Tracking of dietary intakes in early childhood: the Melbourne InFANT Program

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Abbreviations: EER, Estimated Energy Requirement; AI, Adequate Intake; EAR, Estimated Average Requirement; IQR, Inter-quartile Range; OR, Odd-Ratio.

Abstract

Background/Objectives: The objectives of the present study were to describe food and nutrient intakes in children aged 9 and 18 months; and to assess tracking of intakes between these two ages.

Subjects/Methods: Participants were 177 children of first-time mothers from the control arm of the Melbourne Infant Feeding Activity and Nutrition Trial (InFANT) Program. Dietary intake was collected at 9 and 18 months using three 24-hour diet recalls. Tracking was assessed for food and nutrient intakes using logistic regression analysis and estimating partial correlation coefficients, respectively.

Results: While overall nutrient intakes estimated in this study did not indicate a particular risk of nutrient deficiency, our findings suggest that consumption of energy-dense, nutrient-poor foods occurred as early as 9 months of age, with some of these foods tracking highly over the weaning period. Intakes of healthier foods such as fruits, vegetables, dairy products, eggs, fish and water were also relatively stable over this transition from infancy to toddlerhood, along with moderate tracking for riboflavin, iodine, fibre, calcium, and iron. Tracking was low but close to rho=0.3 for zinc, magnesium, and potassium intakes.

Conclusions: The tracking of energy-dense, nutrient-poor foods has important implications for public health given the development of early eating behaviours is likely to be modifiable. At this stage of life, dietary intakes are largely influenced by the foods parents provide, parental feeding practices and modelling. This study supports the importance of promoting healthy dietary trajectories from infancy.

Introduction

Early childhood is a vulnerable time with regard to nutrition. This is a period of relatively rapid growth, associated with changing physiological requirements and nutritional needs. This is also a time of dietary transition, from exclusive breast or formula milk consumption to a familial diversified diet. Children's early exposure to foods influences the development of taste and food preferences, which in turn impact on subsequent eating habits[1,2]. Further, some aspects of diet and growth in infancy, such as breast-feeding, protein intake and rapid early weight gain, have been shown to exert an influence on adiposity[3-6] and poor cardiovascular health[7] in later life.

However, despite the importance of eating behaviours throughout infancy, international studies describing food and nutrient intakes in infants or toddlers are limited and primarily cross-sectional[8-14]. In Australia, only four cross-sectional studies performed >7-10 years ago have reported dietary intakes in children aged 9 months[15], 16-24 months[16], 12-36 months[17] and 1-5 y[18]; and there are no national dietary surveys of children <2y. Nonetheless, these few studies have raised concern about some characteristics of weaning diets, such as the excessive energy intake in infancy and toddlerhood[19], and also their overall quality. Existing international research suggests that early diets contain relatively high levels of energy-dense, nutrient-poor foods and beverages, while the consumption of fruits and vegetable is less than recommended[11,13,19]. In terms of nutrient intakes, deficiencies have been shown to be unlikely in industrialised countries, with the possible exceptions of iron, zinc and fibre[12,18,20].

While adherence to complementary feeding guidelines has been shown to predict diet at 3 y[21] and diet has been found to track throughout childhood[22-24], less is known about tracking of foods and nutrients during infancy[25]. Tracking refers to the stability of a relative position in rank of behaviour over time, or the predictability of a measurement of a given risk factor early in life for values of the same risk factor later in life[26]. The aims of the current study were to cross-sectionally describe food and nutrient intakes in children aged 9 and 18 months and to assess tracking of intakes between these two ages. Dietary data were provided from first-time mothers involved in the control arm of the Melbourne Infant Feeding Activity and Nutrition Trial (InFANT) Program.

Materials and methods

Study design and participants

The Melbourne InFANT Program was a cluster randomised controlled trial, involving first-time mothers from when their infants were 4 to 20 months of age[27]. The transition to motherhood is likely to be a time when mothers may be more likely to seek information on their changing circumstances and may be more able to enact and maintain behavioural changes given their daily routines are being renegotiated as they find a new equilibrium[28]. The intervention, conducted in 2008-2010 within Greater Melbourne (Victoria, Australia) across areas displaying a wide range of socio-economic positions, focused on parenting skills and strategies aimed at promoting the development of healthy behaviours from early infancy. Briefly, a two-stage random sampling design was used to include English-speaking primary caregivers attending first-time parents' groups, a free and universal service provided by Maternal and Child Health nurses. Eighty six percent of eligible parents consented to participate (n=542). We excluded children from non-first-time mothers (n=14); those lost at follow-up (n=48); and those completing less than two dietary recalls at either 9 or 18 months (n=95). Due to field constraints, not all children were aged exactly 9 and 18 months at the two measurement times (T2 and T3, respectively). To avoid a possible influence of age on the results, we excluded from all analyses children younger than 7 months or older than 11 months at T2 (n=19); and those younger than 16 months or older than 20 months at T3 (n=16). Outliers for energy and liquid intakes were excluded according to the criterion of mean +/- 3 SD (n=8). As the aim of the current study is the description of the natural history of dietary intake in early childhood (i.e. independent from the intervention), the present analysis is restricted to children in the control group only. This resulted in a sample of 177 children.

The Melbourne InFANT Program was approved by the Deakin University Human Research Ethics Committee and the Victorian Government Department of Human Services, Office for Children, Research Coordinating Committee.

Measurements

Self-administered questionnaires were utilized to collect demographic (including education level) and socio-economic data at baseline. Education level was defined in three categories: low (secondary school or below), intermediate (trade and certificate qualifications) or high (university degree or higher). Mother's pre-pregnancy weight and height, duration of pregnancy and infant's age when first introduced to solid foods were also reported. Children's height/length and weight without clothes were measured by trained staff at each time point. Height/length was measured to 0.1cm using a calibrated measuring mat (Seca 210, Seca Deutschland, Germany) or portable stadiometer (Invicta IPO955, Oadby, Leicester). Weight was measured to 10 grams using calibrated infant digital scales (Tanita 1582,- Tokyo, Japan). The average of two measures was used in analyses.

The children's dietary intakes were assessed by trained nutritionists when they were 9 months of age (from December 2008 to June 2009) and 18 months of age (from August 2009 to February 2010) by telephone-administered multi-pass 24-hour recall with parents[29]. Purpose-designed booklets adapted to age including photographs of common portion sizes and examples of measures were provided to parents to aid estimation of food consumption. The booklets included pictures of cups, bowls, drink containers, and spoons. Images were taken with permission from the Food Model Booklet developed for the 2007 Australian Children's Nutrition and Physical Activity Survey (CNPAS). Food items included in the food model book used at 18 months were those considered difficult for parents to quantify, important to the Melbourne InFANT Program hypotheses, and/or frequently consumed by this age group. Knowledge of frequently consumed foods was based on Webb and colleagues' paper reporting diets of 16-24 month-old Australian children in the Childhood Asthma Prevention Study (CAPS)[(30)]. The book included primarily vegetables, fruits, cereals, spreads and non-core foods (energy-dense, nutrient poor foods and beverages). Where available, the portion sizes photographed were based on intakes reported in the CAPS, with three pictures of each food item representing the 25th percentile, median, and 75th percentile of reported intake per eating occasion. Where the food item had not been reported in the CAPS, the amounts photographed were based on reported weights of similar food items. At both 9 and 18 month data collections, 2 or 3 non-consecutive days of dietary data were collected, including one weekend day (3 days were available for 92% and 97% of the study sample at T2 and T3, respectively). Calls were unscheduled where possible (96% of all calls). Nutrient intakes were evaluated using the 2007 AUSNUT Database (Food Standards Australia New Zealand, 2008). Where brands of foods or beverages consumed were not found in this database, the nutrient composition data was sought from the manufacturing company or the product's nutrition information panel. Where a reported food or drink could not be matched to an item in AUSNUT 2007, such as some infant-specific commercial products, a new food item was created in the database utilising the product's nutrient composition. Recipe creation was informed by recipes frequently described by Melbourne InFANT Program participants. Parents indeed provided detailed information on home-made recipes including ingredients and/or proportions, which enabled the classification of mixed dishes. Data were checked for accuracy by a dietician. Breastfeeding was recorded as minutes of time spent breastfeeding and then converted to volume consistent with previous studies[(31)].

Analyses

Average daily dietary intakes were calculated for each child. Eighteen food groups were defined, as described in Appendix A. For each food group, we assessed the percentage of subjects consuming the food, along with both median and inter-quartile range intakes (expressed in g/d). Intakes were also estimated amongst consumers of each food group only (Supplementary Table). Mean intakes of macro- and micro-nutrients were estimated along with energy density (excluding liquids). The latter was estimated at the individual level, weighting the composition of each food consumed (energy, in kJ) by its effective consumption (g)[32]. Differences in food and nutrient intakes between T2 and T3 were tested using Wilcoxon signed rank tests and paired t-tests, respectively. Dietary intakes of selected micro-nutrients were compared with the Nutrient Reference Values for Australia and New Zealand[33]. For nutrients with an available Estimated Average Requirement (EAR), we assessed the proportion of the sample with intakes less than the EAR, which is an estimate of the proportion of the population with inadequate intakes[34]. When EAR was not available, we compared the mean intake to the Adequate Intake (AI)[34].

With regards to the assessment of tracking, as food intakes changed substantially between 9 and 18 months of age and the distributions were highly skewed, we considered food intake either as a binomial variable (consuming, yes/no), or in tertiles (when the percentage of subjects consuming was >66.7%). In this case, a new binomial variable was then defined, i.e. high *vs.* intermediate or low levels of consumption (which corresponds to the 3rd tertile *vs.* the 2nd or 1st tertiles). Subsequently, for a given food group, we investigated to what extent being a consumer at 9 months (or having a high level of consumption) predicted being a consumer at 18 months (or displaying a high level of consumption) using logistic regression analysis. Odds-ratios (ORs) with 95% confidence intervals (CIs) were calculated. Child age at both T2 and T3 was accounted for in all models (one for each food group), as the strength of tracking depends on both the age at baseline and the length of the follow-up[26], which varied slightly between children in the current study (Table 1). Analyses were also adjusted for gender due to differences in intakes between boys and girls (not shown). For assessment of tracking of nutrient intakes, nutrients were adjusted for age and gender using the residual method[35], and Pearson partial correlation coefficients were calculated between adjusted nutrient intakes at 9 and 18 months. Recommendations for interpreting these correlation coefficients are the following: low <0.3; moderate 0.3-0.6; and high >0.6[26]. All analyses accounted for clustering of participants in first time parents' groups. Other methods for assessing tracking (e.g. changes in quantiles along with the associated Cohen's Kappa coefficient; or the Kendall rank correlation coefficient) do not allow for adjustment for potential confounders: age and time between the two measurements of diet were considered as important confounders to include in the current analysis.

The significance level was set at 5%. Analyses were conducted using Stata software (Release 11; StataCorpLP, College Station, TX, USA).

Results

Sample characteristics

Demographic characteristics of the sample are shown in Table 1. It should be noted that the 94 children of the control arm who were excluded from the analyses due to loss at follow-up or based on exclusion criteria, came from families where the mothers were less likely to have achieved a high education level (43.8% *vs.* 63.3%).

Dietary intakes

Overall, excluding water intake, foods represented on average 40.5% and 56.7% of total food and beverage intake (in grams) in children aged 9 months and 18 months, respectively. Nearly half of the infants were still breastfed at 9 months, reducing to 9% at 18 months (Table 2). Most of the infants already consumed water, cereal-based products, meat or poultry, fruits, vegetables and dairy foods when aged 9 months. The amounts consumed for these groups increased with age, with the exception of fish (similar amounts at both ages) and vegetables (lesser amounts at 18 months). This decrease in vegetable consumption was consistent with findings amongst consumers only (Supplementary Table). The proportions of children consuming sweetened beverages, savoury and sweet energy-dense snacks, meat products, egg products, and milk increased more than two fold between 9 and 18 months (Table 2). Similar results were observed when the 20 infants with 2 recalls only were excluded from the analysis (results not shown).

For most of the foods, being a consumer, or consuming larger amounts at 9 months, was predictive of a greater level of consumption 9 months later. The association was stronger for fruits, water, sweetened beverages, dairy foods, egg products, animal products, sweet energy-dense snacks, baby foods in jars, formula, vegetables, fish, and meat and poultry (by descending order, and ORs>0.20) than for other foods/beverages. Similar results were observed when these multivariable analyses were further adjusted for energy intake (results not shown).

Nutrient intakes

Energy intake increased by 30% from 9 to 18 months (Table 3). Absolute intakes of protein, fibre, magnesium, sodium, folate and riboflavin increased even more, with sodium increasing the most (114%). The energy density of the diet also increased (36%) between infancy and toddlerhood. For nutrients with available EARs, the proportion of the sample with inadequate intakes was relatively low (0 to 36%)[36]. Regarding the other micro-nutrients, estimated mean intakes were generally higher than the AIs (or quite close).

Amongst the nutrients assessed by the current study, tracking was found to be moderate for riboflavin, iodine, fibre, fibre, calcium, and iron (rho ranging from 0.30 to 0.37, p<0.001). Tracking was low but close to rho=0.3 for zinc, magnesium, and potassium intakes. Similar results were observed when tracking was assessed using nutrients further adjusted for energy intake (results not shown).

Discussion

The present study provides important insights into the dietary intakes of Australian children under 2 years of age and how these dietary intakes track during the transition from infancy to toddlerhood. To our knowledge, this has not been described previously using longitudinal data collected at the individual level based upon multiple 24-hour recalls.

Overall, our findings confirm that the period between 9 and 18 months is a time of significant dietary transition. While milk intake (all sources included) was still greater than the intake of solids at 9 months (expressed in grams), this was no longer the case 9 months later. Along with this weaning process, some typical baby foods (e.g. baby foods in jars, formula, breast-milk) were displaced by foods from the family diet, as shown by the change in food group consumption rates between the two ages (Table 2).

In addition to complementary foods, 46% and 9% of the mothers were still breastfeeding at 9 and 18 months respectively. Few publications have reported the prevalence of breastfeeding after 6 months: similar rates of partly breast-fed infants were reported in Denmark[(14)], but lower rates were described in the United States (33% and 3% at 9 months and 18 months, respectively)[(13)], and in England (2% at 18 months)[(12)]. Most of the infants consumed a variety of recommended items such as water, cereal-based products, meat or poultry, fruits, vegetables and dairy foods when aged 9 months, and the proportion of children consuming these foods remained high at 18 months. However, percentages of consumers of less healthy food groups increased more than two-fold between 9 and 18 months, including items such as sweetened beverages, meat products, savoury and sweet energy-dense snacks. The corresponding quantitative intakes are high considering that these foods are predominantly energy-dense, nutrient-poor and therefore not essential for growth. In addition, they are likely to displace foods of better nutritional quality[(37)], leading to a diet of higher energy density. It is also noteworthy that the consumption of vegetables actually decreased between the two ages, consistent with findings in children aged 24-30 months[(38)]. While these results are not easily comparable to other studies due to differences in methodology, ‘extra’ foods (energy-dense, nutrient-poor) have previously been shown to contribute substantially to the diet in other studies involving children <2y[13,15,17].

Frequent exposure to specific foods during infancy has been shown to influence taste development and later food preferences[2]. This early learning is influenced by genetic susceptibilities, which include the innate preference for both sweet and salty tastes, and the rejection of sour and bitter flavours[1]. New experiences and competencies influence the transition from a milk diet to a solid and diversified diet. Familiarity with specific foods - even in small amounts - appears likely to influence infants' preferences[39]. Exposing infants and toddlers to energy-dense snacks of high palatability is therefore likely to negatively influence later food preferences and dietary habits[40]. Conversely, early and frequent exposure to fruits and vegetables has been suggested to increase their consumption in later life[41,42,43]. This is all the more important since our findings suggest that some of these food intakes already track highly between infancy and toddlerhood. This is the case not only for energy-dense, nutrient-poor foods (in particular sweet energy-dense snacks and sweetened beverages), but also for nutrient-dense products, such as fruits, vegetables, dairy foods and fish. Water, the recommended beverage, also tracked highly between these two ages. Similar stability over the second half of infancy (6 to12 months) has also been shown in the longitudinal Southampton Women's Survey, for both healthy and less healthy dietary patterns[25]. Therefore, while the overall moderate stability in our study probably relates to the fact that this period covers the transition from weaning foods to table foods, it appears that tracking of key foods starts as soon as weaning begins, and is likely to persist into later childhood[22-24]. Future research investigating the determinants of tracking of dietary intakes would be of interest.

The changes in nutrient intakes from 9 to 18 months did not consistently reflect the magnitude of increase of energy intake (30%), suggesting varying trajectories of nutrient density across infancy. Despite methodological differences, nutrient intakes estimated in the current work are similar to those reported in other studies[9,12,18,20]. Overall, when compared to EARs or AIs, our results suggest that the population studied is not at a particular risk for inadequate nutritional intake[36], which has also been reported in children aged 2-3 and 4-8 of the 2007 Australian National Children's Nutrition and Physical Activity Survey[44]. However, the relatively high intake of sodium at both 9 and 18 months should be noted. While international recommendations regarding upper limits are lacking for infants, it has been suggested in the UK that intakes of sodium should not exceed 400 mg/d up to the age of 12 months[45]. In Australia, the Nutrient Reference Values for 1-3 year-olds have suggested an upper limit of 1000 mg/d[33]. Based on these two recommendations, more than half of the sample has excessive intakes. Our data also showed that sodium levels increased sharply between infancy and toddlerhood, along with the introduction of foods from the family diet. This is of concern, not only in the short term regarding blood pressure(46), but also regarding the development of taste(47) and the subsequent food preferences during childhood and long term eating habits(1,2). Although salt is found in high concentrations in staple foods like cows' milk and processed grain products, it is also a significant component of savoury snacks, the consumption of which was shown to increase sharply between 9 and 18 months.

Tracking of nutrient intakes appeared to be moderate to low, which may be explained by the transition in diet between 9 and 18 months. Nonetheless, some consistency in tracking was suggested between fruits, vegetables, dairy products, eggs, fish, water, and nutrients contained within these foods, such as riboflavin, iodine, fibre, calcium, iron, zinc, magnesium, and potassium.

Limitations

Although all socio-economic positions were represented in this study, university educated mothers were over-represented, which may limit the generalizability of these findings. Considering that the quality of infant diets has been shown to positively relate to maternal education(25,48), we may expect diets of even lower quality in the general population. In addition, dietary recommendations refer to usual nutrient intakes(33), which we were not able to strictly assess using three days of recalls and without accounting for vitamins and minerals provided from supplements. Consequently, comparison with recommendations should be considered with caution. Our assessment of nutrient adequacy based on the AIs should also be considered carefully, since the evidence base for AI is weaker than for EARs. Furthermore, it is acknowledged that sodium intakes can be difficult to estimate due to issues with self-reporting added salt and also the quality of food composition databases(49). Another limitation of the present study concerns the estimation of mixed dishes (for example recipes including both vegetables and animal products, i.e. meat products, meat and poultry, fish, or egg products). Mixed dishes where animal products were the main component were classified as animal products, while mixed dishes including animal products where vegetables were the major components were classified as vegetables. The coding and classification of mixed dishes is a challenge in dietary assessment and reporting. This may have slightly impacted the precision of the estimation of animal products and vegetable intakes, and thus the assessment of tracking for these specific food groups. Finally, we cannot rule out the possible mis-reporting of dietary intake. However, treatment of "mis-reporters" in studies of <2 y varies in the literature(12,14,16), with only one study excluding them(16). To date, in this age range, over-reporting appears to be more prevalent than under-reporting, with rates varying between [0-12%] and [11-32%], respectively, depending on the definitions used and the populations studied. A standardized method to define mis-reporting in children's dietary studies is lacking and this issue is even more challenging in infants and toddlers, due to the large day-to-day variability that characterizes their dietary intake[50]. In the absence of a more agreed definition for this age group, we have not excluded mis-reporters, although those reporting extreme energy intakes (mean ± 3 standard deviations) were excluded. Furthermore, the focus of the current study was to investigate intakes from a longitudinal perspective, and while mis-reporting may be present, we hypothesize that the potential biases may affect the same children at the two points in time[51], and therefore have little influence on our findings with respect to tracking.

Conclusion

While overall nutrient intakes estimated in this sample do not indicate an important risk of nutrient deficiency, our findings suggest that sub-optimal food consumption occurs as early as 9 months of age. Tracking of intakes was observed not only for energy-dense, nutrient-poor foods, but also for healthier food choices, along with key nutrients. These findings have implications for public health, since behaviours leading to dietary intake are modifiable[52]. At this stage of life, dietary intakes are largely influenced by characteristics of the home environment, in particular the foods provided by parents, parental feeding practices and modelling. This study adds evidence to the importance of promoting healthy dietary trajectories focusing on infancy, and involving parents.

Authors' contributions

S. L. conducted the statistical analysis, contributed to interpretation of results, drafted and edited the manuscript, and had primary responsibility for final content. S. A. M. led and managed the dietary data collection, guided the statistical analysis, contributed to interpretation of results, drafted and edited the manuscript. A. C. S contributed to the dietary data collection, drafted and edited the manuscript. D. C. guided the statistical analysis, contributed to interpretation of results, drafted and edited the manuscript. K. J. C. was the principal investigator on The Melbourne InFANT Program. She designed and led that study, managed the dietary data collection, guided the statistical analysis, contributed to interpretation of results, drafted and edited the manuscript. All authors have read and approved the final manuscript.

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Table 1. Characteristics of the sample (n=177)

	%	Mean (sd)
MOTHER		
Age at baseline (yrs)		32.2 (4.4)
BMI[a] before pregnancy (kg/m^2)		23.9 (4.6)
Duration of pregnancy (weeks)		38.7 (2.4)
Education level		
Low (secondary school or below)	18.1	
Intermediate (trade and certificate qualifications)	18.6	
High (university degree or higher)	63.3	
Country of birth		
Australia	79.7	
Other	20.3	
Language spoken at home		
English	94.9	
Other	5.1	
CHILD		
Sex		
Male	52.0	
Female	48.0	
Birth weight (kg)		3.4 (0.6)
First follow-up, T2		
Age (months)		9.3 (0.8)
Age when first introduced to solid foods (months)		5.3 (0.8)
Weight (kg)		8.9 (1.1)
Second follow-up, T3		
Age (months)		17.8 (1.0)
Time between T2 and T3		8.5 (0.7)
Weight (kg)		11.3 (1.3)

[a]Body mass index (BMI) was calculated as weight/height^2 (kg/m^2).

Table 2. Daily food intakes in children aged 9 and 18 months of age and tracking between these two ages (n=177)

Food groups	9 months (T2)				18 months (T3)				Odds of high consumption at 18 months compared to 9 months, OR (CI95%)[a]
	Consumers %	Intakes (grams)			Consumers %	Intakes (grams)			
		Median	IQR	66.7^{th} percentile		Median[b]	IQR	66.7^{th} percentile	
Sweetened beverages[c]	13.0	0	0; 0		31.1	0***	0; 7.5		3.50 (1.26; 9.77)*
Water[d]	96.0	106.7	50.0; 185.8	143.3	100	300.0***	208.3; 433.3	400.0	3.91 (1.69; 9.05)**
Cereal-based products[d]	96.6	31.9	15.2; 59.6	46.8	100	90.4***	63.4; 118.2	108.9	1.29 (0.67; 2.46)
Savoury energy-dense snacks[e]	19.8	0	0; 0		63.3	9.5***	0; 33.2	23.2	1.51 (0.61; 3.71)
Sweet energy-dense snacks[e]	38.4	0	0; 3.33		86.4	20.0***	8.0; 46.7	37.0	2.59 (1.15; 5.83)*
Fats and spreads[e]	53.7	0.2	0; 2.4		87.6	2.8***	1.0; 7.2	5.1	1.30 (0.71; 2.38)
Meat products[c]	12.4	0	0; 0		46.9	0***	0; 10.0		1.87 (0.68; 5.11)
Meat and poultry[d]	81.4	15.2	2.3; 40.4	31.0	81.4	24.3**	8.0; 54.0	41.0	2.14 (1.21; 3.81)*
Fish[c]	32.8	0	0; 5.1		35.0	0	0; 9.0		2.22 (1.10; 4.50)*
Egg products[c]	11.3	0	0; 0		28.2	0***	0; 5.4		3.11 (1.14; 8.39)*
Animal products[d] (meat products, meat and poultry, fish, and egg products)	89.3	23.5	6.9; 48.0	39.5	96.6	47.7***	25.6; 78.4	67.1	2.83 (1.49; 5.38)**
Fruits[d]	94.9	66.3	29.4; 130.2	113.5	98.3	144.5***	81.7; 215.3	184.3	4.13 (2.16; 7.91)***
Vegetables[d]	94.9	84.3	37.4; 134.0	112.3	94.9	69.9*	30.5; 124.6	104.9	2.27 (1.12; 4.62)*
Dairy foods[d]	88.1	46.5	11.8; 80.0	68.0	96.0	63.3***	29.4; 111.2	91.7	3.26 (1.69; 6.29)***
Baby foods in jars[f]	89.8	47.4	8.2; 107.1	82.6	50.8	0.7***	0; 30.7		2.35 (1.26; 4.39)*
Breast milk[f]	46.3	0	0; 343.3		8.5	0***	0; 0		nd
Infant or toddler formula[f]	71.2	461.1	0; 686.7	615.7	15.8	0***	0; 0		2.30 (1.12 ; 4.72)*
Milk[e]	46.3	0	0; 42.9		91.0	351.9***	151.1; 524.0	464.7	1.95 (0.98 ; 3.90)

IQR, Inter-quartile Range; OR, Odd-Ratio.
[a] Adjusted for age at T2, age at T3, and gender: *P < .5; **P ≤ .01; ***P ≤ .001.
[b] Wilcoxon signed rank tests assessing the difference in intakes between 9 and 18 months: *P < .5; **P ≤ .01; ***P ≤ .001.
[c] Binomial variables defined at both 9 months (T2) and 18 months (T3) as "consuming (yes, no)".
[d] Binomial variables defined at both T2 and T3 as "high level of consumption" (3rd tertile) *vs.* "intermediate or low levels of consumption" (2nd or 1st tertiles). Cut-offs corresponding to the 66.7^{th} percentile are reported in the table.
[e] Binomial variables defined at T2 as "consuming (yes, no)"; and at T3 as "high level of consumption" (3rd tertile) *vs.* "intermediate or low levels of consumption" (2nd or 1st tertiles). Cut-offs corresponding to the 66.7^{th} percentile are reported in the table.

[f] Binomial variables defined at T2 as “high level of consumption” (3rd tertile) *vs.* “intermediate or low levels of consumption” (2nd or 1st tertiles); and at T3 as “consuming (yes, no)”. Cut-offs corresponding to the 66.7th percentile are reported in the table.

Table 3. Daily nutrient intakes in children aged 9 and 18 months of age and tracking between these two ages (n=177)

Nutrients	Reference values for Australia and New Zealand (7-12 months)	Intakes at 9 months (T2)				Reference values for Australia and New Zealand (1-3 years)	Intakes at 18 months (T3)				Tracking between 9 and 18 months, rho[b]
		Inadequacy of intakes, % (CI95%)	Median	Mean	SD		Inadequacy of intakes, % (CI95%)	Median	Mean[a]	SD	
Energy, KJ/day	3100 and 2800 (EER, boys and girls)		3430.1	3453.7	792.9	4000 and 3800 (EER, boys and girls)		4408.4	4473.3***	779.4	0.25***
Energy density, KJ/100g	None set		417.4	432.8	102.8	None set		582.4	586.6***	114.6	0.19*
Macro-nutrients											
Fibre, g/day	None set		7.2	8.3	4.2	14 (AI)		12.3	12.6***	4.1	0.35***
Carbohydrates, g/d	95 (AI)		98.0	98.5	24.0	None set		128.3	128.2***	24.8	0.28***
Proteins, g/day	14 (AI)		27.4	29.0	10.9	12 (AI)		45.2	46.8***	12.1	0.24**
Saturated fat, g/d	None set		17.5	17.5	5.2	None set		19.4	19.8***	5.2	0.20**
Total fats, g/day	30 (AI)		32.2	33.4	8.0	None set		38.1	38.9***	9.3	0.17*
Micro-nutrients											
Riboflavin, mg/d	0.4 (AI)		1.5	1.4	0.6	0.4 (EAR)	0	2.1	2.1***	0.7	0.37***
Iodine, µg/d	110 (AI)		95.4	99.6	30.4	65 (EAR)	9.6 (4.9; 14.3)	115.9	119.7***	42.8	0.35***
Calcium, mg/day	270 (AI)		626.8	643.8	257.0	360 (EAR)	4.0 (0.7; 7.2)	766.1	773.6***	229.4	0.30***
Iron, mg/day	7 (EAR)	35.6 (26.4; 44.7)	8.8	8.7	4.6	4 (EAR)	10.7 (5.4; 16.0)	6.2	6.5***	2.3	0.30***
Zinc, mg/d	2.5 (EAR)	9.0 (4.2; 13.8)	5.8	5.8	2.4	2.5 (EAR)	0	6.2	6.5***	1.8	0.29***
Magnesium, mg/d	75 (AI)		110.9	112.5	36.3	65 (EAR)	0	171.5	174.1***	38.7	0.29***
Potassium, mg/d	700 (AI)		1307.6	1355.1	421.8	2000 (AI)		1815.3	1854.9***	407.2	0.29***
Beta-carotene[c], µg/d	None set		1834.6	2378.7	1884.5	None set		1251.3	1606.9***	1133.1	0.24**
Niacin (equivalents), mg/d	4 (AI)		20.5	20.3	8.5	5 (EAR)	0	24.1	24.8***	6.6	0.24**
Vitamin A (retinol	430 (AI)		403.3	409.9	128.8	210 (EAR)	9.6 (5.5; 13.7)	343.7	345.4***	116.4	0.23***

Nutrients	Reference values for Australia and New Zealand (7-12 months)	Intakes at 9 months (T2)				Reference values for Australia and New Zealand (1-3 years)	Intakes at 18 months (T3)				Tracking between 9 and 18 months, rho[b]
		Inadequacy of intakes, % (CI95%)	Median	Mean	SD		Inadequacy of intakes, % (CI95%)	Median	Mean[a]	SD	
equivalents), µg/d											
Folate (dietary folate equivalents), µg/d	80 (AI)		142.0	160.9	72.2	120 (EAR)	1.1 (0; 2.7)	290.7	309.4***	130.4	0.22***
Thiamin, mg/d	0.3 (AI)		1.0	1.0	0.5	0.4 (EAR)	4.0 (0.8; 7.1)	1.1	1.1	0.5	0.22**
Sodium, mg/d	170 (AI)		469.2	498.7	224.7	200-400 (AI)		1043.1	1065.0***	314.2	0.16*
Vitamin C, mg/d	30 (AI)		97.4	102.0	44.0	25 (EAR)	13.6 (8.2; 18.9)	51.6	58.2***	35.9	0.06
Vitamin E[c], mg/d	5 (AI)		8.0	7.4	4.3	5 (AI)		3.1	3.6***	2.0	0.02

EER, Estimated Energy Requirement; AI, Adequate Intake; EAR, Estimated Average Requirement.

[a] Paired t- tests assessing the difference in intakes between 9 and 18 months: *P < .5; **P ≤ .01; ***P ≤ .001.

[b] Pearson correlation of linear regression predicted residuals of nutrients at 9 and 18 months using age and gender as covariates; *P < .5; **P ≤ .01; ***P ≤ .001.

[c] Log-transformed intakes.

Appendix A. Food classification

Food groups	
Sweetened beverages	Fruit juices; cordials; soft drinks; and flavored mineral waters
Water	Plain water (tap or bottled).
Cereal-based products	Breakfast cereals; porridge; cereal flours; grains; starches; bread; crackers; and pasta.
Savory energy-dense snacks	Savory bread products; fast-food savory dishes (such as pizzas, sandwiches, hamburgers); chips; and savory snacks.
Sweet energy-dense snacks	Sweet biscuits; cakes; pastries; batter-based products; dairy desserts (frozen milk products, custards, others milk-based desserts, flavored milks); sugar products; and confectionery.
Fats and spreads	Fats; oils; cream; sauces; and salad dressings.
Meat products	Sausages; processed meats; and mixed dishes where pork, bacon, or ham is the major component.
Meat and poultry	Meat (beef, lamb, pork, veal); poultry; game products; organ meat and offal; and mixed dishes where meat, poultry or game is the major component.
Fish	Fish; seafood products; and mixed dishes with fish or seafood as the major component.
Egg products	Eggs; and dishes where egg is the major component.
Animal products	Sum of the 4 preceding groups, i.e. meat products, meat and poultry, fish, and egg products.
Fruits	Fruits; dried fruits; preserve fruits; and mixed dishes where fruit is the major component.
Vegetables	Vegetables; non-fat potatoes; legumes and pulses; mixed dishes where vegetables or legumes are the major components; and soups.
Dairy foods	Yogurts and cheese.
Baby foods in jars	Infant cereal products; infant dinners; and infant desserts.
Breast milk	A feed of 10 minutes or greater was estimated at 100mls and for feeds less than ten minutes, a conversion factor of 10mls per minutes was used. If breast milk was expressed, volumes estimated by parental report were used.[26]
Infant or toddler formula	Cow’s milk or soy based.
Milk	Cow, sheep and goat milks.