DIETARY INTAKES AND CONTEMPORARY FEEDING PATTERNS IN AUSTRALIAN INFANTS AND TODDLERS 0-24 MONTHS

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ABSTRACT

Caregiver feeding practices during the first two years of a child's life influence nutrition, growth, and development, as well as long term taste preferences and dietary patterns. Suboptimal feeding practices have been associated with poorer short- and long-term health outcomes. Although the importance of early life nutrition is well-established, there is no Australia-wide survey of contemporary caregiver feeding practices and dietary intakes of children under two years of age.

To inform the Australian Feeding Infants and Toddlers Study (OzFITS 2021), I first conducted an audit of commercial infant and toddler foods sold in Australia. In this audit, I reviewed the nutritional and textural properties of >400 products and found the majority were inconsistent with National Health and Medical Research Council (NHMRC) Infant Feeding Guidelines, being low in iron, sweet tasting and smooth in consistency.

From here, I describe the methods we used to conduct OzFITS 2021. OzFITS 2021 was a cross-sectional survey with caregivers and their children 0-24m across Australia. Using a telephone-based survey, we collected information on early life feeding practices including breastfeeding history, breastmilk substitute use, and the timing of introduction to complementary foods. In addition, we collected dietary intake data using a one-day food record, with repeats in a randomly selected subset of the population. We enrolled 1140 caregiver-child dyads and 850 caregivers completed at least one food record for their child. Dietary data were entered into FoodWorks Professional™ which used composition data from the Australian Food, Supplement and Nutrient Database to assign nutrient values to foods. Due to the lack of composition data on commercial infant and toddler foods, the database created in the audit (Chapter 3) was used.

In the subsequent chapters (4-7), I discuss the results from the child feeding questionnaire and dietary intake survey. Breastfeeding rates were high with nearly all mothers initiating breastfeeding soon after birth, and 40% of toddlers continued to receive breastmilk in the second year. Less than 1% of infants were exclusively breastfed to six months. Most infants started complementary feeding between the fifth and sixth month of life and most were introduced to common food allergens in the first year.

Compared to the Australian Dietary Guidelines, most toddlers consumed foods from all five food groups; however, few met the recommended daily serves for all food groups. Discretionary foods and milks, including breastmilk, contributed 10% and 25% of daily energy, respectively, and may have displaced consumption of other foods.

Compared to the Nutrient Reference Values for Australia and New Zealand, diets were nutritionally adequate for most nutrients; however, we found a high prevalence of inadequacy for iron in older infants and toddlers, and excessive sodium intake in toddlers.

Although breastmilk provides a significant proportion of daily energy, the recommended dietary pattern for toddlers does not include breastmilk. The dietary modelling used to inform the Australian Dietary Guidelines needs revision. While the high prevalence of inadequacy for iron is concerning, it is unclear if our data reflects biochemical deficiency as there is no information on nutritional status for this age group to compare to. A nationally representative survey with biomarkers for key nutrients is urgently needed.

DECLARATION

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint award of this degree.

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Najma Moumin

LIST OF PUBLICATIONS

Moumin NA, Green TJ, Golley RK, Netting MJ. Are the nutrient and textural properties of Australian commercial infant and toddler foods consistent with infant feeding advice? British Journal of Nutrition. 2020;124(7):754-760. doi:10.1017/S0007114520001695.

Moumin NA, Golley RK, Mauch CE, Makrides M, Green TJ, Netting MJ. The Australian Feeding Infants and Toddlers Study (OzFITS) 2021: Study Design, Methods and Sample Description. Nutrients. 2021; 13(12):4524. https://doi.org/10.3390/nu13124524.

Netting MJ, **Moumin NA**, Knight EJ, Golley RK, Makrides M, Green TJ. The Australian Feeding Infants and Toddler Study (OzFITS 2021): Breastfeeding and Early Feeding Practices. Nutrients. 2022; 14(1):206. https://doi.org/10.3390/nu14010206.

Moumin NA, Netting MJ, Golley RK, Mauch CE, Makrides M, Green TJ. Does Food Intake of Australian Toddlers 12–24 Months Align with Recommendations: Findings from the Australian Feeding Infants and Toddlers Study (OzFITS) 2021. Nutrients. 2022; 14(14):2890. https://doi.org/10.3390/nu14142890.

Moumin NA, Netting MJ, Golley RK, Mauch CE, Makrides M, Green TJ. Usual Nutrient Intake Distribution and Prevalence of Inadequacy among Australian Children 0–24 Months: Findings from the Australian Feeding Infants and Toddlers Study (OzFITS) 2021. Nutrients. 2022; 14(7):1381. https://doi.org/10.3390/nu14071381.

CONFERENCE/SEMINAR PRESENTATIONS

ORAL PRESENTATIONS

"The upside to lockdown: Insights from the OzFITS Study" presented at the South Australian Health and Medical Research Institute and Nutrition for Mother and Child Centre for Research Excellence Update, Adelaide, Australia (2020).

"What's on the menu? Assessing feeding patterns of Australian children <2yrs" presented at the South Australian Health and Medical Research Institute Annual Scientific Meeting, 3-Minute Thesis, Adelaide, Australia (2021).

"A deep dive into the OzFITS study: implications for health professionals" presented for the Dietitian's Connection Livestream Webinar, Australia (2022).

"Usual Nutrient Intake Distribution and Prevalence of Inadequacy among Australian Children 0–24 Months: Findings from the Australian Feeding Infants and Toddlers Study (OzFITS) 2021" presented at the Dietitians Australia 2022 Conference, Adelaide, Australia (2022).

POSTER PRESENTATIONS

"Are the nutrient and textural properties of Australian commercial infant and toddler foods consistent with infant feeding advice?" presented at the Florey Postgraduate Research Conference, Adelaide, Australia (2020).

PODCASTS

"Women's and Children's Health Update: Australian Feeding Infants and Toddlers Study (OzFITS) – What have we learned & what to do differently" interview for Healthed professional development for healthcare professionals podcast, Australia (2022).

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LIST OF ABBREVIATIONS

24 HDR	24-hour dietary recall
AHS	Australian Health Survey
AI	Adequate Intake
ANIFS	Australian National Infant Feeding Survey
ALSPAC	Avon Longitudinal Study of Pregnancy and Childhood
ASCIA	Australasian Society for Clinical Immunology and Allergy
CAPS	Childhood Asthma Prevention Study
EARs	Estimated Average Requirement
EER	Estimated Average Requirement
InFANT	Infant Feeding and Nutrition Trial
NRVs	Nutrient Reference Values
RDI	Recommended Dietary Intake
SAIDI	South Australian Infant Dietary Intake
UL	Upper limit
US	United States
UK	United Kingdom

CHAPTER 1. INTRODUCTION

1.1 Introduction

Caregiver feeding practices in the first two years of life strongly influence appetite regulation, taste, and dietary preferences across the life course [1-3]. During this period, energy and nutrient requirements relative to body size are markedly high due to rapidly occurring physiological growth and neurodevelopment [1, 2]. Therefore, sub-optimal feeding practices and nutrition may lead to intractable poor health outcomes. Indeed, energy or nutrient deficiencies during this period have been linked to impaired cognitive and psychosocial development, faltering growth, and poor immune function, whereas excess energy intake during infancy has been linked to an increased risk for overweight and obesity that persists later in life [4-6].

Health authorities in most high-income countries provide advice on feeding and nutrition for young children [7-10]. In Australia, this advice was developed by the National Health and Medical Research Council (NHMRC) [11] and recommends exclusive breastfeeding for the first six months, after which complementary (solid) foods from the five food groups; fruits, vegetables, cereals and grains, dairy, and meats and alternatives, can be introduced [12]. Foods can be introduced in any order at ~6 months, but iron-rich complementary foods such as pureed red meats and iron-fortified infant cereals are strongly recommended as first foods.

In addition to offering a range of nutritious foods consistent with the Australian Dietary Guidelines [12], parents must also offer a variety of textures so the infant can progress from pureed baby foods to eating family foods that require chewing by the end of the first year of life. Prolonged breastfeeding to 12 months and beyond is encouraged for psychosocial benefits

for both mother and infant; however, complementary foods should provide most of the daily energy after the first year of life [11]. After one year of age, special complementary foods marketed towards young children and toddler milks (fortified milks) are no longer necessary for healthy children, and full fat cow's milk is suitable as a main drink. Due to their low energy and high nutrient needs, discretionary foods higher in saturated fat, salt and sugar are not recommended for young children [11, 13].

Although the importance of early life feeding and nutrition is well-recognised, very little is known about the dietary intakes of Australian children <2 years. The Australian government has conducted three national nutrition surveys in the past thirty years, none of which have included children under 2 years. The 2010 ANIF survey provided representative data on early life feeding practices such as breastfeeding and timing of solid food introduction, but it did not include dietary intake data [14]. The few available studies we do have on dietary intake are limited to one or two Australian cities and were conducted ~10-20 years ago. Therefore, contemporary data on feeding practices and dietary intakes in a national sample of Australian children under two years is urgently needed.

The Australian Feeding Infants and Toddlers Study (OzFITS 2021) attempts to fill this gap by providing contemporary data on caregiver feeding practices and food and nutrient intake in Australian children under two years. In this thesis, I will: 1) evaluate the types of commercial infant and toddler foods currently available in Australia and compare their nutrient and textural properties with the NHMRC Infant Feeding Guidelines; 2) provide contemporary breastfeeding data including rates of initiation, duration of exclusive breastfeeding, and use of breastmilk substitutes; 3) compare the timing of introduction to solid foods and food allergens with the NHMRC Infant Feeding Guidelines and current food allergy advice; 4) compare the daily

servings of the five food groups and ‘discretionary’ foods to the recommended dietary patterns in the Australian Dietary Guidelines, and 5) estimate the distribution of usual energy and nutrient intake relative to the Nutrient Reference Values for Australia and New Zealand.

CHAPTER 2. LITERATURE REVIEW

This chapter will summarise current evidence in Australia on caregiver feeding practices and diet quality of children 0-24 months in comparison to the NHMRC Infant Feeding Guidelines [11], the Australian Dietary Guidelines [12], and the Nutrient Reference Values (NRVs) for Australia and New Zealand [15]. I will review national surveys and studies conducted in Australia that have assessed the following: 1) breastfeeding rates; 2) the timing of introduction to solid foods (including food allergens); 3) the types of foods and drinks consumed by young children; 4) the alignment of diets with the recommended serves of the five food groups; 4) the distribution of usual nutrient intakes from foods and drinks; and 5) the prevalence of inadequate or excessive nutrient intakes. It will then close with the key gaps in research and the specific aims and objectives of this thesis.

2.1 Breastmilk

The benefits of breastmilk for both mother and infant are well documented in the literature [16-18]. Breastmilk contains all the essential nutrients an infant requires for the first six months of life along with potent bioactive molecules that exert a protective effect against illness and disease [2, 19]. In addition to psychosocial benefits to both mother and child, prolonged breastfeeding has been shown to reduce the risk for obesity and related conditions in children and protect lactating mothers against some cancers and type 2 diabetes [16, 20]. As such, the World Health Organisation (WHO) [21] and the NHMRC Infant Feeding Guidelines recommend exclusive breastfeeding for the first six months and continued breastfeeding to 12 months and beyond [11, 12]. When breastfeeding is not possible, breastmilk substitutes (infant formula) are recommended in the first year of life.

In Australia, detailed indicators on breastfeeding have been reported in nationally representative surveys such as the 2010 Australian National Infant Feeding Survey (ANIFS) [14] and the 2017/18 Australian Health Survey (AHS) [22]. To date, the 2010 ANIF survey is the largest and most robust survey conducted on infant feeding practices in Australia with a representative sample of 52,000 children aged 0-24 months randomly selected from Medicare Australia. Moreover, the survey questions were rigorous and captured the breadth of experiences in hospital and during the early neonatal period which allowed for accurate estimation of important indicators such as any breastfeeding, ever breastfed, exclusively breastfed, and partially breastfed, consistent with the 2008 WHO breastfeeding definitions (Table 1.1) [21]. In contrast, data reported in the 2017/18 AHS had a much smaller sample size, N = 1498 children aged 0-4 years, high relative standard errors, and did not include probing questions about exposure to breastmilk substitutes in hospital [22]. In a 2019 Victorian report on perinatal outcomes, one third of healthy term infants were supplemented with breastmilk substitutes in hospital [23]. Therefore, without appropriate questions, it is possible some indicators like exclusive breastfeeding may be misclassified.

Table 1.1 Definitions of breastfeeding indicators[1]

Feeding practice	Requires that the infant receive	Allows the infant to receive	Does not allow the infant to receive
Exclusive breastfeeding	Breastmilk (including expressed milk)	Oral rehydration solutions, drops, syrups (vitamins, minerals, medicines)	Anything else
Predominant or 'full' breastfeeding	Breastmilk (including expressed milk) as the predominant source of nourishment	Certain liquids (water and water-based drinks, fruit juice), ritual fluids and oral rehydration salts, drops or syrups (vitamins, minerals, medicines)	Anything else (in particular, non-human milk, food-based fluids)
Complementary feeding or 'partial' breastfeeding	Breastmilk (including expressed milk)	Anything else: any food or liquid including non-human milk and formula	Not applicable
Any breastfeeding	Any of the above definitions		
Ever breastfed	The infant has been breastfed or received expressed breastmilk or colostrum at least once		

[1] Sourced from *2010 Australian National Infant Survey [14]*.

Although 96% of infants were 'ever breastfed' and 90% of Australian mothers initiated 'exclusive breastfeeding', only 2% of infants were exclusively breastfed to six months in the 2010 ANIF survey with the majority losing exclusive breastfeeding status due to exposure to breastmilk substitutes in the first month of life [14]. In contrast the 2017/18 AHS reported a much higher rate of exclusive breastfeeding of 29% which may be overestimated due to the lack of probing questions about experiences in hospital or immediately following discharge

[22]. Despite the low exclusive breastfeeding rates to six months, the proportion of Australian infants 'partially breastfed' to at least 12 months was high at 40% [14].

Demographic indicators such as maternal educational attainment and maternal age have a strong influence on early life feeding practices [4], and these have changed in Australia since 2010 [24, 25]. For example, the percentage of Australian women aged 25-34 years with a bachelor's degree or above increased from 38% to 45% between 2010 and 2018. In the same period, the proportion of women aged 30-34 giving birth increased from 30.8% to 36.0% [25]. In the 2010 ANIF survey, maternal age and educational attainment were positively associated with longer duration of any and exclusive breastfeeding as well as appropriate timing of solid food introduction [14].

In addition to demographic shifts, the market share of breastmilk substitutes aimed at toddlers (toddler milks) increased more than 10-fold between 2010 and 2018, and the retail value of the toddler milk industry is currently estimated at $314.7 million AUD [26]. Use of breastmilk substitutes beyond 12 months was not captured in the 2010 ANIF survey which may influence the transition to family foods in the second year of life. Moreover, it is unclear if cow's milk was introduced as a main drink before or after 12 months as all non-human milks were combined in one category, which may have implications for iron deficiency [11]. Therefore, updated information on early life feeding practices including use of breastmilk substitutes and other milks in infancy and the toddler years are needed.

2.2 Timing of introduction to complementary foods

At around six months, the NHMRC Infant Feeding Guidelines [11] recommend introducing complementary foods from the five food groups to meet the increased demand for energy and

nutrients in the second half of infancy [11, 12]. Early introduction to solid foods has been associated with an increased risk of choking, gastrointestinal disorders, obesity, and the development of allergic disease [1, 27]. Conversely, delayed introduction to solid foods may lead to faltering growth, micronutrient deficiencies, and impaired immune function [1, 11]. Therefore, it is recommended that parents watch for, and respond to developmental signs of readiness that indicate a child is ready to start solid foods (e.g., the ability to sit upright without help, opening of the mouth when a spoon is placed on the lips, disappearance of the tongue thrust reflex, and control of the tongue to move and swallow food) and introduce food accordingly [1, 11, 28].

In Australia, the timing of introduction to solid foods has been captured in the 2010 ANIF survey [14] and the 2017/18 AHS [22]; however, early introduction to solid foods, before 4 months, was not documented in the 2017/18 AHS. According to the 2010 ANIF survey, 9.7% of Australian infants received solids before 4 months, with a disproportionate amount born to younger mothers with lower educational attainment [14]. Delayed introduction was less common with 92% of infants commencing solid foods by six months. Although information on the timing is well documented, critical information such as the textures and types of foods and drinks consumed by young children, including food allergens, was not captured in the 2010 ANIF survey and have not been reported at the national level in Australia.

2.3 Textures

Infants' gross (head and trunk control), fine (finger and hand dexterity), and oral motor development (chewing and swallowing) are linked to the acquisition of self-feeding skills [29]. Although the age at which children may achieve each milestone can vary, behaviours associated with independent self-feeding skills such as picking up food, finger feeding,

chewing, and drinking from a cup, are acquired in a sequential process and occur concurrently with mastery of motor milestones [29]. Thus, parents are advised to expose their children to a range of textures from smooth purees, to mashed and soft lumpy foods, and finally to solid foods so they can develop the oral motor skills required to eat nutritious family foods by the end of the first year of life [11, 29]. Akin to the timing of solid foods, evidence also suggests there may be a critical window within which textured foods must be introduced. Data from the Avon Longitudinal Study of Pregnancy and Childhood (ALSPAC) birth cohort study [30] has shown that children introduced to lumpy foods at 9 months or beyond are significantly less likely to consume family foods, consume fewer fruits and vegetables, and have feeding difficulties that persist at 7 years of age. Since this landmark study, several other studies have also reported decreased dietary diversity (number of food groups consumed) and overall diet quality associated with delayed introduction to textured foods [31-33].

While parents have control over home prepared foods, the textures, tastes and nutritional properties of commercial infant and toddler foods are outside of their degree of influence, and are making up an increasingly large proportion of modern diets [26]. Due to their consistency in taste and texture, these foods are highly palatable to young children and convenient for time poor parents [34-36]. However, reports from other high-income countries such as Germany, the United States (US), the United Kingdom (UK), and New Zealand have revealed troubling trends in the nutritional composition, textures, packaging, and targeted age groups for these products. For example, the Nutrition Commission of the German Society for Pediatrics and Adolescent Medicine recently published a position statement advocating against baby foods packaged in squeeze pouches due to their extremely high sugar contents [35]. The expert group cited concerns over the reduced opportunities for spoon feeding, lost interaction between caregivers and infants that helps to establish responsive feeding (i.e., monitoring and

responding to hunger cues), and the increased risk of dental caries [35]. In the US and New Zealand, more than half of pureed foods were packaged in squeeze pouches with similar sugar contents [36]. Similarly, in the UK, two thirds of all food products were sweet finger foods, one third of which of were targeted at infants less than six months, highlighting a clear discord between national infant feeding guidelines and commercial infant food industry practices [37]. In Australia, only one study has systematically investigated the nutritional content of commercial infant and toddler foods [38]; however, the textural properties and target age groups of these products and their alignment with the NHMRC Infant Feeding Guidelines were not investigated. Moreover, the proportion of these foods relative to home cooked foods in contemporary diets is unknown.

2.4 Food allergens

Previously, infant feeding guidelines recommended delaying the introduction of common food allergens in early childhood as this was thought to be driving the increased incidence of food allergy in industrialised countries [39]. However, conclusive evidence from high quality randomised controlled trials [40, 41] demonstrated that regular consumption of egg and peanut within the first year reduces the risk of food allergy, even in high-risk groups [39]. Evidence around the timing of other common food allergens is not yet available; however, there is consensus not to delay exposure [39]. Based on these findings, the Australasian Society for Clinical Immunology and Allergy (ASCIA) revised the guidelines on infant feeding and allergy prevention in 2016 [42]. In step with the introduction to solid foods, parents are also advised to introduce common food allergens (particularly peanut, cooked egg, dairy and wheat) to their infant's diet before they turn one year, and once introduced to include them regularly in their child's diet [42]. Since this paradigm shift, two studies [43, 44] have assessed uptake of this advice and found a high degree of adherence (>85%) among caregivers; however, both studies

were single city studies. Additional information is needed on uptake of allergy prevention advice in other jurisdictions across Australia.

2.5 Food and nutrient intake

In Australia, food-based dietary guidelines that meet the energy and nutrient requirements for each sex and life stage group have been developed to curb the tide of obesity and related conditions and promote health and well-being across the lifespan [12, 45]. Using a dietary modelling approach, dietary patterns with recommended serve sizes and serves from each of the five food groups, including unsaturated fats and oils, have been developed for each population sub-group [12, 46]. To inform food selection for each of the five food groups, food consumption data from previous national nutrition surveys were used [47, 48]. However, Foundation Diets for toddlers were modelled on consumption data for 2–3-year-old children due to a lack of intake data [46]. As such, the recommended dietary pattern for toddlers in the Australian Dietary Guidelines (Table 1.2), uses the same serve sizes, albeit smaller number of serves, and food groups as older age groups, apart from discretionary foods [12]. Discretionary foods higher in saturated fats, added sugars, salt or alcohol are not recommended for young children due to their limited capacity for food intake and high nutrient needs [11, 13, 15]. In Australia, very little is known about the alignment of contemporary toddler diets with the Australian Dietary Guidelines [12] and even less is known about the nutritional adequacy of diets relative to the NRVs for Australia and New Zealand [15]. To evaluate this, detailed information on dietary intakes are needed.

Table 1.2 Recommended dietary pattern for toddlers 1-2 years[1]

Food	Serve size	Serves a day
Vegetables and legumes/beans	75g	2-3
Fruit	150g	½
Grain (cereal) foods	40g bread equivalent	4
Lean meats, poultry, fish, tofu, eggs, legumes	65g	1
Milk, yoghurt, cheese and/or alternatives	250g milk equivalent	1-1 ½

* An allowance for unsaturated spreads or oils or nut/seed paste of 1 serve (7–10g) per day is included. Whole nuts and seeds are not recommended for children of this age because of the potential choking risk.
[1] Sourced from *Eat For Health Educator Guide* [12].

2.5.1 Assessing food intake

To assess adherence to dietary guidelines and nutritional adequacy, detailed information on food and beverage intake is needed. Several methods have been developed to conduct nutritional assessments in large scale population surveys including the food frequency questionnaire, 24- hour dietary recall (24 HDR), and food record [49].

The food frequency questionnaire employs a checklist of predefined foods and beverages and gathers information on usual consumption (frequency and portion size) over a long time period [49]. Although relatively easy to administer and cost-effective, this method has been widely criticized for its accuracy due to inherent recall bias.

In contrast, the United States Department of Agriculture multiple pass 24 hour dietary recall (24 HDR) interview method yields detailed information on the types and quantities of foods and beverages consumed in a single day [50, 51]. The multiple passes embedded in the interview process aid in participant recall by systematically asking detailed questions regarding food preparation methods, portion size consumed, and additions to food at the time of consumption [50]. However, the 24 HDR method relies on participant recall of intake from the previous day and is prone to over or under estimation of true intake, which, for young children,

would significantly impact results [49, 52]. Moreover, a significant proportion of children under two years of age are enrolled in childcare [53]. Therefore, employing a telephone-based 24 HDR survey when multiple people may feed the same child on the day of the recall is not practical.

The food record on the other hand obtains intake data in real time during meal and snack occasions, reducing recall bias [49, 50]. Similar to the 24 HDR, information on the quantities, types, and food preparation methods can also be obtained [50, 51]. Multiple carers can also complete a food record on a single day and data can be combined to obtain a complete picture of a single day's intake. However, this method is prone to error with respect to portion estimation as it places a significant burden on the caregiver to accurately record amounts consumed and provide detailed description of foods with respect to preparation, additions at the time of consumption, and quantities leftover [49].

A hybrid dietary assessment model combining the food record with the 24 HDR interview method is used to leverage the strengths and minimise the limitations of each method. Using the food record as a memory aid, participants would have greater recall of their child's food consumption in the previous 24 hours. The multi-pass system embedded in the 24 HDR interview would then provide additional details on food preparation, additions, and confirm portion sizes.

2.5.2 Assessing nutrient intake

Once dietary intake data are collected, it is possible to determine total nutrient intake from food and drinks using publicly available food composition tables such as the 2011/13 Australian Food, Supplement and Nutrient Database [54]. This then allows appraisal of diet quality by

comparing total nutrient intakes to the NRVs. In 2006, Australia's National Health and Medical Research Council (NHMRC) published the NRVs for Australia and New Zealand largely based on the US: Canadian Dietary Reference Intakes [55]. Collectively, the NRVs are a set of measures that describe the amounts of a nutrient required for the maintenance of normal physiological and metabolic function as well as thresholds of toxicity and deficiency at the individual and population level [15]. Table 1.3 provides the operational definitions of each NRV and its intended use.

Table 1.3 Definitions of NRVs and their intended use [1]

EAR	**Estimated Average Requirement** A daily nutrient level estimated to meet the requirements of half the healthy individuals in a particular life stage and gender group.
RDI	**Recommended Dietary Intake** The average daily intake level that is sufficient to meet the nutrient requirements of nearly all (97-98 per cent) healthy individuals in a particular life stage and gender group.
AI	**Adequate Intake (used when an RDI cannot be determined)** The average daily nutrient intake level based on observed or experimentally determined approximations or estimates of nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate.
EER	**Estimated Energy Requirement** The average dietary energy intake that is predicted to maintain energy balance in a healthy adult of defined age, gender, weight, height and level of physical activity, consistent with good health. In children and pregnant and lactating women, the EER is taken to include the needs associated with the deposition of tissues or the secretion of milk at rates consistent with good health.
UL	**Upper Level of Intake** The highest average daily nutrient intake level to pose no adverse health effects to almost all individuals in the general population. As intake increases above the UL, the potential risk of adverse effects increases

[1]Sourced from *Nutrient Reference Values for Australia and New Zealand* [15].

For infants 0-6 months, only AIs are available for all nutrients which are derived from breastmilk composition of well-nourished mothers and the mean intakes of apparently healthy

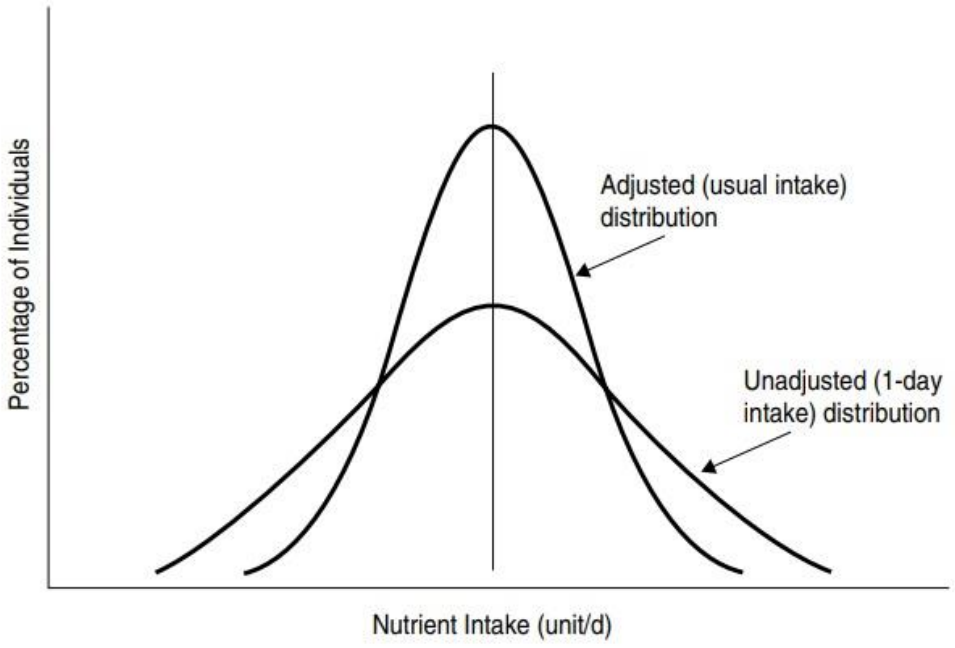
breastfed infants [15]. Similarly, for infants 7-12 months, most nutrients, except for iron and zinc, only have AIs which are derived from the mean intakes of breastfed infants plus the median intake from complementary foods [15]. Although population intakes at or above the AI can be *assumed* to be adequate, there is no evidence to suggest nutritional inadequacy if they fall below as these values are intakes and not requirements.

In contrast, the EAR is the mean requirement of a group derived from observational or experimental studies in humans and can be used to estimate the prevalence of inadequacy, that is, the percentage of the population with intakes below requirements [55]. For infants 7-12 months, iron and zinc EARs were developed because foetal iron stores are depleted by around six months and it is challenging to meet requirements for both of these nutrients [2, 15]. For toddlers 1-3 years of age, most nutrients have established EARs; however, due to insufficient data, most were derived by extrapolating downwards from adults and adjusting for body size [55].

2.5.3 Assessing nutritional adequacy

In order to determine the prevalence of inadequate or excessive nutrient intakes in a population, information on the distribution of usual intakes and dietary requirements (EAR and UL) are needed [55]. Because of the variation in an individual's day-to-day intake, a type of measurement error known as within-person variation occurs if a single day's intake is used [50]. For this reason, at least two non-consecutive days or three consecutive days of dietary intake data are needed from a representative subsample of the population to account for this variance [55]. During analysis, within-person variance can be removed, bringing the tails of the distribution closer to the mean, and representing the true variation in intake between individuals in the study population (Figure 1.1).

Figure 1.1 Nutrient intake distribution using 1-day and multiple day's intake[1]



[1]Sourced from *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements* [55].

Once the distribution of usual nutrient intake is calculated, adjusted intakes can then be compared to the EAR or UL to estimate the prevalence of inadequate or excessive intakes in the population, respectively. For nutrients with EARs that are normally distributed, the EAR cut-point method can be used by categorising intakes as either above or below the EAR; the same can be done for the UL [55]. However, for some nutrients, like iron, the distribution is asymmetrical about the EAR, therefore the cut-point approach cannot be used as this may underestimate the true prevalence of inadequacy [55]. Instead, the full probability approach must be used to estimate the risk of inadequacy. This is accomplished by comparing the distribution for usual intake to the estimated percentiles of requirement. Finally, for some nutrients, particularly iron and zinc, absorption factors must also be applied as bioavailability of these nutrients may vary depending on the type of diet (e.g., mixed vs vegetarian/cereal based diets) [55].

2.5.4 Summary of Australian studies assessing food intake in children 6-24 months

Although there are no national studies, some local studies have investigated diet quality in young children aged 6-24 months [34, 56-60]; however, only one study [56] compared food intake data to recommended food group serves in the Australian Dietary Guidelines, whereas the remainder reported consumption data as the combined sum (grams) for each food group. Aggregating data in this manner is problematic as the quantity of a food required to satisfy a serving for a food group varies depending on the type of food selected [12]. For example, 30g of dried fruit, 1 cup of canned fruit without added sugar, and a medium sized banana all equate to one serving of fruit. Similarly, 65 grams of cooked lean red meat, 100 grams of cooked fish, and 30 grams of nuts or seeds are all equivalent to one serving of meat or meat alternatives [12]. Combining all foods from a particular food group into an absolute weight without converting to the standard serve size does not permit an appropriate appraisal of toddler diets.

Although limited to fruits, vegetables and discretionary foods, Spence et al [56] compared serves of these food groups at 9, 18, 42 and 60 months to the recommended serves in the Australian Dietary Guidelines using data from the Melbourne-based nutrition and lifestyle intervention trial. The authors found age related decreases in vegetable consumption but not fruit and increased discretionary food consumption over time. In fact, the proportion of children with adequate vegetable serves decreased from 96% at 9 months to only 3% by 18 months of age and remained low at subsequent time points. Conversely, the proportion of children with adequate fruit intakes remained high (>70%) until 3.5 years of age. Almost no children met recommendations for discretionary foods at any time points and, by 3.5 years, discretionary foods accounted for more than 25% of total energy intake. These results are sobering as they also reflect a sample that is highly educated, half of which were exposed to a nutritional intervention. Moreover, the affinity towards fruit and discretionary foods coupled with the

rejection of vegetables is indicative of children's innate preference for sweet and salty tastes and the importance of frequent exposure to bitter tastes during infancy [3].

Similar data collection protocols permitted the pooling of intake data from the control arm of NOURISH, a multi-site randomised controlled trial conducted in Brisbane and Adelaide, and the South Australian Infant Dietary Intake (SAIDI) study, a longitudinal birth cohort study, also found suboptimal dietary patterns emerging early in the complementary feeding period [34, 61]. At 6-12 months, almost no children met recommendations for weekly serves of meat (beef, lamb, veal, and/or pork), and less than 15% met recommendations for servings of meat alternatives (poultry, fish, seafood, eggs and/or legumes) at a time when the demand for iron is highest [34].

By 1 year, most toddlers consumed foods from all five food groups; however, the quantities eaten were low with disproportionate amounts of energy sourced from some food groups, namely cereals and dairy [61]. Meat consumption remained low with one half of toddlers aged 12-16 months consuming less than half the recommended daily serve [61]. In line with Spence et al [56], adequate fruit consumption remained high with a median (IQR) intake of 131 (176-199) g/day compared to 89 (43-164) g/day for vegetables, suggesting that ~75% of toddlers did not meet the recommended daily minimum serve [12, 61]. Although not recommended, discretionary foods were consumed by >90% of toddlers and accounted for ~10% of daily energy, displacing consumption of five-food group foods [61]. By 24 months, processed meats including ham, sausages and deli meats, high in sodium and nitrates, were consumed by more than a third of toddlers suggesting the transition to family foods is inconsistent with both the Australian Dietary Guidelines and the NHMRC Infant Feeding Guidelines [34].

2.5.5 Summary of Australian studies assessing nutrient intake in infants 6-24 months

Like food intake, few Australian studies [57, 60, 62-65] have investigated energy and nutrient intake in this population in comparison to the NRVs for Australia and New Zealand [15]. Conn et al [63] were the first to describe nutrient intakes in infants; however, this study used an unstructured food frequency questionnaire with a 30-day recall period to assess dietary intakes. Because of the long recall period, this method is not suitable for this age group as portion sizes are small and diets change rapidly. Nevertheless, the authors found a low prevalence of inadequacy for iron (<10%) and zinc (<1%). However, these estimates did not include breastfed infants who comprised one third of the sample.

Others have reported on nutrient intakes in both breastfed and non-breastfed infants and toddlers and found iron and sodium to be nutrients of concern [57, 60, 62]. According to data from the Melbourne based InFANT trial, 33% of infants aged 9 months and 19% of toddlers aged 20 months had inadequate iron intakes [62], and more than half of the sample consumed too much sodium [57]. Similar results were reported in a Sydney-based Asthma prevention study where one quarter of toddlers aged 16-24 months had iron intakes <EAR [60]. Although the prevalence of inadequacy for other nutrients was low, ~10% of toddlers consumed excess energy relative to their estimated energy requirements (EER) and 62% exceeded the UL (1000 mg/day) for sodium [60]. Although both of the aforementioned studies were intervention trials, Zhou et al [65] reported similar findings in a representative sample of preschool children aged 12-59 months in Adelaide. In this study, 16% of 1–2-year-olds had inadequate iron intakes and, iron deficiency was confirmed in 10% of toddlers by measures of serum ferritin. Interestingly, dietary data suggested adequacy for zinc (3% < EAR); however, biochemical measures of zinc status revealed that 32% of toddlers were deficient. These findings are sobering and the

discrepancy between dietary intake data and biochemical data highlight the need for validation of dietary requirements.

In Australia, breastfeeding beyond 12 months is recommended [11]; however, infants should transition to mainly family foods consistent with the Australian Dietary Guidelines by one year to meet their high energy and nutrient requirements [15]. Only one Australian study has examined the relationship between nutrient adequacy and milk feeding type [64]. In a South Australian cohort of toddlers aged 12 months (*n = 832*), one third were still receiving breastmilk with or without formula and two thirds were receiving some formula. In this study, breastfed toddlers were significantly more likely to be inadequate for multiple micronutrients including iron and calcium, compared to other milk feeding types (e.g., formula and other). Moreover, in both breastfed and formula-fed toddlers, milks contributed one third of daily energy intake indicating that the dietary transition to mainly family foods may not be optimal. However, it is unclear if differences in nutrient adequacy translate to differences in food consumption patterns. Further research is needed to explore food consumption patterns according to primary milk type.

Table 1.4 Australian studies assessing food and nutrient intake in children 0-24m

First author & study name	Location and duration of study	Study design	Sample size	Age (months)	Data collected	Main results/conclusions [1]	Gaps/Limitations
Food intake							
Spence, A.C. [56] Melbourne Infant Feeding, Activity and Nutrition Trial Program (InFANT)	Melbourne 2008-2010	Cluster randomised controlled trial	N=542 first time parents and their infants attending parents' groups	3 – 60m	3 x 24 HDR at each time point: 9m, ~18m, 42m, and 60m	-*n=467* children (from both the control and intervention groups) with at least 1 time point complete. - >90% of infants aged 9m had adequate F&V intake - <10% adequate V at all subsequent time points. -F intake high at all timepoints. -nearly all consumed disc foods at all time points	-Intake of other food groups missing e.g., dairy, cereals and grains, meats, and alternatives -Single city study -Data > 10 years old -High SES sample
Lioret, S [57] InFANT	Melbourne 2008-2010	Cluster randomised controlled trial	n = 177	9-18m	3 x 24 HDR at 9m and 18m	-Most had eaten from five food groups at 9m and 18 m -V intake ↓ with age. -2-fold ↑ in disc food consumption from 9 to 18 m	-Single city study and small sample size -50% dropout rate in control arm, most of which were mothers with low education -Absolute weights of food groups reported rather than serves

First author & study name	Location and duration of study	Study design	Sample size	Age (months)	Data collected	Main results/conclusions [1]	Gaps/Limitations
Koh, G [59] South Australian Infant Dietary Intake Study (SAIDI)	September 2008 and March 2009	Prospective longitudinal cohort study	n=277	Birth-24m	2-day Food record 1 X 24 HDR at age 6m	*Prevalence F&V Consumption* -87% F and 92% V *Median (IQR) Frequency F&V consumption* -4 (1-7) F and 6 (3-11) V *Median (IQR) Variety F&V* -2 (1-3) F and 3 (2-5) V -Variety of foods were limited and preference for sweet and/or starchy foods (pumpkin, carrot, potato, apple, pear) was evident	-One third of original sample completed assessment at 6m -Intake data limited to F&V only and did not report quantities or serves of food groups (e,g, iron rich complementary foods) -Data >10 years old -Single city study

First author & study name	Location and duration of study	Study design	Sample size	Age (months)	Data collected	Main results/conclusions [1]	Gaps/Limitations
Byrne, R [61] NOURISH and SAIDI	June 2009-June 2010	Prospective longitudinal cohort study	n=551 mother child dyads	12-16m	1 X 24 HDR	*Food Intake* -Most consumed foods from all five food groups -Median quantities were lower for all food groups, except fruit and dairy -90% consumed disc foods -50% consumed < ½ MMA serving *Top energy sources among consumers* -Dairy (29%), Cereals (18%), disc foods (9%), CM (22%) and BMS (29%), and BM (15%) *Milk types* -23% BM and 32% BMS	-Reported quantities of foods rather than standard serves in the AGHE -Data is > 10 years old -High SES sample -Results are based on single day's intake

First author & study name	Location and duration of study	Study design	Sample size	Age (months)	Data collected	Main results/conclusions [1]	Gaps/Limitations
Mauch C.E. [58] NOURISH and SAIDI	2009	Prospective longitudinal cohort study	*n = 409* and *n = 363* mother child dyads	14m and 24m	2-day food record 1 X 24 HDR	*Changes in consumption 14-24m* -% BF↓ from 25% to 10% -Variety of F ↑ but V↓ -% consuming ham and sausages ↑, beef ↓, and no change in chicken -variety of disc foods ↑ 2-fold -portion sizes of most foods were ½ or 1/3 of an adult serve	-Reported median portion sizes of specific foods consumed by ≥ 10% of sample over time -Cannot compare total food group serves at each time point, only individual foods -Data is > 10 years old -High SES sample

First author & study name	Location and duration of study	Study design	Sample size	Age (months)	Data collected	Main results/conclusions [1]	Gaps/Limitations
Mauch, C.E. [34] NOURISH and SAIDI	2008	Prospective longitudinal cohort study	n = 482 n = 600 n = 533	4-24m	2-day food record 1 X 24 HDR	-Mean age 5.5m, 14m, and 24m at Time 1, 2, 3 respectively *Time 1* -Commercial meat-based foods most common source of MMA *Time 2* -meat based mixed dishes most common source of MMA. -Processed meats ↑ most and consumed in largest quantities *Time 3* - meat based mixed dishes and ham were the most common source of MMA *% Meeting recommended serves of MMA* -6-12m: 1% and 14% met recommended weekly serves of meats and alternatives, respectively -13-36m: approx. one third met recommended weekly serves	Did not convert alternatives to 65g red meat equivalents and may have overestimated proportion meeting requirements.

First author & study name	Location and duration of study	Study design	Sample size	Age (months)	Data collected	Main results/conclusions [1]	Gaps/Limitations
Webb, K. [60] Childhood Asthma Prevention Study (CAPS)	Western Sydney 1997-2000	Cross-sectional data from a randomised controlled trial	N=616 pregnant women with family history of asthma	16-24m	3-day weighed food record	-Mean age 19m -Most toddlers consumed all food groups in small quantities except milk and milk products -Milk and milk products, and non-milk beverages were consumed the most ~ 500 and 400 mL/ day, respectively -F&V serve was low: 1/2 and 2/3 of a serve, respectively	No quantity of BM just occasion Disc & non-disc foods grouped together; portions are not reported in standard AGHE servings Sample has family history of allergy and may not consume allergenic foods Data ~25 years old
Nutrient intakes							
Lioret, S [57] InFANT Study	Melbourne 2008-2010	Cluster randomised controlled trial	N=177 infants from the control arm	9m and 18m	Socio-demographic questionnaire & anthropometry 3 X 24 HDR at 9m and 18m	Most nutrients above the AI or EAR at 9m and 18m *Problem nutrients:* -9% <EAR for Zn at 9m-36% and 11% <EAR for Fe at 9m and 18m, respectively -10-14% <EAR for iodine, Vit A and Vit C ->50% had high Na intakes at 9m and 18m (>400mg/day and 1000mg/day, respectively)	Single city study, small sample size, and data is > 10 years old Didn't adjust for DTDV; used cut point method for Fe ~50% dropout in control arm, most of which were mothers with low education

First author & study name	Location and duration of study	Study design	Sample size	Age (months)	Data collected	Main results/conclusions [1]	Gaps/Limitations
Atkins L.A. [62] InFANT	Melbourne 2008-2010	Cluster randomised controlled trial	N=485	9m and 18m	Socio-demographic questionnaire and child anthropometry 3 X 24 HDR at 9 and 18 months of age	-Usual intakes reported with adjustment for DTDV -Full probability approach used to estimate % at risk of inadequate iron intake *Mean Fe intakes* -9·1± 4.3 mg/d for infants and 6·6 ± 2·4 mg/d for toddlers. *% at risk of inadequate Fe intakes* -33% and 19 at 9m and 18m, respectively *Factors associated with low Fe* -Female sex and currently BF children at higher risk of inadequacy *Sources of Fe* -BMS and iron-fortified cereals were top iron sources in infants and toddlers, respectively.	Single city study and data is > 10 years old Combined control and intervention arms' data High SES sample of first-time parents only, results may not be generalizable to households with multiple children

First author & study name	Location and duration of study	Study design	Sample size	Age (months)	Data collected	Main results/conclusions [1]	Gaps/Limitations
Scott, J [64] SMILE	Adelaide 2013-2014	Cross-sectional analysis of dietary data collected from a population-based birth cohort study	N = 832 mother child dyad	~12m	1 X 24 HDR 2-day food record	Most nutrients above AI or EAR *Limiting nutrients* -% <EAR: ~14% Vit C and Thiamin, 12% Ca, 23% Fe -% >UL: 8% Na and 14% Zn *Milk feeding type* BM only: 28%; BM+BMS: 8%; BMS only:39%; Neither BM/ BMS: 25% *Energy & nutrient intake by feeding type* -highest energy, protein, Na, Ca intakes + lowest vit C intakes in neither group -No sig diff in mean energy and protein intakes in BM only and BMS only group -Higher Ca, Zn, and Fe in F only group compared to others -BMS contributed 31% and 50% of total Fe in BM+BMS and BMS only groups, respectively -BM only group more likely to be < EAR for Ca, Fe, Thiamin; 49% were < EAR for Fe -BM or BMS made up one third of energy	Intake data is not usual intake as authors did not adjust for DTDV in intake. EAR cut-point method rather than the full probability approach was used to estimate inadequate iron intake Analysis only includes <50% of sample; however low SES oversampled to ensure representativeness Single city study Data nearly 10 years old

First author & study name	Location and duration of study	Study design	Sample size	Age (months)	Data collected	Main results/conclusions [1]	Gaps/Limitations
Zhou, J [65]	Adelaide, SA 2005-2007	Cross sectional survey using stratified random sampling	N=300 children 1-5 years	12-60m	Anthropometry 3-day weighed food record 2–5mL non-fasting blood sample by venepuncture	*Breastfeeding indicators* -20% BF >12 months -Median duration BF ~7.8 months 70% of toddlers were overweight or obese *Limiting nutrients* -% < EAR: 16% Fe, 18% vit C, <5% Zn and Ca *Biochemical deficiency* -10% ID and 3% IDA -32% low serum Zn	Small sample of toddlers 1-2 years old (*n = 92*) Intake data is not usual intake as authors did not adjust for DTDV in intake. EAR cut-point method rather than the full probability approach was used to estimate inadequate iron intake

First author & study name	Location and duration of study	Study design	Sample size	Age (months)	Data collected	Main results/conclusions [1]	Gaps/Limitations
Webb, K [60] CAPS	Western Sydney 1997-2000	Cross-sectional dietary intake data from a randomised controlled trial	N=616 pregnant women with family history of asthma	16-24m	3-day weighed food record	*n = 429* *Limiting nutrients* -% < EAR: 23% Fe, 14% vit C, 8% Ca, and 7% vit A -% > UL: 62% Na - ~10% > EER *Source of nutrients* -Cereals (15%) and dairy (35%) provided most energy -Cereals provided a third of Fe -Saturated fat and sugars contributed 51 % and 55% of the energy from fat and carbohydrate, respectively	-Unclear if nutrient contribution from BM is factored into total nutrient intake -Intake data is not usual intake as authors did not adjust for DTDV in intake. -EAR cut-point method rather than the full probability approach was used to estimate inadequate iron intake -Sample has family history of allergy and may not consume allergenic foods; thus data is not generalisable to the general population -Data is >20 years old

First author & study name	Location and duration of study	Study design	Sample size	Age (months)	Data collected	Main results/conclusions [1]	Gaps/Limitations
Conn et al (2008) [63]	Adelaide, SA 1998-2000	Cross sectional survey of a longitudinal birth cohort study	N=557 pregnant women enrolled	9m	Feeding questionnaire Structured open-ended interview with an FFQ format; recall period one month	*Breastfeeding indicators* 35% BF at 9m *Nutrient intake* -mean Fe intake 6.3mg and 11.3 mg/day in BF and non-BF infants, respectively -40% of daily energy from BM in BF infants *Limiting nutrients* -% <EAR: 9% Fe and <1% Zn in non-BF infants	- BM estimate may be inaccurate as standard volume was applied to range of feeds -Results are based on n=341 (68%) due to overreporting -Intake data is not usual intake as authors did not adjust for DTDV in intake. Commercial foods excluded from food groups and may underestimate % consuming five food groups

[1]**Abbreviations**: 24 HDR, 24-hour dietary recall; AGHE, Australian Guide to Healthy Eating; AI, adequate intake; approx., approximately; BF, breastfeeding or breastfed; BM, breastmilk; BMS, breastmilk substitute; Ca, calcium; CM, cow's milk; disc foods, discretionary foods; DTDV, day to day variation; EAR, estimated average requirement; FFQ, food frequency questionnaire; F, fruit; Fe, iron; ID, iron deficiency; IDA, iron deficiency anaemia MMA, meat and meat alternatives; Na, sodium; sig diff; significant difference; UL, upper limit; V, vegetable; Vit A, vitamin A; Vit C, vitamin C; Zn, zinc.
Symbols: ↑, increasing or increased; ↓decreasing or decreased

2.6 Thesis aims and objectives

Given the importance of nutrition in the early years, the aims of this thesis are to describe contemporary caregiver feeding practices and dietary intakes in Australian children under two years. The primary objectives of this thesis are:

- To examine the types of commercial infant and toddler foods currently available in Australia and compare their nutrient and textural properties with the NHMRC Infant Feeding Guidelines.
- To provide contemporary breastfeeding data including rates of initiation, duration of exclusive breastfeeding, and use of breastmilk substitutes.
- To compare the timing of introduction to solid foods and food allergens to the NHMRC Infant Feeding Guidelines and current food allergy advice.
- To compare the daily servings of the five food groups and 'discretionary' foods to the recommended dietary patterns in the Australian Dietary Guidelines, and
- To estimate the distribution of usual energy and nutrient intake relative to the Nutrient Reference Values for Australia and New Zealand.

CHAPTER 3. ARE THE NUTRIENT AND TEXTURAL PROPERTIES OF AUSTRALIAN COMMERCIAL INFANT AND TODDLER FOODS CONSISTENT WITH INFANT FEEDING ADVICE?

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The manuscript entitled “Are the nutrient and textural properties of Australian commercial infant and toddler foods consistent with infant feeding advice?” was published in the peer reviewed journal *British Journal of Nutrition*. 2020;124.

Supplementary table 1 is listed in Appendix 3. Median (range) serve size and nutrient content per serve of infant and toddler food products—Chapter 3.

Statement of Authorship

Title of Paper	Are the nutrient and textural properties of Australian commercial infant and toddler foods consistent with infant feeding advice?
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Name of Principal Author (Candidate)	Najma Moumin		
Contribution to the Paper	Contributed to the research design and research protocol development. Conducted the research, performed statistical analysis, and contributed to interpretation of findings. Wrote the first draft and had primary responsibility for the final version of the manuscript.		
Overall percentage (%)	75		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	11/08/2022

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);

ii. permission is granted for the candidate in include the publication in the thesis; and

iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

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Contribution to the Paper	Contributed to the revision of the manuscript and supervision of the overall study.		
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Contribution to the Paper	Contributed to the revision of the manuscript, interpretation of findings, and editing of the final version.		
Signature		Date	11/08/2022

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Contribution to the Paper	Conceived of the research and contributed to protocol development, data collection, supervision of study, interpretation of findings, and revision of manuscript. Acted as corresponding author and was responsible for the final version of the manuscript.		
Signature		Date	11/08/2022

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Are the nutrient and textural properties of Australian commercial infant and toddler foods consistent with infant feeding advice?

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Abstract

Infant feeding guidelines worldwide recommend first foods to be Fe rich with no added sugars and that nutrient-poor discretionary foods are to be avoided. Feeding guidelines also recommend exposing infants to a variety of foods and flavours with increasingly complex textures. Here, we compare nutritional and textural properties of commercial infant and toddler foods available in Australia with established infant feeding guidelines. Nutrition information and ingredient lists were obtained from food labels, manufacturer and/or retailer websites. In total, 414 foods were identified, comprising mostly mixed main dishes, fruit and vegetable first foods and snacks. Most products were poor sources of Fe, and 80 % of first foods were fruit-based. Half of all products were purées in squeeze pouches, and one-third of all products were discretionary foods. The nutritional content of many products was inconsistent with guidelines, being low in Fe, sweet, smooth in consistency or classified as discretionary. Reformulation of products is warranted to improve Fe content, particularly in mixed main dishes, expand the range of vegetable-only foods and textural variety. Greater regulatory oversight may be needed to better inform parents and caregivers. Frequent consumption of commercial baby foods low in Fe may increase the risk of Fe deficiency. Excessive consumption of purées via squeeze pouches may also have implications for overweight and obesity risk.

Key words: **Commercial complementary foods: Infant foods: Toddler foods: Nutrient and textural properties**

The first 24 months of life is a period marked by rapid growth and neurodevelopment which requires a high intake of energy and nutrients[1–4]. Indeed, requirements during this period on a per kg body weight basis exceed any other life stage. Poor food choices have adverse effects on health and development which persist into later life[4,5]. Infant feeding guidelines from the UK, the European Union, USA, Canada and Australia recommend exclusive breastfeeding for the first 6 months and introduction of Fe-rich foods as first foods along with a variety of other foods introduced in any order at around 6 months (Fig. 1)[6–13]. Furthermore, recommendations state that from 6 to 12 months, parents should offer foods with increasingly complex textures with the aim of transitioning to nutritious family foods around the end of the first year of life[6,7]. Discretionary foods high in saturated fat, added sugars and/or added salt are not recommended for young children[6]. The few available studies assessing the nutritional quality of these products indicate that ready-to-feed puréed baby foods are high in total sugars increasing the risk for overweight and obesity[14]. Others have also reported that a substantial proportion of these products contain free sugars[15,16]. The WHO recommends that free sugars should not exceed 5–10 % of total energy intake, while the National Health and Medical Research Council (NHMRC) recommends no sugars to be added to foods for infants <1 years[6,17].

The range of foods available on the infant and toddler food market has expanded in recent years. Between 2013 and 2018, the retail value of the Australian baby food industry doubled from $573·8 million to $1·2 billion, and similar increases have been reported internationally[16,18]. In the past, weaning foods of varying textures were primarily sold in jars and designed to transition the child to family foods. However, since the last iteration of the Australian NHMRC feeding guidelines in 2013, many puréed baby foods sold in pouches have entered the marketplace. The nozzle featured on these pouches allows food to be squeezed directly into children's mouths which may lead to poorer acceptance of foods with lumpy textures and delay acquisition of independent feeding skills if frequently used as a mode of feeding[14–16]. In addition to baby food purées, there

Abbreviation: NHMRC, National Health and Medical Research Council.

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Fig. 1. Themes in international feeding guidelines. Adapted from Netting & Makrides[13].

has been a marked increase in the number of discretionary (snack foods) marketed towards toddlers 12 months and up.

In Australia, the most recent data on the nutritional content of commercial infant and toddler foods are from 2013[19]. Given the rapid growth in this market sector in the past 5 years, including the expansion of foods aimed specifically for toddlers, an updated analysis is needed. Here we examine the types of commercial infant and toddler foods and compare their properties with current Australian and International Infant Feeding Guidelines.

Methods

Infant and toddler food products available as of August 2019 were identified by searching for 'baby food' on retailer websites and by location in the 'baby food' section of major supermarket chains (Coles, Woolworths, Aldi and Foodland) in Adelaide, South Australia, which is representative of foods available nationally. Supermarkets in Australia do not distinguish between infant and toddler foods, referring to them all as baby foods. Manufacturer websites were cross checked to identify all products available. The nutrient composition of the foods was obtained from the nutrient information panel on the product label, manufacturer or retailer websites. In total, 446 products from seventeen brands were reviewed, which accounted for over 90 % of the market share[18]. Infant and toddler formula were not included as these are covered by a different set of standards[20].

Products were categorised according to the classification system of Tedstone *et al.*[16]. Briefly, foods were grouped into three main product types, meals, finger foods and drinks. Within meals, products were further classified into categories: mixed main dishes, fruit and vegetable first foods (single fruit, mixed fruit, single vegetable, mixed vegetable and mixed fruit and vegetable), dry cereals/foods (savoury or sweet), readymade desserts and breakfasts and other (plain cereals and grains). Finger foods were sub-categorised into savoury finger foods, fruit- and vegetable-based finger foods and sweet finger foods. Finger foods were defined as savoury if the name suggested a plain or savoury flavour profile and were primarily starchy or legume-based. Products were classified as sweet finger foods if the name indicated a sweet flavour profile or were fruit flavoured. Finally, foods had to contain more than 25 % fruit and vegetables to be classified as fruit- and vegetable-based finger foods. The target age for consumption (as identified on the packet), textural properties and product packing were described.

To enable comparison with similar reports, energy and nutrient content were expressed per 100 g of product and per recommended serve. Since very few products declared the quantity of free sugars, ingredient lists were used to determine the presence of free sugars as defined by Food Standards Australia New Zealand which includes 'all sugars defined as added sugars plus the sugar component of honey, fruit juice and fruit juice concentrates'[21]. Fruit pastes were coded as free sugars. Products were classified as containing or not containing free sugars. All products are reported as sold, except for dry cereals where the reported quantity is per 100 g as prepared according to manufacturer directions. All statistical analyses were completed using SPSS version 25.0[22].

Results

Of the 446 products identified, 414 had nutrition information and ingredient lists. Thirty-two products were excluded due to incomplete product information on manufacturer or retailer websites or because products were not stocked on shelves during supermarket visits. The most common product types identified were meals which accounted for two-thirds of the foods included in this analysis (Table 1). Within this category, mixed main dishes comprised 30 % of products, followed by ready-made desserts and breakfasts (29 %) and puréed fruit and vegetable first foods (25 %). Approximately, 80 % of fruit and vegetable first foods were fruit-based and less than 10 % were vegetable-based. Finger foods accounted for one-third of all products, and over half of the finger foods were sweet. Fruit- and vegetable-based finger foods accounted for less than 10 % of products. Approximately, 30 % of all products (125 of 414) were targeted at older infants 6 months of age (Table 2). Products intended for toddlers 12 months and older comprised one quarter of the market with nearly two-thirds of all the snack foods identified aimed at toddlers.

Fe content was reported for fifty products, mostly cereals and fortified snacks (Table 3). Based on ingredient lists, most foods were poor sources of Fe except Fe fortified cereals (data not shown). Among meals, fruit and vegetable first foods were highest in total sugar at 10·9 (range 2·3–15·5) g/100 g followed by

Table 1. Number and proportion of infant and toddler food products on the market by category and sub-category (Numbers and percentages)

Product category/sub-category	Number of products (*n* 414)	Proportion of products within category (%)	Proportion of all products (%)
Meals	282	100	68·1
Mixed main dishes	84	30	20·3
Fruit and vegetable first foods	73	26	17·6
Single vegetables	0	0	0
Single fruit	7	10	1·7
Mixed fruit	49	67·1	11·8
Mixed vegetables	7	9·6	1·7
Mixed fruits and vegetables	10	13·7	2·4
Dry cereals/foods	23	8·2	5·6
Desserts and breakfasts	83	29·4	20·0
Other	19	6·7	4·3
Finger foods	130	100	31·4
Savoury finger foods	45	34·6	10·8
Fruit- and vegetable-based finger foods	9	6·9	2·2
Sweet finger foods	76	58·5	18·4
Drinks	2	100	0·5
Drinks	2	100	0·5

Table 2. Target age of infant and toddler food products by product category (Numbers and percentages)

	All products		Meals		Finger foods		Drinks	
Age range product is marketed at	*n*	%	*n*	%	*n*	%	*n*	%
4 Months+	69	17	69	25	0	0	0	0
5 Months+	2	1	2	1	0	0	0	0
6 Months+	125	30	119	42	6	5	0	0
7 Months+	30	7	6	2	24	19	0	0
8 Months+	44	11	40	14	4	3	0	0
10 Months+	34	8	17	6	17	13	0	0
12 Months+	107	26	39	10	75	59	2	100
18 Months+	3	1	0	0	3	2	0	0
Total	414	100	282	100	130	100	2	100

desserts and breakfasts at 8·2 (range 4·3–17·5) g/100 g, respectively. The quantity of free sugars was not available, but based on ingredient lists, 40 % of products contained free sugars. Savoury finger foods contained more Na than other product categories with a median of 70 (range 0–1160) mg/100 g. The most energy-dense foods were savoury and sweet finger foods containing on average 1810 (range 1437–2222) and 1711 (range 1580–2380) kJ/100 g, respectively. Serve sizes were most varied within desserts and breakfasts relative to packaging with several products containing >1 serve. Nutrient content per serve is available in online supplementary materials (online Supplementary Table S1).

Almost 50 % of all products were smooth purées (Table 4) including nearly all fruit and vegetable first foods and readymade desserts and breakfasts. Among snack foods, 40 % of savoury finger foods and 15 % of sweet finger foods were extruded puffs. The most common packaging type identified was the 'squeeze pouch' (Table 5). More than 70 % of products marketed to infants four to 6 months, and nearly 40 % of products marketed for older infants 8 months and up were presented in these pouches.

Discussion

The primary aims of the present study were to provide contemporary data on the types of commercial infant and toddler foods currently available in Australia in comparison with infant feeding advice. This is only the second study to examine commercial foods aimed at children under 2 years of age in Australia, and the first to assess product packaging and food texture. In 2013, Dunford *et al.*[19] completed an audit of baby foods stocked in Sydney supermarkets and concluded that most products were nutritionally adequate. However, since Dunford *et al.*[19] published their findings, the number of available products has increased by 30 %, from 341 to 446, highlighting a need for updated information.

At minimum, Food Standards Australia New Zealand requires all products to declare information on servings, energy and key nutrients or active substances on the nutrition information panel[23]. However, only 12 % of products, mostly fortified cereals and snack foods, declared Fe content. Only one product marketed as a mixed main dish included Fe. For infants 7–12 months, the recommended daily intake for Fe is 11 mg/d[24]. To meet this high

Table 3. Serve size and nutrient content per 100 g of infant and toddler food products (Median values and ranges)

		Serve size (g)		Energy (kJ) per 100 g		Protein (g) per 100 g		Total fat (g) per 100 g		Carbohydrate (g) per 100 g		Total sugars (g) per 100 g		Na (mg) per 100 g		Fe (mg) per 100 g*	
Product category	*n*	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range
Mixed main dishes	84	170	85–220	271	166–527	3·1	0·9–6·5	1·7	0·2–7·4	8·8	4·9–17·7	2·6	0·7–7·7	19·5	5–118	0·8	0·5–1
Fruit and vegetable first foods	73	120	55–120	249	128–339	0·6	0·1–2·8	0·2	0·1–2·5	12·4	3–18·1	10·9	2·3–15·5	3	0–24	–	
Dry cereals/foods†	23	96	50–180	308	188–1650	2·4	0·7–11·9	1·1	0·2–6·3	14·4	7·7–85·2	4·3	0·02–12	5·3	1–50	3·4	2·5–5·7
Desserts and breakfasts	83	120	55–150	311	192–465	1·5	0·6–7·7	1·2	0·1–4·5	13·5	4·8–20·9	8·2	4·3–17·5	14	1–61	–	
Other	19	90	25–111	269	170–1630	1·4	0·7–15	0·8	0·1–2·6	12·8	7·6–84·2	1·0	0–3·5	2·2	0–25	3·2	1·4–21
Savoury finger foods‡	45	12	3–25	1810	1437–2222	8·0	1–20	13·6	0·2–29·3	69·3	10–93·9	3·8	0–35	70	0–1160	20	20–20·5
Fruit- and vegetable-based finger foods	9	15	12–17	1410	1281–1520	2·3	0·8–7·7	0·5	0·5–6·3	72	61·3–81·2	59	35–67·5	20	6·7–85	–	
Sweet finger foods§	76	10	4–30	1711	1580–2380	7·1	3·1–17·3	11·3	0·3–34·4	70·5	0·8–92·8	18·8	2·6–62·9	29	0–330	20	20–35
Drinks	2	200	200–200	127	119–134	0·1	0·1–0·1	0·1	0·1–0·1	7·4	7·1–7·7	6·7	6·5–6·9	3·7	1–6·3	–	

* Fe was reported for *n* 50 products.
† Quantity per serve and nutrient content for dry cereals were reported as prepared products made up with water, milk or expressed breast milk.
‡ Serve size for *n* 6 savoury finger foods was missing.
§ Serve size for *n* 2 sweet finger foods was missing.

Table 4. Texture profiles of products within each category (Numbers and percentages)

		Product texture															
		Smooth		Lumpy		Mashed		Extruded		Crunchy		Chewy		Chunky		Liquid	
Product category	*n*	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Mixed main dishes	84	27	32	20	24	18	21	0	0	0	0	0	0	19	23	0	0
Fruit and vegetable first foods	73	72	99	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Dry cereals/foods	23	15	65	6	26	0	0	0	0	0	0	0	0	2	8·7	0	0
Desserts and breakfasts	83	73	88	2	2	8	10	0	0	0	0	0	0	0	0	0	0
Other	19	13	68	0	0	0	0	0	0	0	0	6	32	0	0	0	0
Savoury finger foods	45	0	0	0	0	0	0	18	40	26	58	1	2	0	0	0	0
Fruit- and vegetable-based finger foods	9	0	0	0	0	0	0	0	0	0	0	9	100	0	0	0	0
Sweet finger foods	76	0	0	0	0	0	0	12	16	42	55	22	29	0	0	0	0
Drinks	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	100
Total	414	200	48	28	7	27	7	30	7	68	16	38	9	21	5	2	1

Table 5. Target age of food products and packaging type (Numbers and percentages)

	Squeeze pouch		Resealable pouch (non-squeeze)		Jar		Plastic bag/ wrapping		Box	
Target age (months)	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
4 months+	55	80	6	9	6	9	0	0	2	3
5 months+	0	0	2	100	0	0	0	0	0	0
6 months+	88	70	9	7	13	10	1	1	14	11
7 months+	0	0	0	0	2	7	24	80	4	13
8 months+	18	41	10	23	7	16	3	7	6	14
10 months+	0	0	14	41	0	0	8	24	12	35
12 months+	9	8	5	5	0	0	38	36	52	49
18 months+	0	0	0	0	0	0	0	0	3	100
Total	170	41	46	11	28	7	74	18	93	23

nutrient demand, the NHMRC recommends offering 30 g of meat or meat alternatives each day[6,7]; however, the actual meat content in meat-based mixed main dishes amounted to 9·0 (SD 2·7) % of the total ingredients (data not shown) conservatively equating to approximately 0·26 mg or, 2 % of the recommended daily intake[25]. Despite this, all of these products indicated the type of meat, poultry or fish used prominently within the product name suggesting to consumers it was a good source of protein and, by extension, Fe. Given this nutrient's significance for the developing infant brain, this misleading package labelling is concerning[19,26]. Greater government regulatory oversight may be needed to better inform parents and caregivers.

We found a high proportion of fruit-based products sold as first foods (80 %), and a high proportion of products with free sugars (40 %), mostly snack foods and readymade desserts and breakfasts. Since infants have an affinity towards sweet tastes, foods with intrinsically bitter taste profiles such as vegetables are not as readily accepted[27]. Three recently published systematic reviews on strategies to improve vegetable acceptance in infants and toddlers all concluded that repeated taste exposure to a variety of vegetables is the most effective approach to increase children's vegetable intake[27–29]. Pairing of vegetables with familiar sweet flavours does not appear to improve vegetable acceptance[30]. The few available vegetable-only first foods in this audit were sweet varieties, typically carrot or sweet potato, and the mixed fruit and vegetable first foods contained 50–70 % puréed apple. The ubiquity of fruit-based products and limited variety of vegetable-based first foods are concerning as this may limit exposure to and reduce acceptance of vegetables and foods with plain or bitter tastes in infants mostly consuming commercial baby foods. However, further research is needed to better describe the degree to which consumption of these foods impacts dietary diversity later in life[31].

According to the Australian NHMRC Infant Feeding Guidelines, by 12 months, special baby foods are no longer necessary, and toddlers should eat family foods consistent with the Australian dietary guidelines. Before 12 months, children should be exposed to a variety of family foods[6,7]. In our audit, nearly one half of all products aimed at older infants 8 months and up were packaged in squeeze pouches, most of which were smooth puréed foods. This is inconsistent with guidelines that infants should be exposed to a variety of foods of increasingly challenging textures moving from smooth purées, to mashed and soft lumpy foods and finally to solid foods[6]. Recent surveys echoed similar findings[14–16]. The concern is that squeeze packs may lead to poor feeding skills acquisition and oro-motor development, delaying self-feeding skills[6]. Feeding directly from a squeeze pouch discourages active exploration and handling of food that facilitates independent feeding skills such as picking up food, finger and spoon feeding and drinking from a cup[14,15,32].

The NHMRC recommends that discretionary foods such as cakes, biscuits or potato chips should be limited or avoided in young children's diets as they are high in saturated fat, added sugars and/or added salt[6]. We identified a high number of discretionary snack foods aimed specifically at toddlers. Although the serve sizes were smaller, these products were the most energy dense and contained the highest amounts of total sugars and Na compared with other categories. Sweet and savoury snack food intake is established early in life and may set up dietary habits contributing to excess discretionary food consumption. Data from the 2011–2012 Australian National Nutrition and Physical Activity Survey revealed that Australian children and adolescents consume more discretionary foods than recommended[33]. Among children 2–3 years old, discretionary foods accounted for 29 % of total energy intake, and sweet biscuits, butter and dairy fats, and processed meat dishes were the most commonly consumed products[33].

Moreover, 40 % of the savoury finger foods identified were highly processed extruded puffs, mostly made of rice and corn flour, low in dietary fibre. These products, primarily packaged in smaller quantities, are also designed to melt upon ingestion limiting the oro-sensory exposure time for the eating occasion[34]. Smooth purées in squeeze packs also have reduced oral processing facilitated by their trademark packaging; however, the uniform packaging size can be misleading as several products contain two serves within a single package. Indeed nearly 20 % of readymade desserts and breakfasts contained two serves (data not shown). Taken together, the packaging and serve size of extruded snack foods and puréed squeeze pack foods may promote snacking behaviour and excess energy intakes, respectively. The textural properties of these products may also be disruptive to normal physiological responses to food intake and satiation[14–16,35].

The present study has several strengths, specifically, the thorough identification of foods for sale specifically targeted at children <24 months. Researchers surveyed retailer and manufacturer websites of seventeen popular brands and visited major supermarket chains in metropolitan Adelaide to compile nutrition information. Furthermore, the present study provides nutrition information on products currently on the market as well as new information on the packaging type and texture profiles of Australian commercial baby foods. A potential limitation is that the information presented on product packages and/or manufacturer websites may not necessarily reflect true nutrient content; however, brands included in our analysis covered 90 % of the market share, and therefore, we can be confident in our results. Another limitation is the nutrient analysis of dry cereals. Nutrition information was presented as prepared products, made up with water, milk or expressed breast milk. Thus, it was not possible to evaluate true nutrient content of products as sold.

Conclusion

The nutritional and textural properties of a high proportion of commercial infant and toddler products were poorly aligned with feeding guidelines, being low in Fe, sweet tasting, smooth in consistency and classified as discretionary foods. Only 12 % of products included information on Fe. Most products, especially mixed main dishes, were poor sources of Fe. Vegetable first foods were most commonly sold in combination with sweet fruits and, when presented alone, were sweet varieties. Most puréed products were packaged in non-traditional squeeze pouches that may not encourage spoon feeding. A high proportion of savoury snack foods were extruded puffs with low nutritional value, and 40 % of all products contained free sugars. More stringent monitoring to ensure compliance with Food Standards Australia New Zealand food labelling requirements is needed, particularly with Fe content.

There is scope for manufacturers of commercial baby foods to improve their products to support implementation of infant feeding guidelines, specifically, reformulation to offer vegetable-only first food varieties, mixed main dishes with increased meat content and reduced proportions of sweet fruits in mixed vegetable and fruit products. Moreover, we encourage companies to include the required nutritional information on all products.

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M. J. N. designed the research. M. J. N. and N. A. M. developed the research protocol and conducted the research. N. A. M. performed the statistical analysis. M. J. N., N. A. M., T. J. G. and R. K. G. drafted, reviewed and edited the manuscript. M. J. N. had primary responsibility for the final content. All authors read and approved the final version of the manuscript.

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Supplementary material

For supplementary material referred to in this article, please visit https://doi.org/10.1017/S0007114520001695

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CHAPTER 4. THE AUSTRALIAN FEEDING INFANTS AND TODDLERS STUDY (OZFITS) 2021: STUDY DESIGN, METHODS AND SAMPLE DESCRIPTION.

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The manuscript entitled “The Australian Feeding Infants and Toddlers Study (OzFITS) 2021: Study Design, Methods and Sample Description” was published in the peer reviewed journal *Nutrients*. 2021;13.

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Article

The Australian Feeding Infants and Toddlers Study (OzFITS) 2021: Study Design, Methods and Sample Description

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Abstract: (1) Background: Caregiver feeding practices during the first two years of a child's life influence nutrition, growth, and development, as well as long term taste preferences and dietary patterns. Suboptimal feeding practices lead to poorer health outcomes, such as obesity, that persist into adulthood. Although the importance of early life nutrition is well-established, there are no Australia-wide surveys of dietary intakes of children under two years of age. The 2021 Australian Feeding Infants and Toddlers Study (OzFITS) aims to fill this gap. This paper describes the methods and study sample of OzFITS 2021. (2) Methods: OzFITS 2021 is a cross-sectional study of children aged 0 to 23.9 months of age and their caregiver across Australia. Data were collected between April 2020 and April 2021. A telephone-based survey was completed with a caregiver to obtain information on child and caregiver characteristics and feeding practices. For exclusively breastfed infants, the number of breastfeeds in a 24 h period was reported. Dietary intakes for mixed fed children were estimated using a one-day food record, with 30% of caregivers completing a second food record on a non-consecutive day. (3) Results: We enrolled 1140 caregiver and child dyads. Of those eligible to complete a food record, 853 (87%) completed the food record. Compared to the Australian population, caregivers were more likely to be university-educated (>75%), married or in a de facto relationship (94%), and have a household income >$100,000/y (60%). (4) Conclusions: OzFITS 2021 is the first national study to examine food and nutrient intake in Australian children aged under 2 years. The study will provide information on breastfeeding rates and duration, use of breast milk substitutes, and timing of solid food introduction. Dietary intake data will allow the comparison of core food groups and discretionary food intake to Australian guidelines and estimate the prevalence of inadequate intake of key nutrients, like iron. Healthcare practitioners and policymakers can use the study findings as a source of evidence to inform the next iteration of infant feeding guidelines.

Keywords: Australian feeding infants and toddlers study; complementary feeding; nutrient intakes; feeding practices

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1. Introduction

During the first two years of life, caregiver feeding practices influence a child's growth and development along with their long-term taste preferences, dietary patterns, and appetite regulation [1–4]. Suboptimal feeding practices and nutrition in early childhood contribute to malnutrition and poor child health outcomes that may persist into adulthood [5,6]. During this period, nutrient or energy deficiencies may lead to increased disease

risk, stunting, and impaired cognitive development [5,7]. Conversely, excess weight gain during the first two years is associated with overweight and obesity and chronic disease later in life [8].

Health authorities in many countries give guidance on infant and toddler feeding and nutrition [9–14]. Most emphasize exclusive breastfeeding for the first six months of life, followed by the introduction of complementary foods at around six months, emphasizing iron-rich foods and continued breastfeeding to two years and beyond [2,9–15]. Further, caregivers are advised to offer infants a range of nutritious foods with increasing complexity of textures so that children can eat mainly family foods by one year of age [11,12]. More recently, deliberate introduction to and regular intake of common food allergens, specifically egg and peanut has been encouraged prior to one year of age as a primary allergy prevention strategy [16]. Despite the recognized importance of early childhood feeding and nutrition, limited data exist on caregiver feeding practices and dietary intakes of Australian children under two years of age.

Over the last 30 years, three national nutrition surveys have been conducted in Australia, but none have included children less than 24 months of age [17–19]. Although the 2010 Australian National Infant Feeding Survey captured breastfeeding rates and early caregiver feeding practices, including the age of introduction of solid foods, it did not capture the types of foods and drinks consumed by young Australians [20]. The few studies that have reported dietary intake in this age group suggest that infant feeding practices do not meet current guidelines; however, these studies were only in select cities and are over a decade old [21–24].

Given the importance of early life feeding practices on short- and long-term health outcomes, it is surprising that there is no national data on the contemporary feeding practices of young children. To address this gap, in this study, we aim to: (1) describe breastfeeding initiation rates, duration, and use of breast milk substitutes; (2) determine the timing of introduction of solid foods including common food allergens; (3) estimate usual energy and nutrient intake distribution and prevalence of inadequate nutrient intakes; and (4) compare dietary intake of core food groups and discretionary foods to Australian Guidelines for Healthy Eating [12]. Here, we report the methods used for the 2021 Australian Feeding Infants and Toddlers Study (OzFITS) in the papers that follow. Specifically, we describe the study design, recruitment method, instrument development and testing, sampling frame, data collection, and key characteristics of the participants.

2. Materials and Methods

2.1. Study Design

The 2021 OzFITS study was a cross-sectional survey of a convenience sample of Australian infants and toddlers 0–24 months of age. The study was conducted between April 2020 and April 2021 and consisted of a telephone-based socio-demographic and child-feeding questionnaire and a food record completed by the child's caregiver. The Women and Children's Health Network Human Research Ethics Committee (HREC/19/WCHN/44) approved the study, and all caregivers gave informed verbal consent.

2.2. Pilot Testing

Prior to commencing the study, data collection instruments were developed, tested, and revised. The socio-demographic and child-feeding questionnaire, portion estimation guide, and food record (Section 2.4.3.1) were pilot tested in a group (n = 48) of caregivers with children aged under 2 years in Adelaide. Participant feedback was used to revise the survey questions for clarity, add additional questions, develop processes to improve the food record's user experience and streamline participant flow. A data quality audit was performed of all food records and assessed each child's energy intake against their Estimated Energy Requirements (EER) [25].

The feasibility of a random selection recruitment method was also piloted. Postcodes were stratified according to the socioeconomic index for areas index and ranked into tertiles

of relative advantage and disadvantage [26]. Postcodes were then randomly selected based on probability proportional to population size. Flyers were sent to all households within randomly selected postcodes in South Australia, inviting them to participate in the study if they had a child aged less than two years. Of 17,200 brochures sent out, only 16 participants responded. Because of the desired sample size and study timeline, this recruitment method was deemed infeasible. Therefore, the recruitment method described in Section 2.3 was adopted.

2.3. Sampling Frame

Caregivers were recruited through targeted online advertising using a trial recruitment company, Trialfacts [27]. Caregivers were pre-screened for eligibility. To be included they needed to (1) have a child between 0–24 months; (2) be knowledgeable about the child's diet and able to answer questions about the child from birth; (3) have basic English fluency and able to provide informed consent. Infants or toddlers with significant health issues that affected feeding were excluded.

The sampling frame included all Australian states and territories, with the target sample within each state and territory proportional to its population size. A major aim of our study was to estimate the prevalence of inadequacy of select nutrients, with emphasis on iron, an essential limiting nutrient in this age group. Due to a lack of representative Australian data, the expected proportion of the population with inadequate intakes were based on FITS 2016 data [28]. Assuming an overall population size of 150,000 infants 6–12 months and 300,000 toddlers 12–24 months [29], we estimated a minimum sample size of 227 and 100 caregiver-child pairs, respectively, to determine the true prevalence of inadequacy for iron to within ±5% and 95% confidence. For all other nutrients, the required sample size ranged from 1 for vitamin C to 126 for calcium. Due to uncertainty around prevalence estimates and to maintain the Type 1 error rate at 5% with multiple estimates, we enrolled 250 children per six-month age band: 0–5.9 months; 6–11.9 months; 12–17.9 months; and 18–23.9 months.

2.4. Data Collection

2.4.1. Socio-Demographic and Child-Feeding Questionnaire

The socio-demographic and child-feeding questionnaire questions were adapted from the 2016 United States Feeding Infants and Toddlers Study (FITS) and the 2010 Australian National Infant Feeding Survey [20,30]. As 1 in 10 Australian infants aged 12 months has a confirmed food allergy [31], a module on the timing of allergen introduction and prevalence of food allergy was included. Eligible caregivers were asked to schedule a time to be contacted by study staff. Up to five phone call attempts were made to contact caregivers of eligible children.

Verbal informed consent was obtained from the caregiver before commencing the phone survey. The survey consisted of six modules: (1) caregiver socio-demographics; (2) childbirth details and anthropometric measures; (3) breastfeeding history and use of breastmilk substitutes; (4) timing of introduction of complementary foods and common allergens; (5) use of commercial baby foods and mode of feeding; and (6) dietary supplement use. Once the survey was complete, the caregiver received a $20 supermarket gift card. Following the survey, eligible caregivers were asked to complete a food record and participate in a follow up phone interview to collect data of child food intake. Caregivers of children who were exclusively breastfed did not complete this module. Instead, a detailed breastfeeding history including the average number of breastfeeds in a 24-h period were collected. All survey data were collected and managed using REDCap™ (Research Electronic Data Capture), a secure, web-based software platform that supports data capture, audit, and export for research studies [32,33]. Study staff received a two-day training seminar on the survey instrument and the REDCap™ data entry system.

2.4.2. Child Anthropometry

Child length (cm) and weight (kg) measurements taken by a health professional in the previous 30 days were used. If these were not available, caregivers were asked to measure their child's length and weight at home. Instructions adapted from the WHO Training Course on Child Growth Assessment were sent to caregivers [34].

2.4.3. Dietary Assessment Method

Food and beverage intake was assessed using a 1-day food record, with repeats in a random subset (30% of the sample), followed by a phone call to review the food record for accuracy and completeness. A 24-h dietary recall method was not used because this method relies on participant recall of intake from the previous day and is prone to over-estimation of true intake, which, for this age group would significantly impact results [35,36]. Further, a large proportion of children in this age group are often cared for and fed by other people (i.e., childcare workers and grandparents), and the caregiver would not necessarily be able to recall what the child had eaten the previous day. The food record on the other hand allowed multiple caregivers to record food intake. A validated portion estimation guide, training prior to record collection, and real time data capture helped minimize errors with portion estimation [37].

2.4.3.1. Food Record

Caregivers were randomly assigned to a day of the week to complete a food record for their child. A ~30% subsample of the study population was randomly selected to complete a second day's intake on a non-consecutive day, to allow estimation of usual intake distribution. The randomization schedule was developed by a statistician to ensure a balance of weekdays and weekend days. Caregivers were asked to record everything the child consumed from midnight the previous day to midnight the following day. A study package including a food record booklet, and a portion estimation guide [17,30] were mailed to the caregivers to help them record the child's intake. Additional food record booklets were included if the child was under someone else's care.

Once the study package was received, staff completed a preparatory phone call with the caregivers. Caregivers were instructed on how to record portion sizes of foods offered and amounts of food left uneaten using standard metric cup and spoon measures available in the home, or alternatively using gram measurements if household kitchen scales were available. If neither of these options were feasible, staff explained the portion estimation guide in detail. An example entry day was also reviewed with caregivers to ensure understanding of the level of detail required in describing food items including how to record household recipes. A copy of the instructions was also included with the secondary forms along with study staff contact information should questions arise. Once completed, caregivers were asked to take photos of the booklet(s) and scan or email them back to study staff. Reminder text messages, phone calls, and emails were sent up to a maximum of five times before participants were classified as lost to follow up.

2.4.3.2. Follow-Up Call

After the food record(s) were returned, study staff scheduled a phone appointment with caregivers. Interview techniques outlined in the four pass 24-h recall method were used to review the record [38]. The food record served as pass one, where all foods and drinks listed were reviewed and confirmed. Pass two entailed obtaining a detailed description of each listed item i.e., brand name, variety, preparation methods, and/or additions at the time of consumption. The third pass involved confirming portion sizes and the number of serves including amounts leftover or spilled. If quantities appeared implausible or incomplete, the portion estimation guide was used to help clarify quantities. Finally, the fourth pass involved reviewing the record, probing for forgotten foods and drinks and determining how usual the intake for the day was (e.g., illness, party etc.). If the caregiver reported food/drink intake to be more or less than usual, interviewers recorded

the reasons provided. Caregivers received an additional $20 supermarket gift card upon completion of the food record and follow-up interview.

2.4.3.3. Handling of Food Intake Data

All food intake data was entered directly into FoodWorks™ Professional version 10 [39]. This program used the 2011-13 Australian Food, Supplement and Nutrient Database (AUSNUT) developed during the National Nutrition and Physical Activity Survey [40]. As most commercial infant and toddler foods were not included in the AUSNUT database, we developed our own infant and toddler foods database [41]. The database was periodically updated as new products became available. Nutrient information and ingredient lists for these foods were obtained directly from product packaging or vendor/manufacturer websites. Foods and household recipes with less than four ingredients were entered as individual food items. Household recipes with more than four ingredients were added as a recipe; the amount consumed by the child was then calculated as a proportion of the total recipe. For commercial products, the amount of a micronutrient was only on the nutrition information panel if a nutrient claim was made; therefore, a recipe approach based on product ingredient lists was used to estimate the micronutrient content of most foods [42]. Briefly, ingredients were entered as cooked food items in FoodWorks™ based on their proportion within the ingredient list (product recipe). Where a single percentage was reported for multiple ingredients, different quantities were imputed for individual ingredients until a nutrient profile that closely matched the nutrition information panel was achieved. All product recipes imputed in this way were within 10% of the manufacturer reported energy, total fat, carbohydrate, protein, and total sugars. For fortified products, nutrient values generated by FoodWorks™ were replaced with manufacturer reported values.

All commercial foods and formula added to FoodWorks as new items (n = 301) were assigned a unique 8-digit food code based on AUSNUT 2011-13 major and sub-major food group classifications [40]. If home prepared recipes closely matched existing recipes in the AUSNUT 2011-13 recipe database, the same code was applied. Otherwise, unique codes were assigned based on the major food group or the ingredient accounting for the largest proportion within the recipe in the case of mixed food group recipes. Additional steps were also taken when coding recipes and commercial food items to categorize them as either discretionary or non-discretionary according to the Australian Bureau of Statistics discretionary food flag list [43]. The same principles outlined in the Australian Health Survey were used to systematically assess recipes and products [43].

Breastmilk intakes were estimated using validated assumptions used in previous studies developed in the United Kingdom (UK) and adapted in previous Australian studies [22,44,45]. The number of minutes the child actively suckled from the breast was recorded for each feed. A time of 10 min was recorded for feeds exceeding 10 min or when feeds occurring within 30 min of one another totaled over 10 min. Breastfeeds less than two minutes were excluded. The mass flow rate of breastmilk was estimated to be 10 g/min and energy intake was assumed to be 2.77 kJ/g [25,44].

Infant formula and toddler milk intakes were calculated from information in the food record, specifically, the number of scoops added to a volume of water, the prepared volume offered, and the prepared volume remaining in the bottle after a feeding. The gram weight of infant formula or toddler milk consumed was then determined by the following equation: formula (g) = scoop weight formula (g)/prepared volume (mL) × consumed volume (mL).

Food intake data was entered by one of two trained interviewers. The training included a comprehensive review of OzFITS 2021 methods, study protocols, and data entry rules for the follow-up interviews. Investigators completed a data quality audit of 10% of food records. Selected food records and their corresponding entries in FoodWorks™ were compared for consistency. Any obvious mistakes such as a missed food was corrected during the audit. Any unclear quantities were investigated further by reviewing case notes and discussing the entry with the respective interviewer. For outliers with extremely low or

very high energy intakes, food records were reviewed by an investigator (MN) to ascertain the plausibility of reported intakes.

2.5. Data Analysis

Descriptive statistics—specifically, frequencies, means and standard deviations were used to report sample characteristics. As loss to follow up and withdrawal was low (10.9%), only cases with valid responses were included in the analysis. All statistical analysis was completed using SPSS version 28.0 [46]. Data analysis for the remainder of the papers in this supplement will be presented in the papers that follow.

3. Results

3.1. Sample Size and Response Rate

Study recruitment occurred between April 2020 and April 2021. In total, 1140 caregivers were enrolled. Over 90% of caregivers were recruited through the online recruitment agency (Figure 1). After screening for eligibility, 17 caregivers were ineligible, three were eligible but declined to participate, and five had already participated. Completion rates for each phase of the study by age band are described in Table 1. Of the 976 caregivers asked to complete a food record, 87% completed at least a single day. A total of 345 (35%) of caregivers were asked to complete a second day's food record, and 290 (84%) did so.

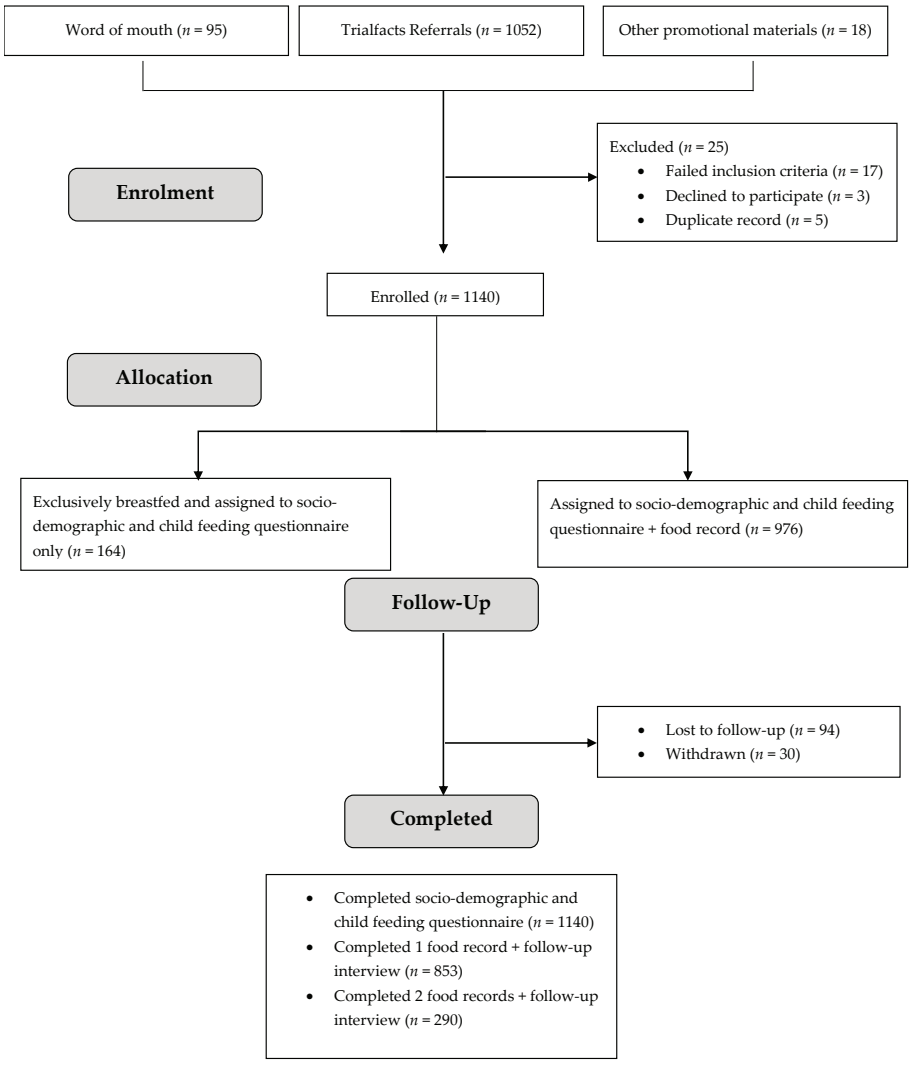

Figure 1. Participant flow and follow-up for OzFITS 2021.

Table 1. Completed questionnaire, food record, and follow up interview by age band for infants and toddlers enrolled in OzFITS 2021 (n = 1140).

Age Group, Months	Child-Feeding Questionnaire	Eligible for Food Record, *n* (%)	Assigned to Complete a Second Food Record, *n* (%)	Completed Food Record	
				One Day Food Record, *n* (%)	Two-Day Food Record, *n* (%)
0–5.9	290 (25.4)	126 (43.4)	47 (37.3)	114 (90.5)	46 (97.9)
6–11.9	308 (27.0)	308 (100)	110 (35.7)	279 (90.6)	98 (89.1)
12–17.9	289 (25.4)	289(100)	99 (34.3)	245 (84.8)	75 (75.8)
18–23.9	253 (22.2)	253 (100)	89 (35.2)	215 (85.0)	71 (80.0)
Total	1140(100)	976 (85.6)	345 (35.3)	853 (87.4)	290 (84.1)

3.2. Sample Characteristics

The key characteristics of the sample are presented in Table 2. The average age of caregivers was 34.2 ± 4.5 years and nearly all (98%) were the child's biological mother. Over 75% of respondents had an undergraduate degree or above, 61% reported an annual household income greater than $100,000, and over 90% were married or living with a partner in a de facto relationship. Around 70% of the respondents were born in Australia and the remainder were born overseas. Of those born overseas, the majority were from the UK, Vietnam, New Zealand, Malaysia, and India.

Table 2. Demographic characteristics of 2021 OzFITS sample (n = 1140).

Demographic Characteristics	2021 OzFITS Sample
Household size, *n* (%)	
2	34 (3.0)
3	616 (54.0)
4	337 (29.6)
>4	151 (13.2)
Australian State, *n* (%)	
Australian Capital Territory	30 (2.6)
New South Wales	333 (29.2)
Northern Territory	9 (0.8)
Queensland	205 (18.0)
South Australia	119 (10.4)
Tasmania	30 (2.6)
Victoria	312 (27.4)
Western Australia	102 (8.9)
Annual Household Income (AUD), *n* (%)	
<$40,000	50 (4.4)
$40,001–$70,000	113 (9.9)
$70,001–$105,000	267 (23.4)
$105,001–$205,000	537 (47.1)
>$205,000	158 (13.9)
Prefer not to disclose	15 (1.3)
Caregiver age, y (mean ± SD)	34.2 ± 4.5
Relationship to the child *n* (%)	
Biological Mother	1112 (97.5)
Other	28 (2.5)
Parity *n* (%)	
Only child	678 (59.5)
2 children	355 (31.1)
>2 children	107 (9.4)
Born in Australia *n* (%)	804 (70.5)
Aboriginal and Torres Strait Islander *n* (%)	10 (0.9)

Table 2. *Cont.*

Demographic Characteristics	2021 OzFITS Sample
Marital Status *n* (%)	
Married/de facto	1073 (94.1)
Other	67 (5.8)
Educational Attainment, *n* (%)	
Year 10 or 11	8 (0.7)
Secondary school	53 (4.6)
Certificate or Diploma	218 (19.1)
Bachelor degree or above	861 (75.5)
Employment Status, *n* (%)	
Parental leave	50 (4.4)
Caring duties	159 (13.9)
Employed full time or part-time	903 (79.2)
Student	20 (1.8)
Other	8 (0.7)

4. Discussion

OzFITS 2021 is the first comprehensive assessment of dietary intakes of a national sample of Australian infants and toddlers. Based on the 2016 US FITS study, OzFITS 2021 benefits from the methodological rigor developed over the past three iterations of the survey. Data from OzFITS 2021 will fill an important evidence gap by providing contemporary data on the following: breastfeeding duration and use of breast milk substitutes; timing and introduction of solid foods; consumption of core food groups and discretionary foods; and nutrient intakes. OzFITS 2021 will also allow the identification of new and emerging trends in infant feeding practices in Australia.

There are study design and methods limitations. Due to feasibility, the survey used a convenience sampling instead of a random sampling method. The impact of this sampling method is selection bias, which in this study was towards caregivers from high SES groups. Compared to the 2016 Australian population, the OzFITS 2021 sample was more likely to be university educated (76% vs. 22%) and report higher annual household incomes (>$100,000 vs. $74,776) [47]. Since maternal education and household income are known to be positively associated with nutrition status, our results may not be representative of the wider population [5]. The National Nutrition and Physical Activity Survey required a complex sampling frame identifying eligible households and took considerable financial and human resources to obtain a representative sample of Australians.

Another potential limitation is that the food record removed the element of surprise; however, this method improves portion size estimation and reduces recall bias. Unlike studies of intake in adults where intake is often underestimated, this does not seem to be an issue when estimating intake in infants and toddlers [28]. However, social desirability bias in our study may have influenced food choices and led to under- or overestimation of discretionary or healthful foods, respectively [48]. Finally, data collection occurred during the SARS-CoV-2 pandemic in which many Australians were locked down and may have influenced feeding practices. However, restrictions were short lived in most Australian cities, excluding Melbourne, and most caregivers did not report any impact of the pandemic on feeding practices for their children.

In conclusion, the OzFITS 2021 used robust methods to report caregiver feeding practices and dietary intakes of Australian children 0–23.9 months of age. For the first time, nutrient intake, and prevalence of inadequate intake for a range of nutrients is available for a national sample of infants and toddlers. Results from the OzFITS study can be used to inform future iterations of national infant feeding guidelines and interventions to optimize early life feeding. Ultimately, OzFITS provides the necessary tools and framework needed to implement a nationally representative nutrition survey within this age group.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Women and Children's Health Network Human Research Ethics Committee (HREC/19/WCHN/44).

Informed Consent Statement: Verbal informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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Conflicts of Interest: Honoraria from talks have been paid to Netting's institution to support professional development by the Nestlé Nutrition Institute. Green reports a grant from the Nestlé Nutrition Institute and honoraria from Nestlé Dubai for an invited talk that was paid to his institute. Makrides reports serving on a board for Trajan Nutrition until November 2020. Moumin reports an educational grant in aid from the Nestlé Nutrition Institute. There are no other financial disclosures or conflicts of interest to report. The funder, Nestlé Nutrition Institute, had no role in the design of this study nor in its execution, analyses, interpretation, or decision to submit results.

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CHAPTER 5. THE AUSTRALIAN FEEDING INFANTS AND TODDLER STUDY (OZFITS 2021): BREASTFEEDING AND EARLY FEEDING PRACTICES

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Article

The Australian Feeding Infants and Toddler Study (OzFITS 2021): Breastfeeding and Early Feeding Practices

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Abstract: The Australian Feeding Infants and Toddler Study 2021 (OzFITS 2021) is a nationwide survey of Australian caregivers' infant and toddler feeding practices. Here, we describe breastfeeding rates and duration, use of breastmilk substitutes, and introduction of complementary (solid) foods, including common food allergens. Caregivers (n = 1140) were recruited by a digital marketing company and were interviewed using a structured telephone questionnaire to obtain information. Breastfeeding was initiated in 98% of infants, but the duration of exclusive breastfeeding to six months was less than 1%. Nearly 40% of children continued to receive breastmilk beyond one year, with 10% of toddlers receiving breastmilk at two years. One-quarter of infants were introduced to solid foods between 4 to 5 months, and nearly all infants had received solid foods by 7 months. New guidelines encourage the early introduction of potential food allergens to reduce the risk of allergy, and by 12 months, over 90% of children had been given eggs and peanuts. One-third of children received no breastmilk substitutes during their first year. One-third of infants first received breastmilk substitutes following birth and before discharge from the hospital. Of these infants, 30% ceased breastmilk substitute use after discharge. Our findings suggest a high rate of continued breastfeeding with 44% receiving breastmilk beyond 1 year. One approach to increase the duration of exclusive breastfeeding is to reduce breastmilk substitute use while in hospital.

Keywords: Australian feeding infants and toddler study; solid feeding; nutrient intakes; feeding practices; breastfeeding; allergen introduction

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1. Introduction

The Australian National Health and Medical Research Council (NHMRC) Infant Feeding Guidelines recommend exclusive breastfeeding for the first six months to optimize infant growth, development, and health [1–3]. Afterward, infants should be given nutritious complementary (solid) foods with continued breastfeeding to 12 months and beyond. Solid foods should be introduced at around six months because breastmilk alone does not meet infant requirements for energy and select nutrients, particularly iron [3]. The type and order of solid foods introduced is not important as long as they are iron-rich and nutrient-dense [3], with increasingly complex textures matching the infant's development.

Despite the importance of early infant feeding, there is very little data on breastfeeding practices and the timing of solid food introduction of Australian caregivers. The 2010

Australian National Infant Feeding Survey (ANIFS) [4] provides the most comprehensive assessment of early feeding against key breastfeeding indicators established by the World Health Organization and adapted for Australia. In the ANIFS, breastfeeding initiation was over 90%, with 27% of infants exclusively breastfed to four months. At 12 months, 40% of children were still receiving breastmilk. Nearly all infants had received solid foods by six months, with around 10% receiving them as early as three months. Because the ANIFS was conducted over a decade ago, breastfeeding patterns and the timing of solid food introduction will have likely changed. Furthermore, the ANIFS did not address the use and timing of the introduction of breastmilk substitutes.

In their 2012 Infant Feeding Guidelines, the NHMRC [3] advised that foods or food allergens no longer needed to be avoided during infancy to prevent food allergies. In response to recent evidence [5], the Australasian Society of Clinical Immunology and Allergy (ASCIA) now encourages deliberate and regular inclusion of common allergens (e.g., egg and peanut) into infants' diets before one year [6]. However, there are limited data on whether caregivers follow this advice.

Here, we provide recent nationwide data on breastfeeding initiation, duration of exclusive, and the use of breastmilk substitutes among Australian caregivers. We also provide new data on the timing of introduction to solid foods, including early exposure to common food allergens.

2. Materials and Methods

2.1. OzFITS 2021 Survey Methods

The methods for OzFITS 2021 are described in detail elsewhere in this supplement [7]. Briefly, caregivers with a child aged 0–24 months and who could answer questions about their dietary intake from birth were recruited using targeted social media advertisements. The sampling frame included all Australian states and territories, with the target sample proportional to population size. Telephone-based surveys and interviews were used to collect information. Participants (n = 1140) were surveyed between April 2020 and 2021.

Questions regarding initiation of breastfeeding and feeds in the early neonatal period were consistent with the ANIFS [4]: "What was [CHILD] first feed?", "How soon after [child] was born did he/she first have breastmilk?", "While in hospital, did [child] ever have any other fluids or foods?", "When [child] first came home from the hospital, was he/she receiving breastmilk?". The timing of solid food introduction was determined by self-report. Caregivers were asked, "Has [CHILD] ever been given any food, including baby cereal added to bottles?" If they responded 'yes', they were asked what age solid foods were introduced. Introduction to the broad food groups and timing of common food allergen introduction (egg, peanut, tree nuts, and sesame) were also assessed using a questionnaire.

Age definitions adopted were based on completed months, consistent with the ANIFS [4]. The definitions for breastfeeding based on WHO 2008 were adopted for use in the ANIFS survey (Table 1) [2,4].

Table 1. Definitions of infant feeding practices used for OzFITS 2021 [1].

Feeding Practice	Requires that the Infant Receive	Allows the Infant to Receive	Does Not Allow the Infant to Receive
Exclusive breastfeeding	Breastmilk (including expressed milk)	Oral rehydration solutions, drops, syrups (vitamins, minerals, medicines)	Anything else
Predominant or 'full' breastfeeding	Breastmilk (including expressed milk) as the predominant source of nourishment	Certain liquids (water and water-based drinks, fruit juice), and oral rehydration salts, drops, or syrups (vitamins, minerals, medicines)	Anything else

Table 1. *Cont.*

Feeding Practice	Requires that the Infant Receive	Allows the Infant to Receive	Does Not Allow the Infant to Receive
Solid feeding or 'partial' breastfeeding	Breastmilk (including expressed milk)	Anything else	
Any breastfeeding	Any of the above definitions		
Ever breastfed	Breastfed or received expressed breastmilk at least once	Anything else	

[1] Adapted from the Australian National Infant Feeding Survey [4].

2.2. Statistical Analysis

The OzFITS 2021 cross-sectional survey enrolled 1140 caregivers with children in four age bands: 0–5.9 months; 6–11.9 months; 12–17.9 months; and 18–23.9 months. A feature of the data when looking at events such as exclusive breastfeeding, predominant breastfeeding, and introduction to solid foods are censored responses: children who had not yet experienced the relevant event at the time of the survey. Kaplan–Meier survival analysis was used to estimate the cumulative proportion surviving at each event time and associated 95% confidence intervals. We estimated one minus the cumulative proportion of surviving at each event for solid food introduction. We were interested in the proportion who have experienced the event (e.g., started solid foods) rather than the proportion who have experienced a disqualifying event (e.g., stopped breastfeeding). Statistical analyses were completed using SPSS 28.0 (I.B.M. Corp., Armonk, NY, USA) [8].

3. Results

3.1. Breastfeeding

Exclusive breastfeeding was initiated in 93% of infants; however, only 59% were exclusively breastfed to one month, and 39% were exclusively breastfed to four months. Less than 1% of infants were exclusively breastfed to six months (Table 2). The main reason for exclusive breastfeeding cessation under one month of age was hospital exposure to breastmilk substitutes.

Table 2. Cumulative proportion of children exclusively breastfed, predominately breastfed, or receiving any breastmilk by month of age.

Age (to Month)	Equivalent Duration	Exclusively Breastfed [1]	Predominantly Breastfed [2]	Receiving Any Breastmilk
			% (95% CI)	
0 to <1	Less than 1 month	59 (56, 62)	60 (57, 63)	98 (97, 99)
1	Less than 2 months	57 (54, 60)	58 (55, 60)	95 (94, 96)
2	Less than 3 months	54 (51, 57)	55 (52, 58)	91 (90, 93)
3	Less than 4 months	51 (48, 54)	52 (50, 55)	87 (85, 89)
4	Less than 5 months	39 (36, 42)	40 (37, 43)	82 (79, 84)
5	Less than 6 months	22 (19, 24)	23 (20, 26)	75 (72, 77)
6	Less than 7 months	1 (0, 1)	1 (0, 2)	68 (65, 71)
7	Less than 8 months	0 (0, 1)	0 (0, 1)	63 (60, 66)
8	Less than 9 months	0 (0, 0)	0 (0, 1)	60 (57, 63)
9	etc.	-	-	54 (51, 57)
10		-	-	50 (46, 53)
11		-	-	47 (44, 51)
12		-	-	44 (40, 47)
13		-	-	39 (35, 42)
14		-	-	34 (30, 37)
15		-	-	30 (27, 33)

Table 2. *Cont.*

Age (to Month)	Equivalent Duration	Exclusively Breastfed [1]	Predominantly Breastfed [2]	Receiving Any Breastmilk
			% (95% CI)	
16		-	-	27 (24, 30)
17		-	-	22 (19, 25)
18		-	-	17 (14, 20)
19		-	-	14 (11, 17)
20		-	-	10 (8, 13)
21		-	-	6 (4, 9)
22		-	-	4 (3, 6)
>23		-	-	4 (3, 6)

[1] Allows breastmilk, expressed milk, oral rehydration solutions, vitamins, and minerals. [2] Allows breast milk as the only milk source; breast milk substitutes or other kinds of milk are not permitted. Oral rehydration solutions, vitamins and minerals, water, and juice are permitted.

The median duration of any breastfeeding was 11.0 months (95% CI 10.2 to 11.8). Breastfeeding was initiated in 98% of infants, and at six months of age, 68% (95% CI 65 to 71) were breastfed. Nearly 40% of children were breastfed beyond 12 months, and at 20 months of age, 10% of toddlers were still receiving some breastmilk.

3.2. Introduction to Breastmilk Substitutes

By six months of age, just over half of the infants had been given breastmilk substitutes, with 40% of infants introduced during the first month of life. By age one, 35% of children had never received breastmilk substitutes (Table 3). Of the 40% (n = 455) of infants consuming breastmilk substitutes in their first month of life, 78% (350/455) received these in hospital soon after birth. Of the infants who began breastmilk substitutes in the hospital, 33% (116/350) ceased consuming breastmilk substitutes after hospital discharge and received only breastmilk. Another 58% (202/350) continued to receive both breastmilk and a breastmilk substitute, and only 9% (32/350) received breastmilk substitutes alone. In contrast, of the children introduced to breastmilk substitutes at home by one month of age, 9% (9/105) ceased breastmilk substitutes and then only received breastmilk for a period; 81% (86/105) received both, and 10% (10/105) received only breastmilk substitutes.

Table 3. Use of breastmilk substitutes and first exposure to solids foods reported as a cumulative proportion by age in months.

Age (Months)	Introduced to Breastmilk Substitute	Introduced to Solid Foods
	% (95% CI)	
<1 month	40 (37, 43)	0 (0, 1)
1 to <2 months	42 (40, 45)	0 (0, 1)
2	45 (42, 48)	0 (0, 1)
3	48 (45, 51)	1 (1, 2)
4	51 (48, 54)	25 (23, 28)
5	53 (50, 56)	58 (55, 61)
6	56 (53, 60)	97 (95, 98)
7	57 (54, 60)	98 (97, 99)
8	60 (57, 63)	99 (99, 100)
9	61 (58, 65)	99 (99, 100)
10	64 (61, 67)	100 (99, 100)
11	65 (62, 68)	100 (99, 100)
12	66 (63, 70)	100 (99, 100)
>12	67 (64, 71)	100 (99, 100)

3.3. Timing of Introduction Complementary (Solid) Foods

The median age at first introduction to solid foods was 5 months (95% CI 4.9 to 5.1). One-quarter of all children were introduced to solid foods between 4 and 5 months, 33% commenced solids between 5 and 6 months, and by 6 to 7 months, 97% were introduced to solid foods. A small number (n = 13) started solid foods before 4 months. Of these, one child (<1 month of age) was given honey on their pacifier, one child (1–2 months) of age had pureed food at 4 weeks, and the remainder (n = 11) started solid foods at around 3 months and 3 weeks of age. Delayed food introduction beyond seven months was observed among 3% of infants (7–8 months n = 15; 8–12 months n = 15). Reasons for delaying the introduction to solid foods included prematurity n = 5; food intolerances or allergy n = 3; n = 22 parents gave no specific reason.

3.4. Introduction to Common Allergens and Medically Diagnosed IgE-Mediated Food Allergy

By one year, around 95% of children had been exposed to the common food allergens hen's egg and peanut, 76% of the children had consumed tree nuts, and 82% had consumed sesame (Table 4). The median age for introduction to egg was 6 months (95% CI 5.9 to 6.1), peanut was 7 months (95% CI 6.9 to 7.1), and sesame was 8 months (95% CI 7.7 to 8.3).

Table 4. First exposure to common food allergens reported as a cumulative proportion by age in months.

Month	Egg	Peanut	Tree Nuts	Sesame
	% (95% CI)			
Birth to <1	0 (0, 0)	0 (0, 1)	0 (0, 0)	0 (0, 0)
1	0 (0, 0)	0 (0, 1)	0 (0, 0)	0 (0, 0)
2	0 (0, 0)	0 (0, 1)	0 (0, 1)	0 (0, 0)
3	0 (0, 1)	0 (0, 1)	0 (0, 1)	0 (0, 0)
4	3 (2, 4)	3 (2, 5)	1 (1, 2)	1 (0, 2)
5	12 (10, 14)	13 (11, 15)	6 (4, 7)	5 (4, 6)
6	54 (50, 57)	50 (47, 53)	22 (19, 25)	22 (19, 25)
7	71 (68, 74)	67 (64, 70)	37 (33, 40)	37 (34, 40)
8	82 (79, 85)	78 (75, 81)	49 (46, 53)	51 (47, 54)
9	87 (85, 90)	83 (80, 86)	56 (52, 59)	59 (55, 62)
10	92 (90, 94)	87 (85, 90)	62 (59, 66)	66 (63, 70)
11	93 (91, 95)	88 (86, 90)	65 (61, 68)	69 (65, 72)
12	97 (95, 98)	94 (93, 96)	76 (72, 79)	82 (79, 85)
>12	98 (97, 99)	98 (97, 99)	87 (84, 90)	91 (89, 93)

Amongst the children (n = 922) who had started solid foods, caregivers reported medically diagnosed IgE mediated food allergy, which was confirmed by allergen testing (skin prick test or allergen-specific IgE) in 77/922 children (8.5%). Of these, IgE-mediated egg allergy was reported in 2.4% (22/922), and peanut allergy was reported in 1.6% (15/922) of children.

4. Discussion

Here, we report the results of a recent, nationwide Australian survey of early infant feeding practices. We found that the duration of exclusive breastfeeding to 4 months was 40%, falling to less than 1% at 6 months. Our findings are similar to exclusive breastfeeding rates reported in the 2010 ANIFS [4], where exclusive breastfeeding to 4 and 6 months was 27% and 2%, respectively. Our findings also suggest that exclusive breastfeeding rates have remained unchanged during the last decade.

Our exclusive breastfeeding duration differs from that reported in the Australian Bureau of Statistics, 2017–2018 National Health Survey of Breastfeeding, where 61% and 29% of children were exclusively breastfed to 4 and 6 months, respectively [9]. This difference is likely due to differences in the survey questions used in the two studies. In

the Australian Bureau of Statistics Survey, a single question was asked to determine the rate of exclusive breastfeeding. In the ANIFS and our survey, caregivers were probed for breastmilk substitute exposure while in hospital and after hospital discharge, which may have led to an overestimation of exclusive breastfeeding rates in the Australian Bureau of Statistics. Survey.

Of concern is that one-third of infants in our study lost their exclusive breastfeeding status due to exposure to breastmilk substitutes while in hospital. Of these infants, 30% stopped consuming breastmilk substitutes after discharge and received only breastmilk for a time. These findings are consistent with a Victorian (Australia) state-wide perinatal indicators report where 29% of infants were given breastmilk substitutes in hospital [10]. Further studies are required to determine the reasons for early introduction to breastmilk substitutes in hospitals. Strengthened antenatal education and increased support for breastfeeding in the early neonatal period may help decrease breastmilk substitute use in hospitals [1]. The Baby-Friendly Hospital Initiative [11] was established to increase exclusive breastfeeding rates, but only 26% of Australian hospitals are accredited [12].

Despite the short duration of exclusive breastfeeding in OzFITS 2021, breastfeeding duration to one year was high, with many children breastfed into their second year of life. Our finding of long breastfeeding duration is consistent with other Australian cohorts and surveys [13,14]. In the 2017–2018 National Health Survey of Breastfeeding, 40% of children were breastfed to at least 12 months of age compared to 44% of OzFITS 2021 participants. Although half of the infants in our survey had consumed breastmilk substitutes, one-third of the infants surveyed had never received breastmilk substitutes. Among those who had received breastmilk substitutes, 86% continued to receive some breastmilk, suggesting that many caregivers use them as an addition to, rather than a replacement of breastmilk. There are no comparable Australian data on the use of breastmilk substitutes.

The Australian NHMRC infant feeding guidelines [3] recommend introducing solid foods at around 6 months when the baby is developmentally ready, and by 6 months of age, 96% of our cohort had commenced solid foods. About 25% of infants in OzFITS 2021 were introduced to solid foods at 4–5 months, increasing to two-thirds by 5–6 months. Due to the higher risk of developing an allergy, the Australasian Society of Clinical Immunology and Allergy (ASCIA) advises that solid foods are not introduced before 4 months [5,6]. We found that very few caregivers (1.5%) had introduced solid foods before 4 months of age, 25% (95% CI 23 to 28) introduced at 4 months, and most children (58.1%; 95% CI 55 to 61) had commenced on solid foods between 5 and 6 months of age. The 2010 ANIFS results indicate that 35% of infants surveyed had received solid food at 4–5 months [4]. Results from several other Australian surveys suggest that the timing of solid foods seems to be moving more to the 5 to 6th month, with fewer starting solid foods very early (<4 months of age) [14–16].

In OzFITS 2021, infants were introduced to common allergens such as egg and peanut by one year of age, consistent with results reported elsewhere [17–19]. We also examined tree nuts and sesame timing in babies' diets, as these are common food allergens in Australian children [20]. Furthermore, the hospital exposure to breastmilk substitutes and subsequent cessation may increase the risk of cow's milk allergy [21]. The prevalence of IgE-mediated allergy reported amongst our cohort was consistent with that reported [20].

A strength of this study is that it provides contemporary Australian data with a sample proportionate to the population size within each state. Questions were adapted from the ANIFS but included more comprehensive questions regarding the timing of solid foods and common food allergens. Limitations include the retrospective nature of the feeding survey data collected, specifically for the older age group. We used convenience sampling, which is more subject to response bias than purposeful sampling. In our case, participants were more highly educated and had a higher family income than the Australian population [7,22]. Despite this, our early feeding data are consistent with the ANIFS and other Australian feeding studies reported.

In conclusion, for OzFITS 2021, we report exclusive breastfeeding rates at 4 and 6 months compared with the ANIFS 2010. Most caregivers commenced solid foods at around 6 months of age, according to the NHMRC Infant Feeding Guidelines, and most infants were exposed to common allergens in the first year of life. Perhaps the most worrying finding is the early introduction to breastmilk substitutes in hospitals, affecting exclusive breastfeeding rates. Many caregivers surveyed ceased breast milk substitutes, and gave their infant only breastmilk, possibly suggesting they intended to exclusively breastfeed their babies. Strategies that support exclusive breastfeeding while in hospital are needed.

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Informed Consent Statement: Verbal informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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Conflicts of Interest: Honoraria from talks have been paid to Netting's and Green's institution to support professional development by the Nestlé Nutrition Institute and from Nestlé Dubai, respectively. Makrides reports serving on a board for Trajan Nutrition until November 2020. There are no other financial disclosures or conflicts of interest to declare.

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CHAPTER 6. DOES FOOD INTAKE OF AUSTRALIAN TODDLERS 12–24 MONTHS ALIGN WITH RECOMMENDATIONS: FINDINGS FROM THE AUSTRALIAN FEEDING INFANTS AND TODDLERS STUDY (OZFITS) 2021.

Moumin NA, Netting MJ, Golley RK, Mauch CE, Makrides M, Green TJ

The manuscript entitled "Does Food Intake of Australian Toddlers 12–24 Months Align with Recommendations: Findings from the Australian Feeding Infants and Toddlers Study (OzFITS) 2021" was published in the peer reviewed journal *Nutrients*. 2022;14.

Supplementary table 1 is listed as Appendix 11. Daily serves of five food group and discretionary foods consumed by toddlers 12–<18 months stratified by breastmilk intake, OzFITS 2021—Chapter 6

Supplementary table 2 is listed as Appendix 12. Energy and percentage total energy from five food group and discretionary foods for toddlers aged 12–<18 months stratified by breastmilk intake, OzFITS 2021—Chapter 6

Supplementary table 3 is listed as Appendix 13. Daily serves of five food group and discretionary foods consumed by toddlers 18–24 months stratified by breastmilk intake, OzFITS 2021—Chapter 6

Supplementary table 4 is listed as Appendix 14. Energy and percentage total energy from five food group and discretionary foods for toddlers 18–24 months stratified by breastmilk intake, OzFITS 2021—Chapter 6

An additional supplementary table not included in the publication is listed as Appendix 15. Percentage of toddlers meeting recommended daily serves of five food group and discretionary foods stratified by age, OzFITS 2021—Chapter 6

Statement of Authorship

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Contribution to the Paper	Contributed to the research design and research protocol. Conducted the research, performed statistical analysis, and contributed to interpretation of findings. Wrote the first draft and had primary responsibility for the final version of the manuscript.		
Overall percentage (%)	70		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
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Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);

ii. permission is granted for the candidate in include the publication in the thesis; and

iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

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Does Food Intake of Australian Toddlers 12–24 Months Align with Recommendations: Findings from the Australian Feeding Infants and Toddlers Study (OzFITS) 2021

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Abstract: (1) Background: Food-based dietary guidelines promote population health and well-being through dietary patterns that reduce chronic disease risk while providing adequate energy and nutrients. In Australia, recommended dietary patterns based on servings per day from the five food groups—fruits, vegetables, cereals and grains, meats and alternatives, and dairy—have been developed for toddlers 1–2 years of age. However, no study has assessed the intake of the five food groups in this age group nationally. (2) Aim: To compare daily servings and the percentage of energy from the five food groups and discretionary foods in toddlers 1–2 years old to the Australian Dietary Guidelines. (3) Methods: Dietary intake was assessed using a one-day food record for 475 toddlers. (4) Results: Apart from fruit and dairy, servings of the five food groups were below the recommendations. Two-thirds of toddlers did not consume enough vegetables, and only 10% consumed the recommended number of servings for cereals and grains. On average, toddlers consumed only half the recommended servings of meat and alternatives. Nearly all toddlers (89%) consumed discretionary foods, which accounted for ~12% of total energy. Forty-five percent of toddlers received breastmilk. On average, breastfed toddlers consumed fewer servings from the five food groups than non-breastfed toddlers. Dairy contributed 20% of daily energy in all toddlers; however, this food group accounted for 13% in breastfed and 32% in non-breastfed toddlers on the day of the food record. (4) Conclusions: Compared to the recommendations, alignment with the servings of the five food group foods was not achieved by most toddlers, except for fruit and dairy. Discretionary foods may have displaced nutritious family foods. Consistent with Australian Infant Feeding Guidelines, many toddlers in this study continued to receive breastmilk but the recommended dietary patterns do not include breastmilk. Dietary modeling, including breastmilk as the primary milk source, is urgently needed, along with practical advice on incorporating breastmilk in a toddler's diet while optimizing food consumption.

Keywords: toddlers; serving sizes; core foods; discretionary foods; Australia; dietary intake; survey

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1. Introduction

Many countries have established food-based dietary guidelines to promote food intake that meets energy and nutrient requirements while minimizing the risk of obesity and chronic disease [1]. Dietary patterns have also been developed to guide food selection, including the suggested number of servings and serving sizes for each food group.

The Australian Dietary Guidelines were last updated in 2013 [2]. Along with the guidelines, a companion document [3] was developed to provide practical advice on meeting the guidelines. In Australia, there are five food groups, fruits, vegetables, cereals and grains, meats and alternatives, and dairy foods, along with an allowance for unsaturated fats and oils. In addition to the five food groups, the guidelines also limit the number of discretionary food servings—nutrient-poor and energy-dense foods and beverages higher in saturated fat, added sugars, salt, or alcohol [4]. Dietary modeling based on population intake data from nationally representative surveys was used to construct foundation diets and dietary patterns based on the recommended daily servings for each of the five food groups [5,6]. The serving sizes and the number of servings required from each food group were designed to meet the energy and nutrient needs for each sex and life stage group [7,8].

Due to a lack of Australian dietary intake data on children under 2 years, modeling for this age group was based on the dietary intake of 2–3-year-olds from the 1995 National Nutrition and Physical Activity Survey [5] and the 2007 Children's National Nutrition and Physical Activity Survey [6,8]. Therefore, the dietary patterns for toddlers in the Australian Guide to Healthy Eating (AGHE) include the same five food groups and serving sizes as older age groups with smaller numbers of servings for each food group. However, discretionary foods are not recommended due to toddlers' high nutrient needs relative to their low energy requirements [2].

In this paper, we compare the number of daily servings of the five food groups and discretionary foods consumed by toddlers enrolled in the Australian Feeding Infants and Toddlers Study (OzFITS) 2021 to dietary patterns recommended in the Australian Dietary Guidelines [2,9]. Due to the high breastfeeding rates in the second year of life [10], we compared the intake of the five food groups and discretionary foods in breastfed and non-breastfed toddlers. We also report the percentage of energy derived from each food group and the contribution of beverages, including breastmilk, to total energy intake.

2. Materials and Methods

OzFITS 2021 was a cross-sectional survey conducted with caregivers of children 0–24 months old [11,12]. Between April 2020 and April 2021, 1140 participants were enrolled across Australia, with recruitment proportional to population size in each state and territory. The Women's and Children's Health Network Human Research Ethics Committee (HREC/19/WCHN/44) approved the study, and all caregivers provided verbal consent.

Dietary intake data were collected using a one-day food record, with repeats on a non-consecutive day in 30% of the sample. This analysis includes dietary data collected from toddlers 12–24 months on the first day (n = 475). Caregivers were randomly allocated to a day of the week to record all foods and beverages consumed by their child. The details of the food record instrument [13–15] and follow-up interview [15] are described in detail elsewhere in the supplement [11]. All foods and beverages were entered directly into FoodWorks™ Professional Version 10 [16] using the 2011–2013 Australian Food, Supplement and Nutrient Database [17]. An additional database consisting of commercial infant and toddler foods (OzFITS Foods) was developed as these foods were largely unavailable in FoodWorks™.

All new foods, infant formula, and toddler milk entered in FoodWorks™ were assigned a unique 8-digit food group code based on the AUSNUT 2011-13 classification system [18]. Existing 8-digit codes in the AUSNUT 2011-13 Recipe database were applied to home-prepared mixed dishes with a similar composition. A new 8-digit code was created for unique recipes based on the major ingredient or the food group comprising the largest proportion of the dish [17,18]. Foods and recipes were further classified as discretionary or non-discretionary according to the criteria described in the Australian Bureau of Statistics discretionary flag list [4].

Breastmilk intake was estimated based on the number of minutes of active feeding to a maximum of ten minutes per feed, consistent with previous studies [19–21]. Breastfeeds lasting less than two minutes were excluded. Expressed breastmilk was entered as the

reported quantity consumed by the child. The quantity (g) of dry formula or toddler milk consumed was calculated using the following equation: formula (g) = scoop weight (g)/prepared volume (mL) × consumed volume (mL). Similarly, the quantity of water consumed with formula was calculated as: water (mL) = water (mL)/total prepared volume (mL) × consumed (mL). The actual volume of water consumed was then added to the actual amount of formula or toddler milk consumed.

Data Analysis

Dietary data were extracted from FoodWorks™ and linked with existing or unique 8-digit food group codes in the AUSNUT 2011-13 database [17] or OzFITS foods database. These codes permitted the identification and classification of foods into their respective food groups for analysis. Foods classified as five food groups included fruits, vegetables, cereals and grains, meats and alternatives, and dairy [2]. Other food groups were created for breast milk, formula and toddler milk, unsaturated fats and oils, and discretionary foods.

Serving sizes were assigned to five food group foods and unsaturated fats and oils correspond to those found in the Australian food selection guide [2]. Dairy servings with and without formula or toddler milks were reported. According to the manufacturer's instructions, a serving of formula or toddler milk was defined as 250 mL and assumed to be prepared at full strength. Discretionary foods higher in fat, added sugars, and salt are not recommended for young children [2,9]. Since there is no allowance for discretionary foods in the recommended dietary patterns for children < 2 years, it is unclear if the serving size for discretionary foods (600 kJ) applies to this group [2]. For this reason, we applied a smaller serving size of 418 kJ/serving, consistent with toddler snacks. Foods and recipes classified as discretionary were excluded from the daily total for five food group servings. Daily servings of the five food groups and discretionary foods were calculated for the whole sample and then stratified according to breastmilk intake. Children were categorized as breastfed if they received breastmilk or were breastfed on the day of the food record. If they did not receive any breastmilk, they were categorized as not breastfed.

For mixed dishes, recipe data were disaggregated, and the gram weight of each food group was calculated using the following formula: portion (g) consumed/cooked recipe (g) × raw ingredient (g). Constituent parts were added to the daily total for each food group (g/day). The median (IQR) for each food group and beverage type was calculated for consumers only. Percent daily energy contribution from each food group and beverage type was calculated for both consumers and the whole sample. Total energy was attributed to the aggregated dish for mixed dishes based on the major ingredient or food group. For example, if a Bolognese pasta sauce recipe was 70% meat and 30% vegetable, the energy contribution was applied to the meat and alternatives food group.

3. Results

Demographic characteristics of caregivers and their toddlers who completed food records are described in Table 1. Approximately 80% of caregivers were university educated, and nearly all (97%) were the biological mothers of their children. One-half of caregivers were ≥35 years, and 40% had at least two children residing in the family home. The average age of children in the sample was 18 ± 3.4 months. Most children had a birth weight within the normal range of 2500–4499 g [22] and 73% (345/475) had commenced complementary feeding between their fifth and sixth months of life.

Consumption of five food groups and discretionary foods: The proportion of toddlers aged 12–24 months consuming five food groups and discretionary foods on the day of the food record and the median serving size for each group are presented in Tables 2 and 3. Apart from unsaturated fats and oils, most children consumed foods from the five food groups on the day of the food record. Forty-two percent (97/233) of toddlers aged 12 to <18 months and 33% (80/242) of toddlers 18–24 months old did not consume any unsaturated fats or oils. Median daily servings for all five food group foods except for fruit and dairy were below the recommendations in both age groups. Over 90% of toddlers consumed meats

and alternatives; however, this food group was consumed in small quantities, with both age groups consuming only half the recommended serving per day.

Table 1. Characteristics of caregivers and their toddlers, OzFITS 2021 (n = 475) [1].

	***n* (%)**
Caregiver Characteristics	
Educational attainment (≥university degree)	364 (77)
Marital status (de facto or married)	446 (94)
Relationship to child (mother)	461 (97)
Age (years)	
<25	2 (0)
25–34	254 (54)
≥35	219 (46)
Country of birth	
Australia/New Zealand	351 (74)
Southeast Asia	31 (7)
United Kingdom/Ireland	30 (6)
Other	63 (13)
Number of children in the household	
1 child	291 (61)
2 children	139 (29)
≥3 children	45 (9)
Child characteristics	
Sex (female)	252 (47)
Age (months), mean ± SD	18 ± 3.4
Birthweight (g)	
<2500	24 (5)
2500–4499	444 (93)
≥4500	6 (1)
Solid food introduction (age, months)	
<4	6 (1)
4	100 (21)
5–6	345 (73)
≥7	24 (5)
Energy intake, kJ/day	
12 to <18 months	3902 (3359–4766)
18 to 24 months	4330 (3695–5125)

[1] Data are presented as observed counts and percentages, mean ± standard deviation (SD), or median (IQR). OzFITS; Australian Feeding Infants and Toddler Study.

Table 2. Daily servings of five food groups and discretionary foods consumed by toddlers aged 12–24 months, OzFITS 2021 (n = 475).

Food Group	**Consumers *n* (%)**	**AGHE Serving Size [1]**	**Recommended Servings per Day**	**Number of Servings per Day [2]**
Fruit	457 (96)	150 g	$\frac{1}{2}$	1.04 (0.51–1.62)
Vegetables	458 (96)	75 g	2–3	1.24 (0.56–2.31)
Cereals and grains	466 (98)	40 g bread	4	2.18 (1.28–3.18)
Meats and alternatives	432 (91)	65 g red meat	1	0.55 (0.23–1.10)
Dairy				
Without toddler milks	450 (95)	250 mL milk	1–1 $\frac{1}{2}$	1.05 (0.51–1.71)
With toddler milks [3]	455 (96)	250 mL milk	1–1 $\frac{1}{2}$	1.33 (0.64–2.16)
Fats and oils	298 (63)	7–10 g	1	0.21 (0–0.70)
Discretionary foods	422 (89)	418 kJ	0	1.04 (0.36–2.27)

[1] AGHE; Australian Guide to Healthy Eating; equivalent of 40 g bread, 65 g red meat, or 250 mL milk. For example, 40 g of cheese equals one serving of dairy [2]. [2] Values are median (IQR). The lower bound is used where a range exists for a recommended serving per day. [3] Dairy, including formula/toddler milk. A serving of formula/toddler milk is defined as 250 mL prepared volume.

Table 3. Daily servings of five food groups and discretionary foods consumed by toddlers stratified by age, OzFITS 2021.

Food Group	Consumers *n* (%)	AGHE Serving Size [1]	Recommended Servings per Day	Number of Servings per Day [2]
Toddlers 12 to <18 months (*n* = 233)				
Fruit	224 (96)	150 g	$\frac{1}{2}$	0.98 (0.51–1.52)
Vegetables	229 (98)	75 g	2–3	1.26 (0.56–2.25)
Cereals and grains	225 (97)	40 g bread	4	1.99 (1.10–2.88)
Meats and alternatives	213 (91)	65 g red meat	1	0.49 (0.21–0.98)
Dairy				
Without toddler milks	220 (94)	250 mL milk	1–1 $\frac{1}{2}$	1.04 (0.44–1.75)
With toddler milks [3]	221 (95)	250 mL milk	1–1 $\frac{1}{2}$	1.35 (0.57–2.24)
Fats and oils	136 (58)	7–10 g	1	0.12 (0–0.64)
Discretionary foods	201 (86)	418 kJ	0	0.78 (0.21–1.83)
Toddlers 18 to 24 months (*n* = 242)				
Fruit	233 (96)	150 g	$\frac{1}{2}$	1.12 (0.52–1.73)
Vegetables	229 (95)	75 g	2–3	1.19 (0.55–2.43)
Cereals and grains	241 (100)	40 g bread	4	2.39 (1.40–3.33)
Meats and alternatives	219 (91)	65 g red meat	1	0.60 (0.25–1.25)
Dairy				
Without toddler milks	230 (95)	250 mL milk	1–1 $\frac{1}{2}$	1.11 (0.61–1.66)
With toddler milks [3]	234 (97)	250 mL milk	1–1 $\frac{1}{2}$	1.31 (0.71–2.04)
Fats and oils	162 (67)	7–10 g	1	0.29 (0–0.78)
Discretionary foods	221 (91)	418 kJ	0	1.47 (0.52–2.67)

[1] AGHE; Australian Guide to Healthy Eating; equivalent of 40 g bread, 65 g red meat, or 250 mL milk. For example, 40 g of cheese equals one serving of dairy [2]. [2] Values are median (IQR). The lower bound is used where a range exists for a recommended serving per day. [3] Dairy, including formula/toddler milk. A serving of formula/toddler milk is defined as 250 mL prepared volume.

Energy Intake: The energy contribution from five food groups and discretionary foods are reported in Tables 4 and 5. Nearly all children consumed cereals and dairy foods, and these foods contributed the most to daily energy intake. A total of 85–90% of toddlers consumed discretionary foods. Discretionary foods were the third-largest contributor to daily energy in older toddlers aged 18–24 months. In total, *n* = 1 toddler 12 to <18 months and *n* = 4 toddlers 18 to 24 months consumed only formula or toddler milk as their dairy source on the day of the food record.

Table 4. Energy and percentage total energy from five food groups and discretionary foods for toddlers aged 12–24 months, OzFITS 2021 (*n* = 475).

Food Group	Consumers *n* (%)	Energy, kJ/day [1]	Percentage of Total Energy Intake [1]
Fruit	457 (96)	367 (176–589)	9 (5–13)
Vegetables	458 (96)	173 (36–419)	4 (1–10)
Cereals and grains	466 (98)	859 (487–1269)	20 (12–30)
Meats and alternatives	432 (91)	297 (67–720)	9 (3–18)
Dairy			
Without toddler milks	450 (95)	709 (320–1146)	17 (8–27)
With toddler milks [2]	455 (96)	888 (428–1495)	22 (10–34)
Fats and oils	298 (63)	53 (0–179)	1 (0–4)
Discretionary foods	422 (89)	435 (146–946)	10 (4–23)

[1] Values are median (IQR). [2] Dairy, including formula or toddler milk. A serving of formula or toddler milk was defined as 250 mL prepared volume.

Table 5. Energy and percentage total energy from five food groups and discretionary foods for toddlers stratified by age, OzFITS 2021.

Food Group	Consumers *n* (%)	Energy, kJ/day [1]	Percentage of Total Energy Intake [1]
Toddlers 12 to <18 months (*n* = 233)			
Fruit	224 (96)	362 (168–561)	9 (5–14)
Vegetables	229 (98)	173 (49–410)	4 (1–10)
Cereals and grains	225 (97)	773 (399–1137)	19 (11–29)
Meats and alternatives	213 (91)	297 (67–720)	8 (2–17)
Dairy			
Without toddler milks	220 (94)	691 (279–1135)	17 (7–28)
With toddler milks [2]	221 (95)	853 (415–1509)	22 (10–37)
Fats and oils	136 (58)	31 (0–159)	1 (0–4)
Discretionary foods	201 (86)	305 (84–755)	8 (2–19)
Toddlers 18 to 24 months (*n* = 242)			
Fruit	233 (96)	372 (177–600)	9 (5–13)
Vegetables	229 (95)	173 (19–425)	4 (1–10)
Cereals and grains	241 (100)	931 (544–1421)	21 (13–31)
Meats and alternatives	219 (91)	428 (132–856)	11 (3–20)
Dairy			
Without toddler milks	230 (95)	733 (365–1136)	17 (9–27)
With toddler milks	234 (97)	890 (443–1469)	22 (11–32)
Fats and oils	162 (67)	74 (0–214)	2 (0–4)
Discretionary foods	221 (91)	617 (216–1116)	15 (5–25)

[1] Values are median (IQR). [2] Dairy, including formula or toddler milk. A serving of formula or toddler milk was defined as 250 mL prepared volume.

Main drinks consumed by toddlers on the day of the food record: The types, amounts, and energy contribution from drinks are summarized in Table 6. One-half (51%) of toddlers 12 to <18 months and 40% of toddlers aged 18 to 24 months consumed breastmilk on the day of the food record, accounting for one-third and one-fifth of total energy, respectively. One-fifth of toddlers consumed formula or toddler milks, contributing 18–23% of total energy. Less than one-half of all toddlers consumed cow's milk as the main drink.

Table 6. The percentage of total energy from drinks for toddlers stratified by age, OzFITS 2021.

	Consumers *n* (%)	Intake, g/day [1]	Energy, kJ/day [1]	Percentage of Total Energy Intake [1]
Toddlers 12 to <18 months (*n* = 233)				
Breastmilk	119 (51)	350 (200–540)	1000 (571–1542)	28 (13–42)
Formula/toddler milks	47 (20)	423 (227–619)	1057 (623–1614)	23 (13–37)
Cow's milk (drink)	86 (37)	210 (116–411)	569 (312–1079)	15 (7–25)
Total milks [2]	221 (95)	380 (206–541) [2]	990 (570–1428)[2]	24 (14–38) [2]
Water	228 (98)	243 (135–375)	–	–
Sweetened beverages	5 (2)	250 (156–231)	364 (251–445)	6 (5–9)
Toddlers 18 to 24 months (*n* = 242)				
Breastmilk	90 (37)	330 (200–513)	900 (564–1464)	22 (12–34)
Formula/toddler milks	42 (17)	354 (212–462)	869 (524–1252)	18 (10–30)
Cow's milk (drink)	120 (50)	208 (129–324)	539 (315–822)	13 (8–19)
Total milks	211 (87)	300 (133–450)	792 (338–1232)	17 (8–30)
Water	230 (95)	289 (200–452)	–	–
Sweetened beverages	11 (5)	152 (104–263)	271 (163–473)	5 (3–8)

[1] Values are median (IQR) for consumers of each beverage type except total milks, where values are for the whole sample. [2] Total milks are the sum of breastmilk, formula/toddler milks, cow's milk, and alternatives consumed as a beverage.

Daily servings of five food groups and discretionary foods in breastfed and non-breastfed toddlers: Consumption of five food groups and discretionary foods according to breastmilk intake on the day of the food record are presented in Supplementary Materials Tables S1–S4.

On average, non-breastfed toddlers consumed greater servings of all five food groups than breastfed toddlers. In non-breastfed toddlers, dairy foods contributed to 40% and 25% of daily energy for those 12 to <18 months and 18 to 24 months, respectively.

4. Discussion

Our study is the first to compare Australian toddlers' intake of the five food groups and discretionary foods to the dietary patterns recommended in the Australian food selection guide. Most toddlers aged 12–24 months consumed foods from all five food groups; however, apart from fruit and dairy, the median servings of the five food groups were below the recommendations. Less than one-third of all toddlers consumed the recommended serving for meat and alternatives, and two-thirds did not consume the minimum recommended servings for vegetables. Only 10% of toddlers consumed the recommended servings of cereals and grains. In contrast, over half of toddlers consumed twice the amount of fruit recommended, and nearly half of toddlers consumed more than 1.5 servings of dairy foods. For the highest consumers (top quartile), dairy foods accounted for 30% of total energy. Despite no allowance for discretionary foods, 9 out of 10 toddlers consumed discretionary foods, contributing 8 to 15% of total energy for younger and older toddlers.

Our findings share some similarities with previous Australian studies of toddler dietary intakes from Adelaide and Brisbane (12–16 months) [20], Melbourne (18 months) [23], and Western Sydney (18 months) [24]. For example, the 20% energy coming from cereals and grains and 22% from dairy foods compare well with the 15–17% from cereals and grains and 28–35% of daily energy from dairy in the Adelaide/Brisbane and Western Sydney studies, respectively [20,24]. Consistent with these Australian studies [20,23,24], meat and meat alternatives in OzFITS 2021 were also consumed in small amounts with few toddlers consuming the recommended daily serving of 65 g. Factors contributing to low intakes from this food group may include the savory flavor profile [25] and the complex texture of these foods [26].

The National Health and Medical Research Council recommends cow's milk and water as the ideal drinks for toddlers and limits sugar-sweetened drinks and fruit juice [9]. In addition, breastfeeding into the second year of life is encouraged [9]. Sugar-sweetened beverages were consumed by less than 5% of children, which is markedly lower than that reported in the 2016 US FITS at around 30% [27]. We also observed a lower percentage of toddlers (44%) consuming cow's milk as a main drink compared to the US (83%). Over 50% of younger toddlers (12 to <18 months) and nearly 40% of older toddlers (18 to 24 months) in our survey consumed breastmilk as their main fluid on the day of food record. This is much higher than that reported in the 2010 Australian Infant Feeding Survey at 18% at 12 to <18 months and 7% of 18 to 24 months [28], and the US FITS 2016 at 18% and 5%, respectively [27]. Despite parents being advised to continue breastfeeding beyond 12 months [9], breastmilk is not included in the modeling used to inform the AGHE [8]. Given that around 45% of toddlers consumed breastmilk and breastmilk contributed to over 40% of energy for some toddlers, future modeling should include an allowance for breastmilk.

Due to the high breastfeeding rate in the second year of life [10], we stratified the consumption of core food servings and discretionary foods by breastmilk intake on the day of the food record to determine if any differences in consumption patterns for breastfed and non-breastfed toddlers existed. On average, breastfed toddlers consumed less of the five good group foods than non-breastfed toddlers, which may have implications for nutrient intake. Given that fortified cereals accounted for nearly half of all iron intake in toddlers in a Melbourne-based study, breastfed toddlers may be at greater risk of inadequate iron intake [19]. Similarly, toddlers in an Adelaide-based birth cohort study (mean 13.1 months) who received breastmilk as their sole milk source were at greater risk of inadequate intake of iron (50%) than those receiving formula (3%) with or without breastmilk [29]. A third of toddlers who received breastmilk only also had inadequate intakes of calcium compared

to less than 10% for those who received other milks. Although breastmilk has the same amount of energy as toddler or cow's milk, it contains less than a third of the calcium. Inadequate iron intakes were common in toddlers in our study and around 10% had low calcium intakes [12]. While the benefits of breastfeeding into the second year is beyond doubt, some toddlers may be receiving too much breastmilk as little practical guidance is given on how and when to offer breastmilk to optimize the consumption of core foods as toddlers transition from a milk-based diet to mostly family foods.

Our finding that discretionary foods are commonly consumed is consistent with other Australian studies [30–32]. For the highest quartile of the older toddlers, discretionary foods contributed up to one-quarter of daily energy intake, increasing the risk of obesity and displacement of other food groups in the diet. Commercial toddler foods marketed as healthy snacks in Australia [33] may be driving this as they were the most common foods consumed during snacking.

Our study has several strengths; chief among them is that it compared the five food group and discretionary food intake to the national recommendations. Furthermore, we have provided estimations of portion sizes consumed for each of the five food groups, which may be used to inform dietary modeling for this age group in subsequent revisions of the foundation diets [8]. In addition, we stratified the consumption of five food groups and discretionary food servings by breastmilk intake to illustrate differences in consumption patterns for breastfed and non-breastfed toddlers. As detailed in our previous paper, breastmilk intake may have been underestimated or overestimated as volume assumptions do not account for variation in feeding efficiency between toddlers [34]. However, the energy intakes for toddlers reported in our study [12] closely match the estimated energy requirements for this age group [7]. Maternal age is a strong predictor of continued breastfeeding [35] and may explain the high breastfeeding rates observed in our sample compared to previous Australian studies. Caregivers in our sample were highly educated and economically advantaged and may not be representative of the Australian population [11,36]. Finally, our analyses are based on a single day's intake, which may not reflect usual intake; however, our findings are consistent with those reported in similar studies using 3-day weighed food records or 24 h recalls [23,24].

5. Conclusions

Toddlers enrolled in OzFITS 2021 consumed less than the recommended daily servings for all five food groups except for fruit and dairy. Of concern is that 9 out of 10 toddlers consumed discretionary foods, which may displace five food group foods in the diet. Milk consumption from all sources, including breastmilk, accounted for one-quarter of daily energy and may impact the nutritional adequacy of toddler diets. Given the high percentage of toddlers receiving breastmilk, there is an urgent need to develop dietary patterns that include breastmilk.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/nu14142890/s1: Table S1: Daily servings of five food group and discretionary foods consumed by toddlers 12–<18 months stratified by breastmilk intake, OzFITS 2021; Table S2: Energy and percentage total energy from five food group and discretionary foods for toddlers aged 12–<18 months stratified by breastmilk intake, OzFITS 2021; Table S3: Daily servings of five food group and discretionary foods consumed by toddlers 18–24 months stratified by breastmilk intake, OzFITS 2021; Table S4: Energy and percentage total energy from five food group and discretionary foods for toddlers 18–24 months old stratified by breastmilk intake, OzFITS 2021.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Women and Children's Health Network Human Research Ethics Committee (HREC/19/WCHN/44).

Informed Consent Statement: Verbal informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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CHAPTER 7. USUAL NUTRIENT INTAKE DISTRIBUTION AND PREVALENCE OF INADEQUACY AMONG AUSTRALIAN CHILDREN 0–24 MONTHS: FINDINGS FROM THE AUSTRALIAN FEEDING INFANTS AND TODDLERS STUDY (OZFITS) 2021

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Contribution to the Paper	Contributed to the research design and research protocol. Conducted the research, performed statistical analysis, and contributed to interpretation of findings. Wrote the first draft and had primary responsibility for the final version of the manuscript.		
Overall percentage (%)	60		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	11/08/2022

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By signing the Statement of Authorship, each author certifies that:

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Usual Nutrient Intake Distribution and Prevalence of Inadequacy among Australian Children 0–24 Months: Findings from the Australian Feeding Infants and Toddlers Study (OzFITS) 2021

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Abstract: (1) Background: Breastmilk provides all the nutrition an infant requires between 0–6 months. After that, complementary foods are needed to meet the child's increasing energy and nutrient requirements. Inadequate energy and nutrient intake may lead to growth faltering, impaired neurodevelopment, and increased disease risk. While the importance of early life nutrition is well recognized, there are few investigations assessing the nutritional adequacy of Australian children < 24 months. Here, we describe usual energy and nutrient intake distributions, including the prevalence of inadequate intakes and exceeding the upper limit (UL), in a national sample of Australian children 6–24 months and infants < six months who had commenced solids and/or formula. (2) Methods: Dietary intakes were assessed using a one-day food record for 976 children with a repeat one-day record in a random subset. (3) Results: Based on the Nutrient Reference Values for Australia and New Zealand, children's intakes were above the Adequate Intake or Estimated Average Requirement for most nutrients. Exceptions were iron and zinc where the prevalence of inadequacy was estimated to be 90% and 20%, respectively, for infants aged 6–11.9 months. Low iron intake was also observed in one quarter of toddlers 12–24 months. On average, children consumed 10% more energy than predicted based on Estimated Energy Requirements, and ~10% were classified as overweight based on their weight for length. One third of toddlers exceeded the tolerable upper limit for sodium and consumed > 1000 mg/day. Of the children under six months, 18% and 43% exceeded the UL for vitamin A (retinol) and zinc. (4) Conclusions: Compared to nutrient reference values, diets were sufficient for most nutrients; however, iron was a limiting nutrient for infants aged 6–11.9 months and toddlers 12–24 months potentially putting them at risk for iron deficiency. Excessive sodium intake among toddlers is a concern as this may increase the risk for hypertension.

Keywords: Australian feeding infants and toddlers study; infants; toddlers; nutrient intake; nutrient reference values; prevalence of inadequacy; Australia; survey

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1. Introduction

The first two years of life are a period of rapid growth and development. For the first six months of life, breastmilk is sufficient to meet nutritional requirements; however, at around six months, complementary (solid) foods are needed to meet increased energy and

nutrient needs for growth [1–3]. On a per kg basis, infants require three times as much energy and five times as much iron, zinc, and vitamin A as an adult [4]. Failure to receive sufficient energy and nutrients from complementary foods may lead to growth faltering, cognitive impairment, and increased risk of infection [5,6]. Conversely, excessive energy intake may lead to rapid weight gain and excess energy from protein has been linked to obesity in later life [3,7,8].

In Australia, children less than two years old have been excluded from national nutrition surveys [9–11]; therefore, little is known about their diets. A small number of Australian studies have reported on energy and nutrient intakes in this age group [12–16], and iron and zinc have been identified as problem nutrients. However, the data for these studies were collected 10–15 years ago and were often limited to one or two Australian cities. Therefore, contemporary data on population intakes are urgently needed to better understand the scope of the problem and to identify evidence-based solutions to improve dietary intakes. To this end, we aim to describe mean energy and nutrient intakes of the population, including the prevalence of inadequate intakes based on Nutrient Reference Values (NRVs) for Australia and New Zealand [4] in a national sample of Australian children 0–24 months. Because breastmilk is assumed to meet infants' nutritional needs for the first six months, energy and nutrient intakes were only assessed for those infants receiving breast milk substitutes (formula) and/or consuming complementary foods.

2. Materials and Methods

A detailed description of the OzFITS 2021 data collection procedures and survey methods can be found elsewhere [17]. OzFITS 2021 was an Australia-wide cross-sectional survey conducted between April 2020 and April 2021. In total, 1140 caregiver-child dyads were enrolled over the 12 months. The study was approved by the Women's and Children's Health Network Human Research Ethics Committee (HREC/19/WCHN/44), and all caregivers gave informed verbal consent.

Caregivers with eligible children were referred to the study via a trial recruitment company [18]. At enrolment, all caregivers completed a sociodemographic and child-feeding questionnaire adapted from the 2016 United States Feeding Infants and Toddlers (FITS) and the 2010 Australian National Infant Feeding Survey [19,20]. Caregivers with children 0–24 months who had commenced complementary foods or consumed formula (n = 976) were invited to complete a food record for their child. Since breastmilk is sufficient to meet energy and nutrient needs for infants less than six months, caregivers with infants receiving only breastmilk at enrolment (n = 164) were not asked to complete a food record. Instead, a detailed breastfeeding history including the average number of breastfeeds in a 24-h period was collected. All survey data were collected and managed using REDCap™ (Research Electronic Data Capture) [21,22].

Dietary intake was estimated using a one-day food record, with a random subset of the population (~30%) completing a second food record on a non-consecutive day. Caregivers were randomly assigned to one or two record keeping days and then sent a study package, by post, which included a food record booklet and portion size estimation guide [10,19]. Once the study package was delivered, caregivers received a preparatory phone call from staff where they were instructed on how to record the portion size of foods and drinks offered using standard metric cup and spoon measures, kitchen scales, and the portion estimation guide. They were then asked to record everything their child consumed in a 24-h period starting from midnight using the food record booklets provided. Once completed, caregivers were asked to take photos of the booklet(s) and scan or email them to study staff. Interviewers then contacted the caregiver to review the food record(s) for completeness and accuracy. Interview techniques described in the four-pass 24-h recall method were used to systematically review food records with caregivers [23]. Pass one involved reviewing all the foods and drinks listed on the food record, followed by a detailed description of each item i.e., preparation method, brand name, variety etc. Portion sizes consumed, inclusive

of leftover amounts and spills, were then confirmed in pass three. Finally, in pass four, the food record was reviewed in full including probing for forgotten foods and snacks.

All food intake data was entered into FoodWorks™ Professional Version 10, a dietary analysis software program [24] which uses the 2011–2013 Australian Food, Supplement and Nutrient Database [25]. Commercial infant and toddler foods that were not available in FoodWorks™ were calculated using nutrient information and ingredient lists from the nutrition information panel. Most micronutrient values were not included on the nutrition information panel; therefore, a recipe approach based on ingredient lists was used to estimate these values [26]. Briefly, ingredients were entered as cooked food items in FoodWorks™ based on their proportion within the ingredient list (product recipe). Different quantities were imputed for individual ingredients until a nutrient profile that closely matched the nutrition information panel was achieved. All product recipes imputed in this way were within 10% of the manufacturer's reported energy, total fat, carbohydrate, protein, and total sugars. For fortified products, nutrient values generated by FoodWorks™ were replaced with the manufacturer's reported values.

Breastmilk intakes were estimated based on validated assumptions used in previous studies [2,27,28]. The number of minutes of active feeding were recorded for each breastfeed and converted to a fluid volume of 12.5 mL/min for infants < 6 months and 10 mL/min for older infants and toddlers up to a maximum of ten min per feed [29]. Feeds less than two minutes were excluded. Energy and nutrient content/100 g breastmilk was then calculated and entered as a food item in FoodWorks™ based on human milk composition data [4]. Expressed breastmilk was entered as the quantity expressed and fed to the child. For infant formula and toddler milk, the amount consumed was calculated from the caregiver's reported method of preparation using the following formula: formula (g) = scoop weight (g)/prepared volume (mL) × consumed volume (mL).

Caregivers were asked to provide their child's current length (cm) and weight (kg). If the child's length and weight had been measured by a healthcare professional in the previous 30 days, these measures were used. Otherwise, caregivers were asked to measure length and weight, according to instructions provided for in-home measurements [30].

Data Analysis

Quality assurance procedures ensured data entry accuracy and investigators completed a line-by-line audit of 10% of food records. Under or overreporting of energy intakes was estimated by comparing energy intakes to age-specific estimated energy requirements (EER) [4]. Energy intakes (EI) were considered plausible if EI: EER was between 0.54–1.46 [15,31]. Two investigators reviewed food records and case notes for all extreme under or over reporters and only two were removed from analysis.

Z-scores for weight for length were calculated using the World Health Organization Anthro Survey Analyzer™ [32], which uses child growth standards developed from the WHO Multicenter Growth Reference Study [33]. Children who were ≥+1 SD, ≥+2 SD, and ≥+3SD above the mean were classified as at risk for overweight, overweight, or obese, respectively [33]. Prevalence estimates with 95% CI were calculated.

Within-person variability in nutrient intake was adjusted using the Iowa State University method with the Intake Modelling, Assessment, and Planning Program (IMAPP) software [34]. Usual intake distributions were compared to the NRVs for Australia and New Zealand. For infants < 12 m, most nutrients lack an estimated average requirement (EAR); therefore, the probability of meeting adequate intakes (AI) is reported [4]. To estimate the prevalence of inadequate and excessive nutrient intakes, the EAR cut points, and tolerable upper limits (UL) described in the NRVs for Australia and New Zealand [4] were used. Since the distribution for iron is asymmetrical about the EAR, the cut point method cannot be used [35]. Thus, to estimate the risk of inadequacy for iron, the 'full probability approach' was used and compared the distribution for usual iron intake to the iron requirement distribution percentiles at 10% and 15% bioavailability for infants 6–11.9 months and toddlers 12–24 months, respectively [4,35]. Although the NRVs estimate

14% iron absorption for toddlers based on dietary modelling, this absorption percentile was not available in IMAPP, therefore the closest available percentile (15%) was used. Nutrient intake from supplements was not included, as only 6% percent of caregivers reported supplement use.

3. Results

Characteristics of the infants and toddlers eligible for food records are described in Table 1. Between April 2020 and April 2021, 976 caregivers with children < 24 months were enrolled and asked to keep a food record for their child; 29 withdrew and 94 were lost to follow before completing the food record. 853/976 (87%) completed the first food record, and 290/345 (84%) completed the second food record, which enabled the estimation of usual nutrient intake distribution. Breastfeeding rates were high in both infant age groups, and 210/542 (44%) of toddlers were still receiving breastmilk on the day of the food record. Nearly 40% of all children were classified as at risk for being overweight, with 10% classified as overweight. Underreporting of energy intake, an EI: EER below 0.54, was only observed in two children. In contrast, 58/851 (7%) of children had EI: EER above 1.46, suggesting a high energy intake. On average, energy intakes were 10% higher than EER for all age groups.

Table 1. Characteristics of children enrolled in OzFITS 2021 eligible for food records (n = 976) [1].

Indicators	0–5.9 Months (n = 126) [2]	6–11.9 Months (n = 308)	12–23.9 Months (n = 542)
Age (months), mean ± SD	4.4 ± 1.3	8.5 ± 1.7	17.7 ± 3.3
Sex (female), *n* (%)	58 (46.0)	152 (49.4)	252 (46.5)
Weight status % (95% CI) [3]			
Risk of overweight	24.3 (15.9, 32.8)	41.2 (35.1, 47.4)	38.6 (33.9, 43.3)
Overweight	9 (3.2, 14.8)	9.9 (6.1, 13.7)	12.8 (9.5, 16.1)
Obese	4.5 (0.2, 8.8)	1.5 (0, 3.2)	2.3 (0.8, 3.9)
Eligible to complete a food record, *n* (%)	126 (43.4)	308 (100)	542 (100)
Asked to complete a 2nd day	47 (37.3)	110 (35.7)	188 (34.7)
Completed food record, *n* (%) [4]			
1st day	114 (90.5)	279 (90.6)	460 (84.9)
2nd day	46 (97.9)	98 (89.1)	146 (77.8)
Milk feeding type [5]			
Breastmilk	65 (70.7)	221 (77.3)	210 (44.2)
Infant formula	76 (82.6)	39 (13.6)	14 (2.9)
Follow on formula	–	59 (20.6)	10 (2.1)
Toddler Milk	–	–	64 (13.5)
Cow's milk	–	–	165 (34.7)
Cow's milk alternative (e.g., nut or cereal based milks)	–	–	18 (3.8)
Energy intake, mean ± SD	2553 ± 571	3009 ± 42	4247 ± 30
Under reporters *n* (%)	1 (0)	1 (0)	0 (0)
Over reporters *n* (%)	9 (10)	18 (6.3)	31 (6.5)
Energy Intake/Estimated Energy Requirement, mean (95% CI)	1.1 (1.0, 1.1)	1.1 (1.0, 1.1)	1.1 (1.1, 1.1)

[1] Data are presented as mean ± SD, observed counts and percentages, or percentages with 95% CI for participants assigned food records; [2] 164/290 (57%) of young infants aged 0–5.9 months consumed only breastmilk at enrolment and were not assigned food records; [3] Weight-for-length z score: >+1 SD, risk of overweight; >+2 SD, overweight; >+3 SD, Obese [33]. Data were missing or implausible for n = 15 young infants aged 0–5.9 months, n = 46 infants 6–11.9 months; and n = 112 toddlers; [4] n = 22 young infants aged 0–5.9 m and n = 15 older infants aged 6–11.9 m moved into the next age bracket on the day of the food record; [5] Data reflects consumption on the day of the main food record for n = 92 young infants aged 0–5.9 months, n = 286 older infants aged 6–11.9 months, and n = 475 toddlers aged 12–24 months.

Table 2 describes the mean nutrient intakes and prevalence of inadequacy or excessive intake for infants 0–5.9 months consuming formula and/or complementary foods. Two infants had energy intakes more than twice the EER and were excluded from analysis. Average daily energy intakes were approximately 2553 ± 60 kJ/day, with carbohydrates and fat contributing equally to energy intake. For most nutrients a high proportion of

infants came close to meeting the AI, except for iodine (69%). The UL for retinol and zinc was exceeded by 18% and 43% of infants, respectively.

Table 2. Usual energy and nutrient intake distribution from foods and beverages for mixed fed infants aged 0–5.9 months OzFITS 2021 (n = 90) [1].

	NRV Values		Distribution of Energy and Nutrient Intake						NRV Compliance (%)	
	AI [2]	UL [2]	10th	25th	50th	Mean ± SE	75th	90th	>AI	>UL
Macronutrients										
Energy, kJ/day	–	–	1915	2109	2477	2553 ± 60	2992	3253	–	–
Protein, g/d	10	–	9.3	10.4	12.5	12.8 ± 0.3	14.7	16.5	83	–
Protein, g/kg BW [3]	1.43	–	1.3	1.6	2.0	2.0 ± 0.06	2.4	2.9	82	–
Fat, g/d	31	–	24	27	31	32 ± 0.8	38	42	51	–
Carbohydrates, g/d	60	–	53	58	68	69 ± 1.6	80	87	69	–
Protein, % kJ	–	–	8	8	8	9 ± 0.1	9	10	–	–
Fat, % kJ	–	–	42	45	48	47 ± 0.4	50	51	–	–
Carbohydrates, % kJ	–	–	43	45	46	46 ± 0.3	47	50	–	–
Micronutrients										
Vitamin A [4], µg RAE/d	250	600	303	384	512	527 ± 19.3	629	732	99	18
Thiamin, mg/d	0.2	–	0.2	0.2	0.3	0.4 ± 0.02	0.6	0.7	78	–
Riboflavin, mg/d	0.3	–	0.2	0.3	0.6	0.7 ± 0.04	1	1.3	80	–
Niacin [5], mg/d	2	–	4.7	6.7	10.5	10.5 ± 0.4	13.2	16.2	100	–
Vitamin B6, mg/d	0.1	–	0.1	0.2	0.3	0.3 ± 0.02	0.4	0.5	94	–
Folate, µg DFE/d	65	–	73	88	108	121 ± 4.7	150	185	92	–
Vitamin B_{12}, µg/d	0.4	–	0.3	0.5	1.0	3.0 ± 1.4	2.1	4.2	82	–
Vitamin C, mg/d	25	–	23	36	54	64 ± 3.5	90	110	89	–
Calcium, mg/d	210	–	169	235	323	357 ± 18	463	560	78	–
Iron, mg/d	0.2	20	0.8	1.6	3.8	4.3 ± 0.4	6.3	8.8	99	1
Magnesium, mg/d	30	–	29	42	66	70 ± 3.4	96	113	90	–
Phosphorus, mg/d	100	–	106	137	209	225 ± 12.0	302	393	93	–
Sodium, mg/d	120	–	106	138	162	176 ± 6.1	213	248	86	–
Iodine, µg/d	90	–	70	84	102	108 ± 3.1	128	150	69	–
Selenium, µg/d	12	45	13	15	17	18 ± 0.5	22	24	92	0
Zinc, mg/d	2	4	1.8	2.3	3.6	3.8 ± 0.2	5.3	6.3	81	43

[1] Nutrient intake data are presented as percentiles of usual intake, mean ± SE, or percentages of NRV compliance. NRV, nutrient reference values; AI, adequate intake, UL, tolerable upper level of intake; RAE, retinol activity equivalent; DFE, dietary folate equivalent; [2] All NRVs are from the NHMRC Nutrient Reference Values for Australia and New Zealand [4]; [3] BW, bodyweight; [4] The UL for vitamin A is for retinol only; [5] The AI for niacin is based on preformed niacin only.

The usual energy and nutrient intake distributions for infants aged 6–11.9 months and toddlers 12–24 months are described in Tables 3 and 4. More than 90% of older infants and one quarter of toddlers had inadequate iron intakes (Tables 3 and 4). Approximately one-fifth of older infants were estimated to be at risk for dietary zinc inadequacy. One third of toddlers exceeded the UL for sodium.

Table 3. Usual energy and nutrient intake distribution from foods and beverages for infants aged 6–11.9 months OzFITS 2021 (n = 286) [1].

	NRV Values			Distribution of Energy and Nutrient Intake						NRV Compliance (%)		
	EAR [2]	AI [2]	UL [2]	10th	25th	50th	Mean ± SE	75th	90th	<EAR	>AI	>UL
Macronutrients												
Energy, kJ/day	–	–	–	2159	2565	2970	3009 ± 42	3393	3951	–	–	–
Protein, g/d	–	14	–	12	16	20	21 ± 1	26	32	–	85	–
Protein, g/kg BW [3]	–	1.6	–	1.5	1.8	2.4	2.5 ± 0.1	2.9	3.6	–	86	–
Fat, g/d	–	30	–	24	28	33	33 ± 0.4	38	43	–	64	–
Carbohydrate, g/d	–	95	–	58	68	80	81 ± 1.2	92	107	–	23	–
Dietary fibre, g/d	–	–	–	1.9	3.7	6.0	7 ± 0.2	9	13	–	–	–

Table 3. *Cont.*

	NRV Values			Distribution of Energy and Nutrient Intake					NRV Compliance (%)		
	EAR [2]	**AI [2]**	**UL [2]**	**10th**	**25th**	**50th**	**Mean ± SE**	**75th**	**90th**	**<EAR**	**>AI**	**>UL**
Protein, % kJ	–	–	–	9	10	12	12 ± 0.2	14	16	–	–	–
Fat, % kJ	–	–	–	35	38	42	41 ± 0.3	45	48	–	–	–
Carbohydrate, % kJ	–	–	–	41	44	46	46 ± 0.3	49	52	–	–	–
Micronutrients												
Vitamin A [4], µg RAE/d	–	430	600	377	468	604	626 ± 13	733	896	–	81	2
Thiamin, mg/d	–	0.3	–	0.2	0.3	0.4	0.5 ± 0.02	0.8	1.0	–	70	–
Riboflavin, mg/d	–	0.4	–	0.3	0.4	0.6	0.8 ± 0.03	1.1	1.4	–	79	–
Niacin [5], mg/d	–	4.0	–	11	13	15	15 ± 0.2	18	20		100	
Vitamin B6, mg/d	–	0.3	–	0.2	0.3	0.4	0.5 ± 0.01	0.6	0.7	–	72	–
Folate, µg DFE/d	–	80	–	91	120	159	179 ± 5	224	295	–	94	–
Vitamin B12, µg/d	–	0.5	–	0.5	0.7	1.1	1.4 ± 0.1	1.8	2.4	–	90	–
Vitamin C, mg/d	–	30	–	30	40	56	65 ± 2	86	114	–	90	–
Calcium, mg/d	–	270	–	185	233	329	373 ± 10	484	633	–	64	
Iodine, mg/d	–	110	–	73	85	100	100 ± 1.4	116	131	–	33	–
Iron [6], mg/d	7	–	20	1.1	2.1	4.3	4.9 ± 0.2	7.0	9.5	92	–	0
Magnesium, mg/d	–	75	–	48	69	99	106 ± 2.8	137	173	–	72	–
Phosphorus, mg/d	–	275	–	171	245	363	389 ± 11	513	627	–	70	–
Selenium, µg/d	–	15	60	15	18	22	23 ± 0.5	28	33	–	90	0
Sodium, mg/d	–	170	–	161	205	281	323 ± 10	400	544	–	86	–
Zinc, mg/d	2.5	–	5	2.2	2.8	3.7	4.0 ± 0.1	5.1	6.1	17	–	26

[1] Nutrient intake data are presented as percentiles of usual intake, mean ± SE, or percentages of RDI compliance. NRV, nutrient reference values; EAR, estimated average requirement; AI, adequate intake; UL, tolerable upper level of intake; RAE, retinol activity equivalent; DFE, dietary folate equivalent; [2] All NRVs are from the National Health and Medical Research Council Nutrient Reference Values for Australia and New Zealand [4]; [3] BW, bodyweight; [4] The UL for vitamin A is for retinol only; [5] The AI for niacin is based on niacin equivalents; [6] The full probability approach at 10% bioavailability was used to estimate percentage at risk of inadequacy [4,35].

Table 4. Usual energy and nutrient intake distribution from foods and beverages for toddlers aged 12–24 months OzFITS 2021 (n = 475) [1].

	NRV Values			Distribution of Energy and Nutrient Intake					NRV Compliance (%)		
	EAR [2]	**AI [2]**	**UL [2]**	**10th**	**25th**	**50th**	**Mean ± SE**	**75th**	**90th**	**<EAR**	**>AI**	**>UL**
Macronutrients												
Energy, kJ/day	–	–	–	3461	3783	4233	4247 ± 30	4662	5090	–	–	–
Protein, g/d	12	–	–	30	35	39	40 ± 0.4	44	50	0	–	–
Protein, g/kg BW [3]	0.92		–	2.6	3.0	3.5	3.6 ± 0.04	4.0	4.6	0	–	–
Fat, g/d	–	–	–	33	36	40	41 ± 0.3	44	48	–	–	–
Carbohydrate [4], g/d	100	–	–	92	101	115	116 ± 1.0	129	143	21	–	–
Dietary fibre, g/d	–	14	–	8.9	11.2	13.6	13.6 ± 0.2	15.7	18.3	–	43	–
Protein, % kJ	–	–	–	13	14	16	16 ± 0.1	17	19	–	–	–
Fat, % kJ	–	–	–	31	33	36	36 ± 0.2	38	40	–	–	–
Carbohydrate, % kJ	–	–	–	41	43	46	47 ± 0.2	49.5	52.2	–	–	–
Micronutrients												
Vitamin A [5], µg RAE/d	210	–	600	436	512	606	641 ± 8.8	736	927	0	–	0
Thiamin, mg/d	0.4	–	–	0.5	0.6	0.8	0.8 ± 0.02	1.0	1.2	3	–	–
Riboflavin, mg/d	0.4	–	–	0.7	0.9	1.2	1.2 ± 0.02	1.5	1.7	0	–	–
Niacin [6], mg/d	5.0	–	150	14	16	18	19 ± 0.2	21	24	0	–	0
Vitamin B6, mg/d	0.4	–	–	0.5	0.6	0.8	0.8 ± 0.01	0.9	1.2	3	–	–
Folate [7], µg DFE/d	120	-	300	217	260	312	320 ± 3.9	365	432	1	–	0
Vitamin B12, µg/d	0.7	–	–	1.2	1.7	2.2	2.4 ± 0.05	2.9	3.7	0	–	–
Vitamin C, mg/d	25	–	–	37	45	56	58 ± 0.9	69	83	2	–	–
Calcium, mg/d	360	–	2500	353	462	592	608 ± 9.6	743	879	11	–	0
Iodine, µg/d	65	–	200	79	94	113	116 ± 1.5	135	156	3	–	1
Iron [8], mg/d	4		20	3.3	4.4	5.5	5.9 ± 0.1	7.0	8.7	25	–	0

Table 4. *Cont.*

	NRV Values			Distribution of Energy and Nutrient Intake						NRV Compliance (%)		
	EAR [2]	AI [2]	UL [2]	10th	25th	50th	Mean ± SE	75th	90th	<EAR	>AI	>UL
Magnesium, mg/d	65	–	65	120	151	174	179 ± 2.0	205	237	0	–	NA
Phosphorus, mg/d	380	–	3000	517	644	758	764 ± 9.2	879	1016	2	–	0
Selenium, µg/d	20	–	90	26	30	34	34 ± 0.3	38	43	0	–	0
Sodium, mg/d	–	200–400	1000	561	706	836	878 ± 12.4	1023	1210	–	100	29
Zinc, mg/d	2.5	–	7	4.2	4.7	5.2	5.3 ± 0.04	5.8	6.3	0	–	4

[1] Nutrient intake data are presented as percentiles of usual intake, mean ± SE, or percentages of NRV compliance. NRV, nutrient reference value; AMDR, Acceptable Macronutrient Distribution Range; EAR, estimated average requirement; AI, adequate intake; UL, tolerable upper level of intake; RAE, retinol activity equivalent; DFE, dietary folate equivalent; NA, not applicable; [2] Unless otherwise stated, all NRVs are from the NHMRC Nutrient Reference Values for Australia and New Zealand [4]; [3] BW, bodyweight; [4] NRV is from the Institute of Medicine Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids; [5] The UL for vitamin A is for retinol only; [6] The EAR for niacin is based on niacin equivalents; [7] The UL for folate is for folic acid only; [8] The full probability approach at 15% bioavailability was used to estimate percentage at risk of inadequacy [35].

4. Discussion

This is the first national study to estimate usual energy and nutrient intake distribution, including the prevalence of inadequate and excessive intakes for key micronutrients, in Australian children under two years of age. Overall, children met or exceeded AIs or EARs and were below the UL for most nutrients. Exceptions were a very high prevalence of inadequacy for iron (>90%) in infants 6–11.9 months and excessive sodium consumption in a high proportion of toddlers 12–24 m (30%).

Because breastmilk is sufficient to meet the nutritional needs of infants < 6 months, we only assessed dietary intakes of infants receiving breastmilk substitutes and/or solid foods. For these infants, a high proportion met their AI, ranging from 69% for iodine to 100% for niacin. Intakes above the AI are considered adequate to meet nutrient requirements; however, intakes below the AI do not indicate nutritional inadequacy as they are based on intakes of apparently healthy groups or populations rather than an EAR [4,36]. Consistent with US FITS 2016 [36], a high proportion of infants in our study exceeded the UL for vitamin A (18%) and zinc (43%) which can be explained by the higher concentrations of these nutrients found in breastmilk substitutes compared to breastmilk. However, given the lack of reports of widespread hypervitaminosis A and zinc toxicity in Australian and US infants, this does not appear to be a problem and the ULs may be set too low [37].

For nutrients with AIs, the proportion of infants (6–11.9 months) meeting or exceeding requirements ranged between 33% for iodine to 100% for niacin. For the two nutrients with EARs, iron and zinc, the prevalence of inadequacy was estimated to be 90% and 20%, respectively. Compared to other life stages, the EARs for iron (7 mg/d) and zinc (2.5 mg/d) are exceptionally high, and inadequate intakes are frequently reported for this age group in other high-income countries [38–40]. Nevertheless, compared to our survey, previous Australian and American studies report much lower prevalence of inadequacy for both iron (9–36%) and zinc (1–9%) [12,15,36]. The reasons for this may be attributable to differences in infant formula and breastmilk consumption. In our study, >75% of infants were breastfed whereas 55–70% of infants in US FITS 2016 [36] and other Australian studies [12,15] consumed infant formula as their primary milk source. Because infant formula is fortified, breastfed infants are more reliant on nutrient dense foods to meet their iron and zinc requirements and are more likely to have inadequate intakes [2,3]. However, whether the high prevalence of dietary inadequacy is reflected in biomarkers of iron status or anemia is unknown. There are no contemporary data on the prevalence of iron or zinc deficiency in Australian infants aged 6–12 months. The only reports are from the 1990s and are from small samples in Sydney and Adelaide, which only assessed iron status [41–43].

EARs have been set for most nutrients for toddlers (one to two years). Apart from iron, the prevalence of inadequacy for all nutrients was low, around 3%. The prevalence

of iron inadequacy in this age group is 25%, which is much lower than for infants and is more consistent with other Australian studies [12–14,16] and the US FITS 2016 [36]. For example, Zhou et al. reported a similar prevalence of inadequate iron intakes (16%) in a representative sample of Adelaide toddlers [13]. The decrease in the prevalence of inadequacy for iron from late infancy to toddlerhood can be attributed to the lower EAR for this age group (4 mg/d vs. 7 mg/d), increased food consumption, and in some cases, consumption of fortified milks. Like infants, there are no national prevalence estimates for iron deficiency or iron deficiency anemia in Australian toddlers. However, the reported prevalence of iron deficiency or iron deficiency anemia (13%) closely matched the estimated prevalence of inadequate iron intake in the Adelaide study [13]. Of concern is the high proportion of toddlers (30%) exceeding the upper limit for sodium consumption. Although the evidence base is equivocal, exposing young children to excess salt may increase their preference for salty foods later in life [44]. A high salt intake is a known risk factor for hypertension and cardiovascular disease in later life [4].

A key strength of this study was the direct data capture afforded by the food record. Although the 24-h recall method has the advantage of the element of surprise, food records reduce recall bias and allow for more accurate estimations of portion size due to real time data capture [45,46]. In our study there was no evidence of under reporting, which is a common problem in dietary assessment. If anything, there was an over estimation of energy intake compared with estimated requirements by 10% in all age groups. This is also reported in the US FITS 2016 [36]. We did not obtain dietary intake data from infants <six months receiving only breastmilk, and those with complete diet records were slightly older, formula fed, and more likely to have commenced complementary feeding compared to breastfed infants. For this reason, results for infants <six months should be interpreted with caution.

We caution that the NRVs for Australia and New Zealand are based on a limited evidence base. Most were adopted from the United States Institute of Medicine, Dietary Reference Values that were established more than 20 years ago [35]. Most EARs and AIs are either based on breastmilk nutrient composition from a small number of mothers or extrapolated from other age groups [4,35].

A challenge inherent in assessing dietary intake in this age group is obtaining accurate estimates of breastmilk intake. Like other studies, we have relied on published assumptions to estimate the volume of breast milk consumed. These assumptions do not take into account variation in breastfeeding efficiency between infants and maternal differences in breastmilk production [29]. Moreover, breastmilk composition is variable, and this variation is not reflected in the nutrient composition tables [4].

We did not assess the dietary intake of Vitamin D in our study due to a lack of food composition data. We recognize that the intake of vitamin D in breastfed infants is likely inadequate due to the low content in breastmilk. Unlike other high-income countries, Australian health authorities do not recommend routine vitamin D supplementation of breastfed infants. We did not include the contribution of infant vitamin and mineral supplements in our nutrient estimates; however, less than 10% of children were given supplements, mainly Vitamin D. We also did not assess maternal vitamin and mineral supplement use. This may have led to an underestimation of the proportion of infants 6–11.9 m meeting the AI for iodine. In Australia, lactating women are advised to take iodine supplements to increase their breastmilk iodine concentration [47].

We acknowledge that our sample is not representative of the Australian population. Our population is more educated and economically advantaged. However, our breastfeeding rates and durations as well as use of breastmilk substitutes is consistent with the 2010 Australian National Infant Feeding survey [20].

5. Conclusions

In sum, children's diets were adequate for most nutrients except iron, zinc, and sodium. Of concern is the very high prevalence of inadequate iron intake amongst infants. We ur-

gently need a nationally representative dietary survey including nutritional biomarkers for iron and other key nutrients in young children. Diet quality, including food sources of limiting nutrients, will be addressed in this publication series. Finally, a global effort towards establishing more robust dietary reference values for infants and children is required.

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Informed Consent Statement: Verbal informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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CHAPTER 8. SUMMARY OF KEY FINDINGS AND FUTURE DIRECTIONS FOR RESEARCH

OzFITS 2021 provides essential baseline data on infant and young child feeding in Australia and allows us to identify where things are going well and areas that need improvement. Ultimately, OzFITS 2021 will inform the need for interventions to improve young child feeding practices in Australia. The findings from OzFITS 2021 are timely as the Australian Dietary Guidelines are currently being revised. Below is a summary of the key findings, limitations, gaps in evidence and future directions for research.

8.1 Key Findings

8.1.1 Breastfeeding, breastmilk substitute use and timing of complementary foods

The NHMRC Infant Feeding Guidelines [11] recommend exclusive breastfeeding to around six months, followed by the introduction of nutritious complementary foods with continued breastfeeding to 12 months and beyond. In Netting et al. [66], we reported a high initiation rate and a long duration of breastfeeding, with 68% of infants breastfed to six months and 44% breastfed into their second year. Almost no infants (1%) were exclusively breastfed to six months, and most lost their exclusive breastfeeding status due to exposure to breastmilk substitutes in hospital. Interestingly, one third of infants exposed to breastmilk substitutes in hospital resumed exclusive breastfeeding until complementary foods were introduced, and one third of infants had never received breastmilk substitutes suggesting a strong desire to breastfeed among Australian mothers.

Early (before four months) or late (after seven months) introduction to complementary foods was negligible in our study, with most infants receiving complementary foods between the fifth and sixth month of life. This is encouraging as early introduction to complementary foods

increases the risk for obesity, gastrointestinal disorders, and food allergy [11]. Likewise, delayed introduction to complementary foods is associated with feeding difficulties, growth faltering, and micronutrient deficiencies [11, 29].

8.1.2 Introduction to common food allergens

Recommendations for infant feeding specific to allergy prevention have recently changed based on new high-level evidence supporting early and regular exposure to common food allergens to reduce the risk of developing IgE-mediated food allergy [40, 41]. The Australasian Society of Clinical Immunology and Allergy (ASCIA) updated its advice in 2016 to reflect this new evidence, which has been widely promoted by the federally funded National Allergy Strategy allergy prevention campaign [42]. Parents enrolled in OzFITS 2021 followed this advice, with 97% introducing eggs and 94% introducing peanuts by one year; however, we did not capture the frequency of exposure in this study. ASCIA advises caregivers to give their infant potential food allergens regularly (twice weekly) once introduced to prevent food allergies from developing [42]. In a South Australian study [43], most caregivers had introduced allergens by one year, but many were not regularly exposing their infant to potential allergens indicating a need for refined public health messaging.

8.1.3 Foods and Drinks

At around 6 months, complementary foods from the five food groups, with an emphasis on iron-rich first foods, should be introduced alongside breastmilk or breastmilk substitutes if breastfeeding is not possible [11]. By 12 months, children should transition away from a primarily milk-based diet and consume nutritious family foods consistent with the Australian Dietary Guidelines [11, 12]. OzFITS 2021 is the first study to compare dietary intakes of Australian toddlers to the recommended servings of the five food groups—fruits, vegetables,

cereals and grains, meats and alternatives, and dairy—outlined in the Australian Dietary Guidelines [46]. We showed a mismatch between dietary intakes and the recommended dietary pattern for toddlers [67]. Although dairy serves generally matched the recommendation, toddlers consumed twice as many fruit servings as recommended. Moreover, nearly all consumed discretionary foods, despite no allowance for these foods. Consumption of fruit and discretionary foods may have displaced other food groups namely, vegetables, cereals and grains, and meat and meat alternatives as toddlers consumed only half the recommended serves of these food groups.

Prolonged breastfeeding beyond one year is recommended in the NHMRC Infant Feeding Guidelines [11]; however, breastmilk is not included in the dietary modelling that underpins the recommended dietary pattern for toddlers [12, 46]. In our study, 44% of toddlers were still receiving breastmilk; among those, one quarter received nearly one third of their daily energy from breastmilk. Because of the high prevalence of continued breastfeeding, we stratified our analysis by breastmilk consumption on the day of the food record. On average, breastfed toddlers consumed a smaller number of servings from the five food groups, of which dairy was consumed the least. For non-breastfed toddlers, those consuming cow's milk met the suggested number of dairy serves, and those consuming toddler milk exceeded recommendations. For the latter group, a significant proportion of energy came from toddler milk and dairy – up to 49% in the highest quartile of 12 to <18m and 37% for those 18 to 24m. While breastfeeding into the second year is beneficial, too much breastmilk may also displace other essential foods and lead to nutrient inadequacy.

The NHMRC Infant Feeding Guidelines provide little practical advice to parents on how to manage the transition from primarily breastmilk or breastmilk substitute-based diets to

consumption of mainly family foods. For breastfeeding parents, the statement “breastfeed as often as the infant desires and the mother is able” [11] may be misleading as they may assume there is no consequence for allowing a toddler to frequently breastfeed. Guidance on how and when to deliver breastmilk while emphasizing food consumption is needed. Further, since toddler milks are consumed as a dairy product, additional guidance on product labels is warranted about how to incorporate these products as part of overall dairy intake and prevent displacement of other essential food groups.

8.1.4 Juice

Unlike other countries, such as the USA [68], juice consumption is not an issue in Australia. Australian public health messaging encouraging water or milk as main drinks for toddlers has been strong. Encouragingly, only 16 of 475 toddlers surveyed consumed juice, suggesting high degree of compliance with this advice.

8.1.5 Discretionary foods

One concerning finding was the high discretionary food intake among toddlers. In older toddlers 18 to 24 months, discretionary foods provided 1116kJ (265Cal), equivalent to one-quarter of the estimated energy requirement, in the top quartile of consumers. Although toddlers mainly consumed commercial snack foods, some ‘healthy’ homemade snacks also fit into the discretionary food category due to their sugar, saturated fat, and/or salt content. For example, bliss balls made with fresh dates, seeds, and coconut oil were popular homemade snacks; however, these seemingly healthy snacks were extremely energy dense at ~ 150Cal per 30 g serve.

In Australia and New Zealand, compositional requirements for Foods for Infants are outlined in FSANZ Standard 2.9.2, with specific conditions for iron and vitamin C fortification,

restrictions on sodium content, and textural requirements for foods produced for infants [69, 70]. However, requirements for toddlers are described in the same schedule as for adults, Schedule 4—Nutrition, health, and related claims [71]. For toddler foods, this is concerning because toddlers have specific growth and developmental needs not addressed in Schedule 4. Moreover, snack foods aimed at toddlers are the fastest growing sub-category of commercial foods, the majority of which are extruded puffs and sweet finger foods with little nutritional value [72]. Recent evidence from Simmonds et al [70] has also shown that nearly all products contain at least one 'better for you' health-related marketing message. Given the strict regulation on infant food products and breastmilk substitutes, parents may erroneously conclude that the nutritional content of toddler foods is as tightly regulated as those intended for infants. Greater regulatory oversight is therefore needed for commercial foods aimed at toddlers to ensure alignment with guidelines [11, 12].

8.1.6 Nutrient intakes

OzFITS 2021 was the first Australian nationwide study to estimate nutrient intakes for children <2 years. For infants <12 months, we could not determine the prevalence of inadequacy for most nutrients, as there is no Estimated Average Requirement (EAR), only an Adequate Intake (AI). Although population intakes below the AI does not indicate inadequacy for a nutrient, intakes above the AI can be assumed to be nutritionally adequate. Most nutrient intakes exceeded the AI for infants.

Only two nutrients have established EARs for infants 7-12m, iron and zinc, both of which had a high prevalence of inadequacy at 92% and 17%, respectively. For toddlers, most nutrients have EARs, and the prevalence of inadequacy was <10% for all but iron, where 25% were below the EAR. The decrease in the prevalence of inadequacy for iron observed in toddlers can

be explained by the drop in requirements from infancy to the toddler years (7mg/day vs 4 mg/day) and the age-related increase in food consumption ~1000 kJ/day [73]. Besides iron, sodium was another nutrient of concern, albeit for excessive rather than inadequate consumption. In our study, 1 in 3 toddlers exceeded the upper limit of 1000mg/day, equivalent to 2.5 grams of salt.

8.1.7 Tastes, textures, and nutrient profiles of commercial foods

The Australian commercial infant and toddler food landscape has changed considerably since the NHMRC Infant Feeding Guidelines and the Australian Dietary Guidelines were published. Since 2013, the retail value of the Australian baby food industry more than doubled and is currently valued at $1.2 billion AUD [26]. Alongside the explosion of highly processed snack foods aimed at toddlers [37, 70, 72], product packaging has shifted from glass jars that promote spoon feeding to squeeze pouches with a nozzle feature that allow food to be sucked directly. As of 2019, nearly 60% of all products sold in Australia were packaged in squeeze pouches [72]. This packaging trend has also been observed in other high-income countries [35-37] and expert bodies such as the Nutrition Commission of the German Society for Pediatrics and Adolescent Medicine have raised concerns around the mode of feeding promoted by these products. Consuming foods directly from the pouch may disrupt regulation of energy intake and satiety and delay the development of oral musculature and self-feeding skills in young children.

Another area of concern pertains to the nutrient, taste, and textural properties of commercial products. Although iron rich complementary foods such as iron-fortified infant cereals and pureed red meats are recommended as first foods, more than 80% of infant products are sweet tasting fruit purees [72]. In our study, only a quarter of infants 6-12m consumed iron rich foods

(unpublished data), thus it is possible that the ubiquity of fruit-based products may have influenced parental choices. Moreover, the few available vegetable-containing products are mostly fruit-based or sweet tasting varieties, which may reduce acceptance of plain or savory flavour profiles [72]. Furthermore, ~50% of all available products are smooth in texture, frequent consumption of which may impede progression to more complex textures. In our study, vegetables, meat, and meat alternatives were poorly consumed among toddlers. Although we have not explored the degree to which these products were consumed, its plausible that limited exposure to plain vegetables, coupled with the uniform texture and limited meat content of composite meals exacerbates food fussiness at one year.

8.1.8 SARS-CoV-2 pandemic

The study commenced during the Sars-CoV-2 global pandemic in early 2020. During this period, parents were working from home and many children could not attend childcare. Although short-lived in most Australian states and territories, Victoria and New South Wales were under stay-at-home orders for 180 and 107 days, respectively. When asked, if the pandemic influenced the way in which they fed their children, 69% (70/101) of the parents that indicated an impact resided in Victoria and New South Wales. Although the responses varied, some common threads appeared. Some parents reported positive changes to feeding practices including a resurgence of family mealtimes, more time to prepare home-cooked foods, less take-away foods, and prolonged breastfeeding. In contrast, others reported negative impacts including more frequent snacking due to boredom, reduced access to fresh produce, increased reliance on packaged infant foods, and early weaning due to a lack of breastfeeding support (unpublished data).

8.2 Limitations

8.2.1 Sampling

As with similar studies, OzFITS 2021 is not a representative sample. We used a convenience sampling strategy which is prone to selection bias towards individuals from advantaged socioeconomic groups. Our sample was more likely to be partnered, university educated, and report household incomes >$100,000 AUD compared to the Australian population [74]. In addition, we were unable to enrol many participants from cultural or linguistically diverse groups, including Aboriginal and Torres Strait Islander peoples using our recruitment strategy.

8.2.2 Estimation of breastmilk intake

For breastfed infants and toddlers, we relied on breastmilk nutrient composition from the 2011/13 Australian Food, Supplement, and Nutrient Database [15, 54]. However, most of these values were adopted from the US and were developed almost 30 years ago. There is also emerging evidence that modern diets higher in fat or sugar alter breastmilk composition in lactating mothers, particularly triglycerides, cholesterol, protein, and lactose concentrations [75]. As such there is an urgent need to update food composition tables with contemporary data from breastfeeding women. Estimation of breastmilk intakes were based on volume calculations derived from studies conducted with exclusively or predominantly breastfed infants [76, 77]. This method does not account for differences in consumption patterns for mixed-fed infants, was not validated in toddlers, and does not reflect variations in feeding efficiency between children.

8.2.3 Anthropometrics

Due to the SARS-CoV-2 pandemic restrictions, parents were unable to visit their maternal child health nurses to monitor their children's weights and lengths. Therefore, we provided parents with instructions on at-home measurments and relied on these self-reported measures.

8.2.4 Lack of Estimated Average Requirements

Average nutrient intakes and the prevalence of inadequate and excessive nutrient intakes are reported in Moumin et al [73]. To assess prevalence of inadequacy for a given nutrient, an EAR is needed. For infants <12 months, a lack of EARs for nearly all nutrients precludes us from estimating nutritional adequacy for this group. Further, most AIs and EARs were adopted from US Dietary Reference Values established in 2001 and were developed with limited evidence. Indeed, the AIs for infants <12 months are based entirely on the nutrient composition of breastmilk from a small number of lactating women, or breastmilk nutrient composition plus the contribution from complementary foods in apparently healthy breastfed infants surveyed in the mid-1990s [15]. Similarly, the EARs for young children were extrapolated from AIs or other age groups and adjusted for body size due to a lack of experimental evidence.

Moreover, we did not gather information on maternal vitamin / mineral supplementation whilst breastfeeding. This is especially important for nutrients like iodine where there is a blanket recommendation for breastfeeding women to take iodine supplements [78]. Additionally, many women continue to take their prenatal supplement whilst breastfeeding which may have underestimated true intake.

8.2.5 Comparison to dietary guidelines

Although dietary guidelines are used as a benchmark with which to evaluate dietary adequacy, they are an evolving document, and a revision is currently underway. In comparing our results to the current guidelines, we may have under or overestimated the magnitude of the problem. Nevertheless, OzFITS is the largest and only nationwide dietary intake study in this age group and can be used to inform the planned revisions.

8.3 Gaps in evidence and future directions for research

Thus far, this critical age group has been excluded from national nutrition surveys. With limited resources, we have shown that it is possible to collect detailed information on early life feeding practices and dietary intake data. Using the OzFITS methodological framework, this survey can be repeated in a nationally representative sample with appropriate financial and human resource backing from the federal government.

Along with a nationally representative nutrition survey, biomarkers for key nutrients such as iron will enable us to validate dietary intake data. Since the NRVs were developed with a limited evidence base more than 20 years ago, it may be that dietary requirements for nutrients like iron are too high; however, without estimates of the prevalence of iron deficiency or anaemia to compare to, we cannot conclusively say if this is the case.

Like the NRVs, nutrient composition of breastmilk is outdated and contemporary data with Australian mothers are sorely needed. Moreover, volume calculations for both exclusively breastfed and mixed-fed young infants and toddlers need to be validated with robust measures such as the doubly labelled water method. Test-weighing before and after each food has been

criticized for interrupting the natural rhythm of breastfeeding and infant-mother interaction [79].

Since the national nutrition surveys do not include young children, foods consumed by this group were largely unavailable in the 2011/13 Australian Food, Supplement and Nutrient database [54]. Therefore, we developed an infant and toddler specific commercial food composition table in 2019 [72] which was updated during OzFITS 2021. However, the commercial baby food industry is constantly changing, and the database requires routine monitoring to stay abreast of re-formulations of existing products and the development of new product lines.

Finally, we have identified a mismatch between the recommended dietary patterns for toddlers in the Australian Dietary Guidelines and the NHMRC Infant Feeding Guidelines, specifically related to the inclusion of breastmilk in toddler diets. It is imperative that NHMRC advice is consistent for both parents and clinicians. One way this can be achieved is by utilizing age-appropriate food consumption data, including breastmilk, to underpin dietary modelling. OzFITS 2021 is uniquely positioned to provide this data for preliminary analyses before a national representative survey is conducted.

8.4 Conclusion

In summary, OzFITS 2021 provides contemporary data on early life feeding practices and food and nutrient intake in Australian children 0-24m. Although rates for exclusive breastfeeding to six months were low, a high proportion of infants received breastmilk to 12 months and beyond. Overall, diets were nutritionally adequate; however, we report a high prevalence of inadequacy for iron in older infants and toddlers, and excessive sodium intake in toddlers. Although

toddlers consumed foods from all five food groups, few met recommended serves. Discretionary foods and milks, including breastmilk, contributed 10% and 25% of daily energy, respectively, and may have displaced consumption of other foods. Due to budget constraints, we employed a convenience sample. Therefore, a nationally representative survey with biomarkers for key nutrients is urgently needed. Furthermore, the dietary modelling for toddlers warrants a revision as breastmilk provides such a significant portion of daily energy.

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APPENDICES

Appendix 1. PubMed Logic grid and key search terms—Chapter 2

Diet/food/breastfeeding/formula	Nutrient intake	Infants OR toddlers	Australia
"Diet"[mh] OR "weaning"[mh] OR "Food"[mh] OR "breast feeding"[mh] OR "milk, human"[mh] OR "infant formula"[mh] OR "feeding behavior"[mh] OR "feeding methods"[mh] OR "infant food"[mh] OR Diet[tiab] OR food[tiab] OR wean*[tiab] OR complementary feeding[tiab] OR Breastfeeding[tiab] OR breast feeding[tiab] OR breast fed [tiab] OR breastfed[tiab] OR human milk[tiab] OR breast milk[tiab] OR breastmilk[tiab] OR infant formula[tiab] OR formula[tiab] OR exclusive breastfeeding[tiab] OR exclusively breastfeeding[tiab] OR exclusively breastfed[tiab] OR partially breastfeeding[tiab] OR partial breastfeeding[tiab] OR partially breastfed[tiab] OR combination fed[tiab] OR solid food introduc*[tiab] OR solid food[tiab] OR solid food transition[tiab] OR timing solid food*[tiab]	"Eating"[mh] OR "Nutritional status"[mh] OR "nutrients"[mh] OR "nutrition assessment"[mh] OR nutritional value[mh] OR Eating[tiab] OR Eat[tiab] OR nutritional status[tiab] OR nutrition*[tiab] OR nutrient*[tiab] OR dietary assessment*[tiab] OR food intake[tiab]	"infant"[mh] OR Toddler*[tiab] OR Newborn[tiab] OR infant*[tiab] OR baby[tiab] OR babies[tiab] OR term infant*[tiab]	"Australia"[mh] OR Australia*[tiab]

Appendix 2. Embase logic grid and key search terms—Chapter 2

Diet/food Breastfeeding/formula	Nutrient intake	Infants OR toddlers	Australia OR New Zealand
diet.sh OR weaning.sh OR food.sh OR baby food.sh OR breast feeding.sh OR breast milk.sh OR artificial milk.sh OR feeding behaviour.sh OR food intake.sh OR (Diet OR food OR wean* OR complementary feeding OR Breastfeeding OR breast feeding OR breast fed OR breastfed OR human milk OR breast milk OR breastmilk OR infant formula OR formula OR exclusive breastfeeding OR exclusively breastfeeding OR exclusively breastfed OR partially breastfeeding OR partial breastfeeding OR partially breastfed OR combination fed OR solid food introduc* OR solid food OR solid food transition OR timing solid food*).ti,ab	Eating.sh OR infant feeding.sh OR Nutritional status.sh OR nutrient.sh OR nutrient intake.sh OR nutritional assessment.sh OR nutritional value.sh OR caloric intake.sh OR (Eating OR Eat OR nutritional status OR nutrition* OR nutrient* OR dietary assessment* OR food intake OR dietary survey).ti,ab	infant.sh OR toddler.sh OR newborn.sh OR (toddler* OR Newborn OR infant* OR baby OR babies OR term infant*).ti,ab	Australia.sh OR Australia*.ti,ab

Appendix 3. Median (range) serve size and nutrient content per serve of infant and toddler food products—Chapter 3

Supplementary Table 1 in reference from publication

Product Category	n	Serve size (g)	Energy (kJ) per serve	Protein (g) per serve	Total fat (g) per serve	Carbohydrate (g) per serve	Total Sugars (g) per serve	Sodium (mg) per serve	[1]Iron (mg) per serve
Mixed main dishes	84	170 (85-220)	376 (207-1050)	4.4 (1-13)	2.4 (0.2-14.8)	11.9 (6.2-35.4)	3.8 (1-9.2)	28 (5-236)	10 (2.4-15)
Fruit and vegetable first foods	73	120 (55-120)	280 (140-407)	0.6 (0.1-2.8)	0.2 (0.09-2.5)	14.3 (5.5-21.7)	12 (2.8-18.6)	4 (0-30)	--
[2]Dry cereals/foods	23	96 (50-180)	342 (84-817)	2.1 (0.3-4.8)	0.9 (0.1-5.5)	14 (4.4-30)	5.3 (0.2-12)	8.2 (0.7-40)	3.1 (1.7-6.3)
Desserts and breakfasts	83	120 (55-150)	362 (150-560)	1.7 (0.6-9.2)	1.3 (0.1-5.4)	15.3 (3.4-25.1)	9.2 (3.4-20.1)	14 (1-73)	--
Other	19	90 (25-111)	239 (75-1531)	1.1 (0.3-15)	0.7 (0.1-1.9)	11.9 (3.8-79)	1 (0-3.5)	1.4 (0-25)	2.6 (1.1-6.3)
[3]Savoury finger foods	45	12 (3-25)	209 (40-470)	1 (0.1-3)	1.5 (0-3.7)	7.3 (1.6-68)	0.5 (0-4.9)	10 (0-116)	2 (1-2.4)
Fruit and vegetable-based finger foods	9	15 (12-17)	210 (159-230)	0.5 (0.1-1.2)	0.5 (0.07-0.9)	9.7 (9.1-12)	7.5 (5.3-10)	5 (0-13)	--
[2]Sweet finger foods	76	10 (4-30)	181.5 (71-554)	0.8 (0.2-2.8)	1.1 (0-7.9)	7.1 (3.8-18.7)	1.6 (0.2-11)	4.5 (0-56)	2.4 (1-2.8)
Drinks	2	200 (200-200)	253 (238-268)	0.1 (0.1-0.2)	0.1 (0.1-0.2)	14.9 (14.3-15.4)	13.4 (13-13.7)	7.3 (2-12.6)	--

[1]Iron was reported for n=50 products
[2] Quantity per serve and nutrient content for dry cereals were reported as prepared products made up with water, milk, or expressed breast milk
[3]Serve size for n=6 savoury finger foods were missing
[4]Serve size for n= 2 sweet finger foods were missing

Appendix 4. Ethics Approval—Chapter 4

Government of South Australia | Health Women's and Children's Health Network

Women's & Children's Hospital

12th March 2020

Research Secretariat
Women's and Children's Health Network
2nd floor
Samuel Way Building
72 King William Road
NORTH ADELAIDE SA 5006
Tel 08 8161 6521
Tel 08 8161 8175
www.wch.sa.gov.au

Ms N Moumin
SAMHRI Women and Kids
WCHN

Dear Najma

Re: The Australian Feeding Infants and Toddlers Study: the OZFITS pilot study. HREC/19/WCHN/44.

Thank you for your email dated 11th March 2020 in which you responded to the matters raised by the WCHN Human Research Ethics Committee at its meeting dated 26th February 2020. I now advise approval of the protocol amendment and the following documents:

Document	Version	Date
Protocol	2.1	28/01/2020
Participant Information Sheet and Consent Form (PICF)	2.2	28/01/2020
Brochure	2.2	24/01/2020
Trialfacts Advertising	1.0	28/01/2020
Trialfacts Data Security Policy	1.0	28/01/2020
Screening Form	2.2	11/02/2020
Case Report Form (CRF)	2.2	11/02/2020
Food Record Prep Guide	1.1	11/02/2020
24 HDR Second Script	1.1	11/02/2020
24 HDR Protocol	1.1	05/02/2020
24 HDR Second Pass Probe List	1.0	11/02/2020
Child Carer Record Form	1.1	11/02/2020
Food Record	1.1	11/02/2020
Food Measurement Book	1.0	11/02/2020
Food Measurement Book Key	1.1	11/02/2020
Queries Record	1.0	11/02/2020
Recipe Food Group Codes	1.0	11/02/2020

Yours sincerely

TAMARA ZUTLEVICS (DR)
CHAIR
WCHN HUMAN RESEARCH ETHICS COMMITTEE

Appendix 5. Participant information sheet and consent form—Chapter 4

HREC Study Number:	HREC/19/WCHN/044		
Short Name of Study:	The OzFITS Study		
Full Name of Study:	The Australian Feeding Infants and Toddlers Study – the OzFITS Study		
Principal Researcher:	Dr Merryn Netting, Research Fellow | Adv APD, Healthy Mothers, Babies and Children SAHMRI		
Version Number:	Version 2.2	**Version Date:**	28/01/2020

Thank you for taking the time to read this **Participant Information Statement and Consent Form**. We would like to invite you to take part in a research study that is explained in this form.

This form is 6 pages long. Please make sure you have all the pages.

What is an Information Statement and Consent Form?

An Information and Consent Form tells you about the research study. It explains exactly what the research study will involve. This information is to help you decide whether or not you would like to take part in the research. Please read it carefully.

Before you decide if you want to take part or not, you can ask us any questions you have about the study. You may want to talk about the study with your family, friends or health care worker.

Taking part in the research study is up to you

It is your choice whether or not you take part in the research study. You do not have to agree if

you do not want to.

Signing the form

If you want to take part in the research, please sign the consent form at the end of this document. By signing the form, you are telling us that you:

- understand what you have read
- had a chance to ask questions and received satisfactory answers
- consent to taking part in the study.

We will give you a copy of this form to keep.

1. What is the research study about?

You are invited to take part in a study that aims to assess dietary intake and current feeding practices among infants and toddlers 0-24 months old in Australia.

2. Who is running the study?

This study will be conducted by Dr Merryn Netting and her colleagues from the SAHMRI Women and Kids theme at the South Australian Health and Medical Research Institute. Under the supervision of Dr Netting, Miss Najma Moumin will work on this study as a part of her PhD Project. This study is supported by a combination of funds received from the SAHMRI Women and Kids theme and an unrestricted grant in aid from Nestle Nutrition Institute.

3. Why am I being asked to take part?

The first two years of a baby's life set the foundation for diets later in life. Previous national nutrition surveys did not include children under two years of age, therefore information on their diets is limited. Understanding infant feeding practices such as breastfeeding and/or formula use, introduction to solid foods, and meal and snack patterns is important to identify areas for improvement in establishing healthy eating patterns at an early age.

In this study, we would like to find out what children under two years of age are eating and drinking. We would also like to see how today's diets and feeding practices compare to Australian dietary guidelines. This information will help us to provide better nutrition information to parents and caregivers about nutrition in the early years.

4. What is involved in this research study?

You may be able to take part in this study if:

i. You are the parent or caregiver of a child between 0 and 24 months of age;
ii. The child does not have major health issues, apart from food allergies and/or intolerances, that severely affect their ability to eat; and
iii. You can answer questions about the child since birth.

This study is broken up into three parts. The first part involves a questionnaire about you and your family's socioeconomic details, and your baby's feeding behaviours. The second part involves filling out a food record (diary) on everything your child eats and drinks for one or two days. Once you complete this part, the third and final part will be completing a 24-hour dietary recall interview. We will contact you to go through your diary entries and enter them in our software. This will give us an idea of eating patterns at a population level and help us estimate usual food and drink intake.

5. What will happen during the study?

i. For part one, your will complete a short survey (~15-20 minutes). We will ask you questions about you and your family, such as contact details, age, education, household size, and employment status. We will also ask you questions about child feeding practices such as breastfeeding, formula use, history of food allergy, and first introduction to solids and family foods. We will then send you

a $20 supermarket gift card for your time and participation.

a. If you are selected to complete a food record (diary), you will be asked to complete part two and three. To do this, we will send you a package of materials in the mail. This package will include a *food diary booklet* to record what your baby eats and drinks, and a *food measurement booklet* to help you measure how much.

ii. For part two, you will be asked to record everything your baby eats and drinks for one day (24 hours) in the booklet mailed to you. We will randomly select some participants to complete a second diary entry on another day, therefore you may be asked to complete two diary entries.

iii. For part three, we will contact you to go through your completed diary entry(ies). During this call, we will enter the information you have recorded into our software. Once we complete this call, we will send you another $20 supermarket gift card for your time.

6. Can I withdraw from the study?

Participation in any research study is voluntary, and you are free to withdraw at any time. All information gathered will be treated with confidence and no information that could identify you will be released to any person not associated directly with the study. These results may eventually be published in medical journals or at professional meetings, but you will not be identified in any way.

Your information will remain confidential except in the case of a legal requirement to pass on personal information to authorized third parties. This requirement is standard and applies to information collected both in research and non-research situations. Such requests to access information are rare; however, we have an obligation to inform you of this possibility.

7. What are the possible benefits for me and other people in the future?

You may not directly benefit by participation in this study. However, data from this study will be used to help provide better nutrition information to parents and caregivers about nutrition in the early years. We will also share a summary of the main results of the study with you.

8. What are the possible risks, side-effects, discomforts and/or inconveniences?

There are no known risks and we don't anticipate any safety concerns as a result of participation in this study.

9. Will there be future follow up studies?

After we complete the pilot study in South Australia, we will run a similar study nationwide. If you consent to participate in this study, it does not mean you have agreed to participate in any future studies. We would contact you again to see if you are willing to take part as each study begins.

Confidentiality

10. What will be done to make sure my information is confidential?

Data will be de-identified and personal information (names, contact details) will be kept separately from outcome data and will be accessible only by research personnel.

All study documents will be stored in a locked office at SAHMRI Women Kids, Women's & Children's Hospital. Only research staff directly involved in the study and SAHMRI quality management team will have access to the information.

Only research staff directly involved in the study will have access to the information. Electronic forms of data are stored on secure servers at SAHMRI. Data will be released only to persons authorised to receive those data.

11. Will I be informed of the results when the research study is finished?

Detailed information about the OzFITS study and our other studies can be found on the SAHMRI Women and Kids web page: https://www.sahmriresearch.org/our-research/themes/healthy-mothers-babies-children/research-list. More information about the work we do can be also found on Facebook at www.facebook.com/CNRCAdelaide.

Once we have analysed the data, we will send all participants a one-page summary on our findings.

Contact Information

12. Who should I contact for more information?

If you would like more information about the study, please call our office at:

Name:	SAHMRI Women and Kids
Contact	Dr Merryn Netting or Najma Moumin
Telephone:	(08) 812 84403 or (08) 812 84407
Email:	ozfitsstudy@sahmri.com

You can contact the Research Information Officer, Mr. Luke Fraser at Women's and Children's Health Network if you:

- have any concerns or complaints about the study
- are worried about your rights as a research participant
- would like to speak to someone independent of the study.

The Research Information Officer can be contacted by telephone on (08) 8161 6521 or email at luke.fraser2@sa.gov.au.

CONSENT FORM

HREC Study Number:	HREC/19/WCHN/044		
Short Name of Study:	The OzFITS Study		
Version Number:	Version 2.2	**Version Date:**	28/01/2020

I

_____

Participant full name

hereby consent to my involvement in the research project entitled:

"The Australian Feeding Infants and Toddlers Study – the OzFITS Study"

1. The nature and purpose of the research project described on the attached Information Sheet has been explained to me. I understand it and agree to taking part.

2. I understand that I may not directly benefit by taking part in this study.

3. I acknowledge that there are no known risks and/or side effects as outlined in the Information Sheet.

4. I understand that I can withdraw from the study at any stage and that this will not affect my medical care or any aspects of my relationship with this healthcare service.

5. I understand that I will receive up to two $20 gift cards for my time once I have completed the study components.

6. I have had the opportunity to discuss taking part in this research project with a family member or friend, and/or have had the opportunity to have a family member or friend present whilst the research project was being explained by the researcher.

7. I am aware that I should retain a copy of the Consent Form, when completed, and the Information Sheet.

8. I consent to the following:

   1) To complete a telephone-based household demographic and infant and young child feeding questionnaire.

   2) To complete one or two-day food records.

   3) To complete a telephone-based 24-hour dietary recall interview within one week of the food records.

9. I am aware that I may be contacted regarding future follow-up studies.

10. I understand that my information will be kept confidential as explained in the information sheet except where there is a requirement by law for it to be divulged.

11. I additionally consent to my child's dietary intake data being used in other research projects, provided the project has the approval of the Women's & Children's Health Network Human Research Ethics Committee.

□ Yes

□ No

Signed:

.....

..

Full name of participant: ……..…….....

Date: .....

I certify that I have explained the study participant and consider that she understands what is involved.

Signed:

.....

Name: …… Title: .....

Date: .....

Appendix 6. Socio-demographic and Child Feeding Questionnaire—Chapter 4

The Australian Feeding Infants and Toddlers Study – the OzFITS Study

The OzFITS Study

CASE REPORT FORM

A REDCap database will be designed based on the questions included in this Case Report Form

STUDY ID: __ __ __ __ __ __

South Australian Health and Medical Research Institute
Women's and Children's Hospital
72 King William Road
North Adelaide, South Australia 5006
AUSTRALIA
Phone (08) 8128 4416

This Case Report Form contains a total of 28 pages

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Record ID_____

Interviewer Name _____

Date of Interview

____ ____ / ____ ____ / ____ ____ ____ ____

DAY MONTH YEAR

SECTION A: CONSENT

READ STATEMENT AND OBTAIN VERBAL CONSENT:

A copy of the Participant Information Sheet and Informed Consent Form is available on the SAHMRI at sahmriresearch.org/ozfits website for your review.

The purpose of this study is to better understand modern diets of Australian infants and young children. The study is broken up into three parts. The first part, which you will complete today, is a short questionnaire (~20 minutes) on your household characteristics and child-feeding practices (e.g. breastfeeding history, formula use, complementary foods etc.). Once you complete part one, we will send you a $20 supermarket gift card for your time and participation.

If selected, you will complete part two and three of the study. For part two, you will be asked to keep a food record, like a diary, of everything your child eats for one or two days. We will send you a package in the mail which will include information on how to keep a food record and the booklets you will use to record this information.

For part three, we will ring you at a scheduled time after you have completed your diary entry(ies) and complete a 24-hour recall interview. During the interview, we will enter all the information you have recorded in your child's food diary in a step by step process (~20 minutes). After we complete this phone interview, we will send you an additional $20 supermarket gift card as a token of our appreciation.

Q. A1 Do you agree to proceed?

❑ Yes—**PROCEED TO CONSENT DETAILS**

❑ No, reason for refusal—**TERMINATE INTERVIEW**

- ❑ Does not want to take part in research
- ❑ Length of survey
- ❑ Don't want to provide information about the child
- ❑ Other family member does not agree
- ❑ Other, specify_____

CONSENT DETAILS

Q. A2 Date of consent

___ ___ / ___ ___ / ___ ___ ___ ___

DAY MONTH YEAR

Q. A3 Participant's first name (child) _____

Q. A4 Participant's last name (child)_____

SECTION B: PARENT/CAREGIVER CONTACT DETAILS

Q. B1 First name _____

Q. B2 Last name _____

Q. B3 Primary phone number _____

Q. B4 Secondary phone number _____

Q. B5 Email address _____

Q. B6 Current mailing address

_____

_____

_____

Q. B7 Postal code ____ ____ ____ ____

SECTION C: PARENTAL BACKGROUND AND HOUSEHOLD INFORMATION

Q. C1 Date of birth

____ ____ / ____ ____ / ____ ____ ____ ____

DAY MONTH YEAR

Q. C2 [**CAREGIVER's**] sex _____

- ❑ Male
- ❑ Female
- ❑ Prefer not to disclose

Q. C3 How many adults, ≥ 16 years of age, live in your household (including you)?

____ ____

Q. C4 How many children, < 16 years of age, live in your household (not including [**CHILD**])?

____ ____

Q. C5 Were you born in Australia?

- ❑ Yes—**GO TO C6**
- ❑ No
- ❑ Unknown

Q. C5a Which country were you born in? _____

Q. C5b How many years have you lived in Australia?

____ ____ years (If <1 year, round up to 1 year)

❑ Unknown

Q. C6 Do you identify as Aboriginal / Torres Strait Islander?

❑ No
❑ Yes, Aboriginal
❑ Yes, Torres Strait Islander
❑ Yes, Both Aboriginal and Torres Strait Islander
❑ Unknown

Q. C7 What is your current marital status?

❑ Married
❑ Living with partner/De Facto
❑ Separated but not Divorced
❑ Divorced
❑ Never Married
❑ Widowed
❑ Other, specify_____

Q. C8 What is the **highest level** of education you have completed?

❑ Secondary School (e.g. year 12 or equivalent)
❑ Certificate (e.g. TAFE, Trade Certificate/Apprenticeship)
❑ Diploma (e.g. Undergraduate Diploma)
❑ Degree (e.g. Undergraduate Degree)
❑ Higher Degree (e.g. Masters or PhD)
❑ Other, specify_____

Q. C9 Have you been in the work force in the last 12 months?

❑ Yes
❑ No—**GO TO C9b**

Q. C9a What is your usual or regular occupation? _____ (**GO TO C10)**

Q. C9b What has been the **main** activity during this time? (CROSS ONE ONLY)

- ❑ Paid Maternity/Paternity leave
- ❑ Actively seeking work
- ❑ Home duties (and *not* actively seeking work)
- ❑ Student (and *not* actively seeking work)
- ❑ Carer Pension
- ❑ Disability Pension
- ❑ Other, specify_____

Q.C10 Which one of the following categories best describes your annual **TOTAL** household income (before tax)?

- ❑ $20,000 or less
- ❑ $20,001 - $40,000
- ❑ $40,000- $70,000
- ❑ $70,001 - $105,000
- ❑ $105,001 - $205,000
- ❑ >$205,000
- ❑ Unknown

SECTION D: PARTICIPANT BACKGROUND (CHILD)

Q. D1 Is [**CHILD**] your first-born child?

- ❑ Yes
- ❑ No
- ❑ Unknown

Q. D2 [**CHILD's**] date of birth

____ ____ / ____ ____ / ____ ____ ____ ____

DAY MONTH YEAR

Q. D3 [**CHILD's**] sex _____

- ❑ Male
- ❑ Female
- ❑ Prefer not to disclose

Q. D4 [**CHILD's**] weight at birth

____ ____ ____ ____ gm

- ❑ Unknown

Q. D5 [**CHILD's**] length at birth

____ ____. ____ cm

- ❑ Unknown

Q. D6 [**CHILD's**] current weight

____ ____. ____ kg

❑ Unknown

Q. D6a How recently was this measurement taken? (**MARK ONE ONLY**)

❑ Taken within last 7 days (1 WEEK)
❑ Taken within 8 and 30 days
❑ More than 30 days (4 WEEKS) ago
❑ Unknown

IF THE MEASURE WAS TAKEN MORE THAN A WEEK AGO, ASK THE PARENT/CAREGIVER TO GET A MORE RECENT MEASURE.

Q. D7 [**CHILD's**] current height or length

____ ____. ____ cm

❑ Unknown

Q. D7a How recently was this measurement taken? (**MARK ONE ONLY**)

❑ Taken within last 7 days (1 WEEK)
❑ Taken within 8 and 30 days
❑ More than 30 days (4 WEEKS) ago
❑ Unknown

Q.D8 Is [**CHILD**] ever in the care of someone besides you on a regular basis (e.g. more than once per week)?
IF THEY SAY PARTNER, MARK NO.

❑ Yes
❑ No—**GO TO SECTION E**
❑ Unknown

Q.D9 Does [**CHILD**] attend a formal childcare service (e.g. childcare center, long day care, or family daycare)?

- ❑ Yes
- ❑ No—**GO TO D10**
- ❑ Unknown

Q. D9a On average, how many days (in a 7-day week), does he/she spend in this care?

____ ____ Total Days

Q. D9b How many hours in total does he/she spend in this care on these days? (**REFER TO D9a**)

____ ____ Total Hours

Q.D10 Does [**CHILD**] attend an informal or private childcare service (e.g. babysitter, relatives/friends, nanny, nanny-sharing, or in-home care)?

- ❑ Yes
- ❑ No—**GO TO SECTION E**
- ❑ Unknown

Q. D10a On average, how many days (in a 7-day week), does he/she spend in this care?

____ ____ Total Days

Q. D10b How many hours in total does he/she spend in this care on these days? (**REFER TO D10a**)

____ ____ Total Hours

SECTION E: BREASTFEEDING AND FORMULA USE

Q. E1 What was [**CHILD's**] first feed?

- ❑ Breastsmilk (includes colostrum, expressed breastmilk, breastmilk from donor/milkbank)
- ❑ Formula—**GO TO E8**
- ❑ Other, specify _____ **(GO TO E8)**

Q. E2 How soon after [**CHILD**] was born did he/she first have breast milk?

- ❑ Immediately or within a few minutes
- ❑ More than a few minutes and up to half an hour
- ❑ More than half an hour and up to one hour
- ❑ More than one hour and up to two hours
- ❑ More than two hours and up to 24 hours
- ❑ After 24 hours
- ❑ Unknown

Q. E3 While in hospital, did [**CHILD**] ever have any other fluids or foods?

- ❑ Yes
- ❑ No
- ❑ Didn't go to hospital
- ❑ Unknown

Q. E4 When [**CHILD**] first came home from hospital, was he/she receiving breast milk?

- ❑ Yes
- ❑ No
- ❑ Didn't go to hospital
- ❑ Unknown

Q. E5 What methods did you use to give [**CHILD**] breast milk? (**MARK ALL THAT APPLY**)

- ❑ Breastfeeding (direct)
- ❑ Bottle, how often?
  - ❑ Rarely
  - ❑ Sometimes
  - ❑ Most of the time
  - ❑ Always
  - ❑ Unknown
- ❑ Gavage feeding
- ❑ Finger-feeding
- ❑ Cup-feeding
- ❑ Supply line
- ❑ Other, specify _____

Q. E6 Is [**CHILD**] still breastfeeding or receiving expressed breast milk?

- ❑ Yes
- ❑ No

  Age stopped receiving any breast milk

  ____ ____ (completed months) OR ❑ Unknown
- ❑ Unknown

Q. E7 Apart from breast milk, has [**CHILD**] ever been given anything else (e.g. formula, other fluids, or foods)?

- ❑ Yes—**GO TO E9**
- ❑ No

  On average, how many times in a 24-hour period is he/she given breast milk or expressed milk?

  ____ ____ Number of Feeds OR ❑ Unknown (**GO TO SECTION G**)
- ❑ Unknown—**GO TO E9**

Q. E8 Has [**CHILD**] ever been given breast milk?

❑ Yes
❑ No—**GO TO E9**
❑ Unknown—**GO TO E9**

Q. E8a Is [**CHILD**] still breastfeeding or receiving expressed breast milk?

❑ Yes
❑ No

Age stopped receiving any breast milk

____ ____ (completed months) OR ❑ Unknown

❑ Unknown

Q. E8b What methods did you use to give your child breast milk? (**MARK ALL THAT APPLY**)

❑ Breastfeeding (direct)
❑ Bottle, how often?
  ❑ Rarely
  ❑ Sometimes
  ❑ Most of the time
  ❑ Always
  ❑ Unknown
❑ Gavage feeding
❑ Finger-feeding
❑ Cup-feeding
❑ Supply line
❑ Other, specify _____

Q. E9 Has [**CHILD**] ***ever*** been given any of the following items:

Item	Yes	No	Age introduced (completed months)
Infant Formula	❑ **COMPLETE E10**	❑	____ ____
Water (as a drink)	❑	❑	____ ____
Cow's milk as a drink (excludes cow's milk mixed with food e.g. cereal)	❑	❑	____ ____
Alternatives to cow's milk including Soymilk, rice and cereal based milk substitutes as a drink (excludes soymilk mixed with food e.g. cereal, excluding soy and rice based infant formula)	❑	❑	____ ____
Other drinks (including soft drinks, cordial, tea/herbal tea)	❑	❑	____ ____
Fruit juice, including diluted fruit juice (excludes juice mixed with food)	❑	❑	____ ____
Any food (including baby cereal added to bottles)	❑ **COMPLETE E12**	❑	____ ____

Q. E10 After formula was introduced, did he/she continue breastfeeding or receiving expressed breast milk?

❑ Yes

❑ No

❑ Unknown

Q. E11 Is [**CHILD**] still consuming formula?

❑ Yes

❑ No

Age stopped consuming formula ____ ____ (completed months) OR ❑ Unknown

❑ Unknown

Q. E12 Is [**CHILD**] currently consuming any solid foods on a daily basis? (including soft, semi-soft, or solid foods)

❑ Yes

❑ No

❑ Unknown

ONLY ASK THE NEXT QUESTION IF THE CHILD HAS NEVER BEEN BREASTFED OR FORMULA FED IN THE FIRST SIX MONTHS.

Q. E13 What did your child consume in the first six months of life?

_____

_____

_____

Q. E14 Is the participant eligible for a food record?

❑ Yes—**GO TO SECTION F**

❑ No—**GO TO SECTION G**

SECTION F: COMPLEMENTARY FOODS

COMPLETE THIS SECTION IF CHILD IS NOT EXCLUSIVELY BREASTFED.

IF THE CHILD IS EXCLUSIVELY BREASTFED GO TO SECTION G.

Q. F1 Has [**CHILD**] been introduced to the following foods?

Food Item	Yes	No	Unknown
Cereals and grains (e.g. infant cereals, pasta, rice, bread, weetbix etc.)	❑	❑	❑
Vegetables	❑	❑	❑
Fruits (including avocado)	❑	❑	❑
Legumes/beans	❑	❑	❑
Fish/Seafood	❑	❑	❑
Red meat (e.g. beef, lamb, pork)	❑	❑	❑
White meat (e.g. chicken, turkey, duck)	❑	❑	❑
Dairy products (e.g. yoghurt, cheese, custard)	❑	❑	❑
Juice (straight or diluted)	❑	❑	❑

Allergens						
Food Item	**Yes**	**No**	**Unknown**	**Age introduced**		**What is the MAIN reason you have not introduced {Food Item}?**
				Completed Months	**Unknown**	
Peanut paste or peanut butter	❑	❑	❑	____ ____	❑	❑ Confirmed food allergy to this food by skin prick test or blood test ❑ Reaction to other allergenic foods ❑ Family history of allergy ❑ Advice from family member/relative ❑ Advice from health professional ❑ Have not introduced yet ❑ Other, specify_____ _____
Tree nuts (e.g. walnuts, cashews)	❑	❑	❑	____ ____	❑	❑ Confirmed food allergy to this food by skin prick test or blood test ❑ Reaction to other allergenic foods ❑ Family history of allergy ❑ Advice from family member/relative ❑ Advice from health professional ❑ Have not introduced yet ❑ Other, specify_____ _____

Sesame (e.g. tahini)	❑	❑	❑	____ ____	❑	❑ Confirmed food allergy to this food by skin prick test or blood test ❑ Reaction to other allergenic foods ❑ Family history of allergy ❑ Advice from family member/relative ❑ Advice from health professional ❑ Have not introduced yet ❑ Other, specify_____ _____
Wheat (e.g. cooked pasta or bread)	❑	❑	❑	____ ____	❑	❑ Confirmed food allergy to this food by skin prick test or blood test ❑ Reaction to other allergenic foods ❑ Family history of allergy ❑ Advice from family member/relative ❑ Advice from health professional ❑ Have not introduced yet ❑ Other, specify_____ _____
Eggs	❑	❑	❑	____ ____	❑	❑ Confirmed food allergy to this food by skin prick test or blood test ❑ Reaction to other allergenic foods ❑ Family history of allergy ❑ Advice from family member/relative ❑ Advice from health professional ❑ Have not introduced yet ❑ Other, specify_____ _____

Cow's milk	❑	❑	❑	____ ____	❑	❑ Confirmed food allergy to this food by skin prick test or blood test ❑ Reaction to other allergenic foods ❑ Family history of allergy ❑ Advice from family member/relative ❑ Advice from health professional ❑ Have not introduced yet ❑ Other, specify_____ _____

Q. F2 Does [**CHILD**] have any other food allergies confirmed by skin prick test or blood test that you have not mentioned yet?

- ❑ Yes, specify_____
- ❑ No
- ❑ Unknown

Q. F3 Does [**CHILD**] follow any special diet that is not medically indicated?

- ❑ Yes, please specify
  - ❑ Gluten Free
  - ❑ Dairy Free
  - ❑ Vegetarian
  - ❑ Vegan
  - ❑ Pescatarian
  - ❑ Halal/Kosher
  - ❑ Paleo
  - ❑ Other, specify_____
- ❑ No
- ❑ Unknown

Q. F4 Do you ever purchase baby food in squeezy pouches?

- ❑ Yes
- ❑ No—**GO TO SECTION G**
- ❑ Unknown—**GO TO SECTION G**

Q. F5 Which of these foods do you purchase for [**CHILD**]? (**MARK ALL THAT APPLY**)

- ❑ Fruit puree
- ❑ Vegetable puree
- ❑ Mixed fruit and vegetables
- ❑ Breakfast meals (e.g. fruit and cereal/porridge)
- ❑ Savoury meals (e.g. meat and vegetables, cereal and vegetables)

❑ Desserts (e.g. yoghurt or custard)

Q. F6 When [**CHILD**] eats foods from a squeezy pouch, which feeding method does he/she use most often:

❑ Suck it directly from the pouch
❑ Eat it off a spoon after the food has been placed in a bowl
❑ Eat it off a spoon after the food has been squeezed from the pouch onto a spoon
❑ Eat it off caregiver's finger after the food has been squeezed from the pouch onto the finger
❑ Eat it off tray table with own hands
❑ Other, specify _____

SECTION G: SUPPLEMENT USE

Q. G1 Does [**CHILD**] currently take any multivitamins, vitamins, or minerals (e.g. vitamin C, vitamin D, iron, or calcium etc.)? (Include gummies, tablets, and drops.)

- ❑ Yes—**complete table below**
- ❑ No
- ❑ Unknown

Type of supplement (*e.g. vitamin C, iron etc.)*	Brand name of the supplement *(e.g. Swiss, Blackmores*)	Dosage taken (*e.g. No. of tablets/capsules/mL/drops consume each time)*	Frequency (*No. of times*)
			❑ Daily ❑ Two-Three times per week ❑ Weekly ❑ Monthly ❑ Unknown ❑ Other, specify_____
			❑ Daily ❑ Two-Three times per week ❑ Weekly ❑ Monthly ❑ Unknown ❑ Other, specify_____

IF THE CHILD IS <u>NOT</u> ELIGIBLE FOR A FOOD RECORD, COMPLETE SECTION H.

IF THE CHILD IS ELIGIBLE FOR A FOOD RECORD, COMPLETE SECTION I, J AND K.

SECTION H: WRAPUP SCRIPT EXCLUSIVELY BREASTFED

Thank you for answering those questions for us today and for being a part of this important study. You have been extremely helpful. Your part is now complete! Before I let you go, I would like to confirm your email address, so we can send you your $20 supermarket gift card as a token of our appreciation**.**

❑ E-mail:

_____

_____

❑ Sent Giftcard

Signature:_____

Date: ____ ____ / ____ ____ / ____ ____ ____ ____

DAY MONTH YEAR

SECTION I: WRAPUP SCRIPT NOT EXCLUSIVELY BREASTFED

For this next part, you will be keeping a food record, like a diary, of everything [**CHILD**] eats and drinks. Would you be able to keep a food diary on [**RANDOMIZED DAY(S)**]?

- ❑ MONDAY
- ❑ TUESDAY
- ❑ WEDNESDAY
- ❑ THURSDAY
- ❑ FRIDAY
- ❑ SATURDAY
- ❑ SUNDAY

You will receive a package from us which includes:

1. Food Record Booklets and Food Measurement Guides for you; and
2. Child-carer Record Forms for other caregivers

Once you get your package in the mail, give us a ring and we'll go through the instructions together in more detail.

When keeping the diary…..

- Record what [**CHILD**] eats and drinks during each feeding occasion, including snacks, from midnight to midnight for your diary day(s).
- If he/she is in the care of someone else, have that person complete the **Child-Carer Form**. Ask them to record what he/she eats and drinks whilst in their care and return the form to you when you pick up [**CHILD**].

After you complete your entry(ies), we will ring you a day or two later at a scheduled time to complete a 24-hour recall interview. In this ~20-minute interview, we will enter the information you have recorded in the diary in a step by step process to make sure we didn't miss anything.

Before I let you go, I would like to confirm your mailing address, so we can send you your study pack, and email address, so we can send you your $20 supermarket gift card**.**

❑ Mailing Address:

_____

_____

_____

_____

_____

_____

_____

_____

❑ E-mail:

_____

_____

❑ Sent Giftcard

Signature:_____

Date: ____ ____ / ____ ____ / ____ ____ ____ ____

DAY MONTH YEAR

SECTION J: FOOD RECORD

Q. J1 Date study pack sent

____ ____ / ____ ____ / ____ ____ ____ ____

DAY MONTH YEAR

Q. J2 Instructions in food record prep guide explained to participant.

- ❑ YES
- ❑ NO

Q. J3 Food Diary Day(s)

- ❑ MONDAY
- ❑ TUESDAY
- ❑ WEDNESDAY
- ❑ THURSDAY
- ❑ FRIDAY
- ❑ SATURDAY
- ❑ SUNDAY

Q. J4 Date of 24-HDR Interview. **(SCHEDULE FOR THE DAY IMMEDIATELY FOLLOWING THE DIARY DAY(S))**

____ ____ / ____ ____ / ____ ____ ____ ____

DAY MONTH YEAR

SECTION K: 24-HOUR RECALL INTERVIEW

Q. K1 Food record(s) returned

- ❑ YES
- ❑ NO—**GO TO K2**

Q. K2 Reason food record(s) not returned

- ❑ Participant lost them
- ❑ Participant damaged them
- ❑ Participant unable to scan/email or send picture text
- ❑ Participant unable to send by post
- ❑ Other, specify _____

Q. K3 24-hour recall interview completed

- ❑ YES
- ❑ NO

Q. K4 Sent second giftcard

Signature:_____

Date: ____ ____ / ____ ____ / ____ ____ ____ ____

DAY MONTH YEAR

REDCap ID:
Name Code:

Appendix 7. Food Record—Chapter 4

My Child's Food Diary

In this Pack:

Baby's Food Diary	For you to complete after your first phone call
Food Measurement Book	To help you measure the amount of food and drinks your baby consumes
Child-carer(s) Record Form	To give to other carer(s), if your child is being looked after by someone else on the diary days

Please complete this food diary in preparation for part three. Once you have finished recording, take photos of the diary entries for both days, including the recipe pages, and email them to us. Our contact details are on the last page.

This Diary is for recording everything that _____eats and drinks on the following days:

_____

_____

Thank you for taking part in the OzFITS study! The following pages will provide you with information on how to keep a food diary in preparation for your scheduled telephone-based food recall.

- Use this booklet to record everything your baby eats and drinks over a 24-hour period (midnight to midnight) on the day indicated on the front page. For example, if your diary day is Sunday, you would start recording from Saturday at midnight and stop on Sunday at midnight.

- Please record **all foods, drinks, and supplements/multivitamins** your baby has during all meal and snack times (e.g. night-time feeds/drinks, breakfast, morning tea, lunch, afternoon tea, dinner, before bed snack etc.)

- Please record the foods and drinks **at the time** they are eaten. This will be easier than trying to remember at the end of a busy day!

- If your baby eats more or less than usual during the day(s) you are keeping the diary, please record this information in the notes page (e.g. ate more than usual at a birthday party; ate less than usual because of illness etc.) and continue to keep the diary as normal. This will help us make sense of the data later!

- Some foods and drinks are easy to forget! In your diary, please make sure to include:
    - Water, juice, milk, breastfeeds and any other drinks
    - Anything you add at the table (e.g. vegemite, butter, milk, salt, sugar)
    - Small sips of drinks and nibbles of food

- To measure the amounts of food/drink your baby has, use the **Food Measurement Book**. Use common measures such as grams (g) or millilitres (mL) to record the amount your baby eats. If there's leftovers, please note the amount.

- For store bought foods, include as much detail as possible. Record the **brand name** (e.g. Heinz), **food item** (e.g. Apple fruit puree), **packaging (**e.g. 120 g pouch**)**, and the **amount** your baby eats (e.g. ½ pouch or 60 grams).

- For products that you need to make up such as formula and baby rice cereal, please write down the preparation/recipe used:
    - The amount of powder/dry food;
    - The amount and type of liquid added (e.g. water, breast milk etc.); and
    - The amount of final product your child ate (e.g. ¼ cup prepared baby rice cereal)

- For home cooked dishes, write the recipe name in the diary and the amount of the dish your child ate (e.g. ½ cup home cooked lentil soup). Then, record the recipe in the **recipe sheet** at the end of this booklet**.**

- If you are breastfeeding, please record the amount of time (minutes) **actively feeding**. Remember to include total time (i.e. both breasts). If your child is formula fed or is given expressed breastmilk from a bottle/cup, record the amount (mL) during each feed.

- If your child is under someone else's care on the day you are keeping the diary, please have this person(s) complete the **Child-carer Record Form** and return it to you when you pick up your child.

- Once you have completed the entries for both diary days (including *carer forms* if applicable), an OzFITS study staff member will call you for your scheduled telephone interview to enter the information you have recorded in a step by step process.

- An **example** diary **entry** and **recipe** are provided on page 21 and 22.

REDCap ID:
Name Code:

Day 1 Entry

DATE: _____/_____/_____

Please circle the day completed:

Monday / Tuesday / Wednesday / Thursday / Friday / Saturday / Sunday

Time and Meal/Snack Occasion e.g. 07:00 am (breakfast)	**Measure of amount served** teaspoon (tsp), tablespoon (tbsp), gram (g), millilitre (mL), minutes (mins), H6, MD 6 etc.	**Foods and Drinks** (supplements if applicable) **For mixed foods include ingredients with amounts (e.g. ½ mashed banana with 2 Tbsp yoghurt)	**Amount leftover** e.g. MD4, H6, ¼ banana etc.

Day 1 Entry continued…

Time and Meal/Snack Occasion e.g. 07:00 am (breakfast)	**Measure of amount served** teaspoon (tsp), tablespoon (tbsp), gram (g), millilitre (mL), minutes (mins), H6, MD 6 etc.	**Foods and Drinks** (supplements if applicable) **For mixed foods include ingredients with amounts (e.g. ½ mashed banana with 2 Tbsp yoghurt)	**Amount leftover** e.g. MD4, H6, ¼ banana etc.

REDCap ID:
Name Code:

Day 1 Entry continued…

Time and Meal/Snack Occasion e.g. 07:00 am (breakfast)	**Measure of amount served** teaspoon (tsp), tablespoon (tbsp), gram (g), millilitre (mL), minutes (mins), H6, MD 6 etc.	**Foods and Drinks** (supplements if applicable) **For mixed foods include ingredients with amounts (e.g. ½ mashed banana with 2 Tbsp yoghurt)	**Amount leftover** e.g. MD4, H6, ¼ banana etc.

Day 1 Entry continued…

Time and Meal/Snack Occasion e.g. 07:00 am (breakfast)	**Measure of amount served** teaspoon (tsp), tablespoon (tbsp), gram (g), millilitre (mL), minutes (mins), H6, MD 6 etc.	**Foods and Drinks** (supplements if applicable) **For mixed foods include ingredients with amounts (e.g. ½ mashed banana with 2 Tbsp yoghurt)	**Amount leftover** e.g. MD4, H6, ¼ banana etc.

REDCap ID:
Name Code:

Day 2 Entry

DATE: _____/_____/_____

Please circle the day completed:

Monday / Tuesday / Wednesday / Thursday / Friday / Saturday / Sunday

Time and Meal/Snack Occasion e.g. 07:00 am (breakfast)	**Measure of amount served** teaspoon (tsp), tablespoon (tbsp), gram (g), millilitre (mL), minutes (mins), H6, MD 6 etc.	**Foods and Drinks** (supplements if applicable) **For mixed foods include ingredients with amounts (e.g. ½ mashed banana with 2 Tbsp yoghurt)	**Amount leftover** e.g. MD4, H6, ¼ banana etc.

REDCap ID:
Name Code:

Day 2 Entry continued…

Time and Meal/Snack Occasion e.g. 07:00 am (breakfast)	**Measure of amount served** teaspoon (tsp), tablespoon (tbsp), gram (g), millilitre (mL), minutes (mins), H6, MD 6 etc.	**Foods and Drinks** (supplements if applicable) **For mixed foods include ingredients with amounts (e.g. ½ mashed banana with 2 Tbsp yoghurt)	**Amount leftover** e.g. MD4, H6, ¼ banana etc.

REDCap ID:
Name Code:

Day 2 Entry continued…

Time and Meal/Snack Occasion e.g. 07:00 am (breakfast)	**Measure of amount served** teaspoon (tsp), tablespoon (tbsp), gram (g), millilitre (mL), minutes (mins), H6, MD 6 etc.	**Foods and Drinks** (supplements if applicable) **For mixed foods include ingredients with amounts (e.g. ½ mashed banana with 2 Tbsp yoghurt)	**Amount leftover** e.g. MD4, H6, ¼ banana etc.

REDCap ID:
Name Code:

Day 2 Entry continued…

Time and Meal/Snack Occasion e.g. 07:00 am (breakfast)	**Measure of amount served** teaspoon (tsp), tablespoon (tbsp), gram (g), millilitre (mL), minutes (mins), H6, MD 6 etc.	**Foods and Drinks** (supplements if applicable) **For mixed foods include ingredients with amounts (e.g. ½ mashed banana with 2 Tbsp yoghurt)	**Amount leftover** e.g. MD4, H6, ¼ banana etc.

REDCap ID:
Name Code:

Home Cooked Recipes

Recipe name:
Ingredients (include amounts):
Total Weight (g) Cooked Dish:

REDCap ID:
Name Code:

Home Cooked Recipes

Recipe name:
Ingredients (include amounts):
Total Weight (g) Cooked Dish:

REDCap ID:
Name Code:

Home Cooked Recipes

Recipe name:
Ingredients (include amounts):
Total Weight (g) Cooked Dish:

REDCap ID:
Name Code:

Home Cooked Recipes

Recipe name:
Ingredients (include amounts):
Total Weight (g) Cooked Dish:

REDCap ID:
Name Code:

Home Cooked Recipes

Recipe name:
Ingredients (include amounts):
Total Weight (g) Cooked Dish:

REDCap ID:
Name Code:

Home Cooked Recipes

Recipe name:
Ingredients (include amounts):
Total Weight (g) Cooked Dish:

REDCap ID:
Name Code:

Home Cooked Recipes

Recipe name:
Ingredients (include amounts):
Total Weight (g) Cooked Dish:

REDCap ID:
Name Code:

Home Cooked Recipes

Recipe name:
Ingredients (include amounts):
Total Weight (g) Cooked Dish:

Notes:

REDCap ID:
Name Code:

Example Diary Entry

DATE: 17th / July / 2019

Please circle the day completed:

Monday / Tuesday / Wednesday / Thursday / Friday / Saturday / Sunday

Time and Meal/Snack Occasion e.g. 07:00 am (breakfast)	**Measure of amount served** teaspoon (tsp), tablespoon (tbsp), gram (g), millilitre (mL), minutes (mins), H6, MD 6 etc.	**Foods and Drinks** (supplements if applicable) **For mixed foods include ingredients with amounts (e.g. ½ mashed banana with 2 Tbsp yoghurt)	**Amount leftover** e.g. MD4, H6, ¼ banana
2.30am (night feed)	15 mins	Breastfeed	n/a
7am (breakfast)	5 tsp	Baby rice cereal - 1 tbsp water and 1 tbsp farex baby rice cereal	1 tsp
7am (breakfast)	½ small banana	Mashed banana	H1
9am (morning tea)	2 cm	**{brand name}** infant teething **rusk**	Ate all
9.30am (morning tea)	20 mL	Boiled tap water	Drank all
10am (morning tea)	160 mL prepared formula	Formula - 150mL tap water and 2 level scoops {**formula brand}**	25 mL left in bottle
12.30pm (lunch)	1 Small tin (120g)	**{brand name}** pureed Lamb & Vegetables 4months+	¼ tin left
12.30pm (lunch)	medium avocado	Mashed avocado	MD4
2.30pm (snack)	60 mL	Boiled tap water	30 mL
3pm (afternoon tea)	tsp	Mashed pear	2
4pm (snack)	160 mL prepared formula	Formula - 150mL tap water and 2 level scoops {**formula brand}**	Drank all
6pm (dinner)	1 cup	Tuna Mornay (**recipe below**)	1/2

Example Home Cooked Recipe

Recipe name: Tuna Mornay
Ingredients (include amounts):
1 x 420g can {**brand name}** Tuna (in spring water), drained
2 medium carrots, peeled, diced
1 cup frozen baby peas
¾ cup grated {**brand name}** cheddar cheese
2 cups {**brand name}** full fat milk
1 cup cooked macaroni pasta
Total Weight (g) Cooked Dish: 1.125 kg

REDCap ID:
Name Code:

Thank you for completing your baby's food diary!

Please remember to take photos of the diary entries for **both** days, including the recipe pages, and email them to us **before** your scheduled follow-up call. Our study staff will then contact you to go through your entries.

Organization:	SAHMRI Women and Kids
Contact Persons:	Najma Moumin 0436 920 673
	Ashley Loh 0483 096 544
Business Hours:	8:00 am- 5:00 pm Monday to Friday
Email:	ozfitsstudy@sahmri.com

ozfits

The Australian Feeding Infants and Toddlers Study

The ozFITS Study

Food Measurement Book

SAHMRI
South Australian Health & Medical Research Institute

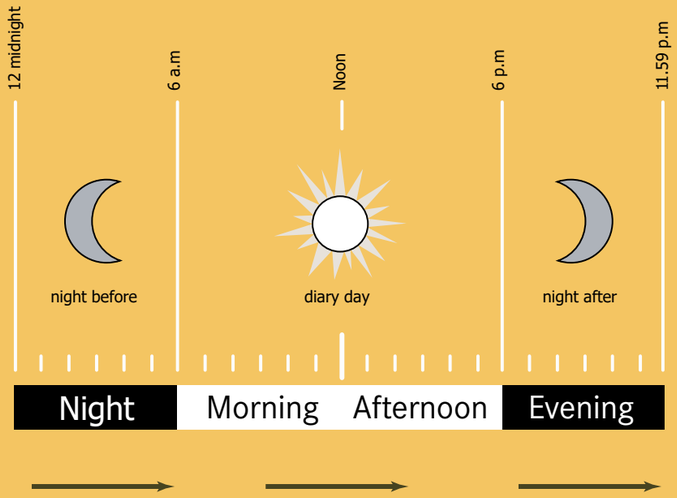
Table of Contents

The drawings and photographs in this booklet are used to describe amounts of food and beverages your child ate and drank on the days you kept the food diary

1	To help you with the interview... The 24-hour time period for your child's food record; frequently forgotten foods and eating occasions.
2	Beverage containers... for beverages such as water, milk, juice, soft drinks. See photographs of common cups, sippy cups and bottles, labeled at the bottom with codes C1 to C8. Lines and letters represent different amounts. For items that come in a pouch like yoghurt, refer to P1 and P2.
3	Food containers... for foods such as hot/cold cereal, soup, and/or stew. Refer to the photographs of bowls with codes B1 to B6. Lines and letters represent different amounts.
4	Shapes and mounds... for foods such as mashed fruit and/or vegetables, spreads, sauces, casseroles, pasta, and rice. There are six photos of spoonfuls labeled H1-H6 and three small mounds beside knives labeled as MD1- MD3. Finally, there are four pages of larger mounds labeled as MD4 to MD12, and freezer cubes labeled as MD13 to help you estimate the portion of food on the plate.
5	Rings... for round foods such as pancakes, apples, oranges, and muffins. A set of different coloured rings, labeled as R1 to R10, that range in size from about 3cm to 23cm across. Use any ring to describe your child's food. **Thickness**... on the next page, there is a ruler ranging from 1cm to 25cm. Choose a number between 1 and 25; don't write in-between numbers.
6	Grid... for foods such as lasagne, meatloaf, steak, and cake slices. Refer to the 16cm grid. Imagine the food item placed in the corner by the star. Use the numbers on the side of the grid to describe the length and width of your food. **Thickness**... use the ruler on page 19 to describe the height of the food ranging from 1 cm to 25 cm
7	Wedge... for foods such as pie, cake and pizza. The shaded wedges are to help you imagine your child's food on a plate. Imagine the food item with one edge along the bottom line and the tip of the food item in the corner by the star. Refer to the numbers on the bottom line to record the length of the food. With your finger on the number at the bottom of the wedge, follow the line upwards until the space between your finger and the bottom line looks like the portion size your child ate. Record the letter on the line closest to your finger. **Thickness**...use the ruler on page 19 ranging from 1cm to 25cm to describe the height of your child's food.
8	Measurement help... here are common measures and conversions that may help you describe how much your child has had to eat. Use the notes section to record the food measures you prefer to use.

This Food Model Book has been adapted from material provided by the Australian Bureau of Statistics, United States Feeding Infants and Toddlers Study 2016, United States Department Of Agriculture Research Service, Food Surveys Research Group, and from the Food Model Booklet developed from the 2007 Australian Children's Nutrition and Physical Activity Survey, funded by the Department of Health And Ageing, Department of Agriculture, Fisheries and Forestry, and the Australian Food and Grocery Council, and from the 4000 for Health Food model booklet developed by the Victorian Government Department of Human Services. Their generosity is gratefully acknowledged.

Food Intake



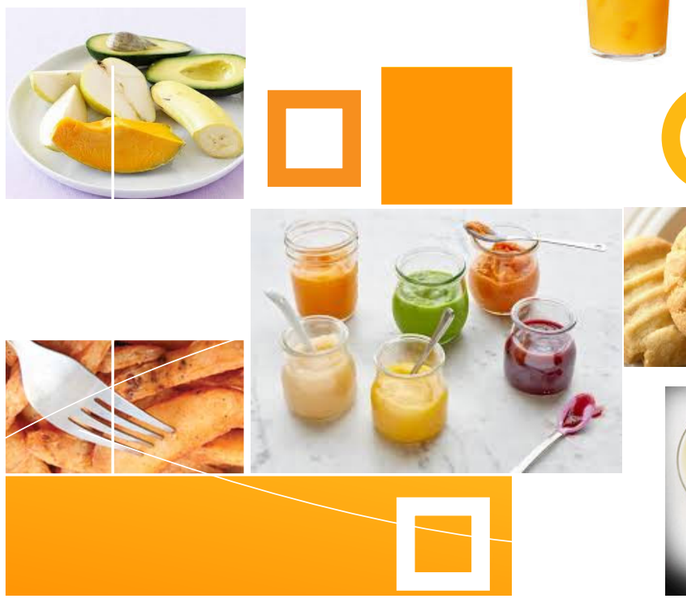
Midnight to Midnight

Frequently forgotten foods

- Water, juice, milk, soft drinks, other beverages
- Muesli bars, cereal bars, ready-to-eat cereals
- Dry biscuits, breads, teething rusks
- Sweet biscuits, candy, ice cream, other sweet foods
- Fruit, vegetables or cheese
- Chopped or ground meats

Eating occasions

- Breakfast
- Morning tea
- Lunch
- Afternoon tea
- Dinner/Supper
- Snack
- Other



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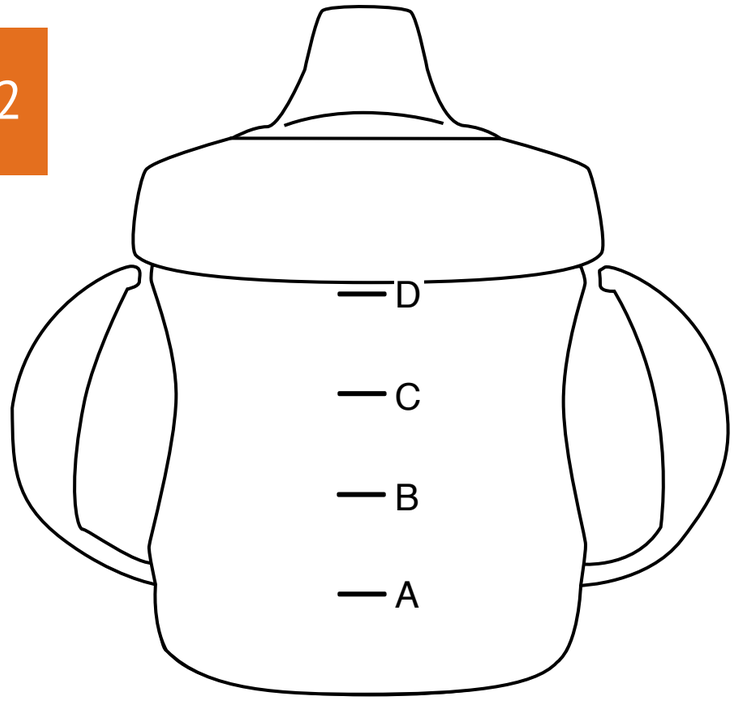
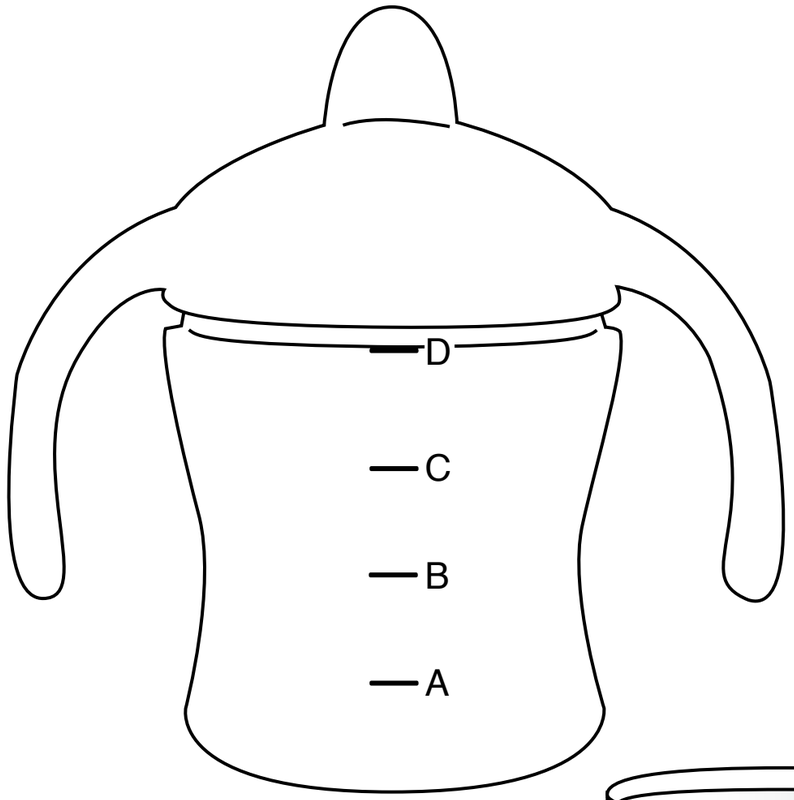


C1



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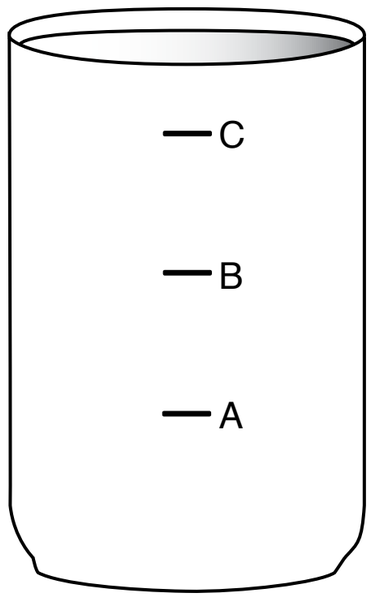
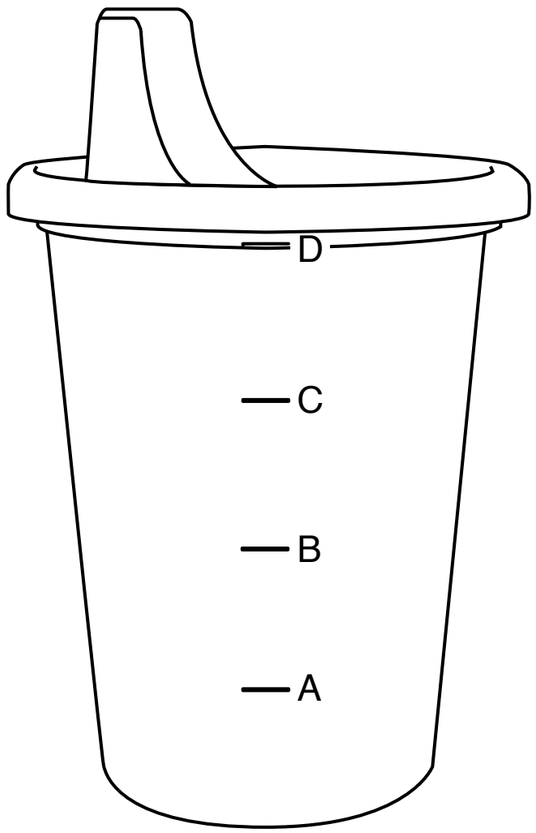
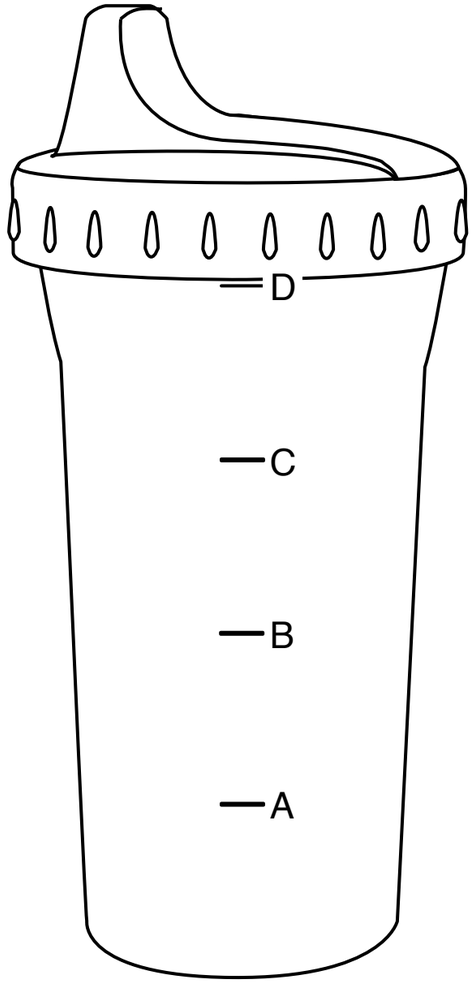


C3

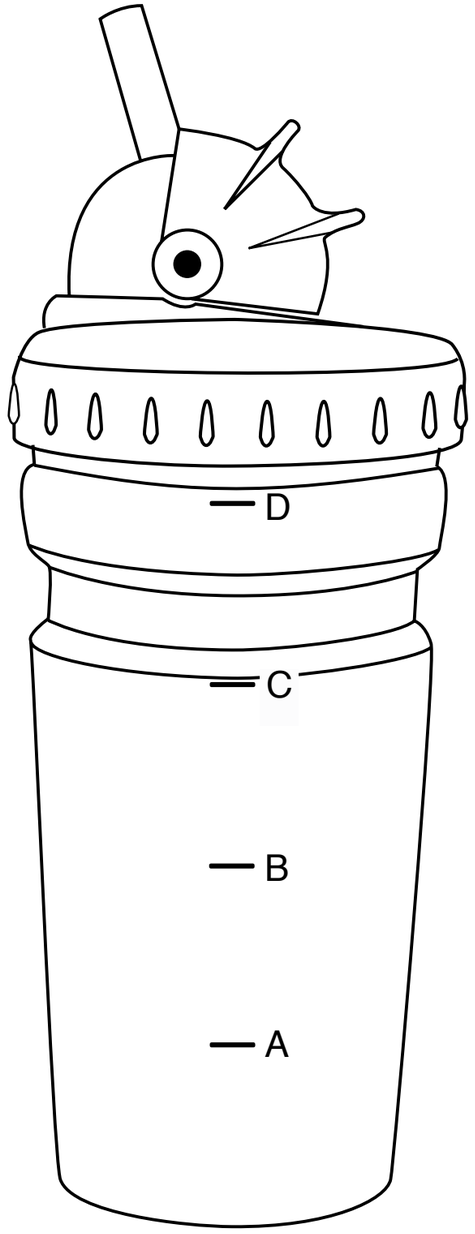
C4



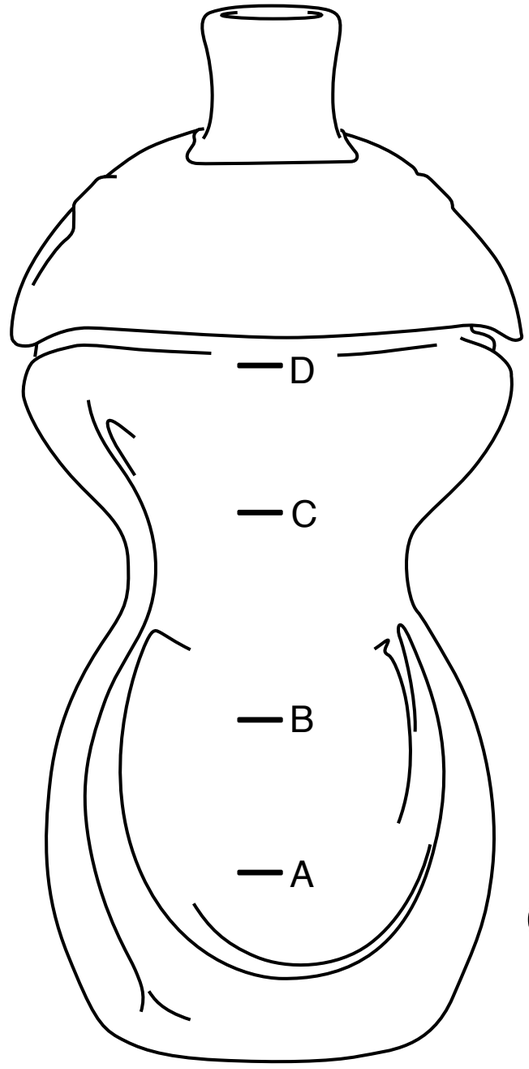
C5



C6



C7



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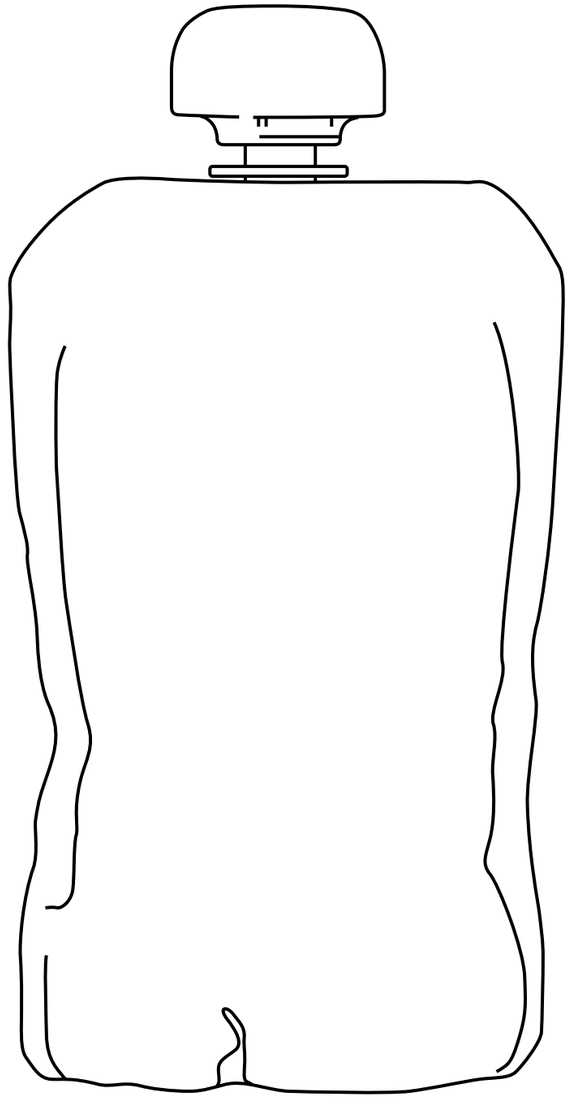

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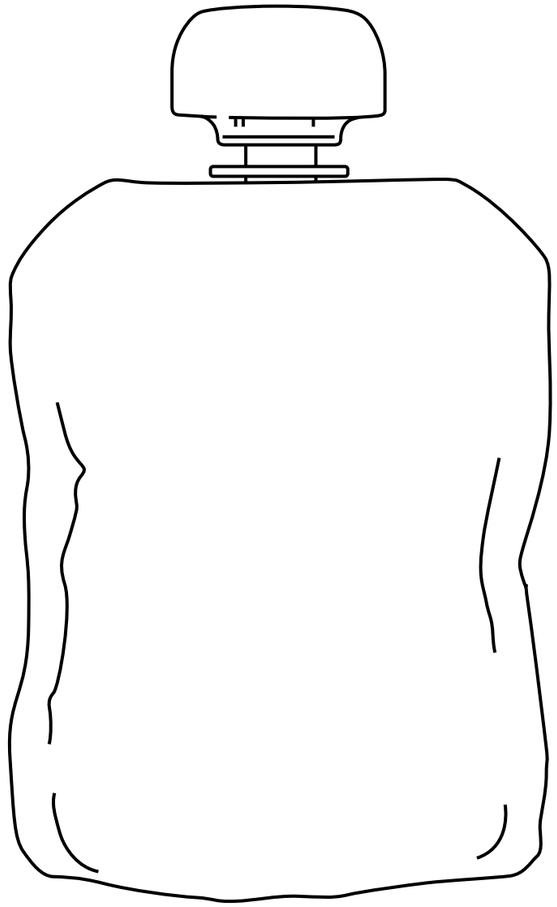

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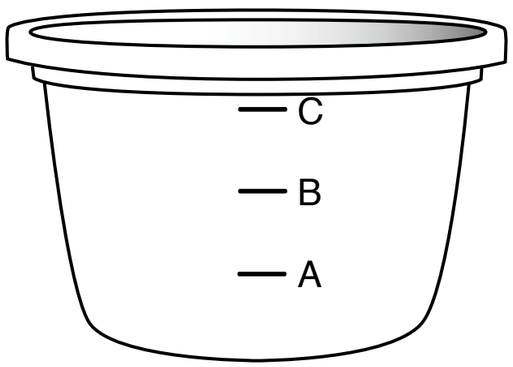

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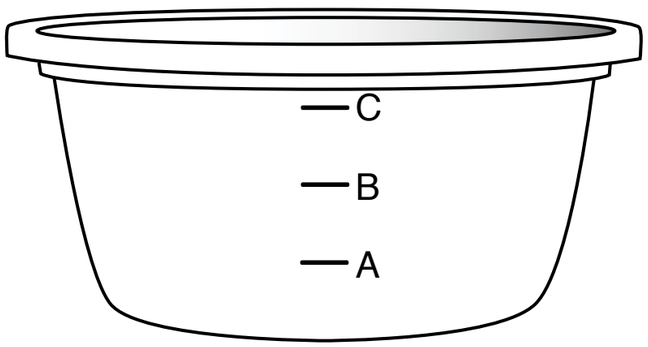

B2

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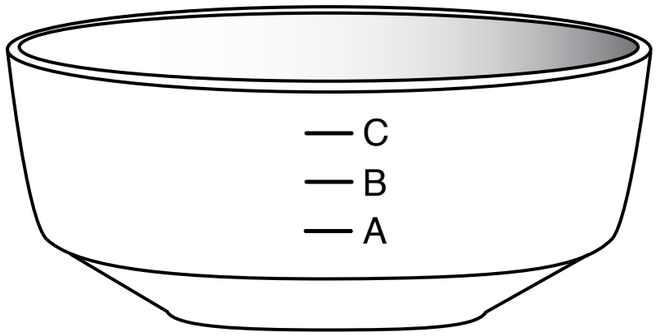

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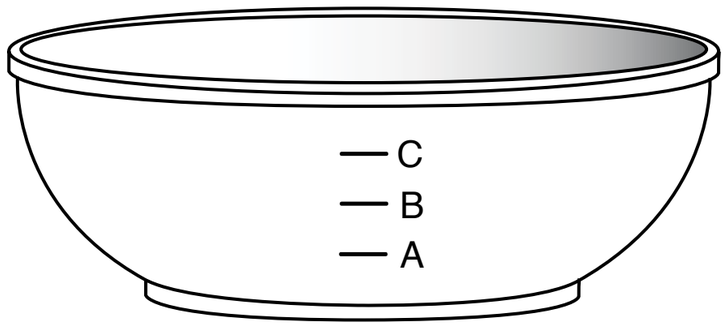

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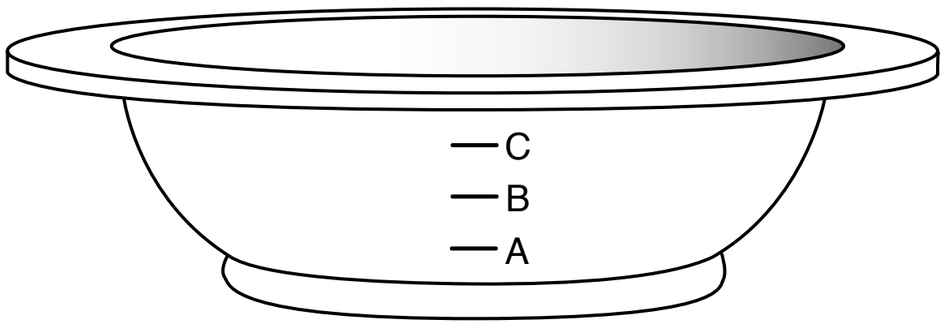

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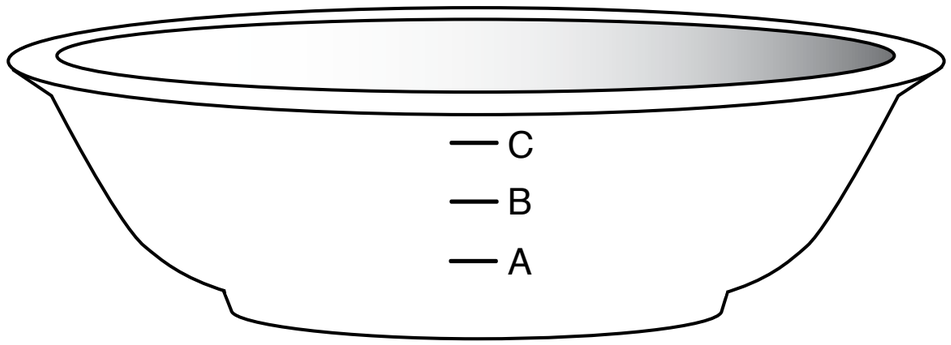
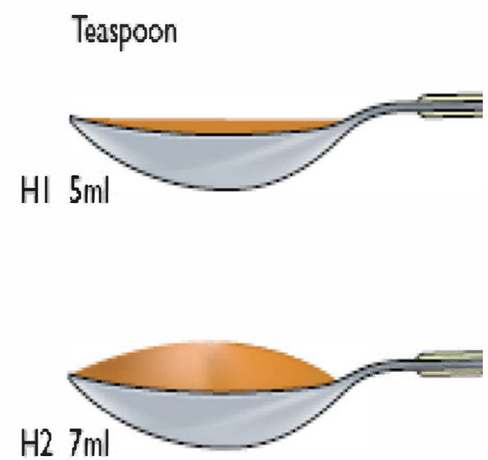
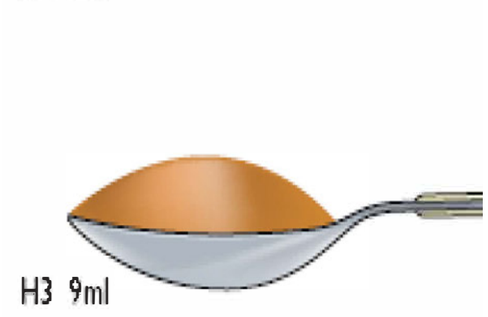


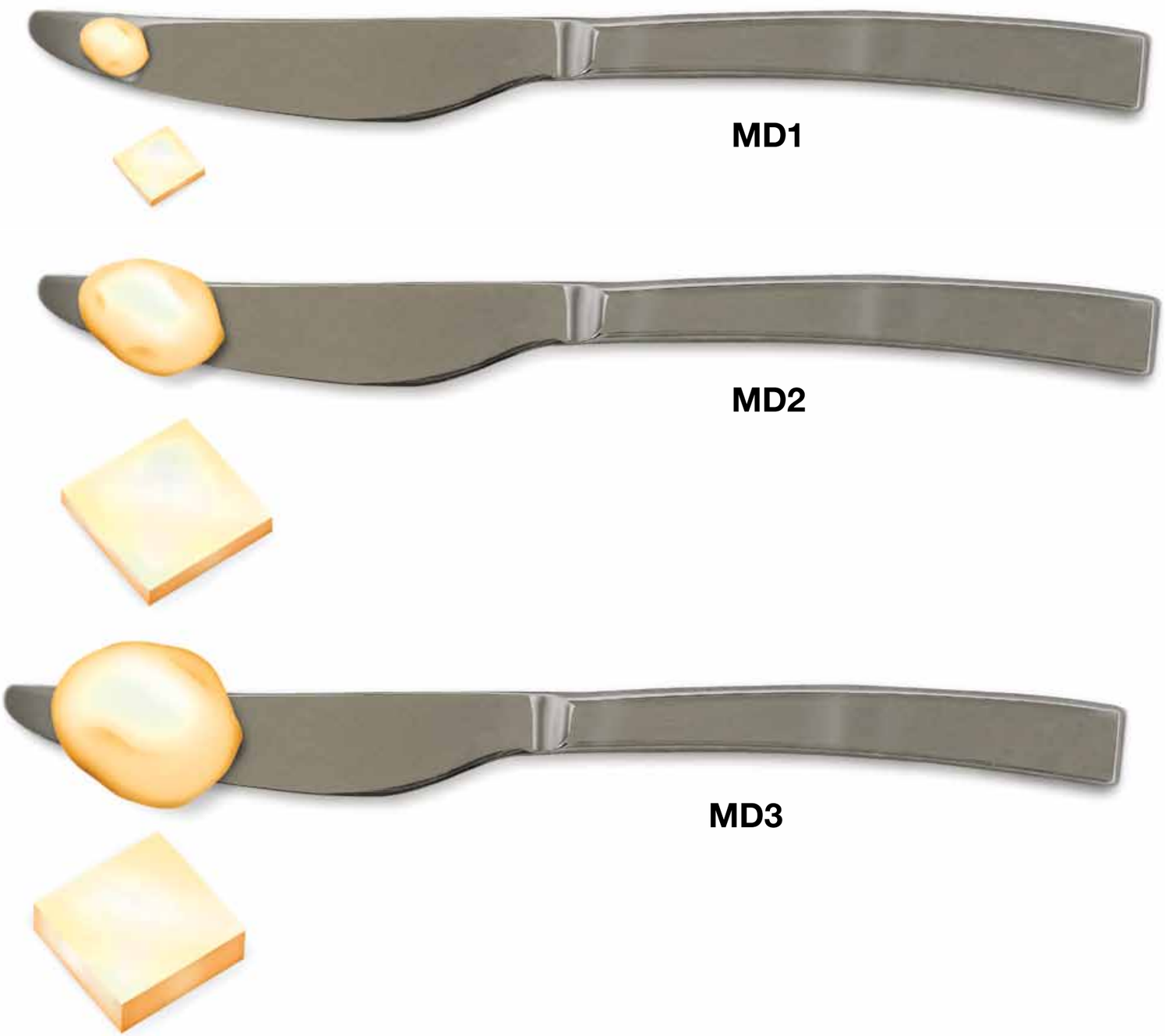
B6

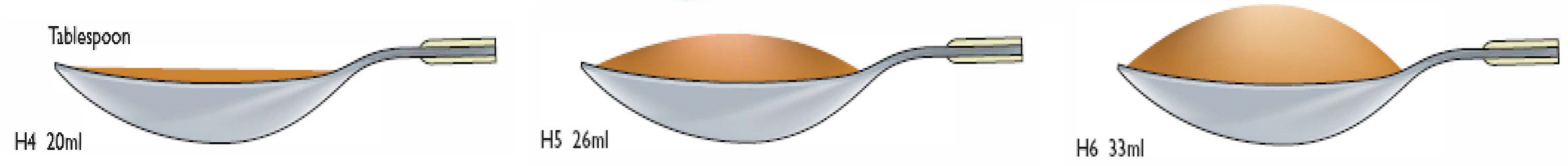
Spoons (level, rounded and heaped)

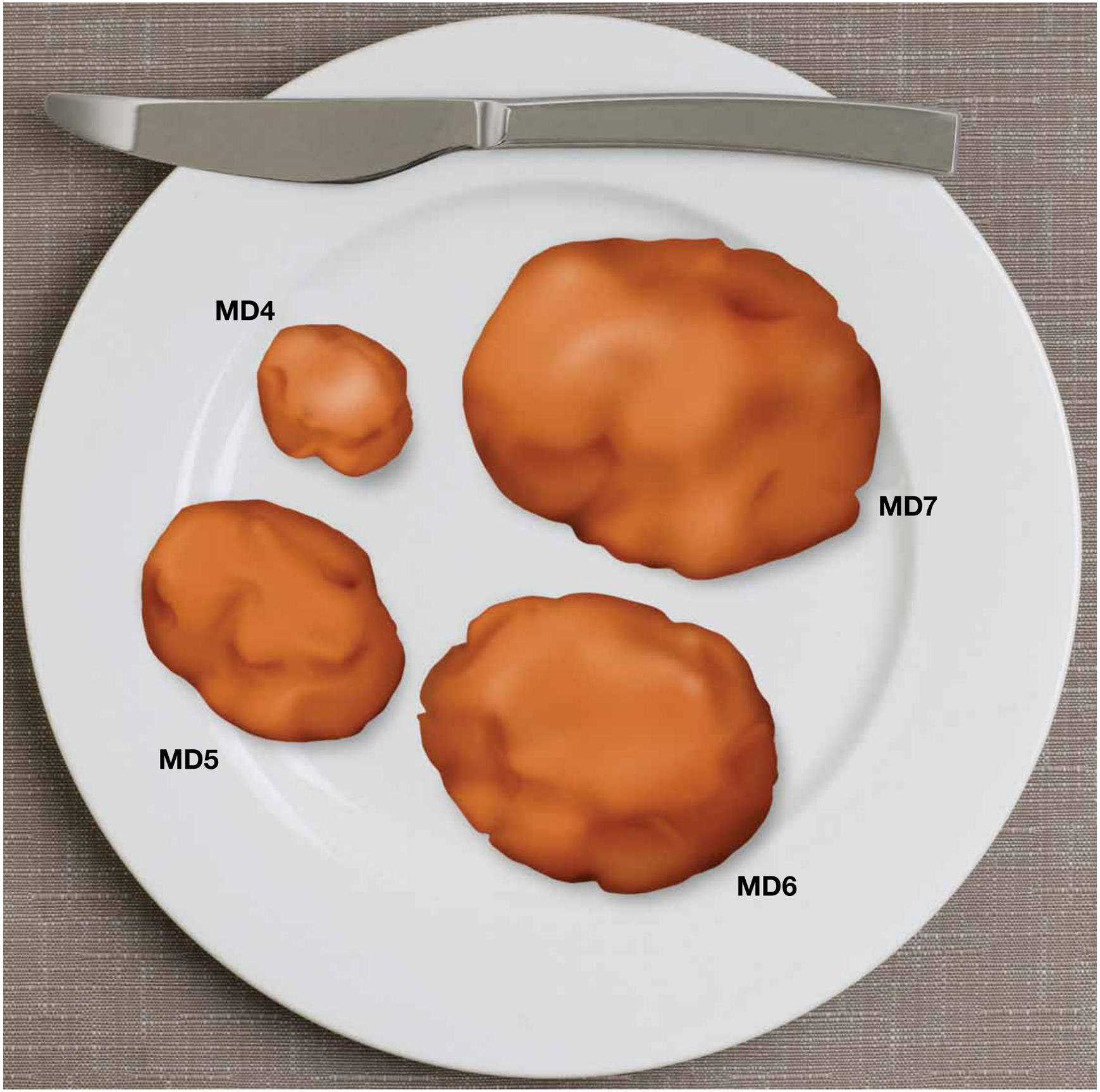
4











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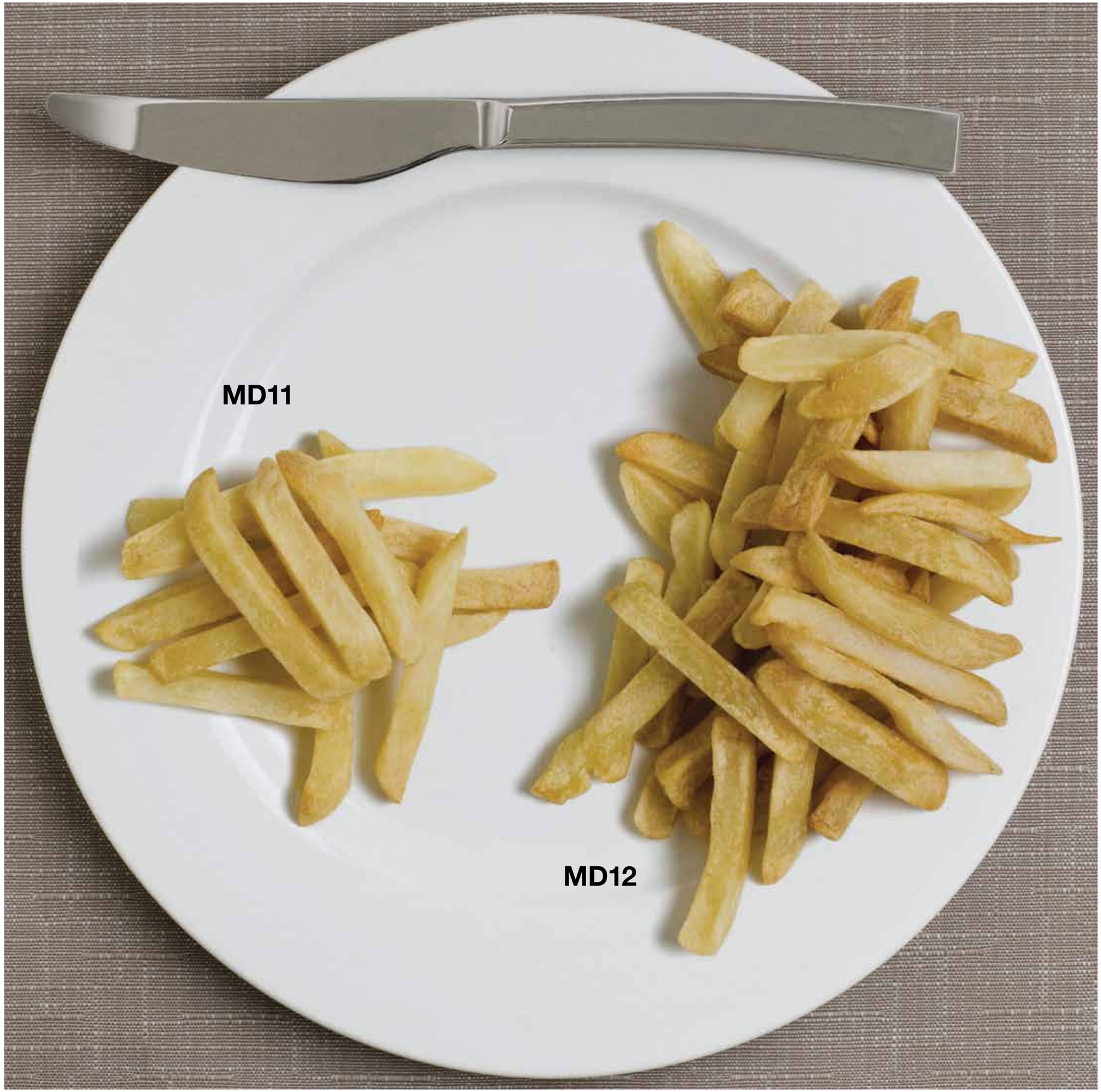

4

MD13


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Height in Inches
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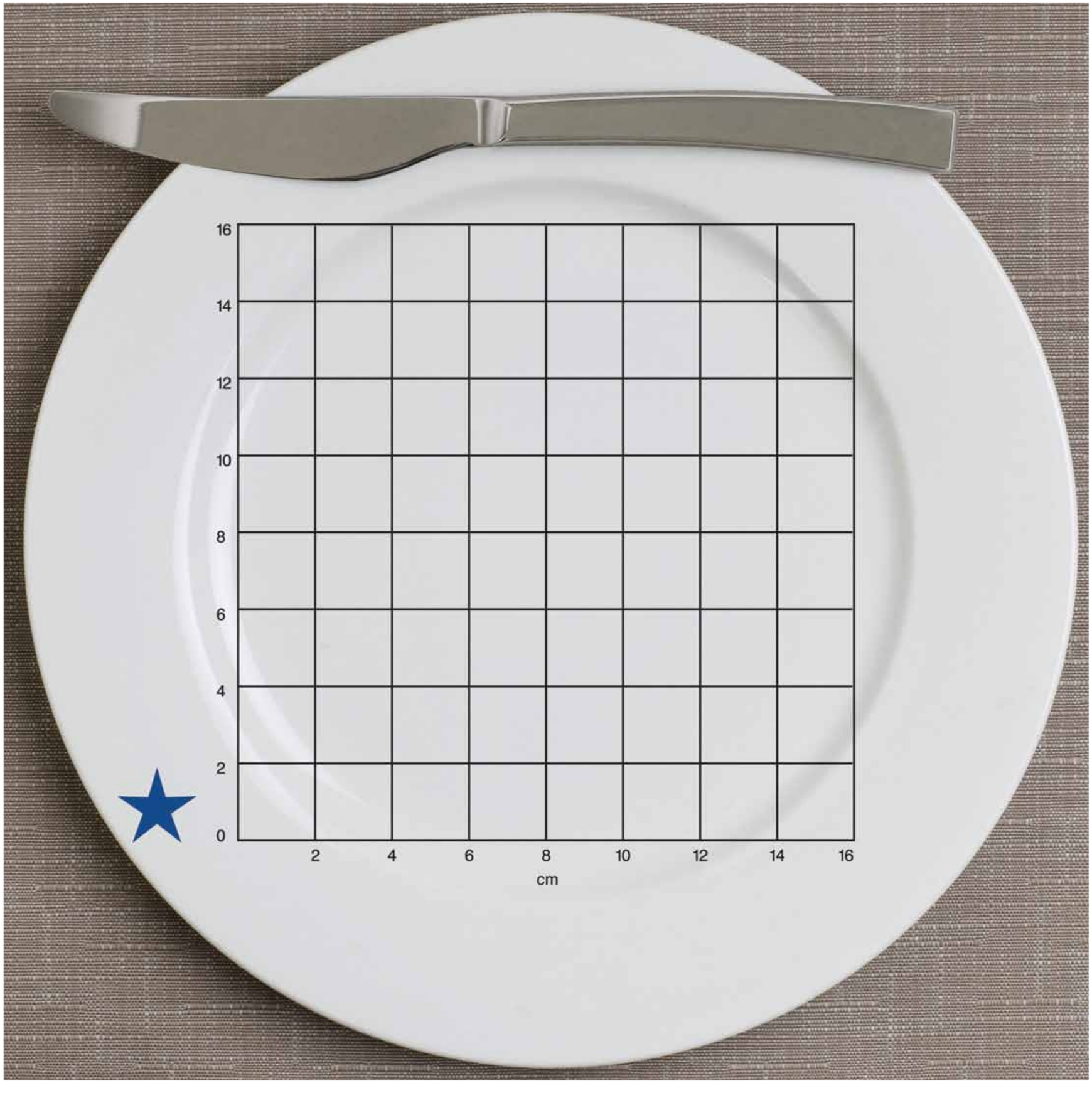
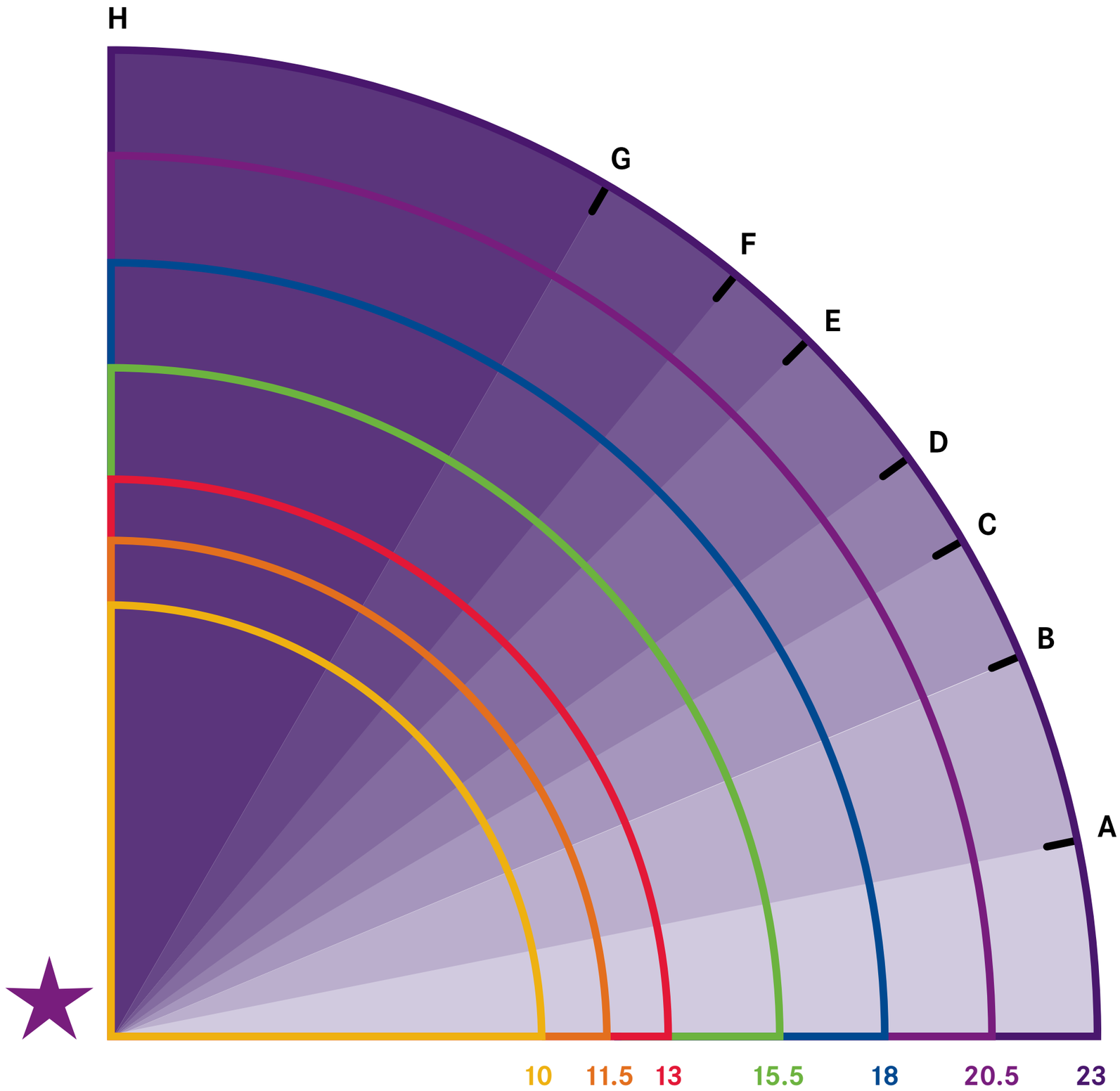
3/8
1/2
5/8
3/4
7/8
1 1/8
1 1/4
1 3/8
1 1/2
1 5/8


R1 3cm
R2 5cm
R3 8cm
R4 10cm
R5 13cm
R6 15cm
R7 18cm
R8 20cm
R9 23cm

5



6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11.5
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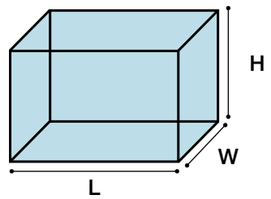
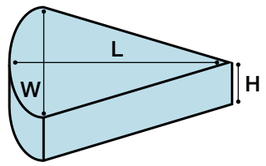
20.5
23

Shapes for volume calculations



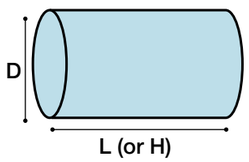
Square or rectangle
(3 dimensions required)

L = Length
W = Width
H = Height



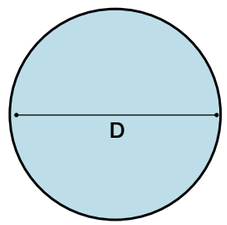
Wedge
(3 dimensions required)

L = Length
W = Width
H = Height/Thickness



Cylinder
(2 dimensions required)

D = Diameter
L = Length/Height



Sphere
(1 dimension required)

D = Diameter

Food measures I commonly use

Useful conversions

Solid measures

Metric	Imperial
20g	3/4 oz
60g	2 oz
125g	4 oz
180g	6 oz
250g	8 oz
500g	16 oz (1 lb)
1kg	32 oz (2 lb)

Liquid measures

Cups	Metric	Imperial
1/4 cup	60ml	2 fl oz
1/3 cup	80ml	2.5 fl oz
1/2 cup	125ml	4 fl oz
2/3 cup	160ml	5 fl oz
3/4 cup	185ml	6 fl oz
1 cup	250ml	8 fl oz
1.5 cups	325ml	12 fl oz
2 cups	500ml	16 fl oz
4 cups	1 litre	32 fl oz

Oven temperatures

Gas Mark	Fahrenheit	Celsius	Description
1/4	225	110	Very cool/very slow
1/2	250	130	
1	275	140	cool
2	300	150	
3	325	170	very moderate
4	350	180	moderate
5	375	190	
6	400	200	moderately hot
7	425	220	hot
8	450	230	
9	475	240	very hot

Appendix 9. Food Record Prep Guide—Chapter 4

PREPARING PARENTS / CARERS TO RECORD FOOD INTAKE

1. ***Check that the respondent has received all necessary documents to complete the entry(ies) e.g. Food Diary booklet, childcare form (if needed), Food Measurement Guide.

2. We need you to record _____'s intake for the following day(s)_____

3. We need to know everything they eat and drink during the 24 hours from midnight to midnight on your diary day(s). So, for Sunday, you would record everything they ate and drank, including any supplements, from midnight Saturday to midnight Sunday.

4. Use the food diary to record their intake, and also any recipes you used during that time.

5. After you have recorded their intake, we will contact you by phone to run through the diary with you and record your child's intake in our food analysis software. Keeping the food diary before the phone call will make it much easier for you to remember what _____ ate and drank. And the process of running through the diary over the phone will also make sure that we don't miss anything or enter anything incorrectly. This will mean that the data we get is much more accurate and reflects the actual intake of Australian infants and toddlers.

6. Please remember to write down everything they eat or drink during this time, including before breakfast, at breakfast, mid-morning, lunch, mid-afternoon, dinner time, before bed, and any night-time feeds/drinks.

7. It is a good idea to record the foods and drinks **at the time** your child has them. It is easy to forget what they ate and drank at the end of a busy day.

8. Please use the food measurement guide to help you determine the amounts your child ate. ***Ask if the respondent has a kitchen food scale at home and encourage them to use it. Remind them to tare the scale to zero before weighing food. *Talk through food measures whilst showing pictures.*

9. ***Ensure understanding of the difference between gram weight and volume measures i.e. ½ cup (125 mL) of cereal does not = 125 g of cereal. Different foods have different densities.*

10. ***Ask the respondent which bowl or cup style from the pictures in the Food Measurement Book they use most often to feed their child. Ask them to measure the volume of the bowl and/or cup ahead of time so you can use it as a reference during the recall. Record this information in the document entitled Participant Notes and file it in the Food Record folder you have created for the participant.

11. Some foods and drinks are easy to forget. In your diary, please include:
    - Water, juice, milk, breastfeeds and any other drinks
    - Anything you add to foods (e.g. butter, milk, salt)

- Tastes of food or sips of drinks

12. When recording water drunk across the day, it is ok to write the total amount drunk at the end of the recall, for example ¾ of a 500ml drink bottle of water drunk across the day.

13. We understand that what your child eats day to day changes, and that what they eat some days doesn't reflect their 'usual' eating habits. Please be sure to record only what they actually eat and drink, but feel free to make a note of anything that may have effected how or what they ate and drank that day in the 'notes' section at the end of each day (for example if they were sick or attended a party). When we call you, we will ask if their intake was usual or if for some reason it was different to usual.

14. Please write down the time spent breastfeeding (in minutes) at each feed. Try to think about the time your baby is actually feeding, and not the time they spent latching on or falling asleep. Remember to include the total time spent at the breast, so if for example they spent 4 minutes on one side, before falling asleep for 5 minutes, followed by a further 3 minutes on one side – only record the 7 minutes spent actively feeding, and not the 5 minutes of sleeping.

15. For products that you need to make up such as formula and baby rice cereal, please write down the recipe including the amount of powder, amount and type of fluid added (e.g. water, breastmilk), the amount that the recipe made up and the amount that your child actually ate. For example, 3 scoops of formula powder, 90mls of water, making up 100mls of formula, drank 70mls.

16. When writing down packaged foods and drinks, please note the brand (e.g. Heinz), and type (e.g. pureed apple and mango), as well as the amount your child eats. Please also include as much other detail as you can for example stage (e.g. 4-6 months) and package size and type (e.g. 110g jar or 70g sachet)

17. For home-prepared foods and drinks, you can write out the recipe on the recipe sheet on the last pages of the diary. An example is given in the Food Diary. Include whether the ingredients are raw/dry or cooked (e.g. 500g raw beef mince, 1 cup dry macaroni).

18. If your child will be with someone other than you on a diary day (for example, at a grandparent's house or at child care), you will need to provide them with the 'Child-carer Record Form'. When you provide them with the diary, it is important to explain the following:
    - Your child is a participant of the OzFITS study, which is collecting information about the dietary intake of infants and toddlers.
    - In order to collect accurate information about children's intake, we need the support of other carers who may feed these children.
    - You need to keep a record of their intake, and will need their input whilst your child is in their care
    - It is important that EVERYTHING your child eats, and drinks is recorded, including water and milk feeds
    - There are some measurement aids in the booklet to help with recording how much they ate or drank

- Recipes / mixtures – need details where possible (if no recipe is available, even just a description of likely ingredients – ie tuna mornay – pasta, tuna, cheese sauce, peas, corn, carrot)

When you pick your child up, have a brief conversation with the other carer to make sure no details have been missed. Check and clarify the following:

- Time of food and meal type – are there any 'gaps' where they may have eaten or drank something?
- Food description – where it is a mixed food, is there a recipe, or at least a general description of the main ingredients? Brand names? Fat content (for example, for milk or yoghurt?)
- Quantities – have they recorded the amounts eaten or drank of each food, and used measures such as teaspoons, tablespoons, cups, mLs, grams etc? have they recorded any left-over amounts?

Try the following questions to probe for further detail:

- There seems to be a gap between 9am and 1pm, did Claire have anything to eat or drink during that time?
- So, I can see that Charlie had tuna mornay, do you have a recipe for that? If not, do you know what sort of ingredients were in it?
- It says here that he had 2 portions – what was the size of one portion? (show measurement aid)
- How much of her drink bottle did she drink? Did she drink anything else other than water from her drink bottle?

Appendix 10. Recipe Food Group Codes—Chapter 6

Recipe Food Group Codes

The ingredients of mixed dishes and recipes is important to capture, especially when the resulting food would be classified as a core food e.g., mixtures of vegetables, mixtures of fruit, meat and vegetables, pasta and meat and vegetables. Therefore, all mixed dishes and recipes entered as a FoodWorks recipe should have a food code assigned to allow grouping of these recipes based on their primary ingredients.

Food codes for recipes are based on the main food group (i.e., vegetables, fruit, meat, dairy, breads & cereals) making up the largest proportion of the dish (excluding water). For example, a recipe with vegetables and meat will be given a code within the vegetable group (i.e., 24) if the vegetable proportion is greater than the meat proportion. For some common recipes there will be an existing code available in FoodWorks that may be used. However, where a close match is not available, the guide below may be used.

Where small amounts of milk/fat/sugar/cereal are added to mashed potato, stewed fruit and other foods prepared for infants, an appropriate food code can be selected from existing codes (e.g., the code used for mashed potato already, rather than creating a new code).

Cut points: mashed veg/fruit < 20%; dairy < 5%; cereal; < 5% fat, < 5% sugar (i.e. if more used than these cut points, suggest creating a new code)

For discretionary mixed dishes / recipes use existing codes where possible.

Recipe major ingredient(s)	Description	Unique 8-digit code	Existing 8-digit code
VEGETABLES	100% veg/legume no additions		24803008
	Pasta sauce without meat (vegetable and tomato-based sauce)		24901004
	100% veg / legumes (incl. dairy<20%)	24803100	
	Veg + fruit (incl. cereal if ≤5%)	24803101	
	Veg + cereal (≥20%)	24904100	
	Veg + breast milk + cereal	24904101	
	Veg + stock		24901001
	Veg + dairy + fat		24903005
	Veg + chicken	24905100	
	Veg + meat (meat ≥ 10%)	24905101	
	Veg + Fruit + meat (meat >2% <10%)	24905102	
	Veg + fish/seafood + cereal + egg (e.g., swe potato salmon fritter)	24903011	
Legumes	Dishes where mature legumes main ingredient	25202	
	Pasta dish, tomato-based sauce + Lentil	25202017	
	Falafel, chickpea patty, fried		25202009

	Bean Soup (veg + meat)	25202018	
	Legume + veg+ rice	25202019	
Fruit	Mixtures across groups + veg	16901200	
	Fruit + Cereal (flour) + Fat (Pear muffin)	16901101	
	Fruit + cereal + dairy	16901104	
	Fruit + cereal + breastmilk	16901106	
	Fruit + cereal + milk alternative +/- seeds	16901010	
	Fruit + cereal + dairy +/- egg (oat chews/bites/non-discretionary slices)	16901103	
MEAT	Lamb + veg	18705100	
	Pork meatball + added veg + breadcrumb coating	18710006	
	Beef + pork + veg Bolognese sauce	18701100	
	Beef + turkey + veg Bolognese sauce	18701103	
	Beef + pork + veg (taco filling)	18701101	
	Beef + veg only (no added fat)	18701102	
	Pork + veg + cereal	18709005	
Chicken	Chicken + veg chicken ≤ 50%	18904002	
	Chicken + veg + cereal	18902030	
	Chicken + fruit + cereal		
	Chicken + veg + fruit	18901100	
Fish/Seafood	Seafood + meat + veg	15603016	
EGG	Egg + cereal + veg + other	17201100	
DAIRY	Mostly milk (>75%) but raw cereal- eaten as cereals		
	Custard with egg (no sugar)	19601010	
	Custard (egg + milk + fruit)	19601003	
	Milk or Yoghurt based smoothies (berries)		19806002
	Milk or Yoghurt based smoothies (banana)		19806001
	Milk or Yoghurt based, smoothies added mixed fruit & nuts or seeds		19806007
	Milk or Yoghurt based smoothies, all flavours, added mixed fruit		19806004
	Non-dairy based (major ingredient if mixed w/ dairy) smoothies, all flavours		20107002
CEREAL *if > 5g/100g saturated fat use 13510 code for pasta and 13512 for rice as the first five digits	Cereal (pasta) + meat + tomato-based sauce		13509055

	Cereal (unfilled pasta) + chicken + meat (bacon/processed meat) + veg + dairy (saturated fat < 5g/ 100g)	13509100	
	Cereal (unfilled pasta) + chicken + meat (bacon/processed meat) + veg + dairy (saturated fat > 5g/ 100g)	13510009	
	Cereal (filled pasta) + chicken + meat (processed meat) + veg + tomato-based sauce	13513100	
	Cereal (filled pasta) + chicken + veg + dairy based sauce	13513200	
	Cereal (unfilled pasta) + beef + processed meat + veg + tomato-based sauce	13509101	
	Cereal (filled pasta) + veg/fruit + oil-based sauce	13513300	
	Cereal (pasta) + seafood + chicken + veg	13509200	
	Cereal (rice) + chicken		
	Cereal (rice) + meat (<10%) + veg	13511044	
	Cereal (rice) + meat (≥10%) + veg	13511045	
	Cereal (rice) + veg/legumes	13511047	
	Cereal (rice) + veg/legumes+ added fat	13511048	
	Cereal (flour) + Veg (savoury muffin) non-discretionary	13307100	
	Cereal (flour) + fruit (e.g., fruit muffin) non-discretionary	13307101	
	Cereal (oat) + Fruit +/- Seeds +/- Fat (breakfast slice)	13306100	
	Cereal (oats) + Milk + Nuts (pb)+ Fruit/Veg	12601025	
	Cereal (oats) + Milk + fruit/veg +/- seed	12601022	
	Cereal (oats) + Milk Alternative + fruit/veg	12601026	
	Cereal (oats) + water + fruit/veg +/- seed	12601027	
	Cereal (oats) + milk + nuts (almond meal)	12601023	
	Cereal (oats) + milk+ seeds	12601024	
	Porridge other (other or mixed grain/ seeds and/or nuts)	12602100	
	Sausage roll		13405037
	Homemade pasta (wheat, egg) + added fat	12401100	
	Pancake (homemade) + pome fruits	13601100	
	Pancake + fruit/veg (oat or seed meal based based)	13602100	
	Gluten free breads (nut based e.g., almond meal)	12213007	
	Wraps > 5g saturated fat w/ meat & cheese	13508100	
SOUP	Pumpkin homemade with milk		21102016
	Veg only + water/stock		21102007
	Veg + cream + stock		21102002

	Veg + chicken		21101007
	Veg/legumes + cereal (pasta or rice)		21102008
SAUCE	Sauce, cream-based, added meat, added veg	23108009	
	Sauce, Chutney, Coconut Based	22203100	
PASTRY	Pastry + veg + bacon + dairy		13405030
Adult Discretionary Snacks	Bliss balls		13306029
	Chia pudding made with coconut milk or coconut yoghurt **coded as rice pudding		19701008
Infant formula and foods (32)	Infant formula	32101100	
	Human breast milk (0-6 m)	32102100	
	Human breast milk (7m +)	32102101	
	Toddler formula	32103100	
	Water for making up formula	11701100	
Infant cereal products (322)	Infant cereals (dry)	32201100	
	Other Infant cereals and grains (e.g., dry plain pastas)	32201200	
	Infant rusks	32202100	
Infant foods (323)	Single vegetables	32301100	
	Single fruit	32301200	
	Mixed fruit	32301300	
	Mixed vegetables	32301400	
	Mixed fruits & vegetables	32301500	
	Infant savoury dishes (meat and veg)	32302100	
	Infant savoury dishes (vegetable only)	32302200	
	Infant custards or yoghurts (readymade breakfasts and desserts)	32303100	
	Infant snacks	32304	
	Infant savoury finger foods (puffs)	32304100	
	Infant savoury finger foods (crackers/biscuits)	32304200	
	Infant savoury finger foods (rice/corn cakes)	32304300	
	Infant fruit and vegetable-based finger foods (cereal bars)	32304400	
	Infant sweet finger foods (puffs)	32304500	
	Infant sweet finger foods (biscuits/crackers)	32304600	
	Infant sweet finger foods (rice/corn cakes)	32304700	

Appendix 11. Daily serves of five food group and discretionary foods consumed by toddlers 12—< 18months stratified by breastmilk intake, OzFITS 2021—Chapter 6

Supplementary Table 1 in reference from publication

Food Group	Consumers *n* (%)	AGHE Serve size [1]	Recommended serves per day	Number of serves per day [2]
		Breastfed toddlers (*n* = 119)		
Fruit	116 (97)	150 g	½	0.88 (0.45–1.47)
Vegetables	118 (99)	75 g	2-3	1.17 (0.54–2.23)
Cereals and grains	115 (97)	40 g bread	4	1.75 (0.87–2.56)
Meats and alternatives	111 (93)	65 g red meat	1	0.52 (0.22–0.95)
Dairy				
Without toddler milks	107 (90)	250 ml milk	1–1 ½	0.58 (0.21–1.21)
With toddler milks [3]	107 (90)	250 ml milk	1–1 ½	0.60 (0.21–1.21)
Fats and oils	69 (58)	7–10 g	1	0.15 (0–0.78)
Discretionary foods	101 (85)	418 kJ	0	0.73 (0.22–1.76)
		Non-breastfed toddlers (*n* = 114)		
Fruit	108 (95)	150 g	½	1.15 (0.69–1.63)
Vegetables	111 (97)	75 g	2–3	1.55 (0.60–2.28)
Cereals and grains	110 (96)	40 g bread	4	2.21 (1.33–3.20)
Meats and alternatives	102 (89)	65 g red meat	1	0.47 (0.18–1.01)
Dairy				
Without toddler milks	113 (99)	250 mL milk	1–1 ½	1.56 (0.79–2.24)
With toddler milks [3]	114 (100)	250 mL milk	1–1 ½	2.24 (1.55–2.96)
Fats and oils	67 (59)	7–10 g	1	0.10 (0–0.51)
Discretionary foods	100 (88)	418 kJ	0	0.79 (0.20–2.04)

[1] AGHE; Australian Guide to Healthy Eating; Equivalent of 40 g bread, 65 g red meat, or 250 ml milk. For example, 40g of cheese equals one serve of dairy [12]. [2] Values are median (IQR). The lower bound is used where a range exists for a recommended serves per day. [3] Dairy, including formula/toddler milk. A serve of formula/toddler milk is defined as 250 mL prepared volume. OzFITS, Australian Feeding Infants and Toddler Study.

Appendix 12. Energy and percentage total energy from five food group and discretionary foods for toddlers aged 12–<18 months stratified by breastmilk intake, OzFITS 2021—Chapter 6

Supplementary Table 2 in reference from publication

Food Group	Consumers *n* (%)	Energy, kJ/day [1]	Percentage of total energy intake [1]
	Breastfed toddlers (*n* = 119)		
Fruit	116 (97)	313 (138–524)	8 (4–13)
Vegetables	118 (99)	151 (30–378)	4 (1–9)
Cereals and grains	115 (97)	654 (327–1057)	18 (10–25)
Meats and alternatives	111 (93)	286 (71–689)	8 (3–16)
Dairy			
Without toddler milks	107 (90)	417 (110–743)	11 (3–19)
With toddler milks [2]	107 (90)	432 (110–792)	11 (3–21)
Fats and oils	69 (58)	37 (0–185)	1 (0–4)
Discretionary foods	101 (85)	290 (85–737)	8 (2–18)
	Non-breastfed toddlers (*n* = 114)		
Fruit	108 (95)	405 (249–622)	10 (6–14)
Vegetables	111 (97)	188 (58–464)	5 (1–11)
Cereals and grains	110 (96)	880 (514–1237)	22 (12–30)
Meats and alternatives	102 (89)	335 (59–750)	9 (2–17)
Dairy			
Without toddler milks	113 (99)	1065 (600–1517)	24 (15–38)
With toddler milks [2]	114 (100)	1499 (1013–1896)	37 (24–49)
Fats and oils	67 (59)	23 (0–139)	1 (0–4)
Discretionary foods	100 (88)	331 (82–841)	9 (2–20)

[1] Values are median (IQR). [2] Dairy, including formula/toddler milk. A serve of formula/toddler milk is defined as 250 mL prepared volume.

Appendix 13. Daily serves of five food group and discretionary foods consumed by toddlers 18–24 months stratified by breastmilk intake, OzFITS 2021—Chapter 6

Supplementary Table 3 in reference from publication

Food Group	Consumers *n* (%)	AGHE Serve size [1]	Recommended serves per day	Number of serves per day [2]
Breastfed toddlers (*n* = 90)				
Fruit	86 (96)	150 g	½	0.89 (0.48–1.62)
Vegetables	86 (96)	75 g	2–3	1.08 (0.49–2.40)
Cereals and grains	90 (100)	40 g bread [1]	4	2.01 (1.0–3.13)
Meats and alternatives	82 (91)	65 g red meat [1]	1	0.55 (0.25–1.29)
Dairy				
Without toddler milks	83 (92)	250 ml milk [1]	1–1 ½	0.73 (0.42–1.42)
With toddler milks [3]	83 (92)	250 ml milk [1]	1–1 ½	0.76 (0.43–1.47)
Fats and oils	54 (60)	7–10 g	1	0.24 (0–0.57)
Discretionary foods	79 (88)	418 kJ	0	1.37 (0.41–2.52)
Non-breastfed toddlers (*n* = 152)				
Fruit	147 (97)	150 g	½	1.25 (0.58–1.85)
Vegetables	143 (94)	75 g	2-3	1.22 (0.56–2.61)
Cereals and grains	151 (99)	40 g bread [1]	4	2.54 (1.71–3.39)
Meats and alternatives	137 (90)	65 g red meat [1]	1	0.62 (0.24–1.19)
Dairy				
Without toddler milks	147 (97)	250 mL milk [1]	1–1 ½	1.24 (0.85–1.93)
With toddler milks [3]	151 (99)	250 mL milk [1]	1–1 ½	1.66 (0.93–2.40)
Fats and oils	108 (71)	7–10 g	1	0.31 (0–0.89)
Discretionary foods	142 (93)	418 kJ	0	1.51 (0.60–2.68)

[1] AGHE; Australian Guide to Healthy Eating; Equivalent of 40 g bread, 65 g red meat, or 250 ml milk. For example, 40g of cheese equals one serve of dairy [12]. [2] Values are median (IQR). The lower bound is used where a range exists for a recommended serves per day. [3] Dairy, including formula/toddler milk. A serve of formula/toddler milk is defined as 250 mL prepared volume.

Appendix 14. Energy and percentage total energy from five food group and discretionary foods for toddlers 18–24 months stratified by breastmilk intake, OzFITS 2021—Chapter 6

Supplementary Table 4 in reference from publication

Food Group	Consumers *n* (%)	Energy, kJ/day [1]	Percentage of total energy intake [1]
Breastfed toddlers (*n* = 90)			
Fruit	86 (96)	294 (158–557)	6 (4–12)
Vegetables	86 (96)	146 (24–324)	3 (1–1)
Cereals and grains	90 (100)	836 (417–1394)	19 (10–31)
Meats and alternatives	82 (91)	500 (150–843)	11 (3–19)
Dairy			
Without toddler milks	83 (92)	520 (203–1004)	14 (6–23)
With toddler milks [2]	83 (92)	520 (205–1021)	14 (6–24)
Fats and oils	54 (60)	58 (0–148)	1 (0–3)
Discretionary foods	79 (88)	575 (172–1056)	12 (4–25)
Non-breastfed toddlers (*n* = 152)			
Fruit	147 (97)	415 (209–645)	9 (5–14)
Vegetables	143 (94)	185 (19–476)	4 (1–12)
Cereals and grains	151 (99)	1003 (620–1434)	23 (14–32)
Meats and alternatives	137 (90)	417 (122–858)	11 (3–20)
Dairy			
Without toddler milks	147 (97)	823 (470–1328)	20 (11–30)
With toddler milks [2]	151 (99)	1129 (630–1562)	26 (16–37)
Fats and oils	108 (71)	82 (0–218)	2 (0–5)
Discretionary foods	142 (93)	633 (249–1121)	16 (6–26)

[1] Values are median (IQR). [2] Dairy, including formula/toddler milk. A serve of formula/toddler milk is defined as 250 mL prepared volume.

Appendix 15. Percentage of toddlers meeting recommended daily serves of five food group and discretionary foods stratified by age, OzFITS 2021—Chapter 6

Food Group	Consumers *n* (%)	AGHE Serve size [1]	Recommended serves per day	Toddlers meeting recommended serves per day *n* (%) [2]
Toddlers 12 to <18months (*n* = 233)				
Fruit	86 (96)	150 g	½	177 (76)
Vegetables	86 (96)	75 g	2–3	74 (32)
Cereals and grains	90 (100)	40 g bread [1]	4	26 (11)
Meats and alternatives	82 (91)	65 g red meat [1]	1	58 (25)
Dairy				
Without toddler milks	83 (92)	250 ml milk [1]	1–1 ½	119 (51)
With toddler milks [3]	83 (92)	250 ml milk [1]	1–1 ½	141 (61)
Fats and oils	54 (60)	7–10 g	1	39 (17)
Discretionary foods	79 (88)	418 kJ	0	32 (14)
Toddlers 18 to 24 months (*n* = 242)				
Fruit	147 (97)	150 g	½	188 (78)
Vegetables	143 (94)	75 g	2-3	83 (34)
Cereals and grains	151 (99)	40 g bread [1]	4	32 (13)
Meats and alternatives	137 (90)	65 g red meat [1]	1	81 (34)
Dairy				
Without toddler milks	147 (97)	250 mL milk [1]	1–1 ½	127 (53)
With toddler milks [3]	151 (99)	250 mL milk [1]	1–1 ½	146 (60)
Fats and oils	108 (71)	7–10 g	1	46 (19)
Discretionary foods	142 (93)	418 kJ	0	21 (9)

[1]AGHE; Australian Guide to Healthy Eating; equivalent of 40 g bread, 65 g red meat, or 250 mL milk. For example, 40 g of cheese equals one serving of dairy [2]. [2]Values are median (IQR). The lower bound is used where a range exists for a recommended serving per day. [3]Dairy, including formula/toddler milk. A serving of formula/toddler milk is defined as 250 mL prepared volume.