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

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22   **Abbreviations**: EER, Estimated Energy Requirement; AI, Adequate Intake; EAR, Estimated

23   Average Requirement; IQR, Inter-quartile Range; OR, Odd-Ratio.

1 **Abstract**

2 Background/Objectives: The objectives of the present study were to describe food and nutrient

3 intakes in children aged 9 and 18 months; and to assess tracking of intakes between these two ages.

4 Subjects/Methods: Participants were 177 children of first-time mothers from the control arm of the

5 Melbourne Infant Feeding Activity and Nutrition Trial (InFANT) Program. Dietary intake was

6 collected at 9 and 18 months using three 24-hour diet recalls. Tracking was assessed for food and

7 nutrient intakes using logistic regression analysis and estimating partial correlation coefficients,

8 respectively.

9 Results: While overall nutrient intakes estimated in this study did not indicate a particular risk of

10 nutrient deficiency, our findings suggest that consumption of energy-dense, nutrient-poor foods

11 occurred as early as 9 months of age, with some of these foods tracking highly over the weaning

12 period. Intakes of healthier foods such as fruits, vegetables, dairy products, eggs, fish and water

13 were also relatively stable over this transition from infancy to toddlerhood, along with moderate

14 tracking for riboflavin, iodine, fibre, calcium, and iron. Tracking was low but close to rho=0.3 for

15 zinc, magnesium, and potassium intakes.

16 Conclusions: The tracking of energy-dense, nutrient-poor foods has important implications for

17 public health given the development of early eating behaviours is likely to be modifiable. At this

18 stage of life, dietary intakes are largely influenced by the foods parents provide, parental feeding

19 practices and modelling. This study supports the importance of promoting healthy dietary

20 trajectories from infancy.

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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

58 routines are being renegotiated as they find a new equilibrium[28]. The intervention, conducted in

59 2008-2010 within Greater Melbourne (Victoria, Australia) across areas displaying a wide range of

60 socio-economic positions, focused on parenting skills and strategies aimed at promoting the

61 development of healthy behaviours from early infancy. Briefly, a two-stage random sampling

62 design was used to include English-speaking primary caregivers attending first-time parents'

63 groups, a free and universal service provided by Maternal and Child Health nurses. Eighty six

64 percent of eligible parents consented to participate (n=542). We excluded children from non-first-

65 time mothers (n=14); those lost at follow-up (n=48); and those completing less than two dietary

66 recalls at either 9 or 18 months (n=95). Due to field constraints, not all children were aged exactly 9

67 and 18 months at the two measurement times (T2 and T3, respectively). To avoid a possible

68 influence of age on the results, we excluded from all analyses children younger than 7 months or

69 older than 11 months at T2 (n=19); and those younger than 16 months or older than 20 months at

70 T3 (n=16). Outliers for energy and liquid intakes were excluded according to the criterion of mean

71 +/- 3 SD (n=8). As the aim of the current study is the description of the natural history of dietary

72 intake in early childhood (i.e. independent from the intervention), the present analysis is restricted

73 to children in the control group only. This resulted in a sample of 177 children.

74   The Melbourne InFANT Program was approved by the Deakin University Human Research

75 Ethics Committee and the Victorian Government Department of Human Services, Office for

76 Children, Research Coordinating Committee.

77

78 *Measurements*

79 Self-administered questionnaires were utilized to collect demographic (including education level)

80 and socio-economic data at baseline. Education level was defined in three categories: low

81 (secondary school or below), intermediate (trade and certificate qualifications) or high (university

82 degree or higher). Mother's pre-pregnancy weight and height, duration of pregnancy and infant's

83 age when first introduced to solid foods were also reported. Children's height/length and weight

84 without clothes were measured by trained staff at each time point. Height/length was measured to

85 0.1cm using a calibrated measuring mat (Seca 210, Seca Deutschland, Germany) or portable

86 stadiometer (Invicta IPO955, Oadby, Leicester). Weight was measured to 10 grams using calibrated

87 infant digital scales (Tanita 1582,- Tokyo, Japan). The average of two measures was used in

88 analyses.

89   The children's dietary intakes were assessed by trained nutritionists when they were 9 months of

90 age (from December 2008 to June 2009) and 18 months of age (from August 2009 to February

91 2010) by telephone-administered multi-pass 24-hour recall with parents[29]. Purpose-designed

92   booklets adapted to age including photographs of common portion sizes and examples of measures

93   were provided to parents to aid estimation of food consumption. The booklets included pictures of

94   cups, bowls, drink containers, and spoons. Images were taken with permission from the Food

95   Model Booklet developed for the 2007 Australian Children's Nutrition and Physical Activity

96   Survey (CNPAS). Food items included in the food model book used at 18 months were those

97   considered difficult for parents to quantify, important to the Melbourne InFANT Program

98   hypotheses, and/or frequently consumed by this age group. Knowledge of frequently consumed

99   foods was based on Webb and colleagues' paper reporting diets of 16-24 month-old Australian

100   children in the Childhood Asthma Prevention Study (CAPS)[30]. The book included primarily

101   vegetables, fruits, cereals, spreads and non-core foods (energy-dense, nutrient poor foods and

102   beverages). Where available, the portion sizes photographed were based on intakes reported in the

103   CAPS, with three pictures of each food item representing the 25th percentile, median, and 75th

104   percentile of reported intake per eating occasion. Where the food item had not been reported in the

105   CAPS, the amounts photographed were based on reported weights of similar food items. At both 9

106   and 18 month data collections, 2 or 3 non-consecutive days of dietary data were collected, including

107   one weekend day (3 days were available for 92% and 97% of the study sample at T2 and T3,

108   respectively). Calls were unscheduled where possible (96% of all calls). Nutrient intakes were

109   evaluated using the 2007 AUSNUT Database (Food Standards Australia New Zealand, 2008).

110   Where brands of foods or beverages consumed were not found in this database, the nutrient

111   composition data was sought from the manufacturing company or the product's nutrition

112   information panel. Where a reported food or drink could not be matched to an item in AUSNUT

113   2007, such as some infant-specific commercial products, a new food item was created in the

114   database utilising the product's nutrient composition. Recipe creation was informed by recipes

115   frequently described by Melbourne InFANT Program participants. Parents indeed provided detailed

116   information on home-made recipes including ingredients and/or proportions, which enabled the

117   classification of mixed dishes. Data were checked for accuracy by a dietician. Breastfeeding was

118   recorded as minutes of time spent breastfeeding and then converted to volume consistent with

119   previous studies[31].

120

121   *Analyses*

122   Average daily dietary intakes were calculated for each child. Eighteen food groups were defined, as

123   described in Appendix A. For each food group, we assessed the percentage of subjects consuming

124   the food, along with both median and inter-quartile range intakes (expressed in g/d). Intakes were

125   also estimated amongst consumers of each food group only (Supplementary Table). Mean intakes of

126 macro- and micro-nutrients were estimated along with energy density (excluding liquids). The latter

127 was estimated at the individual level, weighting the composition of each food consumed (energy, in

128 kJ) by its effective consumption (g)[32]. Differences in food and nutrient intakes between T2 and T3

129 were tested using Wilcoxon signed rank tests and paired t-tests, respectively. Dietary intakes of

130 selected micro-nutrients were compared with the Nutrient Reference Values for Australia and New

131 Zealand[33]. For nutrients with an available Estimated Average Requirement (EAR), we assessed the

132 proportion of the sample with intakes less than the EAR, which is an estimate of the proportion of

133 the population with inadequate intakes[34]. When EAR was not available, we compared the mean

134 intake to the Adequate Intake (AI)[34].

135   With regards to the assessment of tracking, as food intakes changed substantially between 9 and

136 18 months of age and the distributions were highly skewed, we considered food intake either as a

137 binomial variable (consuming, yes/no), or in tertiles (when the percentage of subjects consuming

138 was >66.7%). In this case, a new binomial variable was then defined, i.e. high *vs.* intermediate or

139 low levels of consumption (which corresponds to the 3rd tertile *vs.* the 2nd or 1st tertiles).

140 Subsequently, for a given food group, we investigated to what extent being a consumer at 9 months

141 (or having a high level of consumption) predicted being a consumer at 18 months (or displaying a

142 high level of consumption) using logistic regression analysis. Odds-ratios (ORs) with 95%

143 confidence intervals (CIs) were calculated. Child age at both T2 and T3 was accounted for in all

144 models (one for each food group), as the strength of tracking depends on both the age at baseline

145 and the length of the follow-up[26], which varied slightly between children in the current study

146 (Table 1). Analyses were also adjusted for gender due to differences in intakes between boys and

147 girls (not shown). For assessment of tracking of nutrient intakes, nutrients were adjusted for age and

148 gender using the residual method[35], and Pearson partial correlation coefficients were calculated

149 between adjusted nutrient intakes at 9 and 18 months. Recommendations for interpreting these

150 correlation coefficients are the following: low <0.3; moderate 0.3-0.6; and high >0.6[26]. All

151 analyses accounted for clustering of participants in first time parents' groups. Other methods for

152 assessing tracking (e.g. changes in quantiles along with the associated Cohen's Kappa coefficient;

153 or the Kendall rank correlation coefficient) do not allow for adjustment for potential confounders:

154 age and time between the two measurements of diet were considered as important confounders to

155 include in the current analysis.

156   The significance level was set at 5%. Analyses were conducted using Stata software (Release 11;

157 StataCorpLP, College Station, TX, USA).

158

159

160 **Results**

161 *Sample characteristics*

162 Demographic characteristics of the sample are shown in Table 1. It should be noted that the 94

163 children of the control arm who were excluded from the analyses due to loss at follow-up or based

164 on exclusion criteria, came from families where the mothers were less likely to have achieved a

165 high education level (43.8% *vs.* 63.3%).

166

167 *Dietary intakes*

168 Overall, excluding water intake, foods represented on average 40.5% and 56.7% of total food and

169 beverage intake (in grams) in children aged 9 months and 18 months, respectively. Nearly half of

170 the infants were still breastfed at 9 months, reducing to 9% at 18 months (Table 2). Most of the

171 infants already consumed water, cereal-based products, meat or poultry, fruits, vegetables and dairy

172 foods when aged 9 months. The amounts consumed for these groups increased with age, with the

173 exception of fish (similar amounts at both ages) and vegetables (lesser amounts at 18 months). This

174 decrease in vegetable consumption was consistent with findings amongst consumers only

175 (Supplementary Table). The proportions of children consuming sweetened beverages, savoury and

176 sweet energy-dense snacks, meat products, egg products, and milk increased more than two fold

177 between 9 and 18 months (Table 2). Similar results were observed when the 20 infants with 2

178 recalls only were excluded from the analysis (results not shown).

179   For most of the foods, being a consumer, or consuming larger amounts at 9 months, was

180 predictive of a greater level of consumption 9 months later. The association was stronger for fruits,

181 water, sweetened beverages, dairy foods, egg products, animal products, sweet energy-dense

182 snacks, baby foods in jars, formula, vegetables, fish, and meat and poultry (by descending order,

183 and ORs>0.20) than for other foods/beverages. Similar results were observed when these

184 multivariable analyses were further adjusted for energy intake (results not shown).

185

186 *Nutrient intakes*

187 Energy intake increased by 30% from 9 to 18 months (Table 3). Absolute intakes of protein, fibre,

188 magnesium, sodium, folate and riboflavin increased even more, with sodium increasing the most

189 (114%). The energy density of the diet also increased (36%) between infancy and toddlerhood. For

190 nutrients with available EARs, the proportion of the sample with inadequate intakes was relatively

191 low (0 to 36%)[36]. Regarding the other micro-nutrients, estimated mean intakes were generally

192 higher than the AIs (or quite close).

193   Amongst the nutrients assessed by the current study, tracking was found to be moderate for

194   riboflavin, iodine, fibre, fibre, calcium, and iron (rho ranging from 0.30 to 0.37, p<0.001). Tracking

195   was low but close to rho=0.3 for zinc, magnesium, and potassium intakes. Similar results were

196   observed when tracking was assessed using nutrients further adjusted for energy intake (results not

197   shown).

198

199   **Discussion**

200   The present study provides important insights into the dietary intakes of Australian children under 2

201   years of age and how these dietary intakes track during the transition from infancy to toddlerhood.

202   To our knowledge, this has not been described previously using longitudinal data collected at the

203   individual level based upon multiple 24-hour recalls.

204

205   Overall, our findings confirm that the period between 9 and 18 months is a time of significant

206   dietary transition. While milk intake (all sources included) was still greater than the intake of solids

207   at 9 months (expressed in grams), this was no longer the case 9 months later. Along with this

208   weaning process, some typical baby foods (e.g. baby foods in jars, formula, breast-milk) were

209   displaced by foods from the family diet, as shown by the change in food group consumption rates

210   between the two ages (Table 2).

211   In addition to complementary foods, 46% and 9% of the mothers were still breastfeeding at 9 and

212   18 months respectively. Few publications have reported the prevalence of breastfeeding after 6

213   months: similar rates of partly breast-fed infants were reported in Denmark[14], but lower rates were

214   described in the United States (33% and 3% at 9 months and 18 months, respectively)[13], and in

215   England (2% at 18 months)[12]. Most of the infants consumed a variety of recommended items such

216   as water, cereal-based products, meat or poultry, fruits, vegetables and dairy foods when aged 9

217   months, and the proportion of children consuming these foods remained high at 18 months.

218   However, percentages of consumers of less healthy food groups increased more than two-fold

219   between 9 and 18 months, including items such as sweetened beverages, meat products, savoury

220   and sweet energy-dense snacks. The corresponding quantitative intakes are high considering that

221   these foods are predominantly energy-dense, nutrient-poor and therefore not essential for growth. In

222   addition, they are likely to displace foods of better nutritional quality[37], leading to a diet of higher

223   energy density. It is also noteworthy that the consumption of vegetables actually decreased between

224   the two ages, consistent with findings in children aged 24-30 months[38]. While these results are not

225   easily comparable to other studies due to differences in methodology, 'extra' foods (energy-dense,

226   nutrient-poor) have previously been shown to contribute substantially to the diet in other studies
227   involving children <2y[13,15,17].

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

247

248   The changes in nutrient intakes from 9 to 18 months did not consistently reflect the magnitude of
249   increase of energy intake (30%), suggesting varying trajectories of nutrient density across infancy.
250   Despite methodological differences, nutrient intakes estimated in the current work are similar to
251   those reported in other studies[9,12,18,20]. Overall, when compared to EARs or AIs, our results suggest
252   that the population studied is not at a particular risk for inadequate nutritional intake[36], which has
253   also been reported in children aged 2-3 and 4-8 of the 2007 Australian National Children's
254   Nutrition and Physical Activity Survey[44]. However, the relatively high intake of sodium at both 9
255   and 18 months should be noted. While international recommendations regarding upper limits are
256   lacking for infants, it has been suggested in the UK that intakes of sodium should not exceed 400
257   mg/d up to the age of 12 months[45]. In Australia, the Nutrient Reference Values for 1-3 year-olds
258   have suggested an upper limit of 1000 mg/d[33]. Based on these two recommendations, more than
259   half of the sample has excessive intakes. Our data also showed that sodium levels increased sharply

260 between infancy and toddlerhood, along with the introduction of foods from the family diet. This is

261 of concern, not only in the short term regarding blood pressure[46], but also regarding the

262 development of taste[47] and the subsequent food preferences during childhood and long term eating

263 habits[1,2]. Although salt is found in high concentrations in staple foods like cows' milk and

264 processed grain products, it is also a significant component of savoury snacks, the consumption of

265 which was shown to increase sharply between 9 and 18 months.

266 Tracking of nutrient intakes appeared to be moderate to low, which may be explained by the

267 transition in diet between 9 and 18 months. Nonetheless, some consistency in tracking was

268 suggested between fruits, vegetables, dairy products, eggs, fish, water, and nutrients contained

269 within these foods, such as riboflavin, iodine, fibre, calcium, iron, zinc, magnesium, and potassium.

270

271 *Limitations*

272 Although all socio-economic positions were represented in this study, university educated mothers

273 were over-represented, which may limit the generalizability of these findings. Considering that the

274 quality of infant diets has been shown to positively relate to maternal education[25,48], we may

275 expect diets of even lower quality in the general population. In addition, dietary recommendations

276 refer to usual nutrient intakes[33], which we were not able to strictly assess using three days of

277 recalls and without accounting for vitamins and minerals provided from supplements.

278 Consequently, comparison with recommendations should be considered with caution. Our

279 assessment of nutrient adequacy based on the AIs should also be considered carefully, since the

280 evidence base for AI is weaker than for EARs. Furthermore, it is acknowledged that sodium intakes

281 can be difficult to estimate due to issues with self-reporting added salt and also the quality of food

282 composition databases[49]. Another limitation of the present study concerns the estimation of mixed

283 dishes (for example recipes including both vegetables and animal products, i.e. meat products, meat

284 and poultry, fish, or egg products). Mixed dishes where animal products were the main component

285 were classified as animal products, while mixed dishes including animal products where vegetables

286 were the major components were classified as vegetables. The coding and classification of mixed

287 dishes is a challenge in dietary assessment and reporting. This may have slightly impacted the

288 precision of the estimation of animal products and vegetable intakes, and thus the assessment of

289 tracking for these specific food groups. Finally, we cannot rule out the possible mis-reporting of

290 dietary intake. However, treatment of "mis-reporters" in studies of <2 y varies in the

291 literature[12,14,16], with only one study excluding them[16]. To date, in this age range, over-reporting

292 appears to be more prevalent than under-reporting, with rates varying between [0-12%] and [11-

293 32%], respectively, depending on the definitions used and the populations studied. A standardized

294   method to define mis-reporting in children's dietary studies is lacking and this issue is even more

295   challenging in infants and toddlers, due to the large day-to-day variability that characterizes their

296   dietary intake[50]. In the absence of a more agreed definition for this age group, we have not

297   excluded mis-reporters, although those reporting extreme energy intakes (mean ± 3 standard

298   deviations) were excluded. Furthermore, the focus of the current study was to investigate intakes

299   from a longitudinal perspective, and while mis-reporting may be present, we hypothesize that the

300   potential biases may affect the same children at the two points in time[51], and therefore have little

301   influence on our findings with respect to tracking.

302

303   *Conclusion*

304   While overall nutrient intakes estimated in this sample do not indicate an important risk of nutrient

305   deficiency, our findings suggest that sub-optimal food consumption occurs as early as 9 months of

306   age. Tracking of intakes was observed not only for energy-dense, nutrient-poor foods, but also for

307   healthier food choices, along with key nutrients. These findings have implications for public health,

308   since behaviours leading to dietary intake are modifiable[52]. At this stage of life, dietary intakes are

309   largely influenced by characteristics of the home environment, in particular the foods provided by

310   parents, parental feeding practices and modelling. This study adds evidence to the importance of

311   promoting healthy dietary trajectories focusing on infancy, and involving parents.

312

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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	66.7th percentile		Median[b]	IQR	66.7th 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 66.7th 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 66.7th 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 66.7^{th} 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.