. The exception to this was dry biscuits/crackers, which had a median consumption of two to five times per week. Between age three and five years there were fewer new consumers, whilst the frequency with which discretionary items were consumed tended to slowly increase for most items. These results suggest children are likely exceeding the recommended intake of discretionary items of 0 to ½ a serve a day.

The early introduction of discretionary foods into children's diets has been observed in numerous studies both internationally and in Australia [45, 46, 51, 52, 59, 91, 92, 95, 98, 103]. Existing research also suggests that dietary intake tends to track across time, and that those consuming unhealthy food early in life are likely to continue with this pattern throughout childhood [100]. Discretionary foods tend to be high in kilojoules, saturated fats, sugar and salt, all of which can contribute to the development of overweight and obesity and a range of non-communicable diseases such as hypertension and cardiovascular disease [8]. Frequent consumption of discretionary foods, particularly those which are high in sugar and may be retained in the oral cavity for long periods of time by sticking to teeth (e.g. lollies) can also contribute to the development of dental caries [186].

6.4.3 Beverage intake over time

The most commonly consumed beverages between six months and five years were core beverages – water and full fat cow's milk. However, the early introduction of discretionary beverages into children's diets was also observed in this cohort of children, with just under 20% of children drinking fruit juice/fruit drink when they were six months old. Fruit juice is not recommended to be consumed by children under 12 months of age [9, 41]. Similar to discretionary foods, there were large increases in the proportion of children consuming fruit juice/fruit drink and cordial between six months and three years of age. While the proportion of children consuming fruit juice between age three and five years was stable at 75-80%, the median consumption frequency was once a week or less, whilst mean consumption frequency for consumers steadily decreased. During this same period, the proportion of children consuming soft drink steadily increased. Whilst the median consumption frequency was 0.0 until five years of age when it reached 0.3 times per week, the average consumption of children who did have soft drink was 1-2 times a week. The early introduction of sweetened beverages has been demonstrated in the international and Australian literature with the FITS study observing intake as early as 6 months and the INFANT trial observing intake as early as nine months [45, 46, 48, 52, 98]. Recent research from the LSAC study has shown that fruit juice consumption tended to slowly decrease between the age of two and 10 years, whilst consumption of soft drink and cordial increased during this time [101].

If children do consume fruit juice, it is recommended that it be 100% fruit juice with no added sugar, and that it is only consumed occasionally, as a replacement for a whole piece of fruit [41]. This advice is based primarily on the lack of fibre in many fruit juices, the high simple sugar content which can lead to dental caries and the erosive effect that these beverages can have on tooth enamel [182]. From a public health perspective, the results of this research suggest that young children are consuming fruit juice more often than ‘occasionally’, however it is possible that many parents may not view it this way. The term ‘occasionally’ is open to interpretation as there is no hard definition of what is meant by this term in the dietary guidelines. In Chapter 8 of this thesis, parents and grandparents who were interviewed about providing food and drinks to young children differed in what they considered ‘occasionally’. Some regarded consuming fruit juice once a day as occasionally, whilst for others it may mean once a week, once a month or only on special occasions. Further exploration of this topic with parents and caregivers would be useful to inform future iterations of the dietary guidelines, and the nutrition information that is disseminated to parents and carers in the early years of their child’s life.

As previously mentioned, the LSAC study has suggested that soft drink consumption increases over childhood whilst juice consumption decreases [101]. Similar trends to this were observed in the current study, Soft drinks were also observed in children’s diets as early as 12 months of age, with an increasing proportion of children consuming them up to five years of age, although not as substantially as was seen with fruit juice. This may suggest that parents see fruit juices/fruit drinks as a more acceptable beverage for younger children to consume than soft drinks. Previous research has suggested that people view fruit juices as a healthier option than soft drinks [187]. While this may be true for some nutritional properties, the effect that these two beverages have on the teeth is very similar [188]. Fruit juices, fruit flavoured drinks and soft drinks are all cariogenic, containing around 9 grams of sugar per 100ml, and are also acidic which can lead to dental erosion [188-190]. Young children are particularly susceptible to erosion and dental caries because their tooth enamel is more porous due to its immaturity [188]. Additionally, sweet drinks are highly palatable, and providing them to children may encourage them to seek sweet drinks when they are thirsty, which can lead to overconsumption and energy imbalance [182].

6.4.4 Proportion of core/discretionary foods and beverages over time

To gain a better overall picture of dietary intake over the first five years of life, a score reflecting the relative contribution of core and discretionary foods and beverages to overall consumption frequency was generated. Between six months and three years of age, the mean percentage consumption frequency contributed by core foods decreased considerably then remained relatively stable to five years of age. A similar trend was seen for core beverages, although there was a slight increase in their mean percentage consumption frequency contribution between age four and five years. This suggests that dietary intake is changing to a greater degree between the ages of six months and three years than it is between three and five years of age. As children grow the recommended number of core food serves increases to ensure children meet their increasing energy and nutrient requirements. The current data suggest that rather than increasing core food serves as recommended, children are meeting their energy requirements by the inclusion of discretionary items in their diets. This was evident in the INFANT study, where the number of children who met the dietary guidelines for vegetables decreased greatly between nine months and five years of age, whilst intakes of discretionary foods exceeded recommendations [99]. Vegetable intake remained relatively stable over the time period, but recommended serves increased resulting in a large percentage of children not meeting the dietary guidelines for vegetable intake. Although portion size was not collected in VicGen, the SAIDI, NOURISH and Australian Health Surveys have published research on usual serving sizes for children in this age range [88, 97]. If these data are applied to the VicGen frequency data, it suggests a similar pattern to that observed in the INFANT study. The EFHL birth cohort examined Australian children's dietary patterns between three and five years of age, with those who had unhealthy diets at age three likely to still be in this category at age five. However, children who had healthy diets at age three either stayed in this category or moved to the unhealthy category at age five [102]. Further investigation of the VicGen data is required to see if this pattern is also occurring.

6.4.5 Predicting the contribution of core foods and beverages to overall intake according to frequency

The theoretical frameworks outlined in Chapter 3 of this thesis demonstrate that numerous factors at an individual, family, community and policy level can influence dietary intake, along with the different settings to which children are exposed [28, 131]. In this chapter, the mean consumption frequency contributed by core and discretionary items was further explored in relation to a range of these factors that were of interest and available in the VicGen dataset.

The factors explored primarily sat within the family level of influence (birth order, SEIFA index, parent education, parent age, parent fruit and vegetable intake), but the exposure to childcare and residential area (both physical settings) were also explored.

Core items contributed a greater percentage to total food consumption frequency for children who were living in a regional area, had an older parent or had a parent with a higher fruit and vegetable intake compared with children who lived in metropolitan area, had younger parents and parents who had lower fruit and vegetable intake. Core items also contributed a greater percentage to total beverage consumption frequency for children who had university educated parents compared with those whose parents completed year 10 of secondary school. These results are consistent with previous research examining dietary patterns in young children. French and English children tended to have healthier dietary patterns if their mothers were older and more highly educated [78, 79]. Few Australian studies have examined these types of associations in this age group, although the SAIDI and NOURISH studies did demonstrate that children with younger mothers tended to have less healthy dietary patterns at 14 and 24 months of age. This study also showed that children with university educated parents tended to have healthier diets at 14 months of age, but not at 24 months of age compared with children with parents with high school only education [94]. In older children, the healthiness or quality of parental dietary intake has been associated with healthier child intakes [191, 192]. There is little research that explores this in preschool age children, but the current study has demonstrated that children whose parents had higher fruit and vegetable intakes had a higher mean percentage consumption frequency contributed by core foods.

The findings related to residential location are interesting in the context of the literature in this area. On average, Australians residing in regional and remote areas tend to have higher rates of risk factors for poor health [193] which has primarily been linked to higher levels of disadvantage and the longer distances that people may need to travel to reach services. The current study however, accounted for family socio-economic status in the analysis, and demonstrated that children in regional areas tended to have higher proportions of core foods in their diets than children in metropolitan areas, yet there was no difference between children in rural and metropolitan areas. There is little research examining differences in dietary intake in children residing in different areas. A recent study with 5-12-year-old children from disadvantaged rural and metropolitan areas of Victoria, Australia saw no differences between dietary intakes of core foods, except for non-fried potato, which was consumed in higher amounts by rural children [194]. Some differences were seen in the type of discretionary foods that were consumed, with metropolitan children consuming soft drinks and fast food more frequently, whilst rural children consumed foods like pies and cakes more frequently. The results presented in the current analysis warrant further investigation into other characteristics that differentiate the residential area groups and may help to explain the differences that were observed or the lack of any large differences.

Core food and beverage items contributed a lower percentage to overall food and beverage consumption frequency in children who were not the first-born in their family compared with those who were first-born, which is consistent with other research in this field. Children in Brazil tended to consume more unhealthy snack foods between one and four years of age if they had siblings at home [72] whilst in England and France, children with siblings tended to have less healthy dietary patterns [80, 195]. Examination of dietary data, both in the present study and other research tends to show that discretionary foods become more prevalent in the diets of children as they get older. It is likely that children who have older siblings are exposed to these types of foods and drinks earlier in life than a first-born child, with older siblings bringing home the less healthy environmental influences they are exposed to outside of the house. Parents of infants recently identified time, capacity and resources as key factors in their decision making around what food to provide to their children [196]. The additional responsibilities that caring for more than one child incurs, may persuade parents to choose the most convenient food options for their children, which tend to be less healthy.

The inclusion of predictive variables into this research was limited by what was available in the VicGen dataset. However, there are a wide range of factors demonstrated to influence food and beverage consumption which were not included in the analysis. Whilst parents may have a relatively good understanding of what is and isn't healthy, other influences contribute to the provision of discretionary foods rather than core foods in the early years of life. The type and amount of food available at home, role modelling of parents, regular family meals and portion sizes have all been shown to influence dietary intake [197]. Additionally, factors such as social norms, marketing perishability, cost, quality, availability, time, capacity and resources have all been identified by parents as key influences on what foods and beverages they provide their infants [196].

6.4.6 Strengths and limitations

To my knowledge, this study is one of the first to examine dietary intake of Australian infant and preschool aged children, using longitudinal data and a diverse sample of participants. This study provides valuable insight into the dietary intake of children of this age and provides new information regarding intakes of children in regional, rural and metropolitan areas of Victoria. An additional strength of this study is that the FFQ used to collect data was shown in Chapter 5 to be reliable and valid at a group level.

The food frequency questionnaire used in this study included a wide range of foods and drinks and was specifically designed to include items that were known to be consumed by young children and which may influence oral health. Whilst overall, this allowed for a comprehensive assessment of dietary intake, the questionnaire did not collect specific information on fats and oils and mixed dishes. These items are therefore not accounted for in the analysis presented in this chapter. Also, the exclusion of breastmilk from the current analysis is likely to influence core food consumption frequency, particularly at ages six and twelve months when it is estimated 40% to 60% of children are receiving breastmilk [198]. It was also not possible to distinguish between 100% fruit juice and sweetened fruit drinks. Whilst this is relevant to classifying this beverage in terms of the dietary guidelines, it has little influence on the effect of this beverage in regard to dental caries or dental erosion.

An additional limitation of this tool is the exclusion of portion size information. The tool was designed to collect information related to oral health, and in this case the frequency with which an item is consumed. Median portion sizes from previous research with children of similar ages has been used to guide interpretation of the results from the current study in the context of the dietary guidelines. Whilst these portion sizes are not likely to vary greatly to those consumed by VicGen children, the exact amount of foods and beverages consumed still cannot be determined. Additionally, the wider context of food and beverage consumption is not recorded as part of the FFQ, which has implications for how cariogenic an item may be when it is consumed. For example, the cariogenic effect of lollies on the teeth may be lessened if the they are consumed with a glass of milk. The questions that were pilot tested and reported in Chapter 5 of this thesis attempted to address this concern.

Whilst the longitudinal design of the study provides valuable data, it also resulted in changes to the food frequency questionnaire over time, to try and reduce the participant burden for completion. This resulted in some food questions not being asked consistently in later waves of data collection, and it is therefore difficult to directly compare these specific items. Collating foods into core and discretionary categories helped to overcome this issue. As with any longitudinal study, a proportion of participants were lost to follow up throughout the course of the cohort. Whilst we were able to retain around 70% of the cohort for the first four waves of data collection, the retention rates for the final three waves was between 45.9% and 57.3%. As dietary data were only collected from six months of age onwards, it was not possible to compare the dietary intake of those included and excluded in the analysis. It is possible that those children who dropped out before the six-month data collection had different dietary intakes to children included in the analysis, which may have influenced the results. A strength of the VicGen study is the inclusion of more participants from disadvantaged backgrounds compared to other studies of dietary intake in early childhood. Although the sample did become less disadvantaged over time, with those who remained in the cohort tended to be more advantaged with higher education levels and higher SEIFA scores, the percentage of university educated parents in the sample was still 10 to 15% lower than in other Australian studies exploring diet in early childhood [94, 99]. Additionally, as only family and environmental factors were collected in the VicGen study, I could not examine the macro level influences on food and beverage intake, such as marketing and food policy.

A greater proportion of participants in the overall sample were residing in regional and rural areas and spoke English at home in the final wave compared to earlier waves. Using a linear mixed method helped to maximise the use of available data allowed inclusion of any participant with at least two waves of data. Participants residing in areas of disadvantage were targeted for recruitment into this study, however those not included in the analysis tended to more disadvantaged, with greater health care card possession, reside in areas with a lower mean SEIFA and have lower education levels compared to those included in the analysis. An additional limitation is the use of the baseline variable for residential area for each wave. Residential area data were also only collected at baseline, and whilst a proportion of participants did move throughout the study, they tended to move within the same area classification of area (e.g. metro to metro). Additionally, participants were only from Victoria. Whilst they are likely to have similar characteristics to other states metropolitan and regional areas, the rural areas may differ, as Victoria does not have any remote or very remote communities like some other areas of Australia. This may affect food and service availability, which influences what people eat.

6.4.7 Conclusion

Discretionary foods and beverages are present in children's diets as early as six months of age, and their contribution to overall dietary intake increases considerably from this age until children are around three years old. Between three and five years of age, overall consumption of discretionary items tends to increase at a much slower rate. Many children are consuming discretionary foods in excess of recommendations whilst failing to meet recommended intakes of some core foods, particularly vegetables. Exploration of the potential reasons for this dietary pattern showed that parent education, age and dietary intake, family residential location and child birth order were all associated with the contribution of core foods to overall dietary intake. Future research is warranted to explore these factors in depth, along with other influencing factors that have been identified in socio-ecological models relating to food choice and provision for children.

Chapter 7: Nutrition and oral health in early childhood: Associations with formal and informal care.

7.1 Background

As part of the previous chapter, child care was included as a potential predictor of overall consumption frequency of core and discretionary foods and beverages in the VicGen study. No significant association was observed between childcare and food consumption. Childcare was included in that analysis chapter as a binary variable, without consideration for the type of childcare (formal and/or informal) that children may be attending. The analysis in this chapter was undertaken to more closely examine how childcare type may be associated with dietary intake and oral health/hygiene behaviours.

This chapter was accepted for publication on the 4th of May, 2020 in the academic journal *Public Health Nutrition* . As it is a draft manuscript there will be some repetition of earlier sections of the thesis. The paper uses VicGen data from waves five and six (ages 3 and four years) to compare the dietary intake and oral health and hygiene behaviours of children attending different types of care (formal, informal, formal and informal) with children who do not attend childcare.

Nutrition and oral health in early childhood: Associations with formal and informal care

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ABSTRACT

Objective: Examine associations between childcare type and nutrition and oral health indicators.

Design: Cross-sectional data extracted from a longitudinal birth cohort. Parent-completed food frequency questionnaire and questions regarding oral health and childcare use. The associations between childcare type, classified into four groups: parent care only (PCO), formal childcare only (FCO), informal childcare only (ICO) or combination of care (F&I) and nutrition and oral health indicators were examined.

Setting: Home and childcare.

Participants: Families with children aged three (n=273) and four years (n=249) in Victoria, Australia.

Results: No associations were observed between childcare type and core food/beverage consumption or oral health indicators. For discretionary beverages, compared with children receiving PCO at age three years, children in FCO or F&I were less likely to frequently consume fruit juice/drinks (FCO: Adjusted Odds Ratio:0.41 95%CI: 0.17, 0.96, p=0.04; F&I: AOR:0.32, 95%CI: 0.14, 0.74, p=0.008). At age four years children receiving FCO or ICO were less likely to consume sweet beverages frequently compared with children receiving PCO. Fruit juice/drink (ICO: AOR:0.42, 95%CI: 0.19, 0.94, p= 0.03; FCO: AOR: 0.35, 95%CI: 0.14, 0.88, p = 0.03), soft drink:(ICO: AOR: 0.23, 95%CI: 0.07, 0.74, p=0.01; FCO: AOR: 0.14, 95%CI: 0.03, 0.76, p = 0.02).

Conclusions: Associations between childcare type and discretionary beverage intake were observed. Investigation into knowledge, attitudes and activities in formal and informal childcare settings is required to explore different health promotion practices that may influence nutrition and oral health.

Introduction

A healthy diet during childhood is essential for optimal physical and cognitive growth and development[9], which may reduce risk of many non-communicable diseases including diabetes, obesity, cardiovascular disease, certain cancers and oral disease[199]. The Australian Dietary Guidelines recommend that from 12 months of age children consume items daily from the five 'core' food groups: fruit, vegetables and legumes, meat and alternatives, cereals and dairy/alternatives and drink plenty of water [9]. Whilst intake of energy-dense and nutrient-poor discretionary items such as soft drink (sodas), cakes and biscuits should be limited [9]. Existing research shows a diet containing discretionary food and beverage items at a young age is associated with increased incidence of dental caries [200, 201], and obesity [202].

In addition to diet, it is important to establish good oral hygiene habits at a young age to maintain a healthy mouth [153]. Despite being largely preventable, early signs of dental caries have been seen in children as young as 6-12 months of age [2] and recent data show 26.1% of Australian 5-6 year old children have at least one decayed tooth [203]. Early childhood caries can have wide-ranging negative short and long term consequences including pain, difficulty eating, and missing school [204, 205] and is one of the best predictors of future decay [206] .

Children's early years of life are a critical period during which eating habits and food preferences are established [5, 30] and evidence suggests that dietary patterns developed in these early years track through to adolescence and into adulthood [207]. The foods and beverages that children consume during these early years are influenced by a wide range of factors. In the very early years these are primarily influenced by parents and include feeding style, role modelling, food availability and parental beliefs and attitudes [38, 208]. However, as children grow and spend time in a wider range of settings including childcare, environmental factors including peer and caregiver role modelling, television viewing and food sources (e.g. childcare) influence what they consume [38].

In Australia, young children are cared for in a range of formal (e.g. long day care – centre-based childcare for all or part of the day, family day care –childcare based in the home of a registered childcare provider) and informal (e.g. relatives, friends) settings. Children between one and four years of age have the highest usage rates of childcare in Australia, with around 60% attending some sort of childcare [209]. At age three and four years respectively, 55% and 42% of children, attend formal childcare and around 37% attend informal childcare[209].

Children attending formal childcare do so for an average of 15 hours a week, whilst children in informal childcare are there for on average 12 hours a week [210].

The National Quality Framework (NQF; https://www.acecqa.gov.au/nqf/about), implemented in 2012, requires formal childcare services in Australia to promote healthy eating, and provide nutritious foods and beverages for children [211]. Whilst this is likely to influence oral health through regulating food and beverage consumption, there are no benchmarks that directly target oral hygiene behaviours such as tooth brushing. To meet the NQF benchmarks, many formal childcare services have developed nutrition policies and guidelines. In Australia, the Romp and Chomp Intervention [212-214] and the Start Right, Eat Right program [215] have shown the positive effect of policy and guidelines on the nutrition environment and food consumption in formal childcare settings. However, the extent to which these guidelines are adhered to across all settings is unclear, with recent evidence suggesting that discretionary items are available on a regular basis at childcare centres [216].

In contrast to the regulations in formal childcare settings, there are no requirements to have such structured guidelines in informal childcare. Anecdotal evidence suggests parents may have formal or informal agreements regarding their expectations for their child's nutrition and oral health, with those who provide informal childcare, however there is little evidence for the impact of these on the childcare environment or outcomes for their child.

Most interventions with nutrition outcomes have focused on formal childcare settings or preschools and the role that nutrition plays in obesity [212, 217, 218]. The literature exploring oral health and childcare has primarily focussed on policies and practices in formal childcare settings [219-221], rather than oral health outcomes for children. There is some research examining nutrition outcomes for children in different types of childcare. In the United States, data from 10,700 children in the Early Childhood Longitudinal Study showed that a greater time spent in non-relative or centre-based childcare was associated with a lower consumption of soft drinks, and that vegetable consumption was positively associated with time spent in centre-based childcare [222].

Poor oral health can have a profound impact on children's health and quality of life. Behaviours that influence oral health, such as dietary intake, dental visiting and oral hygiene are influenced by the environment children are exposed to. Many preschool children attend some sort of childcare; however, little is known about the relationship between childcare, oral health and dietary intake. The aims of this study were to 1) examine consumption of foods and beverages and oral health factors when children are aged three and four years old and 2) explore associations between type of childcare and a) food and beverage consumption and b) oral health factors.

Methods

Study Design

The VicGen Birth Cohort study

The VicGen birth cohort study was established to explore the development of early childhood caries[223]. The study was designed to have an emphasis on social disadvantage (e.g. low income, low education), cultural diversity and a mix of locations (metropolitan, regional and rural) and as such participants were recruited from seven local government areas (administrative divisions within a state) in the western corridor of Victoria, Australia. Nurses from the Maternal and Child Health Service in these areas invited families who were attending their newborn's two or four-week health check to participate in the study. Exclusion criteria included: intention to move from the area in the next 12 months, children requiring specialist paediatric childcare, severe illness in family, and presence of parental mental illness. Over a two-year period, 466 newborn infants were recruited into Phase I of the study, and data were collected at child age one, six, twelve and eighteen months (waves 1 to 4). Parents were then asked if they wished to continue in Phase II, involving a further three waves at child age three, four and five years. Each of the seven waves comprised a child oral examination, child saliva sample and a parent completed questionnaire. One oral health professional and one research assistant attended each study visit, with the majority conducted at the participant's home. A small number of study visits were conducted at MCH centres or community halls. A detailed description of the study has been published [223].

Data for the current analysis came from wave five (age three years) and six (age four years), collected between February 2012 and January 2015. These waves contained the information on childcare required for analysis. The VicGen study was a longitudinal cohort, however there were several children for whom data were only available at wave five or wave six. Therefore, to maximise the available N in this paper, data were analysed as two cross-sectional samples.

Questionnaire

A paper-based questionnaire was mailed to the child's primary caregiver (majority mothers) to complete approximately two weeks prior to the study visit for each wave of data collection. Researchers collected the completed questionnaire when they conducted the study visit. In cases where the participant had not completed the questionnaire, they were supplied a reply-paid envelope for return via mail. A food frequency questionnaire, asking capturing the usual weekly consumption of 46 foods and beverages (no time frame specified) known to influence oral health was included in the questionnaire. The questionnaire has been validated for use with children in this age group but did not capture all foods and beverages that children may have consumed. Parents were asked to report how often their child usually consumed 15 core foods (e.g. fruit, vegetables, cereal), 18 discretionary foods (e.g. hot chips, lollies/chocolate, cakes) and 13 beverages (e.g. water, milk, fruit juice). There were eight discrete response options for foods ranging from never to ≥4 times/day, whilst for beverages, parents were asked to report how often per day or week or month their child consumed the item. The questionnaire also collected information on the parent's rating of their child's oral health (five-point scale: poor to excellent), child tooth brushing frequency; and dentist/dental clinic visit frequency. The type of childcare (none (parent only), family day care, childcare centre, paid babysitter/nanny, grandparent, relative, friend/neighbour, other) that the child had received in the last month was also collected. The number of hours per week spent in each childcare type was collected in wave six only.

Data handling and analysis

The independent variable, type of childcare, was collapsed into four categories: *parent only* (had not used any form of childcare), *formal childcare only* (family day care, childcare centres) *informal childcare only* (paid baby sitter/nanny, grandparents, relatives, friends/neighbours), and *mixed formal/informal* (a combination of the two categories). As the number of hours was only collected at wave six, the duration of time in childcare was not included in both analyses. For children attending informal and formal care, a sensitivity analysis was conducted to examine the potential influence of the proportion of time spent in these types of childcare.

The most commonly consumed foods and beverages were included in the analysis (discretionary foods: ≥19% consuming at least once a week, core foods ≥75% consuming at least once/week (except for meat/fish and bread), beverages: ≥10% reported to consume beverage). Water was excluded from analysis due to the lack of variation in consumption frequency. Cut off points were determined after examining the spread of responses in the data.

All outcome variables were dichotomised. Foods and beverages were collapsed into the following categories: core items (cheese, yoghurt, banana, fruit, vegetables, plain milk): <once a day, ≥once day; discretionary items (muesli/fruit bars, ice cream, sweet biscuits, cakes/muffins, lollies/chocolate, potato chips, hot chips, savoury biscuits, fruit juice, cordial, soft drink, flavoured milk): <twice a week, ≥twice a week. Food and beverage items were collapsed based on the current Australian Dietary Guidelines[9] and clinical judgement of a practicing paediatric dietitian (personal communication). Oral health variables were collapsed into the following: brushing frequency: ≤once/day, >once/day; parent rating of child oral health: poor/fair/good, very good/excellent; child has ever visited a dental clinic: yes/no. Oral health items were collapsed based on current recommendations for best oral health care practice[224].

Descriptive statistics were used to examine the childcare type used at each age. The Chi-square statistic and the Fishers exact test (where cell frequency ≤5) were used to examine associations between the type of childcare and outcome variables at each age. Variables with significant associations were examined using univariable and multivariable logistic regression. Analyses were adjusted for variables which may influence nutrition and oral health, including child age, child gender, family health childcare card status at child age three and four years (a means tested card entitling the holder to certain concessions such as reduced cost medications), and area (metropolitan, regional, rural) in which child was born (collected at baseline). Baseline area was included because accurate residential location was not available when children were three and four years of age. Analyses were conducted using Stata 14 with a significance level of $p<0.05$.

Results

Sample characteristics

Table 1 displays the sample characteristics and the type of childcare used in the previous month at age three and four years. The breakdown of child gender, health care card status and area of residence at birth was similar at each wave. The most common type of childcare at each age was a mixture of formal and informal childcare. Compared to age three years, parent only care was more common at age four years (14.3% vs 19.3%) and formal only childcare was less common (16.5 vs 29.3%). There were 241 families with valid data at age three and four years and 42.3% of these reported using a different type of childcare at age four compared to age three.

Table 1 Sample characteristics of VicGen participants at age three and four years

	Age 3 years N=273		Age 4 years N=249	
Child age, mean [sd] years	3.3	[0.2]	4.1	[0.2]
Child sex, n (%)				
Female	129	(47.3)	117	(47.0)
Male	144	(52.7)	132	(53.0)
Health Care Card, n (%)				
Yes	65	(23.8)	59	(23.7)
No	207	(75.8)	188	(75.5)
Missing	1	(0.4)	2	(0.8)
Area[1], n (%)				
Metro	158	(57.9)	142	(57.0)
Regional	44	(16.2)	41	(16.5)
Rural	71	(26.0)	66	(26.5)
Missing	-	-	-	-
Childcare type[2], n (%)				
Parent only	39	(14.3)	48	(19.3)
Formal only	80	(29.3)	41	(16.5)
Informal only	58	(21.3)	65	(26.1)
Informal and formal	95	(34.8)	92	(37.0)
Missing	1	(0.4)	3	(1.2)

[1]Area child was born; [2]31 children had valid data at age 3 years but not age four years, five children had valid data at age four years but not age three years.

Core and discretionary foods and beverages

Table 2 shows the frequency of consumption of food and beverage items according to childcare type at age three and four years. No significant associations between childcare type and consumption frequency were observed in any of the core foods at either age. For discretionary items after adjusting for covariates, significant associations between childcare type and consumption frequency were observed for ice cream, potato chips (crisps), and flavoured milk (age three years only); fruit juice (age three and four years). Hot chips and soft drink neared significance ($p = 0.07$ and 0.06 respectively), and it was decided to include them in the logistic regression models for further exploration.

At age three years, in adjusted models, children who were in formal childcare or a mixture of informal and formal childcare were less likely to consume fruit juice twice a week or more, compared to children who were in parent only care (FCO Adjusted Odds Ratio: 0.41 95%CI: 0.17, 0.96, $p=0.04$), (F&I AOR: 0.32, 95%CI: 0.14, 0.74, $p=0.008$). Children who were receiving formal childcare only, were 71 % less likely to be consuming ice cream (95%CI: 0.10, 0.83, $p = 0.02$) at least twice a week, than children who were in parent only care (Table 3).

At age four years, in adjusted models, similar trends were seen for two sweet beverages. Children who were receiving formal childcare only or informal childcare only, were less likely to be consuming soft drink (FCO AOR: 0.14, 95%CI: 0.03, 0.7, $p=0.02$; ICO AOR: 0.23, 95%CI: 0.07, 0.74, $p=0.01$) and fruit juice/fruit drink (FCO AOR: 0.35, 95%CI: 0.14, 0.88, $p=0.01$; ICO OR: 0.42, 95%CI: 0.19, 0.94, $p = 0.03$) at least twice per week compared to children in parent only care.

The sensitivity analysis for children who spend time in both formal and informal childcare, showed no significant association between soft drink or fruit juice/drink consumption and the proportion of time children spend in either type of childcare each week.

Table 2. Food and beverage consumption frequency by childcare type at age three and four years of the VicGen cohort.

	Age 3 years (N=272[1])			Age 4 years (N=246[1])		
Core foods and beverages, n (%)	**<once/day**	**≥once/day**	**p[2]**	**<once/day**	**≥once/day**	**p[2]**
Cheese						
Parent only	24 (61.5)	15 (38.5)	0.12	33 (68.8)	14 (29.2)	0.65
Formal only	63 (78.8)	16 (20.3)		32 (78.1)	8 (19.5)	
Informal only	41 (70.7)	15 (25.9)		46 (70.8)	19 (29.2)	
Formal and informal	63 (66.3)	32 (33.7)		70 (76.1)	22 (23.9)	
Yoghurt						
Parent only	29 (74.4)	9 (23.8)	0.33	34 (70.8)	13 (27.1)	0.61
Formal only	59 (73.8)	19 (23.8)		32 (78.1)	8 (20.0)	
Informal only	44 (75.9)	14 (24.1)		52 (80.0)	13 (20.0)	
Formal and informal	62 (65.3)	33 (34.7)		66 (71.7)	25 (27.2)	
Banana[5]						
Parent only	31 (79.5)	8 (20.5)	0.52	- -	- -	
Formal only	70 (87.5)	9 (11.3)		- -	- -	
Informal only	47 (81.0)	11 (19.0)		- -	- -	
Formal and informal	76 (80.0)	16 (16.8)		- -	- -	
Fruit[4]						
Parent only	19 (48.7)	19 (48.7)	0.09	15 (31.3)	32 (66.7)	0.48
Formal only	24 (30.0)	54 (67.5)		7 (17.1)	33 (80.5)	
Informal only	23 (39.7)	35 (60.3)		16 (24.6)	48 (73.9)	
Formal and informal	27 (28.4)	66 (69.5)		22 (23.9)	70 (76.1)	
Vegetables (not potato)						
Parent only	22 (56.4)	17 (43.6)	0.38	21 (43.8)	27 (56.3)	0.95
Formal only	34 (42.5)	45 (56.3)		17 (41.5)	23 (56.1)	
Informal only	31 (53.5)	27 (46.6)		27 (41.5)	38 (58.5)	
Formal and informal	42 (44.2)	53 (55.8)		42 (45.7)	49 (53.3)	
Plain milk						
Parent only	4 (10.3)	35 (89.7)	0.87	7 (14.6)	41 (85.4)	0.49
Formal only	13 (16.3)	66 (82.5)		3 (7.3)	37 (90.2)	
Informal only	8 (13.8)	49 (85.5)		8 (12.3)	56 (86.2)	
Formal and informal	14 (14.7)	80 (84.2)		16 (17.4)	74 (80.4)	
Discretionary foods and beverages, n (%)	**≥twice/week**	**<twice/week**	**p**	**≥twice/week**	**<twice/week**	**p**
Muesli bars/fruit sticks/roll-ups						
Parent only	10 (25.6)	28 (71.8)	0.44	9 (18.8)	36 (75.0)	0.63
Formal only	12 (15.0)	66 (82.5)		8 (19.5)	29 (70.7)	

	Age 3 years (N=272[1])			Age 4 years (N=246[1])		
Core foods and beverages, n (%)	**<once/day**	**≥once/day**	**p[2]**	**<once/day**	**≥once/day**	**p[2]**
Informal only	13 (22.4)	44 (75.9)		19 (29.2)	45 (69.2)	
Formal and informal	23 (24.2)	72 (75.8)		25 (27.2)	67 (72.8)	
Ice Cream						
Parent only	11 (28.2)	28 (71.8)	**0.009**	18 (37.5)	27 (56.3)	0.13
Formal only	9 (11.3)	70 (87.5)		8 (19.5)	32 (78.1)	
Informal only	19 (32.8)	39 (67.2)		24 (36.9)	41 (63.1)	
Formal and informal	16 (16.8)	79 (83.2)		25 (27.2)	67 (72.8)	
Sweet biscuits						
Parent only	15 (38.5)	22 (56.4)	0.96	21 (43.8)	25 (52.1)	0.50
Formal only	35 (43.8)	43 (53.8)		23 (56.1)	17 (41.5)	
Informal only	25 (43.1)	33 (56.9)		27 (41.5)	37 (56.9)	
Formal and informal	43 (45.3)	52 (54.7)		43 (46.7)	48 (52.2)	
Cakes/muffins						
Neither care type	9 (23.1)	30 (76.9)	0.86	10 (20.8)	37 (77.1)	0.97
Formal only	17 (21.3)	60 (75.0)		10 (24.4)	29 (70.7)	
Informal only	15 (25.9)	42 (72.4)		16 (24.6)	49 (75.4)	
Formal and informal	26 (27.4)	69 (72.6)		21 (22.8)	69 (75.0)	
Lollies/chocolates						
Parent only	20 (51.3)	19 (48.7)	0.80	21 (43.8)	26 (54.2)	0.62
Formal only	33 (41.3)	45 (56.3)		14 (34.2)	26 (63.4)	
Informal only	28 (48.3)	30 (51.7)		31 (47.7)	34 (52.3)	
Formal and informal	43 (45.3)	52 (54.7)		38 (41.3)	54 (58.7)	
Potato chips /twisties/cheezels						
Parent only	15 (38.5)	23 (59.0)	**0.02**	8 (16.7)	39 (81.3)	0.48
Formal only	20 (25.0)	58 (72.5)		9 (22.0)	30 (73.2)	
Informal only	11 (19.0)	47 (81.0)		9 (13.9)	56 (86.2)	
Formal and informal	15 (15.8)	80 (84.2)		21 (22.8)	71 (77.2)	
Hot chips						
Parent only	13 (33.3)	26 (66.7)	0.07	6 (12.5)	41 (85.4)	0.12
Formal only	12 (15.0)	66 (82.5)		6 (14.6)	33 (80.5)	
Informal only	10 (17.2)	48 (82.8)		16 (24.6)	49 (75.4)	
Formal and informal	14 (14.7)	81 (85.3)		10 (10.9)	82 (89.1)	
Savoury biscuits						
Parent only	30 (76.9)	9 (23.1)	0.55	34 (72.3)	13 (27.7)	0.20
Formal only	67 (85.9)	11 (14.1)		36 (90.0)	4 (10.0)	
Informal only	44 (80.0)	11 (20.0)		52 (80.0)	13 (20.0)	
Formal and informal	73 (78.5)	20 (21.5)		76 (82.6)	16 (17.4)	

	Age 3 years (N=272[1])			Age 4 years (N=246[1])		
Core foods and beverages, n (%)	**<once/day**	**≥once/day**	**p[2]**	**<once/day**	**≥once/day**	**p[2]**
Fruit juice/Fruit drink						
Parent only	28 (71.8)	11 (28.2)	**0.05**	29 (60.4)	19 (39.6)	**0.04**
Formal only	40 (50.0)	38 (47.5)		14 (34.2)	26 (63.4)	
Informal only	32 (55.2)	25 (43.1)		25 (38.5)	38 (58.5)	
Formal and informal	43 (45.3)	51 (53.7)		48 (52.2)	43 (46.7)	
Cordial[3]						
Parent only	7 (18.0)	31 (79.5)	0.52	9 (18.8)	37 (77.1)	0.44
Formal only	8 (10.0)	70 (87.5)		4 (9.8)	36 (87.8)	
Informal only	7 (12.1)	49 (84.5)		14 (21.5)	48 (73.9)	
Formal and informal	16 (16.8)	78 (82.1)		16 (17.4)	75 (81.5)	
Soft drink						
Parent only	10 (25.6)	29 (74.4)	0.23	13 (27.1)	35 (72.9)	0.06
Formal only	12 (15.0)	67 (83.8)		4 (9.8)	36 (87.8)	
Informal only	8 (13.8)	50 (86.2)		6 (9.2)	58 (89.2)	
Formal and informal	11 (11.6)	83 (87.4)		17 (18.5)	74 (80.4)	
Flavoured Milk						
Parent only	6 (15.4)	33 (84.6)	**0.021**	10 (20.8)	38 (79.2)	0.59
Formal only	19 (23.8)	59 (73.8)		10 (24.4)	31 (75.6)	
Informal only	22 (37.9)	36 (62.1)		19 (29.2)	45 (69.2)	
Formal and informal	17 (17.9)	78 (82.1)		28 (30.4)	63 (68.5)	

[1]N varies due to missing values; [2]Chi-squared value or Fishers exact (where frequency ≤5); [3]Syrup mixed with water; [4]Age 3: fresh fruit, excluding banana; Wave six: Fresh or stewed fruit, [5]Banana was included as a separate item in the three-year-old questionnaire, but not in the four-year-old questionnaire.

Table 3. Univariable and multivariable logistic regression for the indicator variable against each food and beverage outcome

	Univariable				Multivariable[1]			
	n	OR	95%CI	p	n	OR	95%CI	p
Age 3 years								
Flavoured milk	270				262			
Parent only		Ref				Ref		
Formal only		1.77	[0.64, 4.87]	0.27		1.68	[0.59, 4.80]	0.33
Informal only		3.36	[1.21, 9.31]	**0.02**		2.44	[0.84, 7.04]	0.10
Formal and informal		1.19	[0.43, 3.31]	0.73		0.80	[0.27, 2.33]	0.68
Fruit juice/fruit drink	268				260			
Parent only		Ref				Ref		
Formal only		0.41	[0.18, 0.95]	**0.04**		0.41	[0.17, 0.96]	**0.04**
Informal only		0.50	[0.21, 1.20]	0.12		0.51	[0.21, 1.27]	0.15
Formal and informal		0.33	[0.15, 0.74]	**0.007**		0.32	[0.14, 0.74]	**0.008**
Ice Cream	271				262			
Parent only		Ref						
Formal only		0.33	[0.12, 0.88]	**0.03**		0.29	[0.10, 0.83]	**0.02**
Informal only		1.24	[0.51, 3.01]	0.63		1.04	[0.40, 2.69]	0.94
Formal and informal		0.52	[0.21, 1.24]	0.14		0.45	[0.17, 1.17]	0.10
Potato chips/ twisties/cheezels	269				260			
Parent only		Ref				Ref		
Formal only		0.53	[0.23, 1.21]	0.13		0.72	[0.30, 1.72]	0.46
Informal only		0.36	[0.14, 0.90]	**0.03**		0.52	[0.19, 1.38]	0.19
Formal and informal		0.29	[0.12, 0.67]	**0.004**		0.43	[0.17, 1.09]	0.07
Hot chips	270				261			
Parent only		Ref				Ref		
Formal only		0.36	[0.15, 0.90]	**0.03**		0.46	[0.18, 1.18]	0.11
Informal only		0.42	[0.16, 1.08]	0.07		0.60	[0.22, 1.64]	0.32
Formal and informal		0.35	[0.14, 0.83]	**0.02**		0.53	[0.21, 1.35]	0.18
Age 4 years								
Soft drink	243				227			
Parent only		Ref				Ref		
Formal only		0.30	[0.09, 1.01]	0.05		0.14	[0.03, 0.76]	**0.02**
Informal only		0.28	[0.10, 0.80]	**0.02**		0.23	[0.07, 0.74]	**0.01**
Formal and informal		0.62	[0.27, 1.41]	0.26		0.64	[0.27, 1.54]	0.32
Fruit juice/fruit drink	242				226			
Parent only		Ref				Ref		
Formal only		0.35	[0.15, 0.84]	**0.02**		0.35	[0.14, 0.88]	**0.03**
Informal only		0.43	[0.20, 0.93]	**0.03**		0.42	[0.19, 0.94]	**0.03**
Formal and informal		0.73	[0.36, 1.49]	0.39		0.89	[0.43, 1.84]	0.75

[1]Models adjusted for child age, child gender, health care card (yes/no) and area.

Oral Health

No associations were seen in brushing frequency, oral health rating or dental visiting when comparing childcare types (Table 4). Low rates of optimal tooth brushing were seen across all childcare types at age three and four years, with 51% or less reported to be brushing twice a day. Low rates of dental visiting were also seen with around 45% of children reported to have never been to a dentist or dental clinic by four years of age.

Table 4. Distribution of oral health measures by childcare type at age three and four years of the VicGen cohort.

	Age three years (N=272)[1]					Age 4 years (N=246)[1]				
Brushing frequency, n (%)	**≤once/day**		**>once/day**		**p[2]**	**≤once/day**		**>once/day**		**p[2]**
Parent only	25	(64.1)	14	(35.9)	0.62	28	(58.3)	20	(41.7)	0.29
Formal only	48	(60.0)	31	(38.8)		26	(63.4)	14	(34.2)	
Informal only	37	(63.8)	21	(36.2)		32	(49.2)	33	(50.8)	
Formal and informal	66	(69.5)	28	(29.5)		58	(63.0)	34	(37.0)	
Parent rating of child's oral health, n (%)	**Poor/Fair/ Good**		**Very good/ Excellent**		**p[2]**	**Poor/Fair/ Good**		**Very good/ Excellent**		**p[2]**
Parent only	16	(41.0)	22	(56.4)	0.99	14	(29.2)	34	(70.8)	0.76
Formal only	33	(41.3)	47	(58.8)		15	(36.6)	26	(63.4)	
Informal only	25	(43.1)	33	(56.9)		19	(29.2)	46	(70.8)	
Formal and informal	41	(43.2)	54	(56.8)		32	(34.8)	59	(64.1)	
Child has ever been to dentist/dental clinic, n (%)	**Yes**		**No**		**p[2]**	**Yes**		**No**		**p[2]**
Parent only	7	(18.0)	31	(79.5)	0.17	26	(54.2)	22	(45.8)	0.95
Formal only	25	(31.3)	54	(67.5)		22	(53.7)	19	(46.3)	
Informal only	14	(24.1)	44	(75.9)		32	(49.2)	33	(50.8)	
Formal and informal	34	(35.8)	61	(64.2)		49	(53.3)	43	(46.7)	

[1] N varies due to missing values, [2]Chi-squared or Fishers exact (where frequency ≤5), without missing values

Discussion

This research has explored food and beverage consumption and oral health related factors in a cohort of Australian children aged three and four years. It has shown associations between the types of childcare these children experience and the frequency with which they consume particular discretionary foods and beverages. No associations were observed between childcare type and core food consumption, tooth-brushing, dental visiting or parent-reported child oral health status. However, childcare type was significantly associated with consumption of discretionary items, particularly sweet beverages - fruit juice/fruit drink and soft drink, and ice cream across these ages, which are associated with increased risk of dental disease.

In the current study, intake of core foods and beverages such as fruit, vegetables and milk were similar across the different types of childcare. Across all childcare groups, many children consumed fruit and vegetables less than once a day (30 - 51% of children aged 3 years and 19 - 33% of children aged four years). The dietary guidelines recommend children of this age consume 2 ½ to 4 ½ servings of vegetables and 1 to 1½ servings of fruit each day. It is unlikely that children who do not consume these items daily are meeting their recommended intake [225]. A substantial proportion of children were consuming discretionary items twice a week or more and the results suggest that many children are consuming multiple discretionary items more than twice a week. The dietary guidelines recommend children aged under eight years avoid discretionary items or restrict consumption to ½ a serving per day [41]. The cumulative intake of multiple discretionary items suggests that many children in this study are exceeding these recommendations. Discretionary food consumption can displace core foods, which contain the nutrients and energy children need to develop [41, 226]. Discretionary foods also tend to be high in salt and sugar and regular provision may encourage children to develop a preference for these flavours [227]. There is evidence that children's dietary intake may track across time [99, 207] and high consumption of discretionary items can lead to excessive energy intake. In the long term this can cause weight gain and increase the risk of diabetes, cardiovascular disease and tooth decay [228, 229].

At three years of age, compared with children receiving parent only care, children attending formal childcare only were 59% less likely to be consuming fruit juice/drink and 71% less likely to be consuming ice cream. Children attending a mixture of formal and informal childcare were 68% less likely to be consuming fruit juice/drink. At four years of age, associations were only seen with sweetened beverages – fruit juice/drink and soft drink- with children attending either formal childcare only or informal childcare only, 58-86% less likely to be consuming these beverages compared with children in parent only care. Although these results were statistically significant, the wide confidence intervals indicate the magnitude of association may be much smaller (as low as 4%) or higher (88%) than observed. Fruit juices and fruit drinks tend to be perceived as healthier than soft drinks [187], despite being similar in terms of energy density, sugar content and the detrimental effect on teeth [230]. Although 100% fruit juice may have some beneficial nutrients and are counted as one serve of fruit in the Australian Dietary Guidelines[9], they lack the fibre and are less satiating than a piece of whole fruit [231, 232]. Additionally, young children innately preference sweet flavours [227], so providing fruit juice and fruit drinks at an early age can encourage them to preference these beverages over water and milk.

There are few published studies comparing dietary intake by type of childcare and those that exist focus on formal childcare settings rather than informal childcare. In Finland and Canada, children in formal childcare were less likely to consume soft drink compared to those not in childcare, but no difference in fruit juice consumption was observed [233, 234]. This is interesting considering both fruit juice and soft drink were less likely to be consumed by children attending care in the current study. The timing of data collection may provide some explanation for these differences, with data from Canada and Finland collected in the mid-2000's whilst data for VicGen were collected from 2011 onwards. the increased focus on childhood obesity rates in the early to mid-2000s [235, 236] encouraged the introduction of nutrition policies in many early childhood services [237]. Policies tended to promote water and milk as the only beverages offered to children in these settings, whilst discouraging sweet beverages, including fruit juice [213, 238, 239]. Compared the Canadian and Finnish children in these studies, children in the VicGen study may have been more likely to be attending childcare where beverage policy may have been implemented for many years.

In addition to childcare centre policies, in early 2012, the National Quality Framework introduced new quality standards across formal childcare settings in Australia, which included guidelines in relation to the provision of nutritious foods in formal childcare settings[211]. Childcare services are assessed on seven quality areas and given a rating, which they must display at their centre. Services must meet a certain standard or be working towards the standard to continue operating. The implementation of this framework commenced around the same time as three-year-old data collection in this study and it is likely that the potential effects of the framework were not immediately seen as services worked towards meeting the benchmarks. The nutrition component of the NQF is relatively small, and the degree to which services adhere to these guidelines is unclear, with recent research showing discretionary foods are regularly offered at childcare centres[216]. This is additionally complicated across family day care services, where childcare provider give childcare out of their own home to a small number of children. The ratio of food provided by the childcare provider to food provided by parents may vary across different family day care services.

The reasons for consumption differences between children attending informal childcare only or a mixture of formal and informal childcare are more difficult to ascertain given the lack of existing evidence about what occurs in informal childcare settings. We theorised that formal childcare policy and guidelines may account for the associations seen with children in a mixture of childcare types. However, a sensitivity analysis was conducted to explore this, at age four years, and there were no associations between the proportion of time children spent in each type of childcare and their consumption of soft drink or fruit juice/drink. This suggests that factors across the formal and informal childcare environment may influence beverage intake for these children. Additionally, the differences seen between informal childcare only and parent only care warrant further exploration. Grandparent care is the most common type of informal childcare used in Australia[209] however there is little published evidence about food and beverage consumption in this environment. Traditionally, grandparents have been considered treat-givers and parents tend to report their children are likely to receive unhealthy foods and beverages from grandparents[240]. However, emerging research has challenged this with grandparents have reported the healthiness of an item as the main influence on the foods and beverages they provide to their grandchildren[241]. Additional evidence suggests that as the amount of time a grandparent cares for their grandchild each week increases, they tend to provide more parent-like care, where unhealthy foods and beverages are limited[124]. Further research into grandparent childcare is warranted to explore the provision of foods and beverages in this environment.

The oral health variables used in this study were selected to capture parent reports of overall oral health, dental visiting patterns and oral hygiene behaviours. While no significant relationship was observed between childcare type and any of these variables, this analysis has identified oral practices that fall short of recommendations. To maintain good oral hygiene, teeth should be brushed twice a day[242], however at age three years, only 30-40% of children across all childcare types were brushing their teeth more than once a day, and this increased only slightly by age four years. These results suggest oral health promotion strategies targeted at families during this time were not eliciting the desired behaviours in this group and reasons for this need to be explored. It is also recommended that children visit a dental professional by the time they are two years old[242]. In 2011, all children under 12 year of age were eligible for general dental services through the public system and had priority access[243], however only 18-36% of three year-olds and just over 50% of four year-olds in this sample had visited a dental professional. Some families considered the oral health check they received as part of the VicGen study to be sufficient, as reported anecdotally during study visits. Geographical barriers may have also played a role, given that a large proportion of this cohort resided in rural areas and only two-thirds of those eligible for public dental care in rural areas live within a 20km radius of a public dental clinic[244]. The reasons behind not visiting a dental professional are likely to be multi-factored and will be explored in further publications from the VicGen study.

In Victoria, most parents will receive oral health information from the Maternal and Child Health Service at their child's 8, 12 and 18-month health checks. However, there is limited published evidence around the implementation and effectiveness of other oral health promotion strategies in different childcare settings in Victoria. There is evidence around the effectiveness of an outreach program where dental professionals visit preschools and reduce barriers to attending dental services [245], which could theoretically be applied to childcare services. Currently, Smiles 4 Miles[246] and the Achievement Program [247] are two ongoing programs run state-wide that have a focus on oral health promotion. At the time of data collection however, very few childcare services were participating in Smiles 4 Miles, with the focus on participation of kindergartens. The Achievement Program, whilst targeting childcare services, was in its infancy at this stage, with oral health messaging starting to be incorporated into the program. The potential influences of these programs are unlikely to have had an effect by the time of data collection for the VicGen cohort, but families may be influenced by the structure and expansion of these programs over time.

The results presented must be interpreted in the context of the limitations of this research. The sample includes participants from metropolitan, regional and rural Victoria, but may not necessarily be representative of the broader population. The food frequency questionnaire captures a broad range of core and discretionary foods and beverages, however as it was designed for use in relation to oral health it only measures the frequency with which items are consumed, not the actual amount as no serving size was specified. Also, parents may not always know what their child is consuming if they are not in their care. The care-type measure is also relatively crude. Parents reported childcare during a typical week over the last month, which may not represent the childcare their child usually receives. Additionally, both measures were parent-reported and thus open to bias compared with more objective measures. There may also be potential differences in the types of informal childcare (e.g. grandparents vs nannies vs friends) that make a difference to these outcomes that are not captured in these data.

Conclusion

The present study demonstrated that, in three and four-year-old children, attending childcare is associated with less frequent consumption of soft drinks and fruit juice/drink, but not associated with the consumption of core foods or most discretionary foods. Childcare was not associated with the oral health and hygiene indicators; overall however, many children were not brushing their teeth twice daily and had not yet seen a dental professional, both of which are recommended for good oral health. Further investigation of healthy eating and oral health in the childcare environment is needed, particularly in informal childcare. There is little understanding of what and how different factors in the informal care environment help or hinder the promotion of healthy eating and good oral health and hygiene. Gaining insight into this environment will help to ascertain which strategies may be transferable to other childcare settings, and potentially parent-only care, as well as identifying areas where care providers may require additional support. Further research with families who do not use childcare is also warranted, to explore the reasons for more frequent consumption of some discretionary items by children in this environment. Understanding factors unique to this context will help identify if and how existing child nutrition and oral health messages reach families, and the barriers and enablers to promote healthy behaviours in parent-only care.

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Chapter 8: The role of grandparent care in early childhood nutrition and oral health

8.1 Introduction

The final component of work presented in this PhD focuses on the role of grandparent care in early childhood nutrition and oral health. In the preceding chapters I have demonstrated the frequent consumption of discretionary foods across the first five years of life and the association of some discretionary foods and beverages with the type of childcare children are exposed to at ages three and four. This chapter explores the most common type of informal childcare used in Australia, grandparent care, and provides an in depth investigation of the factors in this environment that influence nutrition and oral health in young children.

Childcare is an important topic for hundreds of thousands of families in Australia, and around the world. As previously discussed, children between one and four years have the highest usage rates of childcare in Australia with more than 59% of children in this age range attending some sort of care [107]. Grandparent care is the most common type of informal childcare in Australia, with the highest usage rates observed for one-year old children (32.5%), then gradually decreasing with increasing child age to 22.1% of five-year-old children [107]. In preschool children, maternal grandparents are more commonly used as care providers than paternal grandparents and children are also often in other formal care arrangements [248]. Across the first five years of life, if children have parents in employment, the time they spent in their grandparents' care each week is relatively stable. (Children 0 -3 years of age an average of 14 hours per week, 4-5 year old children 11 hours per week [248]).

As discussed in Chapter 2, these early years are important in the development of health behaviours that children will carry with them throughout life. The environments children are exposed to during these years play a significant role in shaping these behaviours. Despite a significant proportion of Australian pre-schoolers spending time in the care of their grandparents each week, there is little research exploring the influence of this environment on children's health and wellbeing, particularly in relation to oral health and to a lesser extent, nutrition.

Research on the influence of grandparents, in general, on the dietary intake of their grandchildren is an emerging field. Whilst published research has traditionally focussed on grandparents who have custodial care of their grandchildren there has been increasing focus in the last 10 years on the influence of grandparents who provide non-custodial care.

There appears to be consensus across much of the research in this field from both grandparents and parents, that grandparents tend to provide unhealthy treat foods more frequently than parents [115-117, 120, 121, 124, 126]. Although, grandparents are conscious of the healthiness of the food they are providing, child age and gender as well as grandparent gender have been shown to moderate foods provided [127]. Younger children and girls tend to be provided with healthier food, and grandmothers are more likely to provide healthier food than grandfathers [127]. The time that grandparents spend caring for children also influences children's diets, with the healthiness of the food provided tending to increase and become more 'parent like' as the time spent in care increases [124]. The cultural context and past experiences of grandparents also influence behaviour. Research from China suggested that grandparents, who had historically experienced food shortages, tended to provide large, frequent serves of foods as they were more concerned that their grandchild had enough to eat rather than the nutritional value of what they were providing [115].

There is little published research examining the influence of grandparent on their grandchild's oral health. The factors examined in the diet related work previously presented are likely to contribute to child oral health, however other factors such as oral hygiene and dental visiting are also important influences. At the time of writing this PhD, only one paper was identified that specifically examined this topic, and it only focussed on the knowledge of grandparents about their grandchildren's general oral health, not the grandparents' actual practices and behaviours [130].

Given the importance of environments on shaping behaviours in the early years and the large proportion of children who spend substantial time in grandparent care, research into this environment is important. However, unlike formal childcare settings there is little research examining the influence that this environment may have on nutrition and oral health in early childhood. There is limited research that explores this care environment from the perspective of parents and grandparents. To better understand the grandparent care environment and identify the potential for health promotion intervention, more research is required. This research needs to explore the key benefits and challenges of using grandparents as care, what challenges parents face and what benefits there are for children in these situations.

The aim of this study was to explore factors within the grandparent care environment which may influence nutrition and oral health of children aged between one and five years and in this care environment for at least five hours per week.

The objectives of this study were to

a. Describe the different contexts and environments within which grandparent care occurs

b. Identify key benefits and challenges that the grandparent care environment presents to promoting child nutrition and oral health, from the perspective of the grandparent(s) and parent(s)

c. Identify opportunities for health promotion interventions within the grandparent care environment.

8.2 Methods

8.2.1 Recruitment

The parents and grandparents of preschool aged children who took part in the validation study presented in Chapter 5 of this thesis were targeted for recruitment into this study. Participants for the validation study were recruited via several methods including social media, word of mouth, staff newsletter and email communication from community health organisations that partner with the research program that this study was conducted within.

The first component of the validation study was a questionnaire. Within this questionnaire the researchers included a statement and two questions to identify potential eligible participants for this study, as outlined below.

1. *Is this child cared for by their grandparent(s) for at least 5 hours each week? (yes/no)*

We plan on conducting interviews later in the year with parents and grandparents. Parents will be the initial contact and will be asked to pass on an information sheet about the interviews to their child's grandparent. If grandparents are interested in being interviewed, they will be able to contact the research team either directly or through the parent involved.

2. *Would you be interested in being contacted about an interview later in the year and willing to pass on the information to your child's grandparent? (yes/no)*

Parents who answered yes to both questions were flagged for follow up at a later date.

Initial searches of the literature showed that existing work had tended to include grandparents who cared for their grandchildren for a minimum of 10 hours per week. After discussing with my advisory group and supervision team (all of whom were or had been working parents), the minimum care hours required was reduced to five per week. The rationale for this being that for many families, 10 hours would equate to the child being cared for more than one day per week by a grandparent and would exclude children who may be cared for by grandparents only one day per week. We felt that grandparents could still potentially have an important influence on their grandchild when only caring for them one day a week and this may be missed if the minimum care hours was 10.

In the questionnaire, 59 of 146 parents (40.4%) indicated that their child was cared for on a regular basis by their grandparent and 53 (89.8%) of these indicated they would be happy to be contacted about an interview. To enable interviews to be conducted face to face with participants in their homes, the potential interviewees were selected from validation study participants who resided in Victoria, Australia. As part of the validation study, parents provided demographic information including: area of residence (metro, regional, rural), parent age, child age, number of children and language spoken at home. Potential interview participants were purposively chosen using this information to get as wide a range of backgrounds included in the interviews as possible.

Parents were contacted via email between 3 and 12 months after participating in the validation study. They were given an outline of what the interview study involved and were asked if they were willing to take part and whether they were willing to pass an information sheet to the grandparent who cared for their child on a regular basis.

Seventeen parents were contacted and invited to participate. Two parents were no longer eligible to participate, one had moved interstate whilst the other was on maternity leave and her son was no longer cared for by his grandparents on a regular basis. One parent declined participation due to a lack of time. From the remaining 14 parents, after reviewing the study information, 10 agreed to pass the study information to the grandparents, whilst five were unable to be contacted despite multiple attempts.

From the remaining 10 parent-grandparent pairs invited to take part, two grandparents declined, one did not want to be interviewed, whilst the other was not confident in her English-speaking abilities. Due to the limited funding associated with this PhD project, interpreters were not available for interviews. The nature of the project required parent-grandparent pairs, so where grandparents were not available the parents were thanked for their time and not contacted again. Two parent-grandparent pairs were unable to be followed up for participation, despite multiple phone and email attempts.

For the remaining six parent-grandparent pairs, grandparents were given the option of being contacted directly by me or through the parent. All elected to be contacted directly. Each participant was sent a plain language statement, interview consent form and photograph consent form in the mail prior to the interview. All participants were sent a confirmation text message the day prior to the interview.

8.2.2 Data Collection

Interviews were scheduled with each grandparent(s) in their homes, and separate interviews were scheduled with parents in their home. In some cases, participants preferred to complete the interview in a different location of their choosing. One parent participated in their interview in an office at the University, and one parent elected to be interviewed in the grandparent's home. The order in which parents/grandparents were interviewed in was dependent only on their availability and scheduling.

Two separate interview schedules were developed for use with parents and grandparents. The schedules contained approximately eight prompts designed to elicit information related to nutrition, oral health and caring for grandchildren. The first two interviews (one parent interview, one grandparent interview) were attended by two researchers, myself and my primary supervisor. My PhD supervisor is an experienced qualitative researcher and attended the interviews to provide guidance to the candidate for interviewing techniques. The other nine interviews were conducted by me.

Written informed consent was received from all participants. Interviews were audio recorded using the Livescribe Smart Pen[1], and participants verbally consented to the recording of interviews prior to commencement of the recording. Participants were advised that they could stop the interview at any time, and it would not affect the parent or grandparent's involvement in the study. Notes were taken during interviews and a reflective memo was written by me after the interview, after leaving the participant's home. Audio files were uploaded to a secure share drive at the University, as well as any notes taken with the Smart Pen. All audio files were transcribed verbatim by a third-party transcribing service that had previously been used by the research group.

Interviews were conducted where possible in the participants' homes, as this was where they cared for their child or grandchild most of the time. It allowed the me to get a firsthand impression of the physical care environment that the child was exposed to and assist with the interpretation of the interview data. Photographs of the care environment were taken in some houses to help illustrate the findings. The style and flow of each interview varied. Some parents and grandparents spent time walking around the house showing me specific areas and items, whilst others were happy to sit and chat.

[1] LiveScribe smart pen is a digital recording pen which allows recording and notes to be simultaneously taken. The notes are then available as a digital file and can be matched with specific time stamps in the recording.

As a thank-you for participating in the interviews, parents and grandparents chose an age-appropriate picture or colouring book for their young child/grandchild.

In some cases, children were present during the interviews and researchers provided them with colouring in sheets and stickers (with the consent of the grandparent/parent). In one case, the voice of a child who was present appeared on the recording when they were at their grandparent's house. The child's parent was verbally advised of this when her interview was conducted and was happy for the recording to be kept.

8.2.3 Ethics Approval

Ethics approval was received from the University of Melbourne Human Research Ethics Committee for the inclusion of the screening questions in the initial study (HREC approval number: 1545410). Ethics approval was also received for the main study from the same committee (HREC approval number: 1647442).

8.2.4 Analytical strategies and timing of data collection

Data collection and analysis for this study were guided by constructivist grounded theory [249]. Grounded theory is a qualitative methodology which provides systematic, yet flexible guidelines for collecting and analysing data. It was pioneered in the 1960s by Glaser and Strauss [250], two sociologists who were examining the social organisation of dying in hospitals. The methodology has evolved since then, and the work presented in this chapter is guided by the principles of grounded theory which have been refined by Charmaz [249]. Grounded theory guides researchers to analyse data using a bottom up approach, which allows theory to emerge and develop from the data that have been collected. Using this approach, data collection and analysis occur concurrently, which gives researchers the flexibility to explore emerging themes or fill gaps in future data collection for the research. For example, an interview guide may be modified to explore emerging themes in more detail or interviewees may be selected based on specific characteristics that have been identified as important but are missing from the current data.

The first interview was analysed using line by line coding, with comparison to the notes and memos from this interview. Line by line coding involves examining each line of data, in this case interview responses, and coding what is happening in that line of the data using gerunds. The first interview was coded together by myself and my primary supervisor, with subsequent transcripts coded only by me. The picture formed from analysis of the first interview was used to inform the analysis of the next interview, memo and notes. The analysis of each subsequent interview was informed by the cumulative findings of previous interviews, memos and notes. Through this process, theory that helps explain the data starts to take shape. During the first phase of analysis, culture and siblings emerged as important themes related to the topic area. To explore these areas in more detail, it was important to select further interviewees based on these characteristics. The pool of potential interviewees had provided information on the number of children that they had and the main language that they spoke at home. The remaining potential interviewees all spoke English at home, so sampling focussed on families where there was more than one child present.

8.3 Results

A total of eleven interviews were conducted (5 with mothers, 4 with grandmothers only, two with grandmothers and grandfathers) in two phases between March and November 2017. Two of the interviews involved an in-law relationship between the grandparent and parent of the child. There was one case in which the parent was unable to be interviewed. At the completion of the grandparent interview, multiple attempts were made to schedule an interview with the parent, however they were unresponsive to these requests and were therefore not interviewed. The first phase of data collection involved nine interviews; four mothers, three grandmothers and two grandmother-grandfather pairs. Interviews were spaced out over approximately 3 months, allowing time to explore themes arising in interviews and adapt to the proceeding interviews. Due to the small sample size and inclusion of only two male grandparents there was risk of the information being identifiable if gender-based pseudonyms (such as grandfather, or mother-in law) or labels were used to describe the information. To negate this risk, results are presented, and quotes attributed to participants using the terms *parent* and *grandparent.*

Four families interviewed resided in metropolitan Melbourne and one family resided in regional Victoria. The children who were being cared for ranged in age from 18 months to five years, however, as described later in these results, families are in a state of flux and there were a number of siblings of these children who had been cared for by their grandparents in the past or would be cared for by them in the future. These children, rightly so, could not be disentangled from the children who were currently being cared for and so were also included in the discussions that occurred.

In all cases, grandparents reported that for the most part their grandchildren came to them and were cared for in their grandparent's home. However it was situation dependent; some grandparents had previously cared for their grandchildren when they (grandchild) were younger in the grandchild's home, and many said that if their grandchild was unwell they would travel to the child's home and care for them there because they felt it was better for their grandchild to be in their home environment when they were unwell.

All grandparents had been involved to some extent in the care of their grandchildren since the child's primary caregiver returned to work. The age of the child varied from family to family, but most children were between three and 12 months of age when their grandparents started caring for them on a regular basis. The length of care time they varied from family to family and across time.

The results are presented under the overarching themes observed in the data, however there is a lot of overlap and interconnection between the strands of information presented within each of these themes. The way in which these factors fit together can be explained to a large extent by the socio-ecological model of health. An ecological model for the grandparent care environment influence on child nutrition and oral health has been developed from these findings and is presented in Figure 8.1. This model incorporates factors discussed in these interviews and places them at the child, family, organisational, community and policy level. The factors included across the model may influence nutrition and oral health in grandparent care in two ways. Firstly, there are factors which primarily influence a) the likelihood of grandparents being able to provide care (e.g. retirement age, residential location) and b) influence the need for parents to seek grandparent care (e.g. government funded maternity leave, flexible working hours). Secondly, there are factors which influence nutrition and oral health when children are in the care of their grandparents (e.g. grandparent eating behaviours, family culture). Using grounded theory allowed constant comparison between interview transcripts, memos and contextual information observed in participants homes. This process helped to extract underlying explanations for different themes that were always explicitly discussed in the interview. The family level of the model consists of factors unique to parents and grandparents as well as shared family factors. Family Systems Theory outlined in Chapter 3 also fits in this level of the model.

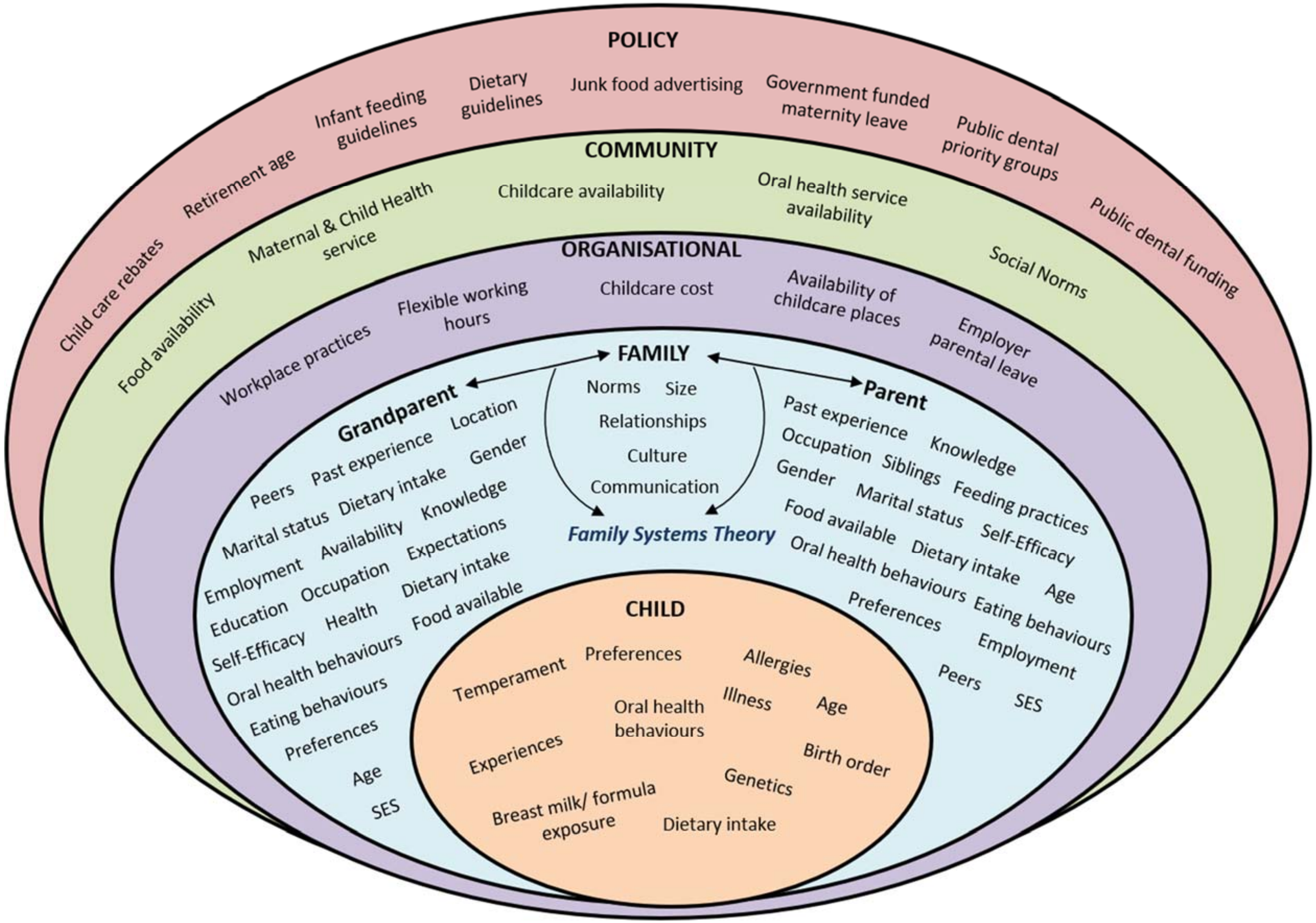

Figure 8.1 Ecological model derived from interviews for grandparent care environment influence on child nutrition and oral health

Throughout the analysis process it was clear that although the key questions of this research related to nutrition and oral health, a multitude of other contextual factors are driving how these topics are approached in this care setting. The results are presented in an order that shows the broad influences on the type of care provided and how these indirectly influence nutrition and oral health, followed by the more practical issues that occur in care that have a direct influence on child nutrition and oral health. Child health and safety were primary concerns for both parents and grandparents and whilst nutrition and oral health played a part in this, they needed to be spoken about in the wider context of parenting and grandparenting preschool aged children.

8.3.1 Care choice

Parents had clearly considered the different options available to them when deciding on how their child would be cared for once they returned to work. There were numerous factors that influenced their decision to have grandparents care for children. These included the number of days or hours of care required each week, the number of children needing care, the proximity of caregivers, the willingness and availability of grandparents, grandparent preferences and parents' own personal preferences.

> *No. They still work a lot, so they're not involved with the extra care."* Parent, when discussing the involvement of grandfathers.

In some cases, choice of grandparent care was largely made by the grandparents themselves. Some parents indicated that they were willing to use a formal childcare centre, but grandparents had said they didn't mind caring for their grandchildren or did not want their grandchildren going into childcare. This was particularly the case for grandparents who did not put their own children into childcare when they were raising them. A mixture of these factors unique to each family resulted in the care arrangements that were in place:

> *[Child] was my first and I was working full-time. I went on maternity leave, had [child] and I wasn't really ready to go back to full-time. I wanted to go back part-time. I knew it probably wasn't going to be worth it going to childcare. My parents put their hand up and said they were willing to do it.* Parent.

I think as a grandmother I didn't want him going to care. My children didn't go to care. It's a different generation, isn't it? I was thinking I don't want this poor child going to child care. Grandparent.

Although all parents seemed content with the decisions they had made regarding their child's care, parents of children who had not attended formal childcare reflected more on this decision. They pondered 'what might have been' if they had sent their child to formal care and what influence exposure to other children may have had:

Sometimes I do wonder should I have put [child] in childcare, but then I think the grandparents love having her, so I feel like I would do a disservice to them if I didn't give them that. Parent.

…I'm thinking what if we had put her in childcare, because she may have started eating better a bit earlier if that was the case. It's hard to know how they would be. Parent.

The cost of childcare was not mentioned by participants as a primary reason for having grandparents care for children. When the cost of childcare was discussed, parents tended to describe the money that they saved by having their child cared for by their grandparent as an additional benefit of grandparent care, rather than a motivating factor, which may reflect the socio-economic position of these particular families.

8.3.2 Care arrangements

In this sample of families, there were two clear types of care arrangements that involved grandparents. The first is that where the grandparents were the sole childcare providers for children throughout the week whilst parents were working, and the other involved families using a combination of care types throughout the week, where children attended a formal childcare centre on some days and spent the other day(s) with their grandparent(s). In discussing what had occurred and what they anticipated occurring, it was also obvious that childcare arrangements were in a dynamic state across those first five years of life, with arrangements changing in response to the ever-changing life-circumstances of a young family:

When I first started to look after [grandchild] I used to have him two days a week… ….and that was fine and that was probably for about less than two years. Grandparent.

In some cases, the responsibility of childcare was shared across both sets of grandparents in the family, along with formal childcare. One grandparent described the number of days that she was responsible for care in the context of other care providers:

> *Officially one and [parent] was working four days, so there were two days of child care and another set of parents were doing one, but they travel more than we travel so I sometimes do two [days.]* Grandparent.

The amount of time that grandparents spent caring for children was negotiated differently across families, and this also changed as circumstances changed within the family. Some grandparents appeared to be content to be constantly available for care, whilst others spoke about setting boundaries with their children regarding the number of hours they were available for care. For some grandparents these boundaries were set prior to the child being born, whilst for others they were in response to expectations as children got older. In many cases they related to being able to enjoy what they had planned for their retirement, particularly travelling:

> *What we wanted to do in retirement was travel, and for a number of years there, we were going away once a year overseas and that was just part of it and [Parent] had to work out who was going to look after the children whilst we were away.* Grandparent.

The boundaries that were initially set did not always remain once children had actually arrived, and in some cases, they were not the same for grandparents who were part of a couple. One parent described the way that this had evolved as her children grew:

> *Before I had [child] he [grandfather] said to me, 'We're not going to be those kinds of grandparents who give up our whole lives to look after your children' and that kind of stuff, but he totally runs around after then. Whatever they need…. whereas mum…she has her own stuff that she wants to do and doesn't want it to monopolise her week.* Parent.

Parents commonly reported being conscious of not overburdening their child's grandparents with caring responsibilities. One parent reported feeling guilty that she had been so reliant on her mother to provide care and hoped that would change when she placed her child in formal childcare for the first time:

> *I won't feel so guilty about having constantly having to turn 'round to my mum and say, 'Can I get you to take [child] again on Friday?* Parent.

Whilst another parent did not want her child’s grandparent to feel like looking after him was burdensome:

> *She’ll always say she’s happy to have him, but she’ll also say if she can’t, which is good. I don’t want it to be a chore. I want her to enjoy having [child].* Parent.

At the same time, grandparents were conscious of not overburdening themselves and making sure they were able to do what they wanted in life as well.

8.3.3 New babies

One of the key influences on changes in care choice throughout this time was the birth of a new baby into the family. This change in life circumstances caused parents to reassess their childcare arrangements and generated new discussions with the grandparents who were caring for them. Parents were very aware of the demands of caring for two young children and were conscious of not overburdening grandparents. In some cases, there were also new cousins being born into the family, and they had to be considered when thinking about not overburdening grandparents. In response to being asked whether it was easier to care for only one child, a grandparent replied:

> *It is. We're definitely getting older…. Lack of energy by the end of the day. End of Wednesday, we're just content to sit quietly.* Grandparent.

Another grandparent, who was expecting the arrival of their second grandchild, recalled that she enjoyed caring for multiple children when she was raising her own children as it made her feel less isolated, but she was uncertain how she would cope caring for multiple grandchildren:

> *“As I’m getting older, I’m not sure how it will go, but we will see.”* Grandparent.

Grandparents were also thinking about how to treat their grandchildren/children fairly and not overburden themselves or be seen to be ‘playing favourites’ with particular children by providing care for one and not the other:

> *We have a connection with them. Who know them better than the other two who are in [another town], you see. We might see them twice a year or so…* Grandparent.

Negotiations between the different sets of grandparents also needed to happen in many circumstances. Again, these were different for each family for many reasons including the physical proximity of each set of grandparents, the willingness of grandparents to care for grandchildren and the amount of time that grandparents had available to dedicate to care. Many grandparents were in transition stages of life, either semi-retired or close to being fully retired. In most cases it was the grandmother who was responsible for caring for the grandchildren, with some grandfathers still working. Negotiations about care were made between the parent and each set of grandparents, or sometimes the grandparents spoke to each other and negotiated care.

8.3.4 Types of grandparent care

Outside of the general negotiations about grandparent childcare there were two distinct types of care that parents recognised grandparents as providing. These types will be referred to as child-centred and grandparent-centred to avoid confusion with other grandparent care types (i.e. custodial/non-custodial). Care types tended to differ between the different sets of grandparents within the family and this appeared to be related to the personality of the grandparent, rather than the relationship between the grandparent and parent (i.e. in-law/blood relationship).

In grandparent-centred care, for most of care time, the child tended to fit into what the grandparent(s) had planned to do on that day. For example, they might go with their grandparent to the supermarket or hardware store. There were few planned activities that were focussed specifically on the grandchild:

> *…it's very much just about supervising and [child] just tags along. There's not a lot of stuff that's about what [child] wants or needs or should have…* Parent.

In child-centred care parents described grandparents fitting their activities in around the care of their grandchild. Grandparents providing this type of care had lots of child-focussed activities during the day, such as painting, playing and reading books. Grandparents tended to organise their own activities, such as grocery shopping or medical visits, around the days when they knew they were not caring for their grandchild:

> *….and we want to do these things that are all about [child] and about what [child] likes and wants and needs. Her stuff gets sandwiched in amongst that.* Parent

Child-centred care was more common than grandparent-centred care and applied to the description of care that grandparents used to explain how they cared for their grandchildren.

8.3.5 Adjusting to new roles

Parents and grandparents reflected on adjusting to their new roles in life when a new baby came along in the family and the influence that this had on their relationships, child care, nutrition and oral health. This was particularly evident when parents and grandparents were discussing the first child or grandchild that came along in their family. Some parents felt that the grandparents struggled to recognise them as adults, responsible for their own children:

> *I'm an older parent. They can't see that we're adults having kids. Sometimes they think we're kids having kids.* Parent.

Whilst parents who were expecting their first child recalled how they felt fitting into their new role as a parent:

> *It's felt like a very steep learning curve and it's probably been a bit of a thing where I expect to be pretty competent with what I'm doing, and I've just had to go 'Okay, I'm just going to muddle through, it'll be okay.'* Parent.

Grandparents reported the differences that they felt caring for their grandchildren compared to raising their own children. One grandparent felt extremely grateful to have the opportunity to be so involved in his grandchildren's lives because he felt like he missed out on time with his own children. His wife was also enjoying the opportunity to share care responsibilities:

> *At the time when we had ours, the little ones, I was doing it all because he was busy working, but now we're doing it together.* Grandparent.

Many felt that at this stage in their life they were much more relaxed and had more time and opportunities to enjoy the time they spent with their grandchildren, which they were not able to do as much as they would have liked when their own children were younger.

8.3.6 Interpersonal relationships of caregivers

It was evident that the complexities of the interpersonal relationships that exist in the family unit influenced the type of care environment that young children were exposed to. A multitude of relationships exist in this scenario and these are outlined in

Figure 8.2. These relationships influence care and in turn nutrition and oral health to varying degrees. The relationships have been defined as primary and secondary. The key primary relationship observed in this work lies between the primary carers of the family, which in this

study were the women of the family; the mother, maternal grandmother and paternal grandmother:

> *But, I think that's actually been a big issue with parenting, is negotiating those relationships and those boundaries with both sets of grandparents, more so the grandmas. Yeah. Pretty much the grandmas.* Parent.

The primary parent and grandparent caregivers in this sample all appeared to have relatively close relationships with each other. Parents and grandparents never seemed to be overly aggressive or angry with each other, but varying degrees of frustration and annoyance could be detected. Three factors that appeared to regulate the level of frustration in the relationship, were those of mutual respect, open communication and common values. In cases where parents and grandparents were in agreement with these factors, frustration tended to be low.

All mothers to some degree, reflected on the differences and similarities between their child's two sets of grandparents and the degree to which they felt comfortable communicating general parenting issues with them. Some felt that it was easier to discuss parenting decisions with their own parents rather than their partner's parents:

> *I definitely feel like my mum will listen to me if I say 'not really comfortable with that'. I try not to do it very often, pick the really important battles and I also feel like she's respectful of that, that we've said hot chocolate is for nanna's, she's heard that, and she hasn't been pushing juice or cordial or other things. She's accepted that, whereas the in-laws occasionally say to me that I should be a less fussy parent. That's very hard to know how to respond to.* Parent.

> *My parents did everything my way. I would say to mum, please do it like this and then she'd just do it. Also its' easier to yell at your own parents if they don't…[do what you want them to].* Parent.

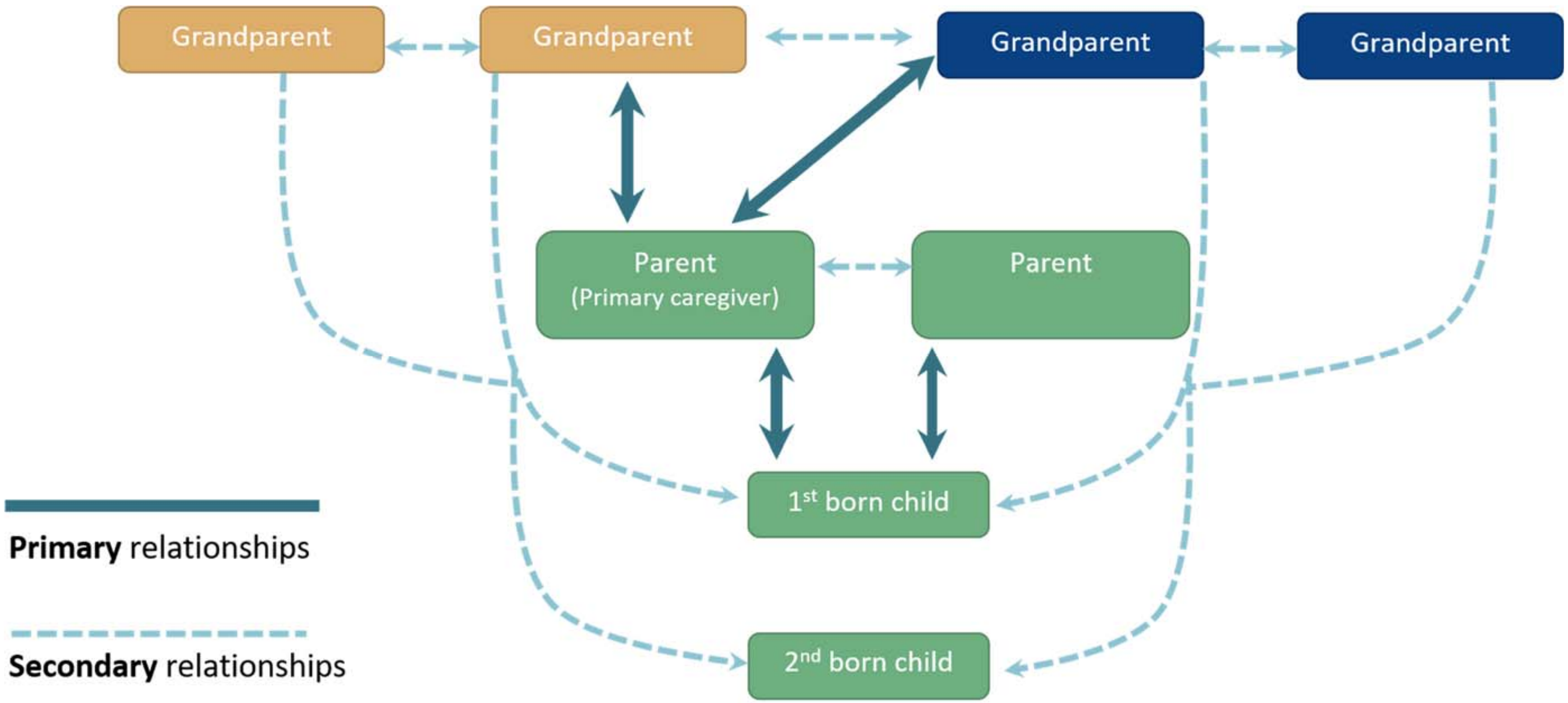

Figure 8.2 Primary and secondary family relationships influencing the grandparent care environment

In contrast some mothers felt more frustration with their own parents, one mother, when speaking about her mother giving her ‘advice’ about her parenting:

> *It’s a trust thing and I feel like she’s constantly questioning what I’m doing and it’s very frustrating. I think she doesn’t understand why I’m upset with her because she thinks that’s her right as a grandparent, because she’s had kids so she’s got that experience.* Parent.

Grandmothers also reported feeling varying degrees of frustration with parents. While some grandparents said that they tried to follow what they were asked to do and what was occurring in the child’s home, others felt that they did not need to be told what to do as they had already raised children. Grandparents also reported offering varying degrees of ‘advice’ to parents about their grandchildren. Some grandparents were conscious of not overstepping what they saw their role to be, whilst others felt that parents needed the advice. Grandparents discussed trying to keep rules consistent with what happened in the child’s home to reduce confusion and conflict:

> *It doesn’t give them mixed messages either about what they can get away with at Nana and Pa’s that we can’t get away with at home or vice versa. They know what the rules are.* Grandparent.

> *… I do try to model what goes on at home just so there’s not a battleground happening.* Grandparent.

Another grandparent reported being conscious of her actions and the advice she provided parents because of her own experiences dealing with grandparents when she was parenting young children:

> *I’ve got to be very careful because when my mother-in-law was around, I’d go “hmm”, so try not to do it, but I know poor [parent] must look at me sometimes and think “Just shut up!”* Grandparent.

Parents reflected the importance of their relationship with their partner when it came to both raising their children and negotiating child care with their grandparents. Many recognised the importance of having open discussions with their partner regarding decision making or having their partner ‘back them up’ on decisions that they had made, particularly if there was some tension between parents and grandparents:

If he and I clashed on a lot of things it would probably make it a lot worse. Because we have similar values and he is quite supportive in general that helps a lot more. Parent.

Luckily we're on the same page and didn't have issues on that. As soon as the kids come along, there's a new set of rules where you've got to decide what each of you think on how they should be raised. Parent.

Despite their frustrations, all parents showed gratitude towards their child's grandparents for being both available and willing to care for their children:

I really value the effort that she puts in with (child), that she really does put her life on hold and sandwich her stuff around him. Parent

But, she's just trying to help. I know it comes from a good place and she's just trying to help and – because she knows I've probably got a lot to do. Parent

This seemed to reduce the stress associated with childcare, with parents noting that grandparent care was much more flexible than child care centres, especially when children were sick and unable to attend childcare.

8.3.7 Experience versus new knowledge

Parents and grandparents spoke about the knowledge they had and the ways in which they learned about nutrition and oral health in the context of overall child rearing. Parents reported getting information from a variety of places, particularly when they had their first child. They were reliant on health professionals (particularly Maternal and Child Health Nurses), child care professionals, their own peers and their parents:

Often, if I need advice on something I don't ask the grandparents. I ask my friends. They've all got slightly older children, so I would go by them before the grandparents. Parent.

Grandparents also reported getting their information from a wide variety of sources. Many mentioned they had retained and relied on the knowledge they gained when raising their own children. However, many also acknowledged that the 'best practice' information had changed quite a bit since they were parents of young children and that they were, to an extent, reliant on parents providing them with up to date information. The degree to which the information that parents provided to grandparents was taken on-board differed between families:

But, sometimes I can't understand why they can't see that we've researched things ourselves and tried to get up to date information on things. That has been an issue too. Parent.

It's new with her and ours is old. She's telling us this is what should be done now in this time, but we've got experience from our old times. It's different but it's the same. Grandparent.

The complex mixture of experience and knowledge helped to shape the care environment provided by grandparents and in some cases generated tension between parents and grandparents.

8.3.8 Grandparents as 'treat-givers'

Grandparents and parents all mentioned that a fundamental right of being a grandparent was the ability to treat children, particularly in relation to food. Parents and grandparents held similar views on what they considered a healthy diet to be, with everyone commenting on the importance of including fruits and vegetables and eating a variety of foods. Limiting processed foods, sugar and fat, and avoiding foods with specific colourings or additives in them were also mentioned as contributing to a healthy diet. Grandparents providing treat foods to children was described in the context of the child's overall diet. Everyone felt that providing the occasional unhealthy treat food was acceptable, as long as the child was receiving a healthy diet the rest of the time:

They can have the cheap treat every now and then. I'm not going to be that super strict parent that says no to those kind of things, but it's important for them to see us eat it [healthy foods] as well, which we do. We've always had veggies with every meal. Parent.

... say junk food, she's [grandmother] the one that introduced [child] to things like biscuits and those types of fruit that are very sweet. [Partner] and I try to be pretty healthy and strict on that kind of stuff. We probably let it go a bit more because it's maybe once a week and I don't want to create tension with my mother-in-law. Parent.

Everything in moderation. You have to have treats and you need to be aware that there is a time when we do this, but we don't do this all the time. Grandparent.

The type of 'treat' food, amount, and frequency such foods were given to children varied across families and between parents and grandparents. For some grandparents, treats were provided only once a day, whereas for others it was only once a week or less than that, for special occasions. The concept of what constituted a 'treat' food was also discussed. For most grandparents 'treat' foods were traditional unhealthy foods such as chocolates, lollies, ice cream and takeaway foods. In contrast, one grandparent said that her grandchild considered raspberries to be a treat food because they were not available all year round. Some parents also described providing healthy versions of 'treat' foods such as plain yoghurt with honey instead of ice cream for desserts. Parents were also conscious of not trying to use treats and rewards that were centred around foods:

> *Food is such a big reward system and I think that's where it goes wrong, and I catch myself doing it sometimes.* Parent.

> *I remember [daughter] had taken them shopping centre shopping and she said he could have a treat, so they went in the fruit shop and he could pick two bits. I think he had a plum and I can't remember what else. Happy as Larry. Thought it was Christmas.* Grandparent.

Grandparents described being able to treat children with food as one of the perks of being a grandparent and something that differentiated them from the child's parents. Grandparents spoke about how they navigated their dual role of grandparent treater and primary caregiver when they were caring for their grandchildren. For some grandparents it was not an issue and they did not differentiate between the roles:

> *It's a treat coming to Nanna and Pops. He has the occasional sweet treat up in the pantry that comes out. It's not that often. I'm under strict instructions [from the parents] not to give them any.* Grandparent.

Other grandparents, particularly those who had regular days of care, remarked that the care they were providing when the parents were at work was different to the care they provide at other times. The likened the care they provided when the parents were at work as essentially an alternative to formal childcare, where they needed to be more of an authority figure and have a structured type of care. The other times they provided care they recognised that they could be more relaxed and take on the role of the 'fun' grandparent that provides treats:

… that nanna day care day is run like a home day, not a visiting nanna day where the treats do come out and things are different. Grandparent.

Parents had varied opinions on the role of the grandparent as the ‘treater’. All parents recognised this traditional role of the grandparent and did not want grandparents to miss out on those experiences. They also, however, recognised the need for a balance between this role and the need for their own family life to be happy and settled:

It’s probably the fact that they’re their grandkids, so they want to spoil them and not remember them as forcing them to eat their veggies and whatever. That’s just my job. Parent.

Some parents also struggled with balancing the grandparents’ role as a ‘treater’ with a sense of being indebted to their parents for taking care of their children:

I do feel like I have to tolerate the treat giving because they’re kind of doing me a favour by looking after the kids. I don’t want to ruin all their fun by being strict about everything they do. Parent.

The frequency with which treats were given to children were a point of tension in most parent-grandparent relationships.

8.3.9 General nutrition

Overall, discussions about food and nutrition were quite emotive. It was obvious that food was a way that grandparents and parents show love. When discussing the foods and drinks that children consumed whilst in grandparent care, children were described as either ‘good eaters’ or ‘picky eaters’, with parents and grandparents having similar opinions of this regarding the child. Where children were described as ‘good eaters’ grandparents and parents tended to share similar approaches to serving food. Picky eaters however, could sometimes be a source of conflict between parents and grandparents, especially when they had different strategies for handling picky eaters. One parent described how she had always struggled to get her child to eat a variety of foods and had tried numerous strategies with varying degrees of success. The parent found it difficult to get consistency with these strategies because the child’s grandparents held different views on how to feed children:

They [grandparents] generally tend to ask them what they want whereas we tend to just say “This is what you’re getting, so you’re not getting anything else. Parent.

[Parent] says if you put [the food] in front of them and they don't have it don't give them anything….. No way in hell. I'm not going for that. We try something else. This is what I had to do with [Parent] and I keep reminding them of that….. That's the attitude now. I can't believe it. Grandparent.

Parents held similar views on what they considered healthy and unhealthy beverages for preschool aged children. Water and milk were reported as the most appropriate beverage options, whilst soft drink was viewed as the least healthy with many citing the detrimental effect that it had on children's teeth. Fruit juice and cordial were also regarded as unhealthy and all parents reported either very rarely or never providing this to their child:

He does not get juice. We try not to have juice in the house. He doesn't get cordial. He doesn't get soft drink. I know when he's with my mum he has a pretty regular hot chocolate but we've tried to say that's nanna's thing and that's okay when you're with nanna but at home you have hot milk, cold milk or water and that's it. I'm pretty sure my in-laws give him juice, but again it's their house, their rules. We try and let that go. Other things are slipping in a little bit and we're trying to think about what we're doing and how often he's getting sweet things is our next challenge. Parent.

Grandparents also cited water and milk as the healthiest options and reported that these were the main beverages that they provided for their grandchildren. The extent to which grandparents provided juice varied across families. Where grandparents did not provide juice to their grandchildren, many mentioned that they had done this at the request of the child's parent. When discussing fruit juices and cordial many grandparents recalled providing these beverages to their own children when they were young. Many grandparents reflected that 'times had changed' since they were parents and those things that may have once been considered appropriate were now not:

… when the kids were little there was probably less money and it was making things go the distance. I think mine probably had Ribena and Coke and Fruit Loops or anything. Grandparent.

Other grandparents expressed confusion as to why this was the case when their own children consumed these things and had never had health issues:

They [children] have milk and water. That's it. There's no lemonade or stuff like that. Actually, I did introduce Prima [a type of fruit drink] to her last week and [parent] stopped me because she says it's got too much sugar in it, orange Prima. Now I remember my children drinking that and it was okay but now it looks like it's not. Grandparent.

Sweetened beverages were a point of tension between parents and grandparents when they did not hold similar views on how appropriate it was to provide them to children.

8.3.10 Cultural Background

For some families, their cultural background had a large influence on the way food was treated within their families. One parent described the influence that her Italian heritage had on the amount of food that is usually provided and the contrasting way that food was treated on her partner's side of the family:

My family being Italian, don't have healthy eating in their vocabulary, which is for my whole family….. there's no portion control and the mass amount of leftovers which you're forced to eat for the next week. There's no healthy eating, which [partner] has always said. I was raised by them, but he was raised with very small portions and not eating just because it's there. Parent.

Another parent of Vietnamese heritage described her frustrations with her own mother in relation to the food that was provided to her children:

…she's a bit obsessed with food basically. I think that's a cultural thing as well, which is they show love through feeding their child, their kids. I worry that she's always offering her food all the time, snacks all the time. Parent.

The role of culture in food provision is an important theme identified in this study, however the limited cultural diversity in the pool of potential interview participants limited further exploration.

8.3.11 Gardening and cooking

Nearly all grandparents reported growing food in their gardens and that their grandchildren were actively involved in the growing and harvesting of the plants. Children helped out in the garden by watering the plants and picking the fruits and vegetables when they were ripe. In many cases children ate items such as strawberries and tomatoes as soon as they had picked them, but grandparents also reported children helping to prepare them for larger meals:

> *All through summer we went out and watered them. One day we brought in one of the little cherry toms and I said to him, 'Show mum.' We hadn't even washed it. I said, 'Show mum what we picked.' He put it straight in [his mouth]. We hadn't washed it, but we don't use pesticides or anything.* Grandparent

> *A couple of weeks ago I had him sitting up and we were doing salads, so he was putting in the cherry tomatoes and the green peppers and the lettuce. He thought it was terrific.* Grandparent.

The extent to which children were involved in the preparation of food varied between families. Some grandparents enjoyed having their grandchild in the kitchen helping them prepare meals and baking, whilst others preferred that children stayed out of the kitchen whilst they were cooking:

> *I think I've done it [had them in the kitchen] on one other occasion, but I'm not sharing my kitchen with children. It's a big mess. I never did it with my own but I can see that it's a plus in the relationship, getting in there and doing that.* Grandparent.

The main reasons grandparents reported not having children in the kitchen included it not being safe, it causing too much of a mess and that children seemed to prefer to do other activities. Safety concerns centred around hot stoves, pots or ovens being reach of children and grandparents having to move around their kitchens with hot pots whilst children were around their feet.

8.3.12 Oral health

Compared to nutrition and food, discussions with grandparents and parents around oral health were much less emotive and much more 'matter of fact'. Oral health was viewed primarily as a health issue by parents and grandparents, although the extent to which grandparents and parents actively thought about oral health varied from family to family.

Oral health and oral hygiene behaviours were not spoken about between parents and grandparents as frequently as factors related to nutrition. The most common factors that parents and grandparents identified as promoting good oral health were tooth brushing, avoiding consumption of sweet beverages (particularly soft drink and cordial) and visiting the dentist. No parents and grandparents mentioned that children had any obvious issues with their teeth in terms of caries.

Many children had their own toothbrush at their grandparent's house, however their use varied from family to family. Some children regularly brushed their teeth at their grandparent's house because they were there early in the morning for breakfast or later at night for dinner and were in a routine of brushing their teeth after these meals:

> *…he [child] does have a toothbrush at her [grandmother's] house and when we have dinner there, after dinner he'll get put into PJs and brush his teeth before we get in the car because he'll be asleep by the time we get home.* Parent.

> *He has his own toothbrush out there [in bathroom] and he knows that after breakfast we go out and do it if he's here with me.* Grandparent.

In other cases, tooth brushing only occurred at grandparents' houses if the child was going to stay overnight. When children did brush their teeth, in most cases they tended to do it themselves, with parents or grandparents assisting when they thought necessary. Few parents and grandparents reported actually brushing the child's teeth for them, which is recommended until children are around seven years of age. Some children met the recommended brushing frequency of twice a day, whilst others were only brushing once a day.

Most grandparents and parents reported that they regularly went to the dentist to have their own teeth checked and also spoke about regularly taking parents to the dentist when they were children. Some grandparents were aware that their grandchild had been to the dentist, whilst others were unsure. Grandparents felt that it was not their role to organise and attend dental visits with their grandchild, although they would be happy to help with this if it made it easier for parents. In some cases, they had already done this for dental visits or doctors' visits. For instance, one grandparent reported attending the dentist with her daughter and two grandchildren so that her daughter and the two children could all have their teeth checked in one visit:

> *We've already got them in, and because I sit with* [child] *on my lap while [parent]'s having her teeth done, they do it all together, the three of them.* Grandparent.

When discussing dental visits with parents, most reported that they themselves regularly went to the dentist, but not all parents had taken their child yet. It is recommended that children have an oral health assessment (by a dentist, oral health professional or Maternal and Child Health Nurse) by the time they are two years old. In one case a parent reported she felt that she did not need to take her child because a dentist had visited the kindergarten her daughter attended, and she had been told that her teeth were ok. The other parents who had not yet taken their children said that they had been thinking about it but were unsure of the correct age to start taking children to the dentist.

> *I did ask [partner] if we're meant to take them to the dentist. I don't even know to be honest. What age are they even supposed [to go]?* Parent.

It was also common for parents to report that they did regularly look in their children's mouths and that their teeth seemed to be ok.

8.4 Discussion

The research presented in this chapter described the multitude of factors which influence the type of environments young children are exposed to when in the care of their grandparents, particularly the dynamics of relationships within the family. Whilst factors specific to nutrition and oral health were identified, these need to be considered in the wider context of the environment, which the development of an ecological model helps to describe. The way families operate as an overall system has a large influence on the type of grandparent care environment provided and there are clear opportunities for nutrition and health promoting behaviours in the grandparent care environment.

Using a grounded theory approach [249] to analyse the results of this research informed the development of an ecological model. This model demonstrates factors at the policy, community, organisation, family and child level which influence nutrition and oral health in the grandparent care environment. The majority of factors were identified at the family level, and these have been grouped in the model as being parent specific, grandparent specific or shared between grandparents and parents. Factors at the policy, community and organisation level of this model influence parents' need for and choice of childcare as well as the availability and promotion of both food and dental services. Factors at the family and child level have a direct influence on foods provided to children and exposure of children to oral health and hygiene practices. The nutrition and oral health behaviours that are established with the first child in the grandparent care environment will influence what occurs with any future children, be it siblings or cousins, exposed to that environment.

Chapter 3 outlined three ecological models which help to guide this thesis. These models focused on childhood overweight [131], food intake [28] and child oral health [132]. Many of the influences identified in the present model for the grandparent care environment overlap with factors described in the guiding models from Chapter 3. These commonalities have been mapped onto the current model and are shown in Figure 8.3. The Fisher-Owens model regarding influences on children's oral health and the Story Et al. framework depicting influences on what people eat focussed at a policy, community and child level which were also identified in the current research. These influences included the provision of services, such as public dental and Maternal and Child Services as well as policies that influenced the need for childcare, such as government funded maternity leave. At child level, age, behaviours, genetics and dietary intake overlapped. At the organisational level there was overlap with only one factor, flexible working hours which matched with Davison and Birch's ecological model of predictors of childhood overweight. Grandparent and parent knowledge, behaviours and preferences were common across each of the models and also identified as part of the current research. Interestingly, the Fisher-Owen's model of child oral health is the only model of the three to explicitly acknowledge the role of family functioning in health outcomes. In the current research, this emerged as one of the strongest influences on the grandparent care environment.

The way individuals within the family unit communicated and interacted with each other emerged as an important factor in keeping the grandparent care environment balanced. This finding is informed by Family Systems Theory, outlined in Chapter 3. This theory defines families as a system, in which people play different roles and interact with each other in specific ways. The actions, thoughts and feelings of one person in the family can affect the actions, thoughts and feelings of another person [136]. The key relationship identified was between the primary parent carer and the primary grandparent carers, which in this study happened to be the mothers and grandmothers in the family. Whilst this may not be representative of the structure in all families who use grandparent care, it would be in many Australian families, as primary caregivers tend to be women [251] and the majority of grandparent caregivers are also women [128].

Whilst parents and grandparents tended to have similar views on oral health and hygiene behaviours, this was not always the case for nutrition related behaviours. In families where parents and grandparents shared similar views on what constituted healthy foods and how children should be fed, there tended to be less conflict and tension compared to families where parents and grandparents differed in their opinions. One construct from Family Systems Theory is that of triangles, where a third person is brought into a two-person relationship to diffuse tension. In the current research, many mothers would look to their partners for support when the relationship with a grandparent became tense. Eli and colleagues [120] report similar findings from interviews with mothers and grandmothers about feeding children, with more conflict arising when there were different beliefs about what was considered healthy. Where different opinions were present in this sample, it appeared to be driven by parents trying to follow current guidelines or best practice provided by health professionals and friends with children, whilst grandparents felt that the experiences and knowledge that they had gained from raising their own healthy children should not be discounted. In families where tension was low, grandparents had either always had relatively healthy habits, or had changed their behaviours based on information provided by either their children or their own research.

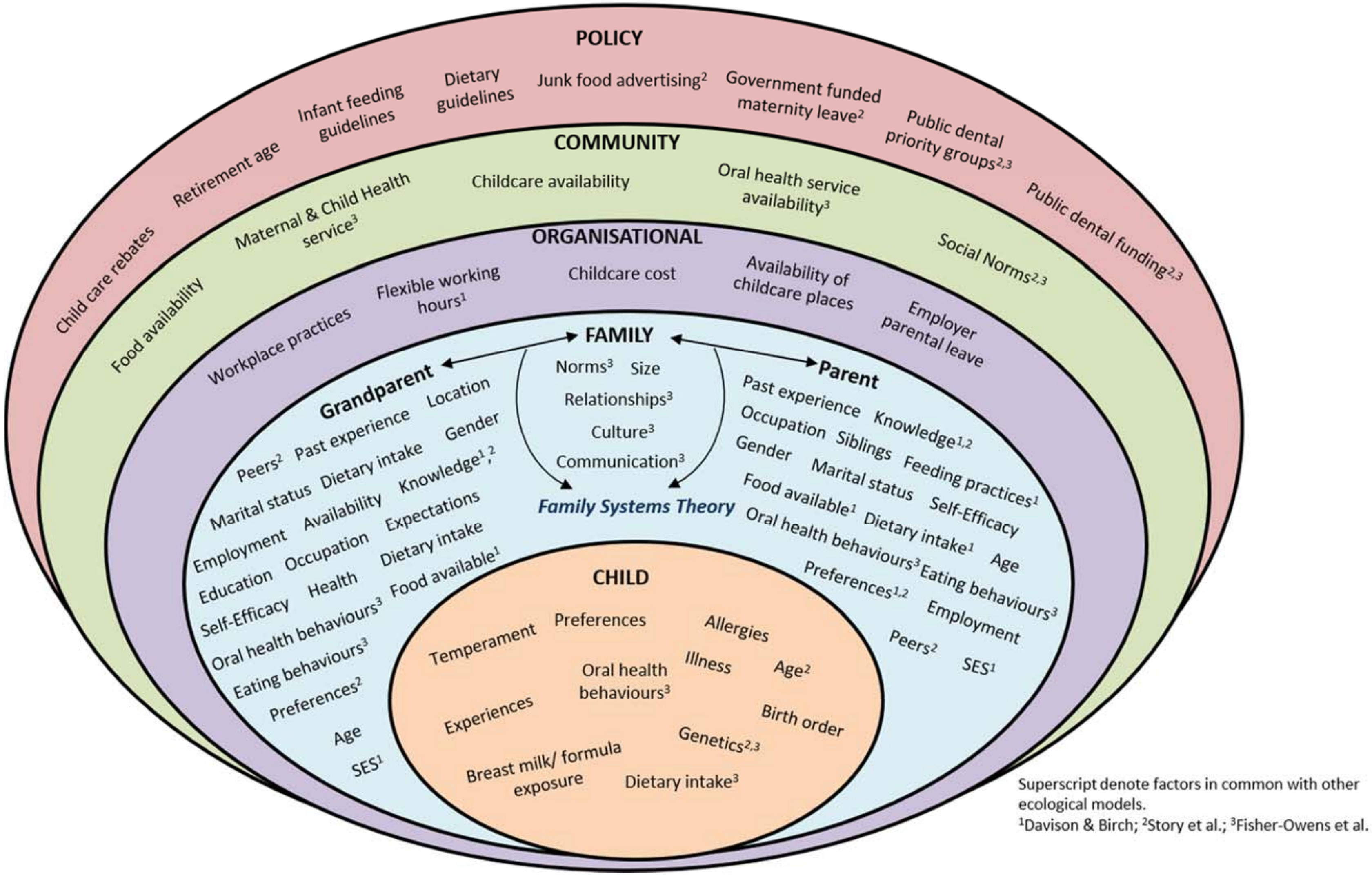

Figure 8.3 Ecological model derived from interviews to describe the influence of the grandparent care environment on child nutrition and oral health, mapped with common factors from other ecological models.

Consistent with Australian statistics [107] some families in this study were solely reliant on grandparents for childcare whilst other families used a mixture of grandparent care and a formal childcare centre. Parents who had only used grandparent care did ponder 'what might have been' if they had sent their child to a formal childcare centre, particularly in relation to their child's nutrition related behaviours if their child was described as a picky eater. Existing literature has shown that peers have a strong influence on what children eat, and they are more likely to try foods if others around them are eating it [252, 253]. In many cases, children solely cared for by grandparents may not have frequent experiences eating with children of a similar age until they attend kindergarten programs at three to four years of age. One potential solution to this is for grandparents to attend structured playgroup sessions with their grandchildren, particularly in cases where children are having difficulties with food or grandparents spend extended time periods caring for them during the week. This provides exposure to children of a similar age and has the additional benefit of social connections for grandparents.

Parents and grandparents discussed the ways in which they transitioned to their new roles in life when children were born into the family. Grandparents and parents acknowledged that grandparents were more likely to provide unhealthy treat foods to children, which is consistent with previous research [126]. The ability to treat children with unhealthy foods was described as one of the privileges of being a grandparent, however the type and frequency with which these treats were provided differed between grandparents. Chocolates, lollies and ice cream were commonly cited treat foods and were provided anywhere between once a day to once a month. It has been suggested in the literature that grandparents tend to adjust their feeding practices to become more parent-like as the amount of time they spend caring for their grandchildren increases [124]. In the current sample, one grandparent adjusted their food-related behaviours in response to the type of care they were providing, with their behaviours more parent-like on the days they were solely responsible for care of their grandchild. This was not mentioned in any of the other interviews, which may in part be because of the small number of grandparents who were interviewed, most of whom were caring for their grandchildren on one or two days of the week.

Although some parents voiced their frustrations with treat giving, most felt the 'occasional' treat from a grandparent could be managed in the context of their child's overall diet. Other parents mentioned modifying what they fed their children to balance out the treat foods. This behaviour is an example of the 'emotional fusion' construct in family systems theory, where individuals ignore their own personal choices or preferences to sustain harmony in a relationship [137]. While the majority of foods that were viewed as treats were unhealthy options, some participants described other healthy foods, such as raspberries, that were considered a treat due to their limited availability and cost across the year. There is scope within the grandparent care environment to promote healthy 'treat' foods, non-food-based treats and rewards such as stickers or colouring sheets or activities like visiting playgrounds. Strategies discouraging the use of food as a reward have been implemented across early childhood settings such as kindergartens and long day care centres [213]. An interesting concept that was raised by one grandparent is having clear self-imposed guidelines around what foods are provided to children on 'nanna day care' days (healthy, structured, following what happens at home) compared to 'fun' nanna days (less structured, occasional treats allowed). This grandparent had implemented this model since she began caring for her grandchild. Although this may be feasible for other families, it may be difficult to implement in families where children have been in grandparent care for a number of years and have established habits.

Nutrition and oral health knowledge were discussed in the overall context of raising happy, healthy children. Health professionals such as Maternal and Child Health Nurses (MCHN) and general practitioners were key sources of information for parents regarding their child's health and wellbeing. Parents also relied on their peers, family and websites. Similar findings have been reported in other Australian parents with 94% of parents with children under 5 years citing their general practitioner as their number one source of health information, followed by friends and family, then websites blogs and online forums fourth and child health nurses sixth [254]. Grandparents primarily relied on their existing knowledge and experiences from raising their own children, although some did do their own online research. Some grandparents recognised that some of their knowledge may be outdated, the extent to which they were open to receiving new information, particularly if it came from parents, varied. Some grandparents relied on parents to provide them with up to date information, whilst others tended to disregard it. In the latter case, parents reported feeling that grandparents still viewed them as 'children' rather than parents.

In Victoria, the Maternal and Child Health Service provides 10 health and wellness checks to children at 10 key ages and stages across the first 3½ years of life. Nurses provide up to date, evidence-based information, and support, to parents for a range of child health and wellbeing issues. Parents who attend these visits are automatically exposed to up to date information regarding their child's health and wellbeing in the first few years of life, however this is not the case for grandparents. Grandparents may benefit from information sheets designed specifically for them, about child health issues, and that address some of their questions with respect to what they did as a parent and what is considered best practice now. The delivery method of this information would need to be tailored to the grandparent. Some may be open to receiving information from parents, whilst others may need to be given it by someone they see as an authority figure, such as a doctor or pharmacist. Further research that examines the delivery method of information with a larger number of grandparents would be useful to determine what is the most effective communication method for grandparents and under what circumstances.

Parents and grandparents tended to concur that water and milk were the healthiest beverage options for children, whilst soft drink was the least healthy option. Opinions around fruit juices were a little more ambiguous. Parents tended to report that they did not provide this to their children, but some grandparents did. Similar views were reported in Eli and colleagues' research [121] with mothers and grandmothers, where grandmothers viewed juice as a healthier option than soft drink. Additional qualitative research with mothers of young children supports this, with grandparents identified as family members who provide sweet drinks to young children [255]. Fruit juice is not recommended to be frequently consumed by children as it is high in kilojoules and low in fibre, has high amounts of sugar which can promote dental caries and the acidic nature of it can promote dental erosion [182, 230]. It can also encourage children to seek sweetened beverages when they are thirsty. The results from the present study indicate that messaging around not providing fruit juice to young children may be reaching this sample of parents, but not all grandparents. There seemed to be particular confusion from some grandparents regarding fruit juice because they had provided it to their own children when they were young, and they had not observed any adverse effects to their children's health. Whilst there is information available regarding the detrimental effects of fruit juice consumption, it is not necessarily targeted to grandparents and the queries they have. Information sheets may be more effective if they can clearly articulate how and why recommendations have changed through generations.

Grandparents and parents held similar views on what constituted a healthy diet, particularly the importance of fruits and vegetables and they also agreed on the types of unhealthy foods that they tried to limit. Most grandparents were responsible for providing food for their grandchildren when they cared for them and found this an easy responsibility. The cultural background of families influenced the types and amounts of food provided. Grandparents of Anglo-Celtic heritage tended to provide basic meat and vegetable meals, whilst grandparents from other backgrounds provided meals that reflected their heritage, for example lasagne, stir fries, dumplings. Parents from these families highlighted the role that their culture plays in the provision of foods, with large portion sizes common, and children being constantly offered food as a way of grandparents showing love. This cultural influence is consistent with research with Chinese grandparents, who tended to be more concerned with children receiving enough food, rather than the nutritional value of what they were feeding them [115].

There is evidence that children are more likely to try foods that they are involved in growing or preparing [5, 256-258]. All children in this study were involved in either the growing of food and/or preparing food when they were in the care of their grandparents, which is a clear benefit of being in grandparent care. Grandparents can spend more one on one time with children in the garden or kitchen that is not possible in a childcare centre and may not be feasible for busy parents. In some cases, grandparents did not want children in the kitchen due to safety concerns. There is potential to provide strategies to grandparents on how to involve children in the preparation of simpler foods and less safety concerns.

Regarding factors directly related to oral health, all parents and grandparents were aware of the importance of tooth brushing, dental visits and limiting sweet drinks. The degree to which grandparents were involved in these activities varied from family to family. It is recommended for children to have an oral health assessment by the time they are two years old and then regular check-ups to detect any problems [259], however there seemed to be a gap in this knowledge with several parents unsure when they should first take their child to the dentist. Grandparents were willing to assist parents with their grandchildren's dental visits, but many did not know if their grandchild had visited a dentist yet. Tooth brushing also varied from family to family. Not all children were brushing their teeth twice a day and the majority of children were brushing their own teeth, with parents or grandparents checking their mouth afterwards. It is recommended that teeth are brushed in the morning and before bed at night by an adult to ensure adequate plaque removal from teeth. It is also recommended that children are assisted to brush their teeth until they are around eight years old [259] as they do not have the fine motor skills to properly clean their teeth at younger ages. Recent research with parents of children aged 18 months demonstrated that 59% of parents were not assisting their child to brush their teeth at least twice a day [260]. Grandparents and parents would benefit from information on the current recommendations on tooth brushing and dental visiting for preschool aged children. Evidence suggests that the provision of targeted oral health promotion information, toothbrushes and paste via Maternal and Child Health Services, can improve oral health practices of parents of young children [260, 261]. There are clear opportunities to involve grandparents more in children's oral hygiene behaviours, by encouraging toothbrushing if a child consumes breakfast or dinner at their grandparent's house.

This study has several strengths and limitations. In particular, the inclusion of both grandparents and parents as interview participants. At the time of writing this thesis, this is the only Australian study I am aware of which examines the grandparent care environment and includes the dual perspectives. Having the two perspectives allowed a deeper analysis and understanding of the data collected. Another strength is the inclusion of grandfathers in this study. Published research in this area has tended to include only grandmothers (mainly because they make up the majority of carers) but the inclusion of grandfathers in the study provides another perspective. This study is also one of the first to explore grandparents' opinions and behaviours in relation to their grandchild's oral health.

This study also has several limitations which must be taken into consideration when interpreting the findings. The sample size is relatively small and the parents who took part in this study were a subsample of parents who took part in another study that focussed on the dietary intake of young children. These parents may have had an existing interest in nutrition and may not represent the views of all parents. Parents were also responsible for inviting their child's grandparents to be interviewed. It is possible that parents asked the grandparents that they thought would give the 'best' answers or they thought would be easier to be interviewed. Additionally, although there were no objective measures of child health used, children in the sample seemed to be relatively healthy. Responses to some questions, particularly around oral health may have differed if children had experienced dental caries. Finally, the sample was relatively homogenous with participants residing in metropolitan or regional areas and parents being relatively highly educated. There was also little variation in the ethnicity of participants other than one Asian family and one Italian family. The results presented would be strengthened by the inclusion of families from rural areas, and those from the lower end of the socio-economic spectrum.

Nutrition and oral health in the grandparent care environment are influenced by a complex mixture of factors at multiple levels of an ecological framework. The dynamics between family members and the willingness of grandparents to acknowledge changes in 'best practice' over time in the care of children play a key role in supporting a health promoting environment. There are clear opportunities to support grandparents in promoting good nutrition and oral health practices for their grandchildren, however this is not required for all grandparents. The ecological framework generated from this research provides a basis from which further research into specific factors can be conducted. Further development of this framework will help to inform potential interventions targeting nutrition and oral health for families requiring support.

Chapter 9: Discussion & Conclusion

9.1 Summary

The aim of this thesis was to identify influences on nutrition and oral health in early childhood. Data from three different samples were analysed to investigate this aim; 1. Families (N=148) with children aged 18-months to five years, who were primarily English speaking and highly educated; 2. A cohort of children (N=214 to 412) followed between birth and five years of age from families who were disadvantaged relative to the general population; and 3. Parents and grandparents (N=13) of children under five years of age, who were primarily English speaking and relatively advantaged.

The food frequency questionnaire used to collect dietary data from children in the VicGen study was shown to be valid and reliable for most food and beverage groups when used at the group level. This FFQ was used to collect data about food and beverage consumption between six months and five years of age in the VicGen study. Discretionary foods and beverages appeared in the diets of children as early as six months of age, with intake increasing until around three years of age. Between three and five years of age intake of discretionary items remained similar. Older parent age, higher parent education and higher parent fruit and vegetable consumption, as well as residing in an area with a higher SEIFA indicator were all associated with a greater contribution of core foods and beverages to overall consumption frequency.

Overall, attending child care was not associated with intake of core/discretionary foods, but associations were observed between different types of care at three and four years of age and intake of sweetened beverages. Children who attended only formal care or a mixture of formal and informal care were less likely to be consuming fruit juices and soft drinks compared to children who were in parent care only. The topics of nutrition and oral health were further explored through semi-structured in interviews in one informal care setting – that of grandparent care. Family relationships, knowledge, experience and traditions were all key influences on the nutrition related behaviours in this environment, although oral health was influenced to a lesser extent. There was a clear need for the promotion of nutrition and oral health in the grandparent care environment.

9.2 Contribution to methodology

This thesis has demonstrated the reliability and validity of a food frequency questionnaire for use with young children. Whilst the primary purpose of the tool was to collect food and beverage data in relation to oral heath, it was also shown to be a useful tool to provide a broad overview of children's diets. There are few openly available FFQs which have been validated for use with young children, particularly for use in terms of oral health. The need to incorporate oral health as part of general health, rather than viewing the mouth as detached from the rest of the body, has long been called for by dental public health experts [262]. This tool is a resource that may be useful for researchers conducting projects with multiple health focusses, for example, overweight/obesity and oral health. A set of questions regarding the context in which children consume different foods and drinks were also developed and tested as part of this thesis. These questions proved feasible for parents to answer, but, in their current format, they are unlikely to provide meaningful data. However, they provide a good foundation on which to develop and test a refined set of questions. Reducing the listed responses from five to three options would improve the questions. Additionally, grouping similar items together into one question, e.g. soft drink, fruit and juice cordial as sweet beverages would be more informative than asking about separate consumption.

9.3 Contribution to theory

The research with grandparents and parents has helped develop a socio-ecological model demonstrating the many levels of interacting influences on child nutrition and oral health including the grandparent care environment. This research confirmed elements present in other socio-ecological models of dietary intake and oral health in children [131, 132, 263], as well as identifying a complex mix of other factors. The different aspects of the new model are underpinned by the relationship dynamics and shared history between grandparents and parents which distinguishes the grandparent care environment from other types of childcare. There were parallels between the relationship dynamics observed and several (although not all) concepts outlined in Family Systems Theory [137]. This highlights the need to consider family dynamics in both research and health promotion interventions in this environment.

This ecological model provides a framework on which further research can develop, confirm and expand understanding of the influencing factors and potential points of intervention. The aspect of family culture requires further exploration with participants from more diverse backgrounds than were included in the current study. The model would also be strengthened by inclusion of families whom vary in their socio-economic status and education level.

9.4 Contribution to health promotion

This thesis has demonstrated the increasing contribution that discretionary foods and beverages make to children's diets across the first five years of life. These findings align with those in other Australian and international studies and contribute additional longitudinal evidence from a diverse sample of participants. The early introduction and expanding contribution of discretionary foods across childhood is concerning given the impact of these items on the demineralisation of teeth contributing to dental caries [153] and excess energy intake, leading to overweight/obesity [8] and the health issues associated with this condition. The current research demonstrated that discretionary foods and drinks are increasingly present in children's diets from six months until three years of age, after which frequency of intake tends to stabilise. This suggests that the period prior to age three is a crucial time for targeted health promotion discouraging intake of discretionary foods and drinks and providing parents with strategies to encourage the consumption of increasing amounts and types of core items. This time period is also ideal for targeted messages around dental visits. Whilst many parents may check their child's teeth themselves and believe that they are healthy, existing literature suggests that many children may have dental problems despite their parents believing they are healthy [264].

Despite health promotion messaging tending to discourage the provision of any sweetened beverages, including fruit juices/fruit drinks to children, each piece of research presented in this thesis has demonstrated that fruit juices/fruit drinks are present in the diets of young children. Fruit juices/fruit drinks have also recently been shown to be a key contributor to free sugars in the diets of children under two years of age [265]. Data from the VicGen study demonstrated fruit juice is more commonly consumed at home than in formal or informal care, and yet interviews with families indicated parents are not providing fruit juices to children, but it may be more common when they are in their grandparent's care. The contrast in these results could be due to multiple factors. One explanation is the timing of data collection. Interview data were collected more recently (2017-2018) than the VicGen data (2008-2016), which may demonstrate influence of health promotion messaging around fruit juice and young children. Alternatively, it may reflect sample bias given the small sample of interview participants who interested in nutrition and were relatively advantaged, which may have made these parents unlikely to provide fruit juice to their children. Irrespective of this, provision of fruit juice was a point of contention between some grandparents and parents, suggesting that current messaging around fruit juice is either not reaching grandparents or is not effective in changing their behaviours.

More debate and discussion with dietitians, oral health professionals and public health professionals is needed regarding the appropriateness of 100% fruit juice being included as a core food in the dietary guidelines, particularly in relation to children under five years of age. Additionally, guidance regarding the term ‘occasional’ is also needed in relation to the provision of 100% fruit juice to children, for the dietary guidelines in general and targeted to families who regularly provide these beverages to children. There were clear differences in participants’ interpretation of ‘occasional’, ranging from ‘only once a month’ through to ‘only once a day’. Existing research has demonstrated the effectiveness of promoting oral health through Maternal and Child Health Nurses (MCHN) [260, 261]. MCHN, General Practitioners and Oral Health Practitioners would be ideal channels for fruit juice messages to be communicated through.

9.5 Conclusion

There is limited longitudinal evidence from diverse Australian samples tracking what children are consuming between birth and five years of age. This research used longitudinal data from a disadvantaged sample, to show discretionary foods and drinks are introduced into infants’ diets at an early age and become more common as they get older, despite health professionals discouraging consumption of these items. This has ongoing implications for a range of health issues including dental caries, overweight and obesity.

Dietary intake and oral health behaviours in young children are influenced by a complex mix of factors across different socio-ecological and physical environments. During their formative years, many children spend a substantial amount of time in their grandparent’s care, yet little is known about what influence these care providers have in dietary intake and oral health. This PhD research has generated a model to inform our understanding of factors in the grandparent care environment which influence provision of food and oral health behaviours. These factors are underpinned by the relationship dynamics within a family. Opportunities exist for further research and health promotion interventions involving grandparents, however interventions need to be tailored and take into account the practicalities of this type of care.

9.6 Recommendations

1. Further research with grandparents and parents is warranted to confirm and expand the socio-ecological model produced in this thesis. This research will be strengthened by the inclusion of participants who: a) are from culturally diverse backgrounds; b) are from disadvantaged backgrounds; and c) have experienced or are experiencing problems with their child's oral health.

2. Further research which explores and refines questions which accurately capture the co-consumption of foods and drinks which may influence the cariogenic properties of these items.

3. Further research exploring the provision and suitability of child oral health and nutrition health promotion materials to grandparents is warranted.

4. Debate and discussion between oral health professionals, dietitians and public health professionals reviewing the current inclusion of 100% fruit juice in the dietary guidelines is warranted. Specifically, how this relates to the provision of this beverage to very young children.

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Appendices

Appendix A: Food frequency questionnaire (beverages) from the VicGen birth cohort

2.9 Does this child drink any of the following?

Select all that apply (and state number of occasions **daily** OR **weekly** OR **monthly** for those that apply)

		Yes	
a	Water	☐1	…….. times/day OR …….. times/week OR …….. times/month
b	Infant formula	☐1	…….. times/day OR …….. times/week OR …….. times/month
c	Full fat cow's milk	☐1	…….. times/day OR …….. times/week OR …….. times/month
d	Low fat cow's milk	☐1	…….. times/day OR …….. times/week OR …….. times/month
e	Sweetened condensed milk	☐1	…….. times/day OR …….. times/week OR …….. times/month
f	Sweetened or flavoured milk (eg with honey, topping, milo etc)	☐1	…….. times/day OR …….. times/week OR …….. times/month
g	Fruit juice or fruit drink	☐1	…….. times/day OR …….. times/week OR …….. times/month
	(tick the dilution) ☐ Undiluted, ☐ ¾ juice / ¼ water ☐ ½ juice / ½ water, ☐ ¼ juice / ¾ water		
h	Cordial	☐1	…….. times/day OR …….. times/week OR …….. times/month
	(tick the dilution) ☐ ¾ syrup / ¼ water, ☐ ½ syrup / ½ water, ☐ ¼ syrup / ¾ water		
i	Soft drink (eg lemonade or coke)	☐1	…….. times/day OR …….. times/week OR …….. times/month
j	Tea or coffee	☐1	…….. times/day OR …….. times/week OR …….. times/month
k	Herbal teas / drinks	☐1	…….. times/day OR …….. times/week OR …….. times/month
l	Sports drinks	☐1	…….. times/day OR …….. times/week OR …….. times/month
m	Other (please describe) ______________________	☐1	…….. times/day OR …….. times/week OR …….. times/month

Appendix B: Food frequency questionnaire (beverages) from the VicGen birth cohort

2.17 In a usual week, how often does the child have the following foods?

(tick one box for each question)	never	rarely	Once/ week	2- 3 times/ week	4-6 times/ week	Once/ day	2 – 3 times/ day	4+ times/ day
peanut butter	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
jam / honey	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
eggs	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
nuts	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
cheese (☐ full fat or ☐ red. fat)	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
yoghurt (☐ full fat or ☐ red. fat)	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
banana	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
other fresh fruit	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
dried fruit	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
muesli bars/fruit sticks/roll-ups	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
stewed fruit	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
cereal (including baby cereals)	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
dry biscuits / crackers	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
bread/rolls (☐ white or ☐ brown)	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
ice cream	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8

pudding	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
custard	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
jelly	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
donuts	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
sweet biscuits	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
cakes/muffins	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
lollies/chocolate	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
hot chips	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
potato chips/twisties/cheezels	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
potato	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
vegetables (other than potato)	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
noodles / pasta	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
rice / couscous	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
baked beans	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
luncheon meats (eg ham, salami, chicken slices	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
ready-to-feed baby food	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
soup	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8

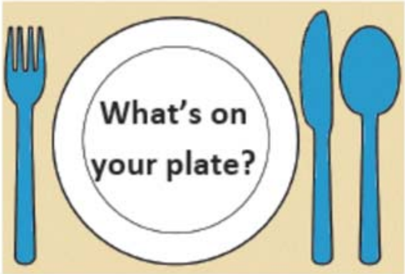
Appendix C: Facebook analytics for validation study recruitment

Posts	Reach	Clicks/Actions	Published
We are still looking for parents of children aged between 18 months and 5 years t...	354	13	Mar 24, 2017 at 3:49pm
I highly recommend checking out this page! it is run by two Accredited...	164	12	Mar 10, 2017 at 11:44am
Do you have a young child or know someone who does? We are still lookin...	2.2K	136	Feb 18, 2017 at 10:21am
Hi Everyone, Many of you may have seen this article in the Herald Sun yesterday,...	238	20	Feb 13, 2017 at 2:16pm
Thankyou to everyone for their support this year! Wishing you all a wonderul...	114	8	Dec 23, 2016 at 3:00pm
We are nearly three-quarters of the way to the number of participants we need f...	883	59	Dec 14, 2016 at 3:04pm
Data collection is currently underway for this project but we are still looking for...	208	19	Nov 10, 2016 at 2:20pm
A huge thanks to everyone who has been sending their surveys back in! We are j...	3.3K	182	Oct 11, 2016 at 3:29pm
We are still looking for families to take part in this study!! A huge thank you to...	1.6K	94	Sep 22, 2016 at 4:28pm
If you are in Australia and have a child aged between 18 months and 5 years ...	5K	333	Sep 14, 2016 at 4:36pm
We would love to hear from anyone who wants to be involved. Private message ...	2.5K	113	Sep 2, 2016 at 5:35pm
If you have a child aged between 18 months and 5 years we would love you ...	1.2K	98	Aug 24, 2016 at 3:29pm
All kids eat differently, some eat a little, some eat a lot, some are fussy and so...	116	10	Aug 21, 2016 at 9:55am
What's on your plate? Early childhood nutrition research project added a new...	3.8K	144	Aug 16, 2016 at 2:42pm
What's on your plate? Early childhood nutrition research project updated their...	0	7	Aug 16, 2016 at 2:30pm
What's on your plate? Early childhood nutrition research project updated their...	0	4	Aug 16, 2016 at 2:22pm

Appendix D: Recruitment flyer for validation study

The Jack Brockhoff Child Health and Wellbeing Program
Research partnerships working for every child

THE UNIVERSITY OF MELBOURNE



Do you have a child who is between 18 months and 5 years of age?

We are looking for people to take part in a study that will help to measure what young children eat and drink.

The study involves completing the following tasks over a 5 week period

- Completing two short surveys, about what your child usually eats and drinks
- Completing a checklist once a day for 7 days about what your child eats and drinks

Every participant receives a book for their child as a thank you for taking part.

If you think you might be interested or would like more information, please contact **Lauren Carpenter** at the University of Melbourne.

Email: lmca@unimelb.edu.au

Phone: 03 8344 0903

Appendix E: Food frequency questionnaire for validation study

SECTION ONE: Some questions about *YOU*

1.1 Today's date is?

d	d	m	m	y	y	y	y
				2	0		

1.2 What is your postcode?

1.3 What is your gender?

☐1 Male

☐2 Female

1.4 What is your age?

☐1 15-19 ☐5 35-39

☐2 20-24 ☐6 40-44

☐3 25-29 ☐7 45-49

☐4 30-34 ☐8 50 and older

1.5 Do you identify as Aboriginal or Torres Strait Islander?

☐1 Yes

☐2 No

1.6 Were you born in Australia?

☐1 Yes

☐2 No

1.7a Is English the main language you speak at home?

☐1 Yes →*continue to question 1.8*

☐2 No →*please compete question 1.7b*

1.7b) What is the main language you speak at home?

☐1 Arabic ☐4 Urdu

☐2 Cantonese ☐5 Vietnamese

☐3 Hindi ☐6 Other *(please write below)*

____

1.8 What is the highest level of education you have completed?

☐1 Year 10 or below ☐5 Diploma/Certificate

☐2 Year 11 (or equivalent) ☐6 Bachelor's degree

☐3 Year 12 (or equivalent) ☐7 Postgraduate Degree

☐4 Technical apprenticeship ☐8 Other (please describe below)

____

SECTION 2: Some questions about *YOUR CHILD*

2.1 What is this child's date of birth?

d	d	m	m	y	y	y	y
				2	0		

2.2 What is this child's gender?

☐1 Male

☐2 Female

2.3 The child taking part in this study is your:

☐1 1st child

☐2 2nd child

☐3 3rd child

☐4 4th child or more

2.4 Does this child identify as Aboriginal or Torres Strait Islander?

☐1 Yes

☐2 No

2.5a Is this child cared for by their grandparent(s) for at least 5 hours each week?

☐1 Yes

☐2 No (go to section 3)

We plan on conducting interviews later in the year with parents and grandparents. Parents will be the initial contact and will be asked to pass on an information sheet about the interviews to their child's grandparent. If grandparents are interested in being interviewed they will be able to contact the research team either directly or through the parent involved.

2.5b Would you be interested in being contacted about an interview later in the year and willing to pass on the information to your child's grandparent?

☐1 Yes

☐2 No

SECTION THREE: Some questions about what *__YOUR CHILD DRINKS__*

3.1 **Does this child drink any of the following?**

Select all that apply (and state the number of occasions **daily** OR **weekly** OR **monthly** for those that apply)

a	Water	☐1▶	…….. times/day OR …….. times/week OR …….. times/month
b	Infant formula	☐1▶	…….. times/day OR …….. times/week OR …….. times/month
c	Full fat cow's milk	☐1▶	…….. times/day OR …….. times/week OR …….. times/month
d	Low fat cow's milk	☐1▶	…….. times/day OR …….. times/week OR …….. times/month
e	Sweetened condensed milk	☐1▶	…….. times/day OR …….. times/week OR …….. times/month
f	Sweetened or flavoured milk (eg with honey, topping milo etc)	☐1▶	…….. times/day OR …….. times/week OR …….. times/month
g	Fruit juice or fruit drink	☐1▶	…….. times/day OR …….. times/week OR …….. times/month
	(tick the approximate dilution) ☐1 **Undiluted**, ☐2 ¾ juice / ¼ water, ☐3 ½ juice / ½ water, ☐4 ¼ juice / ¾ water		
h	Cordial (non-diet)	☐1▶	…….. times/day OR …….. times/week OR …….. times/month
	(tick the approximate dilution) ☐1 ¾ syrup / ¼ water, ☐2 ½ syrup / ½ water, ☐3 ¼ syrup / ¾ water		
i	Soft drink (eg lemonade or coke)	☐1▶	…….. times/day OR …….. times/week OR …….. times/month
j	Tea or coffee	☐1▶	…….. times/day OR …….. times/week OR …….. times/month
k	Herbal teas/drinks	☐1▶	…….. times/day OR …….. times/week OR …….. times/month
l	Sports drinks	☐1▶	…….. times/day OR …….. times/week OR …….. times/month
m	Other (please describe	☐1▶	…….. times/day OR …….. times/week OR …….. times/month

____

SECTION FOUR: Some questions about what *YOUR CHILD EATS*

4.1 In a usual week, how often does this child have the following foods?

	never	rarely	Once/week	2-3 times/ week	4-6 times/ week	Once/ day	2-3 times/ day	4+ times/ day
a) peanut butter / nutella	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
b) jam / honey	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
c) eggs	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
d) nuts	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
e) cheese (☐1 full fat or ☐2 red. fat)	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
f) yoghurt (☐1 full fat or ☐2 red. fat)	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
g) banana	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
h) other fresh fruit	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
i) dried fruit	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
j) muesli bars/fruit sticks/roll-ups	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
k) stewed fruit	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
l) cereal (including baby cereals)	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
m) Savoury dry biscuits / crackers	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
n) bread/rolls (☐1 white or ☐2 brown)	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
o) ice cream	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
p) pudding	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
q) custard	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
r) jelly (non diet)	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
s) donuts	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
t) sweet biscuits	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
u) cakes/muffins	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8

v) lollies/chocolate	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
w)potato chips/twisties/cheezels	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
(*please tick only **one** box for each question)*	**never**	**rarely**	**Once/week**	**2- 3 times/ week**	**4-6 times/ week**	**Once/ day**	**2 – 3 times/ day**	**4+ times/ day**
x) hot chips	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
y) Potato (not including hot chips/potato cakes/gems etc?)	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
z) vegetables (other than potato)	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
aa) noodles / pasta	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
bb) rice / couscous	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
cc) baked beans	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
dd)luncheon meats (e.g. ham, salami, chicken slices)	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
ee) ready-to-feed baby food	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
ff) soup	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
gg) meat or fish	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8

OTHER FOODS

a ___________________________		☐2	☐3	☐4	☐5	☐6	☐7	☐8
b ___________________________		☐2	☐3	☐4	☐5	☐6	☐7	☐8
c ___________________________		☐2	☐3	☐4	☐5	☐6	☐7	☐8

PLEASE GO TO THE NEXT PAGE

SECTION FIVE: Some questions about ***<u>YOUR CHILD'S EATING AND DRINKING</u>***

5.1 For each of the following beverages, please indicate how often your child eats something when having this drink

	My child does not drink this beverage	**Always** eats something when drinking this	**Most of the time** eats something when drinking this	**About half the time** eats something when drinking this	**Hardly ever** eats something when drinking this	**Never** eats something when drinking this
a. Fruit juice/fruit drink	☐0	☐1	☐2	☐3	☐4	☐5
b. Cordial	☐0	☐1	☐2	☐3	☐4	☐5
c. Soft drink	☐0	☐1	☐2	☐3	☐4	☐5

5.2 When your child eats the following foods, how often would they eat them as part of a main meal and how often as a snack? (ie. breakfast, lunch or dinner)

	My child does not eat this food	**Always** eats this as part of a main meal, never as a snack	**Mostly** eats this as part of a main meal**,** hardly ever as a snack	**About half the time** eats this as part of a main meal , about half the time a snack	**Hardly ever** eats this as part of a main meal, mostly eats as a snack	**Never** eats this as part of a main meal, always as a snack
a. Fruit	☐0	☐1	☐2	☐3	☐4	☐5
b. Vegetables	☐0	☐1	☐2	☐3	☐4	☐5
c. Lollies/chocolate	☐0	☐1	☐2	☐3	☐4	☐5
d. Hot chips	☐0	☐1	☐2	☐3	☐4	☐5
e. Muffins/cakes	☐0	☐1	☐2	☐3	☐4	☐5
f. Savoury/dry biscuits	☐0	☐1	☐2	☐3	☐4	☐5

Appendix F: Sample page of 7-day food checklist

DAY 1: PAGE **2** of 4

	DIDN'T HAVE THIS TODAY	BREAKFAST	MORNING SNACK	LUNCH	AFTERNOON SNACK	DINNER	DESSERT	EVENING SNACK	OTHER SNACK 1	OTHER SNACK 2
JAM or HONEY										
PEANUT BUTTER or NUTELLA										
FULL FAT CHEESE										
LOW FAT CHEESE										
FULL FAT YOGHURT										
LOW FAT YOGHURT										
	DIDN'T HAVE THIS TODAY	BREAKFAST	MORNING SNACK	LUNCH	AFTERNOON SNACK	DINNER	DESSERT	EVENING SNACK	OTHER SNACK 1	OTHER SNACK 2
CEREAL										
SAVOURY BISCUITS/ CRACKERS										
BREAD/ROLLS										
NOODLES/PASTA										
RICE/COUSCOUS										
BAKED BEANS										

Appendix G: Supplementary tables for Chapter 6

Table 9.1 Core and unclassified food consumption the VicGen cohort between waves 2 and 7: Percentage of consumers

	Wave 2 (6m) N=364[1]		Wave 3 (12m) N=323[2]		Wave 4 (18m) N=363[3]		Wave 5 (3yr) N=266[4]		Wave 6 (4yr) N=243[5]		Wave 7 (5yr) N=214[6]	
	n	%	n	%	n	%	n	%	n	%	n	%
Potato	274	(75.5)	312	(97.5)	334	(92.8)	250	(94.0)	225	(94.9)	205	(96.2)
Vegetables (not potato)	326	(90.3)	320	(99.7)	357	(99.4)	264	(99.3)	241	(99.6)	210	(100)
Noodles/Pasta	159	(43.8)	305	(95.0)	357	(98.6)	264	(99.6)	242	(99.6)	210	(100)
Rice/couscous	185	(51.0)	303	(94.4)	352	(97.8)	260	(97.7)	233	(95.9)	206	(97.2)
Meat/fish	-		308	(95.7)	353	(97.3)	258	(97.0)	239	(98.4)	212	(99.1)
Banana	305	(84.5)	311	(96.9)	344	(95.8)	251	(95.4)	-		-	
Other fresh fruit	274	(75.9)	313	(97.8)	358	(99.2)	260	(99.2)	-		-	
Fruit (fresh or stewed)	-		-		-		-		241	(100)	212	(100)
Stewed fruit	234	(64.8)	220	(69.2)	227	(63.4)	152	(58.7)	-		-	
Bread/rolls	136	(37.7)	293	(91.3)	342	(96.1)	260	(98.5)	234	(97.9)	210	(98.1)
Cheese	101	(28.0)	292	(90.7)	341	(94.7)	256	(97.0)	237	(97.9)	209	(98.1)
Cereal	317	(88.3)	307	(95.9)	338	(93.4)	249	(95.4)	234	(97.5)	206	(97.2)
Yoghurt	199	(54.8)	303	(95.0)	348	(96.4)	260	(98.5)	235	(97.5)	200	(96.2)
Baked beans	43	(11.9)	179	(56.1)	241	(67.7)	173	(65.5)	162	(67.5)	141	(66.8)
Eggs	72	(19.9)	260	(80.8)	320	(88.6)	234	(90.0)	219	(91.6)	195	(92.0)
Nuts	8	(2.2)	65	(20.3)	158	(44.5)	186	(72.1)	179	(75.9)	158	(76.0)
Dried fruit	32	(8.9)	174	(54.2)	259	(72.1)	195	(74.4)	178	(76.1)	158	(77.0)
Soup	128	(35.6)	238	(74.1)	297	(83.0)	221	(84.0)	208	(86.7)	189	(90.0)
RTF baby food	241	(66.4)	217	(67.2)	156	(43.3)	23	(8.7)	-		-	

Due to missing data: [1]N varies 359-364; [2]N varies 318-323; [3]N varies 355 -363; [4]N varies 258-266; [5]N varies 234-243; [6]N varies 205-214.

Table 9.2 Discretionary food consumption the VicGen cohort between waves 2 and 7: Percentage of consumers

	Wave 2 (6m) N=364[1]		Wave 3 (12m) N=323[2]		Wave 4 (18m) N=363[3]		Wave 5 (3yr) N=266[4]		Wave 6 (4yr) N=243[5]		Wave 7 (5yr) N=214[6]	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Muesli bars/fruit sticks/roll ups	10	(2.8)	109	(34.1)	195	(54.3)	168	(63.9)	162	(68.6)	156	(75.0)
Jam/Honey	41	(11.4)	140	(43.8)	229	(63.8)	217	(82.8)	193	(81.4)	175	(84.1)
Ice cream	48	(13.2)	178	(55.5)	282	(78.6)	258	(97.0)	236	(97.9)	207	(97.2)
Pudding	19	(5.3)	82	(25.6)	139	(39.2)	139	(52.9)	199	(84.3)	180	(85.3)
Sweet biscuits	54	(14.9)	189	(58.9)	303	(84.4)	250	(95.1)	226	(94.6)	205	(96.2)
Cakes/muffins	40	(11.1)	190	(58.8)	307	(85.8)	244	(92.8)	228	(95.4)	205	(96.7)
Chocolates/lollies	25	(6.9)	122	(38.0)	274	(76.1)	258	(97.4)	236	(97.5)	212	(99.0)
Custard	153	(42.3)	213	(66.6)	230	(63.9)	166	(63.4)	-		-	
Donuts	11	(3.0)	58	(18.1)	158	(44.0)	185	(69.8)	-		-	
Jelly	46	(12.7)	122	(38.0)	178	(49.6)	180	(68.4)	-		-	
Dry biscuits/crackers	166	(46.0)	300	(94.3)	347	(96.4)	259	(99.2)	239	(98.8)	209	(98.6)
Potato chips / twisties/ cheezels	19	(5.3)	124	(38.6)	261	(72.5)	239	(90.5)	222	(92.1)	202	(94.8)
Hot chips	63	(17.5)	228	(70.8)	335	(93.3)	255	(96.2)	238	(98.8)	210	(99.1)
Luncheon meats	29	(8.0)	194	(60.3)	293	(82.1)	236	(89.4)	222	(91.7)	206	(96.7)

Due to missing data: [1]N varies 359-364; [2]N varies 318-323; [3]N varies 355 -363; [4]N varies 258-266; [5]N varies 234-243; [6]N varies 205-214.

Table 9.3 Beverage consumption the VicGen cohort between waves 2 and 7: Percentage of consumers

	Wave 2 (6m) N=369		Wave 3 (12m) N=322[1]		Wave 4 (18m) N=366		Wave 5 (3yr) N=266		Wave 6 (4yr) N=242		Wave 7 (5yr) N=212	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Water	316	(85.6)	318	(98.8)	359	(98.1)	260	(97.7)	239	(98.8)	212	(100)
Infant formula	252	(68.3)	131	(40.7)	67	(18.3)	15	(5.6)	-		-	
Full fat cow's milk	33	(8.9)	230	(71.4)	308	(84.2)	209	(78.6)	188	(77.7)	153	(72.2)
Low fat cow's milk	3	(0.8)	7	(2.2)	19	(5.2)	48	(18.1)	59	(24.4)	47	(22.2)
Flavoured milk	6	(1.6)	18	(5.6)	53	(14.5)	110	(41.4)	119	(49.2)	86	(40.6)
Fruit juice/fruit drink	70	(19.0)	114	(35.4)	229	(62.6)	206	(77.4)	194	(80.2)	162	(76.4)
Cordial	9	(2.4)	27	(8.4)	67	(18.4)	67	(25.4)	82	(33.9)	66	(31.1)
Soft drink	0	(0.0)	23	(7.1)	78	(21.3)	120	(45.1)	115	(47.5)	108	(50.9)

Table 9.4 Mean contribution of core and discretionary foods and beverages total food and beverage consumption frequency, from wave 2 to wave 7 of the VicGen birth cohort

	Wave 2 (6m)	Wave 3 (12m)	Wave 4 (18m)	Wave 5 (3yr)	Wave 6 (4yr)	Wave 7 (5yr)
Foods mean (sd)	(n[1]=361)	(n=323)	(n=363)	(n=266)	(n=243)	(n=214)
Core percentage	88.8 (13.2)	81.9 (9.9)	78.6 (9.8)	74.5 (9.8)	74.7 (9.5)	74.0 (9.1)
Discretionary percentage	11.2 (13.2)	18.1 (9.9)	21.4 (9.8)	25.5 (9.8)	25.3 (9.5)	26.0 (9.1)
Beverages mean (sd)	(n=342)	(n=316)	(n=365)	(n=266)	(n=241)	(n=212)
Core percentage	97.2 (9.1)	94.9 (12.2)	88.1 (18.2)	85.0 (17.8)	84.7 (17.4)	87.9 (15.3)
Discretionary percentage	2.9 (9.1)	5.1 (12.2)	11.9 (18.2)	15.0 (17.8)	15.3 (17.4)	12.1 (15.3)

[1]n varies between foods and beverages due to missing data.

Table 9.5 Sequential addition of predictor variables to achieve final food model: model 1 to model 4 (observations =1687, individuals= 411)

	Model 1				Model 2				Model 3				Model 4			
	Coef	**95% CI**		**p**	**Coef**	**95% CI**		**p**	**Coef**	**95% CI**		**p**	**Coef**	**95% CI**		**p**
Child birth order																
2nd	-1.99	-3.76	-0.21	0.029	-1.90	-3.67	-0.13	0.036	-1.86	-3.64	-0.09	0.039	-1.94	-3.71	-0.17	0.031
3rd	-2.78	-5.28	-0.28	0.030	-2.67	-5.16	-0.18	0.036	-2.73	-5.22	-0.24	0.032	-2.91	-5.39	-0.43	0.022
4th or more	-1.97	-5.71	1.78	0.303	-1.89	-5.62	1.83	0.319	-1.89	-5.62	1.84	0.321	-1.87	-5.59	1.85	0.324
Wave																
Wave 3	-7.43	-8.70	-6.17	<0.001	-7.61	-8.88	-6.35	<0.001	-9.30	-11.24	-7.37	<0.001	-9.33	-11.27	-7.40	<0.001
Wave 4	-10.59	-11.82	-9.37	<0.001	-10.52	-11.74	-9.29	<0.001	-13.28	-15.14	-11.42	<0.001	-13.31	-15.17	-11.44	<0.001
Wave 5	-15.02	-16.40	-13.64	<0.001	-14.47	-15.90	-13.05	<0.001	-17.31	-19.48	-15.14	<0.001	-17.32	-19.50	-15.15	<0.001
Wave 6	-15.56	-16.96	-14.15	<0.001	-15.92	-17.34	-14.49	<0.001	-18.06	-19.97	-16.15	<0.001	-18.10	-20.02	-16.19	<0.001
Wave 7	-16.47	-17.93	-15.01	<0.001	-16.88	-18.36	-15.39	<0.001	-19.13	-21.05	-17.21	<0.001	-19.18	-21.10	-17.26	<0.001
Child age/wave difference					-0.37	-0.62	-0.12	0.003	-1.70	-2.44	-0.96	<0.001	-1.70	-2.44	-0.96	<0.001
Child age/wave diff interaction																
Wave 3									0.81	-0.26	1.88	0.137	0.82	-0.25	1.89	0.133
Wave 4									1.62	0.79	2.44	<0.001	1.63	0.81	2.46	<0.001
Wave 5									1.53	0.71	2.35	<0.001	1.52	0.70	2.34	<0.001
Wave 6									1.19	0.15	2.24	0.026	1.20	0.16	2.25	0.024
Wave 7									1.41	0.30	2.52	0.012	1.43	0.32	2.54	0.012
Household region																
Regional													2.71	0.32	5.10	0.027
Rural													0.30	-1.60	2.19	0.759
Constant	89.96	88.55	91.37	<0.001	90.53	89.08	91.98	<0.001	92.76	90.89	94.62	<0.001	92.39	90.46	94.32	<0.001

Table 9.6 Sequential addition of predictor variables to achieve final food model: model 5 to model 8 (observations =1687, individuals= 411)

	Model 5				Model 6				Model 7				Model 8			
	Coef	95% CI		p	Coe	95% CI		p	Coef	95% CI		p	Coef	95% CI		p
Child birth order																
2nd	-1.96	-3.73	-0.19	0.030	-1.91	-3.66	-0.16	0.032	-2.52	-4.30	-0.74	0.005	-2.48	-4.26	-0.70	0.006
3rd	-3.01	-5.51	-0.52	0.018	-2.52	-5.00	-0.03	0.047	-3.48	-6.02	-0.94	0.007	-3.45	-5.99	-0.91	0.008
4th or more	-1.89	-5.61	1.82	0.318	-1.22	-4.90	2.47	0.518	-3.09	-6.93	0.76	0.115	-3.14	-6.98	0.70	0.109
Wave																
Wave 3	-9.33	-11.27	-7.40	<0.001	-9.37	-11.31	-7.43	<0.001	-9.41	-11.35	-7.48	<0.001	-9.39	-11.32	-7.45	<0.00
Wave 4	-13.31	-15.17	-11.44	<0.001	-	-15.26	-11.53	<0.001	-13.47	-15.34	-11.61	<0.001	-	-15.31	-11.59	<0.00
Wave 5	-17.34	-19.51	-15.16	<0.001	-	-19.66	-15.31	<0.001	-17.63	-19.80	-15.46	<0.001	-	-19.77	-15.42	<0.00
Wave 6	-18.11	-20.03	-16.20	<0.001	-	-20.20	-16.36	<0.001	-18.40	-20.32	-16.48	<0.001	-	-20.30	-16.47	<0.00
Wave 7	-19.19	-21.11	-17.27	<0.001	-	-21.38	-17.52	<0.001	-19.53	-21.45	-17.60	<0.001	-	-21.43	-17.57	<0.00
Child age/wave difference	-1.69	-2.44	-0.95	<0.001	-1.75	-2.49	-1.01	<0.001	-1.77	-2.51	-1.03	<0.001	-1.75	-2.49	-1.01	<0.00
Child age/wave diff interaction																
Wave 3	0.82	-0.25	1.89	0.134	0.86	-0.21	1.93	0.116	0.87	-0.20	1.94	0.111	0.85	-0.22	1.92	0.120
Wave 4	1.63	0.80	2.45	<0.001	1.69	0.86	2.51	<0.001	1.71	0.88	2.53	<0.001	1.69	0.87	2.52	<0.00
Wave 5	1.52	0.70	2.34	<0.001	1.57	0.75	2.39	<0.001	1.60	0.78	2.42	<0.001	1.58	0.76	2.40	<0.00
Wave 6	1.20	0.15	2.24	0.025	1.26	0.21	2.30	0.019	1.28	0.24	2.33	0.016	1.28	0.23	2.32	0.016
Wave 7	1.43	0.32	2.53	0.012	1.50	0.39	2.61	0.008	1.49	0.39	2.60	0.008	1.48	0.37	2.58	0.009
Household region																
Regional	2.41	-0.13	4.94	0.063	2.65	0.15	5.15	0.038	2.80	0.32	5.29	0.027	2.80	0.31	5.28	0.027
Rural	0.42	-1.50	2.34	0.669	0.60	-1.30	2.50	0.538	0.91	-0.99	2.81	0.347	0.93	-0.97	2.82	0.337
SEIFA disadvantage decile	0.14	-0.23	0.51	0.474	0.05	-0.32	0.42	0.778	0.00	-0.36	0.37	0.982	-0.01	-0.37	0.36	0.974
Parent education																
Year 11					-2.69	-7.09	1.70	0.230	-2.62	-7.00	1.76	0.242	-2.53	-6.91	1.85	0.258
Year 12					-0.61	-4.18	2.96	0.737	-1.34	-4.92	2.25	0.464	-1.37	-4.96	2.21	0.453
Apprenticeship/Cert/Dip					0.08	-3.00	3.15	0.961	-0.72	-3.82	2.39	0.652	-0.76	-3.86	2.34	0.631
Bachelor's degree					1.24	-1.99	4.47	0.452	0.26	-3.01	3.53	0.877	0.22	-3.05	3.49	0.897
Postgraduate degree					2.84	-0.76	6.43	0.122	1.61	-2.05	5.27	0.389	1.56	-2.10	5.21	0.404
Parent age									0.27	0.10	0.43	0.002	0.27	0.11	0.44	0.001
Child Gender													1.01	-0.55	2.56	0.204
Constant	92.01	89.81	94.20	<0.001	91.5	88.05	95.12	<0.001	84.82	79.33	90.31	<0.001	84.17	78.60	89.74	<0.00

Table 9.7 Sequential addition of predictor variables to achieve final beverage model: model 1 to model 4 (observations =1660, individuals =408)

	Model 1				**Model 2**				**Model 3**				**Model 4**			
	Coef	**95% CI**		**p**	**Coef**	**95% CI**		**p**	**Coef**	**95% CI**		**p**	**Coef**	**95% CI**		**p**
Child birth order																
2nd	-1.20	-3.65	1.26	0.340	-1.03	-3.47	1.41	0.407	-1.14	-3.57	1.30	0.361	-1.18	-3.62	1.26	0.342
3rd	-2.12	-5.57	1.34	0.230	-1.92	-5.35	1.51	0.272	-1.75	-5.17	1.68	0.318	-1.93	-5.35	1.48	0.267
4th or more	-9.24	-14.41	-4.07	<0.001	-9.11	-14.23	-3.98	0.001	-9.13	-14.26	-4.01	0.000	-9.04	-14.15	-3.92	0.001
Wave																
Wave 3	-3.09	-4.98	-1.19	0.001	-3.44	-5.34	-1.55	<0.001	-2.59	-5.51	0.33	0.082	-2.63	-5.55	0.29	0.078
Wave 4	-9.40	-11.22	-7.57	<0.001	-9.27	-11.09	-7.45	<0.001	-7.34	-10.14	-4.54	<0.001	-7.38	-10.18	-4.58	<0.001
Wave 5	-13.16	-15.20	-11.11	<0.001	-12.17	-14.27	-10.06	<0.001	-14.02	-17.26	-10.79	<0.001	-14.04	-17.28	-10.80	<0.001
Wave 6	-13.70	-15.79	-11.60	<0.001	-14.38	-16.50	-12.26	<0.001	-14.29	-17.16	-11.41	<0.001	-14.35	-17.23	-11.48	<0.001
Wave 7	-11.21	-13.39	-9.03	<0.001	-11.99	-14.20	-9.78	<0.001	-11.89	-14.78	-9.00	<0.001	-11.96	-14.85	-9.07	<0.001
Child age/wave difference					-0.68	-1.05	-0.32	<0.001	-0.53	-1.64	0.58	0.349	-0.53	-1.64	0.58	0.351
Child age/wave diff interaction																
Wave 3									-0.67	-2.28	0.94	0.415	-0.66	-2.27	0.95	0.422
Wave 4									-1.06	-2.29	0.17	0.092	-1.04	-2.27	0.19	0.097
Wave 5									0.55	-0.68	1.78	0.380	0.54	-0.69	1.76	0.392
Wave 6									0.18	-1.36	1.73	0.816	0.20	-1.35	1.74	0.803
Wave 7									0.33	-1.32	1.97	0.697	0.35	-1.30	1.99	0.679
Household region																
Regional													2.93	-0.37	6.22	0.082
Rural													-0.04	-2.65	2.58	0.978
Constant	98.60	96.60	100.61	<0.001	99.67	97.60	101.74	<0.001	99.42	96.69	102.16	<0.001	99.11	96.30	101.92	<0.001

Table 9.8 Sequential addition of predictor variables to achieve final beverage model, model 5 to model 8 (observations =1660, individuals =408)

	Model 5				**Model 6**				**Model 7**				**Model 8**			
	Coef	**95% CI**		**p**	**Coef**	**95% CI**		**p**	**Coef**	**95% CI**		**p**	**Coef**	**95% CI**		**p**
Child birth order																
2nd	-1.14	-3.58	1.30	0.360	-1.14	-3.51	1.22	0.345	-1.75	-4.16	0.67	0.156	-1.72	-4.13	0.70	0.163
3rd	-1.76	-5.20	1.68	0.315	-0.52	-3.87	2.84	0.763	-1.46	-4.90	1.98	0.407	-1.43	-4.87	2.01	0.415
4th or more	-9.00	-	-3.88	0.001	-7.36	-	-2.38	0.004	-9.19	-	-3.99	0.001	-9.24	-14.44	-4.03	0.001
Wave																
Wave 3	-2.62	-5.54	0.30	0.079	-2.95	-5.87	-0.03	0.048	-3.00	-5.92	-0.09	0.044	-2.98	-5.90	-0.07	0.045
Wave 4	-7.37	-	-4.57	<0.001	-7.75	-	-4.95	<0.001	-7.82	-	-5.02	<0.001	-7.81	-10.61	-5.01	<0.001
Wave 5	-	-	-10.77	<0.001	-	-	-	<0.001	-	-	-	<0.001	-14.58	-17.83	-11.34	<0.001
Wave 6	-	-	-11.46	<0.001	-	-	-	<0.001	-	-	-	<0.001	-14.96	-17.84	-12.08	<0.001
Wave 7	-	-	-9.04	<0.001	-	-	-9.71	<0.001	-	-	-9.80	<0.001	-12.69	-15.59	-9.78	<0.001
Child age/wave difference	-0.53	-1.64	0.58	0.348	-0.73	-1.84	0.38	0.197	-0.75	-1.86	0.36	0.186	-0.73	-1.84	0.37	0.194
Child age/wave diff interaction																
Wave 3	-0.66	-2.27	0.95	0.422	-0.45	-2.06	1.16	0.587	-0.42	-2.03	1.18	0.605	-0.45	-2.05	1.16	0.587
Wave 4	-1.04	-2.27	0.20	0.099	-0.81	-2.04	0.42	0.199	-0.78	-2.01	0.45	0.213	-0.79	-2.02	0.44	0.206
Wave 5	0.54	-0.69	1.76	0.391	0.71	-0.51	1.94	0.253	0.74	-0.48	1.97	0.233	0.73	-0.50	1.95	0.243
Wave 6	0.21	-1.34	1.75	0.794	0.41	-1.14	1.95	0.605	0.44	-1.11	1.98	0.580	0.43	-1.11	1.98	0.582
Wave 7	0.35	-1.30	1.99	0.679	0.56	-1.08	2.21	0.500	0.55	-1.09	2.20	0.508	0.54	-1.10	2.18	0.520
Household region																
Regional	3.44	-0.06	6.94	0.054	3.88	0.49	7.27	0.025	4.03	0.65	7.41	0.019	4.02	0.64	7.40	0.020
Rural	-0.24	-2.89	2.42	0.862	0.33	-2.24	2.90	0.800	0.65	-1.92	3.23	0.618	0.66	-1.91	3.24	0.613
SEIFA disadvantage decile	-0.22	-0.73	0.29	0.399	-0.45	-0.95	0.05	0.078	-0.50	-1.00	0.00	0.051	-0.51	-1.01	0.00	0.048
Parent education																
Year 11					-1.72	-7.88	4.45	0.585	-1.65	-7.81	4.50	0.598	-1.55	-7.70	4.61	0.622
Year 12					5.04	-0.05	10.12	0.052	4.32	-0.78	9.43	0.097	4.32	-0.79	9.42	0.097
Apprenticeship/Cert/Dip					3.30	-1.09	7.69	0.140	2.54	-1.89	6.97	0.261	2.52	-1.91	6.95	0.264
Bachelor’s degree					6.99	2.41	11.57	0.003	6.05	1.41	10.69	0.011	6.04	1.40	10.67	0.011
Postgraduate degree					9.58	4.51	14.65	<0.001	8.38	3.22	13.54	0.001	8.35	3.20	13.51	0.001
Parent age									0.26	0.04	0.49	0.022	0.27	0.04	0.49	0.020
Child Gender													0.79	-1.31	2.90	0.461
Constant	99.72	96.57	102.86	0.000	95.4	90.4	100.4	<0.001	88.68	81.04	96.33	<0.001	88.15	80.37	95.92	<0.001

Table 9.9 AIC values for each food and beverage model tested

	Food models			Beverage models		
Model	**n**	**df**	**AIC**	**n**	**df**	**AIC**
1	1,687	11	-3115.6	1,660	11	-1836.6
2	1,687	12	-3122.1	1,660	12	-1848.2
3	1,687	17	-3130.0	1,660	17	-1855.7
4	1,687	19	-3130.9	1,660	19	-1854.9
5	1,687	20	-3129.4	1,660	20	-1853.6
6	1,687	25	-3129.1	1,660	25	-1870.9
7	1,687	26	-3137.0	1,660	26	-1874.1
8	1,687	27	-3136.6	1,660	27	-1872.7
9	1,673	28	-3108.3	1,646	28	-1850.0
10	1,002	25	-2186.2	1,001	25	-939.3
11	994	26	-2164.8	993	26	-972.1