Food and beverage intake in Australian children aged 12–16 months participating in the NOURISH and SAIDI studies

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Abstract

Objective: To describe the quantity and diversity of food and beverage intake in Australian children aged 12–16 months and to determine if the amount and type of milk intake is associated with dietary diversity.

Methods: Mothers participating in the NOURISH and South Australian Infant Dietary Intake (SAIDI) studies completed a single 24-hour recall of their child’s food intake, when children (n=551) were aged 12–16 months. The relationship between dietary diversity and intake of cow’s milk, formula or breastmilk was examined using one-way ANOVA.

Results: Dairy and cereal were the most commonly consumed food groups and the greatest contributors to daily energy intake. Most children ate fruit (87%) and vegetables (77%) on the day of the 24-hour recall while 91% ate discretionary items. Half the sample ate less than 30 g of meat/alternatives. A quarter of the children were breastfeeding while formula was consumed by 32% of the sample, providing 29% of daily energy intake. Lower dietary diversity was associated with increased formula intake.

Conclusions: The quality of dietary intake in this group of young children is highly variable. Most toddlers were consuming a diverse diet, though almost all ate discretionary items. The amount and type of meat/alternatives consumed was poor.

Implications: Health professionals should advise parents to offer iron-rich foods, while limiting discretionary choices and use of formula at an age critical in the development of long-term food preferences.

Key words: toddler, intake, diversity, breastfeeding, formula

The toddler years are a time of considerable physical and emotional development and represent a key time in the child’s transition from infant feeding to family food. During the second year of life, the speed of growth slows in comparison to infancy while nutrient needs remain high.1 Children aged 1–2 years require more nutrients and energy per kilogram of body weight than adults, which means toddlers must consume an energy- and nutrient-dense diet. This age coincides with the development of autonomy and independence, food fussiness and neophobia – the refusal of new foods.2 Repeated exposure to fruit and vegetables may overcome a toddler’s natural tendency for food refusal, thereby increasing a child’s liking for these foods and subsequent intake.1 Liking a nutrient-dense diet that incorporates all five core food groups is important, as evidence suggests that food preferences develop during early childhood and persist into adulthood.4 Dietary diversity, represented by the number of foods or food groups eaten during a given time-period, is an indicator of dietary quality and nutrient adequacy in developed countries.5

Normal child development now occurs in a world where paediatric obesity is a global health concern. Since 1986, prevalence of overweight and obesity in Australia has doubled, with about 18–21% of children aged 2–3 years now classified as overweight or obese.6 Dietary intervention in infancy – promoting fruit and vegetable consumption, while reducing intake of foods that are energy dense but nutrient poor – is important to prevent childhood obesity and the onset of chronic disease.7 In contrast, iron deficiency anaemia remains an issue for toddlers in both developed and developing countries.8 High intake of cow’s milk and low meat consumption contribute to iron deficiency.4,8 Excessive intake of formula or cow’s milk may limit intake and diversity of foods in the child’s diet, which in turn limits their exposure to new tastes and textures.10 In the face of such challenges, parents are required to provide their child with a nutritious and varied diet, foster healthy food preferences and support appropriate growth. Unfortunately, health professionals know little about which foods parents are offering and what children are actually eating at the critical 1–2 years of age. Several surveys examine breastfeeding duration and introduction of solid foods during the period from birth to age 12 months,11–13 while the National Children’s Nutrition and Physical Activity Survey (referred to here as the 2007 Children’s Survey) reported on the diets of Australian children from age 2–16 years.6
The few existing surveys reveal poor quality intakes in very young children. The Perth Infant Feeding Study II (PIFS II) conducted in 2002–2003 (n=453) reported that by 52 weeks of age, 92% of infants had consumed biscuits and cakes, 79% hot chips/French fries and 68% had eaten ice-cream. A longitudinal analysis of 177 children participating in the Melbourne Infant Feeding Activity and Nutrition Trial reported that gram intake of vegetables decreased between nine and 18 months of age, while intake of energy-dense snacks increased. In the United States, the Feeding Infants and Toddlers Study (FITS) is a nationally representative survey of children aged between four and 24 months. The most recent survey in 2008, using a single 24-hour recall revealed that among children aged 12–14.9 months (n=243), only three-quarters consumed fruit and the same proportion consumed vegetables. The most commonly consumed vegetable was fried potato. The aims of this analysis were to describe the quantity and diversity of food and beverage intake in a group of Australian children aged 12–16 months and to determine if amount and type of milk intake is associated with dietary diversity as children make the transition from a milk-based diet in infancy to a mixed diet of family meals.

Methods

This is a cross-sectional data analysis of mother-toddler dyads participating in:

1. The control group of NOURISH, a randomised controlled trial (RCT) evaluating the effect of an intervention to promote positive feeding practices in very young children.

2. An additional sample of mothers recruited for the South Australian Infants Dietary Intake (SAIDI) Study.

SAIDI participants were recruited simultaneously and using the same protocol as NOURISH. The active group of the NOURISH RCT was not included in this analysis. It was anticipated these mothers would report higher intakes of core foods and fewer discretionary items following their exposure to the NOURISH intervention, compared to the control group (and SAIDI). Mothers at maternity hospitals in Brisbane, Queensland (n=3) and metropolitan and regional South Australia (n=11) were approached within 72 hours post-partum using consecutive sampling and asked to provide consent to be contacted when infants were four to seven months of age for full enrolment in the studies. Inclusion criteria: mothers 18 years or older, with the facility for written and spoken English, who had delivered a healthy infant (≥37 weeks, ≥2500 g), able and willing to attend sessions at designated clinics and – for NOURISH only – who were first-time mothers. Exclusion criteria: mothers with a documented history of domestic violence, intravenous substance use, self-reported eating or psychiatric disorders, or other mental health problems; and/or infants diagnosed with congenital abnormalities or a chronic condition likely to affect normal development. Approval was gained from 11 human research ethics committees including Queensland University of Technology and Flinders University.

This analysis uses data from the assessment that occurred when children were 12–16 months of age, collected between June 2009 and June 2010. Participants in metropolitan areas attended study-specific assessment clinics where anthropometric measures were taken by trained study staff using a standard protocol. In regional areas, participants were measured at their local child health or medical clinic. Demographic data were collected via self-administered questionnaire. Weight-for-age z-scores were calculated for children using WHO Anthro (2008).

Within two weeks of measurement, a dietitian contacted each mother by telephone, to conduct a three-pass 24-hour dietary recall. Participants were not aware the caller was a dietitian and, while they knew that they would be contacted, the exact date was unknown. Each mother was asked to recall everything her child ate or drank in the previous 24 hours, starting from midnight on the previous day, with quantities estimated using household measures (metric cup, tablespoon and teaspoon). A visual aid, showing images of metric cup sizes and actual size illustrations of tablespoon and teaspoon measures, had been provided at assessment. For dishes prepared at home, the mother was asked to provide the recipe with ingredient quantities and the amount her child consumed. The time of each eating occasion was also recorded. Each mother was given a specially designed booklet, so that if the child was in the care of another person, the carer could record the child’s intake and the mother could accurately report it, if a recall was collected the following day. All items from the 24-hour dietary recall were entered into FoodWorks Professional version 9 using the AUSNUT 2007 database from the 2007 Children’s Survey. Since this database included a limited number of commercial infant products, an additional database containing information on these products was created by study staff. Nutrient information was sourced from websites, manufacturers or nutrient information panels. Mixed dishes prepared at home were added to FoodWorks as a recipe, or if there were fewer than three ingredients the foods were entered directly as separate items. Breastfeeds were quantified as minutes in which the child was actively feeding to a maximum of 10 minutes per feed. Milk transfer from the breast after this duration is considered too slow to contribute significantly to nutrient intake in this age group. If a second breastfeed started within 30 minutes of the start of the previous feed, it was not considered a new feed, and the time was added to the previous feed up to a maximum of 10 minutes. Similarly, breastfeeds of less than two minutes were not considered long enough to contribute to nutrient intake and were not entered as intake in FoodWorks. The child was assumed to take 10 g of milk per minute from the breast with breastmilk providing 2.77 kJ/g.

Each FoodWorks file was checked to ensure the correct subject ID, date of recall and meal times, and that the quantities of food and drink consumed, as well as total energy and macronutrient intakes, appeared reasonable. Any assumptions made in the absence of sufficient detail were also checked to ensure they were consistent with protocol and any suspicious entries were checked against the hardcopy recall. The food recall data were exported from FoodWorks into an Access database and merged with an eight-digit food group code that allows identification of each unique food. These eight-digit codes are available from Food Standards Australia New Zealand for all items in the AUSNUT 2007 database. Study staff allocated additional eight-digit codes to infant foods and mixed dishes. Codes were allocated based on the predominant ingredient, for example, a casserole with 30% beef, 60% vegetable and 10% water was allocated a code within the vegetable group. This database was imported into PASW Statistics 18.0.1 (2009) for analysis.
Food and beverages were classified into 10 groups. These consisted of five core groups: fruit, vegetables (including legumes), cereals, meat/alternatives (including fish, poultry, and eggs) and dairy; and five additional groups: unsaturated fats and oils, discretionary choices, sweet beverages, breastmilk and formula. The dairy group included all milks, yoghurt and cheese and dairy alternatives (soy/rice/oat). Intake of cow’s milk alone was also reported separately. Discretionary items included foods high in fat or sugar, such as biscuits, cakes, sweet/savoury pastry items, spreads and sauces, butter and dairy blends, cream, ice-cream, chocolate, lollies, crisps and ‘fast-food’.20 Juice, fruit drinks, cordial, soft drinks and flavoured milks were classified as sweet beverages. For each group, the proportion of children consuming any of that food or beverage on the day of the 24-hour recall is reported. Intake (g/day) of each group is reported for consumers only. The contribution of each food and beverage group to the total daily energy intake was calculated (for consumers and the entire sample) and expressed as a percentage. A diversity score was calculated for each child as the number of core food groups (as defined above) consumed on the day of the 24-hour recall, giving a potential score between zero and five. Results are presented as mean and standard deviation (SD) or median and interquartile ranges (IQR) as appropriate.

**Table 1: Characteristics of participating mothers and children (n=551).**

| Characteristic                  | Mean (SD) | % (n) |
|--------------------------------|-----------|-------|
| Child age (months)             | 13.7 (1.1) |       |
| Birthweight (kg)               | 3.5 (0.5) |       |
| Weight-for-age z-score* at 12-16 months of age (n=499) | 0.53 (0.90) |       |
| Male gender                    | 46 (254)  |       |
| First-born                     | 66 (365)  |       |
| Maternal age at birth of child (years) (n=549) | 31.2 (5.2) |       |
| Maternal education             |           |       |
| Year 12 or less                | 23 (126)  |       |
| Trade/TAFE                     | 28 (153)  |       |
| University                     | 49 (272)  |       |
| Family income* (n= 470)        |           |       |
| $0 – $50,000                   | 20 (94)   |       |
| $50,001 – $70,000              | 21 (98)   |       |
| More than $70,001              | 59 (278)  |       |

a Derived using WHO Anthro (2008)

b n values <551 due to missing data
c Median gross income in Australia in 2008 – all household types = $67,000

**Table 2: Percentage of children aged 12-16 months (n=551) consuming each food and beverage group on the day of 24-hour recall, median intake (g/day) of consumers, and contribution to total energy intake for consumers and the whole sample.**

| Food or beverage group | Proportion consuming any % (n) | Intake g/day of consumers Median (IQR) | % total energy intake derived from group – consumers only Median (IQR) | % total energy intake derived from group – whole sample Median (IQR) |
|------------------------|--------------------------------|----------------------------------------|---------------------------------------------------------------------|---------------------------------------------------------------------|
| Fruit                  | 87 (481)                       | 131 (76-199)                           | 9 (6-13)                                                            | 8 (4-13)                                                            |
| Vegetables*            | 77 (424)                       | 89 (43-164)                            | 5 (2-100)                                                           | 3 (0.2-9)                                                           |
| Cereals                | 97 (537)                       | 72 (37-121)                            | 18 (11-25)                                                          | 17 (11-25)                                                          |
| Meat & alternatives    | 78 (430)                       | 56 (28-105)                            | 8 (5-14)                                                            | 6 (1-12)                                                            |
| Diary*                 | 96 (529)                       | 373 (146-628)                          | 29 (17-46)                                                          | 28 (15-46)                                                          |
| Cow’s milk             | 78 (431)                       | 370 (129-577)                          | 22 (9-38)                                                           | 14 (6-28)                                                           |
| Unsaturated fats/oils  | 30 (166)                       | 3 (2-4)                                | 2 (1-3)                                                             | 0 (0-1)                                                             |
| Discretionary items    | 91 (502)                       | 23 (10-51)                             | 9 (4-14)                                                            | 8 (3-14)                                                            |
| Sweet beverages*       | 19 (102)                       | 65 (23-131)                            | 2 (0.8-4)                                                           | 0 (0-0)                                                             |
| Formula*               | 32 (179)                       | 441 (258-618)                          | 29 (18-43)                                                          | 0 (0-17)                                                            |
| Breast milk            | 23 (124)                       | 200 (133-350)                          | 15 (9-26)                                                           | 0 (0-0)                                                             |

a including legumes
b regular fat, reduced fat and skim milk, cheese, yogurt, goat’s milk and soy/rice/oat beverages
c including 100% fruit juice
d Infant formula, follow-on formula and toddler milk

d Eighty per cent (n=443) of 24-hour recalls were completed on a weekday; 149 were completed during summer, 19 in autumn, 183 in winter and 29 in spring.

**Results**

Twenty-four hour recall data were available for 551 mother-toddler dyads. Child and maternal characteristics are shown in Table 1. Eighty per cent (n=443) of 24-hour recalls were completed on a weekday; 149 were completed during summer, 19 in autumn, 183 in winter and 29 in spring.

Table 2 shows the proportion of children consuming any fruit, vegetables, cereal, meat/alternatives, dairy, unsaturated fats and oils, discretionary items, sweet beverages, formula or breastmilk. Twenty children ate neither fruit nor vegetables on the day of the 24-hour recall. Only 86% (n=476) of children were reported to consume water as a drink. Table 2 also shows the median daily intake (grams/day) of consumers and the contribution of each food group to daily energy intake for consumers and the whole sample. Mean energy intake on the day of the recall was 4,194 kJ (SD=1092). The most commonly
consumed items within each food group are shown in Table 3.

Of the 179 children consuming formula, 30 were having an infant formula, 60 a follow-on formula, and 91 children were drinking ‘toddler milk’ (one child consumed both infant and follow-on formula; another child both infant formula and toddler milk) on the day of the 24-hour recall. For consumers, formula intake made the greatest contribution to daily energy intake, providing a median of 29%.

Median diversity score was 5 (IQR=4-5). Fifty-six per cent of children (n=307) had a diversity score of five; 31% (n=170) a score of four; 11% (n=61) a score of three; and 2% (n=11) a score of two. No child had a score of one or zero. Diversity score increased with decreasing formula intake (Figure 1). As child age was inversely related to formula intake, \( F(1, 546) = 7.66, p=0.006, r=0.12 \), age was controlled for when investigating the relationship between diversity score and formula intake. There was significant inverse relationship between diversity score and gram intake of formula, \( F(3, 546) = 6.79, p<0.001, \text{partial } \eta^2=0.04 \), and percentage of EER derived from formula, \( F(3, 494) = 5.51, p=0.001, \text{partial } \eta^2=0.03 \). Similar analysis with cow’s milk and breastmilk showed no such relationship.

**Discussion**

This study provides insight into the dietary habits of Australian toddlers – both the quantity and diversity of foods consumed. It includes some of the first detailed intake data on a cohort of healthy children less than two years of age.

The quality of dietary intake across this group is highly variable. Only 56% of children had the maximum diversity score of five, which meant they consumed fruit, vegetables, cereal, meat/alternatives and dairy on the day of the 24-hour recall. Thirteen per cent of children ate foods from three or fewer core food groups. The majority of children ate fruits (87%) and vegetables (77%) on the day of the 24-hour recall – higher than that found in FITS 2008 (74% and 72%), but lower than a study of 374 children aged 12–36 months, also conducted in Adelaide, where 89% of children consumed fruit and 85% vegetables in the previous 24 hours. Only 4% (n=20) of children in the current sample ate neither fruit nor vegetables.

Dairy and cereal were the most commonly consumed food groups, eaten by 96% and 97% of children respectively. Of the five core food groups, these were the greatest contributors to daily energy intake, with dairy contributing 28% and cereal 17%. This is similar to the 2007 Children’s Survey where dairy and cereals provided 45% of total dietary energy for children aged 2–3 years (n=1,000). Median intake of meat/alternatives was 56 g per day for consumers of this food group with the lower limit of the IQR being 28 g, while 22% of children in the sample consumed no items from this food group.

| Food group | % (n) consuming at least once on day of recall |
|------------|---------------------------------------------|
| Fruit      |                                             |
| Banana     | 49 (272)                                   |
| Sultana, dried | 15 (81)                                |
| Strawberry, fresh | 10 (55)                              |
| Seedless green grapes | 10 (55)                          |
| Vegetables |                                             |
| Carrot, baked/boiled/steamed without added fat | 33 (182)                           |
| Potato, peeled, baked/boiled/steamed, no added fat | 26 (142)                           |
| Broccoli, boiled/steamed | 19 (103)                           |
| Cereals    |                                             |
| Breakfast cereal, whole wheat biscuit | 48 (263)                           |
| White bread | 24 (134)                                  |
| Wholemeal bread | 22 (122)                           |
| Meat/alternatives |                                         |
| Egg, chicken, baked | 13 (73)                                |
| Chicken breast, lean, cooked without fat | 12 (67)                             |
| Leg ham, lean | 9 (47)                                   |
| Dairy      |                                             |
| Cow’s milk, regular fat | 75 (414)                           |
| Cheddar cheese, regular fat | 31 (172)                           |
| Cheddar cheese, regular fat, processed | 16 (90)                             |
| Unsaturated Fats and oils |                                         |
| Polysaturated margarine | 13 (72)                              |
| Monounsaturated margarine | 8 (45)                               |
| Olive oil | 7 (39)                                    |
| Discretionary items |                                         |
| Vegemite | 32 (179)                                   |
| Plain sweet biscuit | 21 (116)                              |
| Butter     | 19 (106)                                   |
| Sweet beverages |                                         |
| 100% Apple juice | 4 (22)                                  |
| 100% Orange juice | 2 (12)                                |
| Apple & Blackcurrant juice | 2 (12)                            |
This means almost 50% of children ate less than 30 g meat/alternatives on the day of the recall. In addition, the most commonly consumed items – egg, chicken and ham – are poorer sources of iron compared with red meats. Choosing these foods often may have implications for the iron status of young children.

A food group with a surprising low proportion of consumers – 30% of children – was unsaturated fats and oils. It appears that children are being offered butter as a spread rather than unsaturated choices, with butter consumed by 19% of the sample versus 13% having polyunsaturated and 8% monounsaturated margarines. Butter was the third most commonly eaten item within the food group labelled ‘discretionary choices’ and 91% of children in the sample consumed discretionary foods. Median intake of discretionary choices was not excessive at 23 g; however, the upper level of the IQR was 14% of daily energy intake. This indicates a disproportionate intake of these foods compared with core foods in some children. Toddlers need energy dense foods to ensure sufficient energy for growth, but it is important to consider the quality of food offered. Plain sweet biscuits were popular, eaten by 21% of children. In Perth (PIFS II), 92% of children had tried biscuits/cakes by 12 months of age (n=587).13 Toddlers are very active but have variable appetites. As a result, they tend to consume small frequent meals over the day to meet their energy and nutrient needs. Biscuits may become one of these ‘meals’. Biscuits do not need cold storage or preparation, so are an easy option for parents, particularly when away from home. Offering butter and biscuits is inconsistent with the Australian Dietary Guidelines that recommend limiting intake of foods containing saturated fat, and replacing these foods with choices that contain predominantly polyunsaturated and monounsaturated fats.20 Parents need suggestions for better alternatives, while considering cost, preparation and practicalities of life with a toddler.

Vegemite, a quintessential Australian food, was the most commonly consumed discretionary item, eaten by a third of the toddlers. While it is mostly eaten in small amounts and in conjunction with core-food, the flavour may perpetuate a young child’s innate preference for salt. Parents may be advised to use this spread sparingly and not offer it to children every day.

Water and cow’s milk were the most commonly consumed beverages. Only 19% of children consumed any sweet beverages, with a median intake of 65 g/d (about 62 mL) and 100% juice being the most frequently consumed sweet beverage. This is consistent with feeding guidelines advising that children over the age of 12 months be offered water or milk as drinks in preference to juice, and juice being limited to 120–180 mL per day.1 Juice was classified within the ‘sweet beverage’ category rather than ‘fruit’ in this analysis, given the link between intake of fruit juice and poor health in young children including dental caries, diarrhoea and the development of obesity.21 This approach has been used in other Australian studies.13,14 While milk is recommended, guidelines also advise daily consumption of cow’s milk be less than 500 mL because of the high protein and low iron content and risk of reducing diversity in the diet.1 Median intake of consumers (n=431) was 370 g per day (about 360 mL) – well below the suggested limit – and there was no association between intake of cow’s milk/alternatives and diversity score.

An important finding was that a lower diversity score was associated with greater intake of formula, measured as grams or as a percentage of EER. Despite feeding guidelines advising that cow’s milk can be used as a drink and toddler milks are unnecessary in the second year of life,1 one-third of children in the sample were having some type of formula during the 24-hour recall. Formula provided a substantial proportion of energy intake to those children (29%). Intake did decrease with increasing child age, supporting the idea of a dietary transition during toddlerhood; however, the inverse relationship between diversity score and formula intake remained after controlling for child age.

Why parents continue providing formula in the second year of life requires further study. Food refusal and neophobia are common in toddlers and parents may give their child formula to supplement what they consider to be an inadequate food intake. But the higher protein content and slower rate of gastric emptying of formula (compared to breastmilk)24,25 has the potential to decrease appetite, intake and diversity at an age crucial to the development of lifelong food preferences.

Within this group, with a mean age of 13.7 months, 23% of the children consumed breastmilk on the day of the recall. These figures are similar to the nationally representative Longitudinal Study of Australian Children.26 At 12 months of age, 28% of children in the LSAC cohort (N=5,000) were continuing to breastfeed, decreasing to 9% of children at 18 months. Within the 2010 Australian National Infant Feeding Survey, 18% of children were receiving breastmilk at 13–18 months of age.27

The inherent limitations of this study are those associated with any collection of dietary data. The results are based on a single 24-hour recall. While one day of intake per person is valid for group-level estimates of food intake,28 there is the potential for a single day to under-estimate the proportion that usually consume all five core food groups, given these foods form the basis of daily intake. The potential for over-estimation of energy intake has also been documented in this age group.29 This may be due to errors by caregivers in estimating the portion size consumed. Toddlers can be independent eaters and food spillage may not be taken into account. Over-reporting of intake by caregivers may be motivated by the desire to portray their child as eating well at an age characterised by fussy eating and neophobia.30

Most recalls were completed on a weekday. While the eating patterns of older children and adults vary depending on the day of the week, due to school and work commitments, this variability may be less of an issue in infants with a predominately milk-based diet and toddlers while in the ‘transition’ to family food.

Participants were from high-income families, a factor known to be predictive of healthy eating patterns.31 Mothers agreeing to participate in research may also be better informed regarding the importance of infant nutrition than the general population. However, demographic diversity remains a strength of this study. The sample included participants from urban and rural areas, mothers with varying numbers of children and mothers with varying education levels. About a quarter of mothers had an education level of Year 12 or less, another quarter with a TAFE qualification and the remaining 50% with a university education. The Australian Bureau of Statistics reports that about 40% of women aged 25–29 years hold a bachelor degree or higher.32
Conclusions and implications

This study provides insight into the dietary habits of Australian children aged 12–16 months. Nationally representative dietary data in this age group is not available. Most children were consuming a diverse range of food groups, including fruits and vegetables, while a quarter were continuing to breastfeed. A third of the sample was consuming formula, and children with lower dietary diversity had higher formula intake. Almost all children were consuming discretionary items. These results show a need to support parents in providing their child with healthier alternatives – offering all the core food groups daily as well as unsaturated fats and oils, limiting discretionary choices and ceasing formula use – at a time crucial to the development of long-term food preferences.

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