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What do babies eat? Evaluation of a food frequency questionnaire to assess the diets of infants aged 12 months

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Abstract

Objective: To evaluate the relative validity of an FFQ for assessing nutrient intakes in 12-month-old infants.
Design and setting: The FFQ was developed to assess the diets of infants born to women in the Southampton Women's Survey (SWS), a population-based survey of young women and their offspring. The energy and nutrient intakes obtained from an interviewer-administered FFQ were compared with those obtained from 4 d weighed diaries (WD).
Subjects and methods: A sub-sample of fifty infants (aged 1 year) from the SWS had their diets assessed by both methods. The FFQ recorded the frequencies and amounts of foods and drinks consumed by the infants over the previous 28 d; milk consumption was recorded separately. The WD recorded the weights of all foods and drinks consumed by the infants on 4 d following the FFQ completion.
Results: The Spearman rank correlation coefficients for intakes of energy, macronutrients and eighteen micronutrients, determined by the two methods, ranged from $r=0{\cdot}25$ to $0{\cdot}66$. Bland–Altman statistics showed that mean differences between methods were in the range +5 % to +60 % except for vitamin D (+106 %). Differences in micronutrient intake were partly explained by changes in patterns of milk consumption between the two assessments.
Conclusion: Although there were differences in absolute energy and nutrient intakes between methods, there was reasonable agreement in the ranking of intakes. The FFQ is a useful tool for assessing energy and nutrient intakes of healthy infants aged around 12 months.

Keywords
Infant
Food frequency questionnaire
Weighed diary
Validation

The determination of energy and nutrient intakes during infancy and childhood is important for the evaluation of the impact of diet on growth, development and long-term health. Various methods have been used to assess the dietary intakes of infants and toddlers[(1)]. FFQ are particularly useful for establishing generalised patterns of food intake but with the exception of a few recent studies[(2–5)] have not been widely used to assess dietary intakes of infants and/or young children.

We have previously described an FFQ for dietary assessment at 6 months of age[(6)]. In the present paper, we evaluate the use of an interviewer-administered FFQ to assess the diets of infants aged 12 months, for use in a large population survey (the Southampton Women's Survey (SWS)), that would describe dietary patterns, and would rank infants in terms of their nutrient intake. In a sample of SWS infants, we compare energy and nutrient intakes assessed by the FFQ with intakes determined from 4 d weighed diaries (WD).

Subjects and methods

Subjects

The study was set within the SWS[(7)], in which non-pregnant women were recruited, then followed through their subsequent pregnancy and the offspring followed up. The SWS study population of infants born between 1998 and 2003 comprised 1973 infants. Of these, 1618 (82 %) were visited within 2 weeks before and 3 weeks after their first birthday when diet was assessed. After stratification by current breastfeeding status and infant sex, a random number system was used to select ninety-eight families to participate in a weighed intake study between September 2001 and April 2003. In total, sixty-four (65 %) families approached agreed to participate in the study; fifty (51 %) successfully completed the WD.

The FFQ

Foods were included in the FFQ[(8)] following review of data from a UK survey of children aged 18 months[(9)], 24 h

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recalls collected from the mothers attending a baby clinic, and the food diaries of 12-month-old preterm infants[10]. The FFQ assesses intakes of meat, fish, vegetables, fruit, cereals, breads, cheese, eggs, vegetarian foods, puddings, spreads and snack foods (fifty-eight categories), ten categories of commercial baby foods (sub-divided by brand), and ten types of non-milk drinks. The frequency of consumption and the amount consumed over the previous 28 d of each food in the seventy-eight-item FFQ are recorded. Prompt cards are used to show the foods included in each food group, to ensure standardised responses to the FFQ. Portion size is described using household measures and food models. At the end of the FFQ, an open section in the same format is included, to record frequencies of consumption and amounts of any foods that were not listed on the FFQ, if consumed once per week or more. Human milk, baby formula and other milk intakes are recorded in a separate section.

The weighed diary

A 4 d WD was used to assess the relative validity of the 12-month FFQ, to be consistent with the diary lengths chosen for recent dietary intake studies[11–13], and because calculations of inter-individual and intra-individual variation from energy intake data from a previous 7 d WD study for infants aged 12 months[10] showed that 4 d would classify more than 75 % of infants into the correct quintile of intake at this age. All non-human milks, foods and drinks consumed by the infant on each of 4 d were recorded by weight and cooking method. Each WD was completed after the FFQ. The methods for FFQ and WD collection resembled those reported for the evaluation of the 6-month FFQ[6].

Dietary analysis

For the FFQ and WD, human milk intake was estimated using an algorithm based on length of suckling, derived from published intake data[14,15]. Nutritional composition information for infant formulas and commercial baby foods was obtained from manufacturers and/or by calculation from ingredients; and for non-baby products was taken from *The Composition of Foods*, 5th edition and supplements[16]. Nutrient intakes from dietary supplements were excluded.

Statistical methods

Spearman's rank correlation coefficients were used to summarise the association between the two assessments of each dietary variable. All nutrients were then adjusted for energy intake using the method of Willett[17] and the correlation coefficients recalculated. The Bland–Altman plots[18] were produced to assess the level of agreement between the two methods. As the distributions of all nutrients were skewed, logarithmic transformations were used prior to the Bland–Altman analysis; the Bland–Altman limits of agreement are expressed as symmetric percentages, which summarise the percentage differences between the FFQ and the WD intakes[19].

Ethical approval

Ethical approval was granted by Southampton & South West Hants Local Research Ethics Committee.

Results

The characteristics of the fifty mother–infant pairs studied were comparable with the remainder of the SWS cohort[8] ($P > 0{\cdot}05$ for all comparisons; Table 1). The median (interquartile range, IQR) interval between FFQ completion and the beginning of the WD was 7 (4–10) d; 72 % of diaries were completed on four consecutive days.

Comparison of FFQ with WD intake

In general, intakes assessed by the FFQ were higher than WD-assessed intakes, but the correlation coefficients (r)

Table 1 Characteristics of mother–infant pairs in weighed diary sub-sample and remainder of the cohort born by end of 2003[8]

	Weighed diary group (*n* 50)		Remainder of cohort (*n* 1582)	
Characteristics	*n* or median	% or IQR	*n* or median	% or IQR
Maternal				
Educational qualifications				
GCSE grade D or below	7	14	200	13
GCSE grade C to HND	28	56	1024	66
University degree or above	15	30	331	21
Age at child's birth (years)	30	27–32	30	27–33
BMI, pre-pregnant (kg/m^2)	24·9	22·5–29·8	24·3	22·0–27·7
Smoker, pre-pregnant	8	16	432	28
Infant				
Sex: female	23	46	743	47
Birth weight (kg)	3·50	3·08–3·78	3·47	3·15–3·81
Weight at FFQ (kg)	9·92	9·18–10·52	9·96	9·28–10·80
Birth order				
First	23	46	724	46
Second	18	36	589	38
Third or later	9	18	245	16
Still breastfed at FFQ	7	14	156	10

IQR, interquartile range; GCSE, general certificate of secondary education; HND, higher national diploma.

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Table 2 Energy and nutrient intakes from all foods and drinks, FFQ and WD, the Spearman rank correlation coefficients (r), energy-adjusted correlation coefficients (r^a) and Bland–Altman statistics

	FFQ		WD				Bland–Altman	
Energy/nutrient	Median	IQR	Median	IQR	r*	r^{a}**	Mean difference, FFQ − WD (%)	Limits of agreement (%)
Energy (kJ)	4422	4044–5550	3771	3426–4315	0·46	–	19	−26 to 64
Protein (g)	37·0	32·6–52·1	34·5	28·9–39·4	0·52	0·50	16	−41 to 72
Fat (g)	42·4	38·3–52·6	36·6	33·8–46·3	0·36	0·35	14	−45 to 72
Carbohydrate (g)	135	117–155	112	96–127	0·49	0·44	23	−18 to 64
Total sugar (g)	82·3	71·3–99·4	65·4	51·8–79·7	0·53	0·71	24	−21 to 68
Na (mg)	861	681–1248	862	613–1084	0·66	0·75	5	−63 to 73
K (mg)	1744	1410–2035	1402	1243–1641	0·51	0·42	19	−31 to 68
Ca (mg)	877	783–978	784	611–990	0·65	0·61	12	−42 to 65
Mg (mg)	142	117–176	129	103–149	0·53	0·57	17	−37 to 71
P (mg)	833	698–1027	768	587–928	0·49	0·58	13	−44 to 69
Fe (mg)	8·48	5·92–10·72	5·20	3·96–7·40	0·44	0·50	46	−37 to 128
Zn (mg)	6·25	5·37–7·40	4·54	3·97–5·48	0·39	0·48	31	−26 to 88
Cu (mg)	0·64	0·49–0·80	0·43	0·33–0·51	0·50	0·63	46	−19 to 111
Retinol (μg)	569	474–657	400	329–547	0·48	0·58	27	−37 to 92
Vitamin D (μg)	6·29	3·93–7·97	1·54	0·75–4·55	0·43	0·40	106	−89 to 301
Vitamin E (mg)	6·13	4·92–6·92	4·11	2·67–5·26	0·25	0·27	45	−42 to 132
Thiamin (mg)	0·96	0·74–1·32	0·75	0·59–0·92	0·55	0·53	28	−39 to 96
Riboflavin (mg)	1·70	1·37–1·90	1·43	1·13–1·83	0·48	0·51	14	−46 to 74
Niacin (mg)	10·52	7·81–13·83	7·48	5·30–9·18	0·59	0·60	43	−28 to 114
Vitamin B_6 (mg)	1·09	0·86–1·36	0·81	0·70–1·17	0·62	0·54	23	−36 to 83
Folic acid (μg)	143	125–181	112	87–137	0·39	0·31	29	−35 to 94
Vitamin B_{12} (μg)	3·08	2·48–4·04	2·80	2·12–3·60	0·42	0·24	13	−69 to 94
Vitamin C (mg)	79·6	58·2–108·6	42·3	26·3–62·8	0·52	0·47	60	−46 to 166

WD, weighed diary; IQR, interquartile range.
*All $P<0·01$ except fat $P=0·01$ and vitamin E $P=0·08$.
**All $P<0·01$ except fat $P=0·01$, vitamin E $P=0·06$, vitamin B_{12} $P=0·079$, folic acid $P=0·03$.

Table 3 Types of milk used at the FFQ and the WD assessments

	At FFQ collection		At WD collection	
Type of milk used	*n*	%	*n*	%
Human milk	8	16	5	10
Baby milk formulas	40	80	20	40
Cow's milk (including other animal milks)	46	92	47	94

WD, weighed diary.
Note: Total > 100 % because many infants consumed more than one type of milk.

demonstrated comparable rankings of intakes from the two methods. The coefficients ranged from $r=0·25$ (vitamin E) to 0·66 (Na) (Table 2). The range of correlation coefficients for micronutrients tended to be wider than that for energy and macronutrients (0·36 (fat) to 0·52 (protein)). Adjustment for energy intake had little effect on the levels of correlation, range, $r^a=0·24–0·75$ (Table 2).

In the comparison of absolute intakes of energy and nutrients assessed by the FFQ and the WD, all mean differences (MD) were positive, and within the range of 5 % to 60 % except for vitamin D (106 %) (Table 2). The median energy/kg body weight was 450 kJ (FFQ) and 387 kJ (WD).

Exploration of differences between FFQ and weighed diary

At 1 year, milk still comprises a substantial part of the diet for most infants; the median (IQR) energy intake derived from milks in the diet was 37 % (27–45 %) from the FFQ and 38 % (25–45 %) from the WD. Although the energy derived from milks was very similar for both methods, there were changes in the patterns of milk feeding between the periods assessed by the FFQ and the WD (Table 3). Eleven infants (22 %) changed from consuming a baby milk formula as their main milk to consuming only cow's milk during WD collection. We defined these eleven infants as 'major milk changers'.

Since there are substantial differences in the nutritional composition between formula milks and cow's milk (including much higher levels of Fe, Cu, vitamins C, D, E and niacin in formula milks), we compared nutrient intakes assessed by the FFQ and the WD from foods and drinks other than milks (referred to as 'non-milk' foods and drinks). Comparison of nutrients from non-milk foods and drinks assessed by the FFQ and the WD (Table 4) generally yielded higher correlation coefficients (range 0·44–0·70) than those found for the whole diet,

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Table 4 Energy and nutrient intakes from foods and drinks other than milks, FFQ and WD, the Spearman rank correlation coefficients (*r*) and Bland–Altman statistics

	FFQ		WD			Bland–Altman	
Energy/nutrient	Median	IQR	Median	IQR	*r**	Mean difference, FFQ − WD (%)	Limits of agreement (%)
Energy (kJ)	2698	2276–3749	2352	1921–2890	0·65	20	−34 to 73
Protein (g)	23·9	19·4–36·4	20·4	15·9–25·8	0·70	25	−36 to 86
Fat (g)	21·4	17·1–31·1	18·0	14·9–23·7	0·44	16	−60 to 92
Carbohydrate (g)	89·8	77·8–116·3	78·8	63·8–101·8	0·67	20	−30 to 70
Total sugar (g)	43·6	33·5–54·6	37·3	28·8–44·4	0·66	20	−35 to 75
Na (mg)	665	439–938	596	465–853	0·70	9	−68 to 86
K (mg)	1080	830–1401	820	640–951	0·65	30	−26 to 86
Ca (mg)	346	290–448	287	225–385	0·59	25	−46 to 96
Mg (mg)	89·6	79·6–136·5	74·6	59·8–96·6	0·64	27	−31 to 84
P (mg)	444	365–637	333	298–448	0·58	26	−36 to 88
Fe (mg)	4·42	3·28–6·80	3·97	3·14–4·93	0·58	20	−54 to 95
Zn (mg)	2·70	2·14–4·12	2·09	1·82–2·99	0·66	26	−36 to 88
Cu (mg)	0·46	0·34–0·59	0·34	0·26–0·42	0·46	33	−36 to 112
Retinol (μg)	172	118–253	124	97–168	0·56	34	−74 to 142
Vitamin D (μg)	0·90	0·48–1·58	0·57	0·36–1·24	0·59	33	−108 to 174
Vitamin E (mg)	2·93	2·01–3·70	2·49	1·81–3·18	0·38	13	−81 to 107
Thiamin (mg)	0·59	0·44–0·89	0·48	0·39–0·68	0·58	27	−53 to 107
Riboflavin (mg)	0·87	0·58–1·04	0·67	0·48–0·85	0·52	21	−51 to 93
Niacin (mg)	6·83	4·66–10·40	6·15	3·92–7·18	0·64	28	−53 to 110
Vitamin B_6 (mg)	0·74	0·55–1·10	0·60	0·38–0·75	0·69	31	−42 to 103
Folic acid (μg)	100·0	75·9–138·1	77·2	60·2–102·3	0·61	28	−44 to 99
Vitamin B_{12} (μg)	1·79	1·21–2·46	1·30	0·75–1·66	0·44	35	−80 to 150
Vitamin C (mg)	39·4	26·5–56·2	24·8	17·9–35·7	0·58	43	−66 to 152

WD, weighed diary; IQR, interquartile range.
*All $P < 0.001$ except fat $P = 0.0013$, vitamin E $P = 0.007$ and vitamin B_{12} $P = 0.0015$.

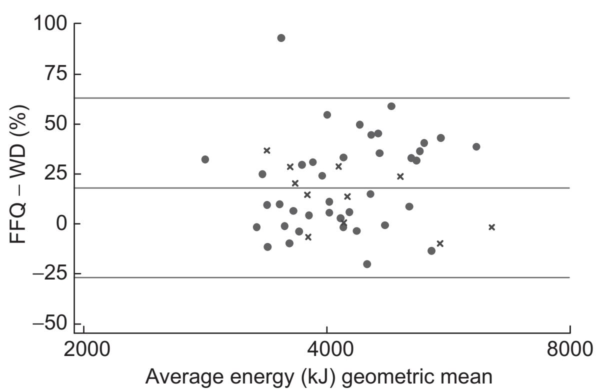

Fig. 1 The Bland–Altman plot for energy intake, according to whether there was a major milk change or not (●, no major milk change; ×, major milk change). WD, weighed diary

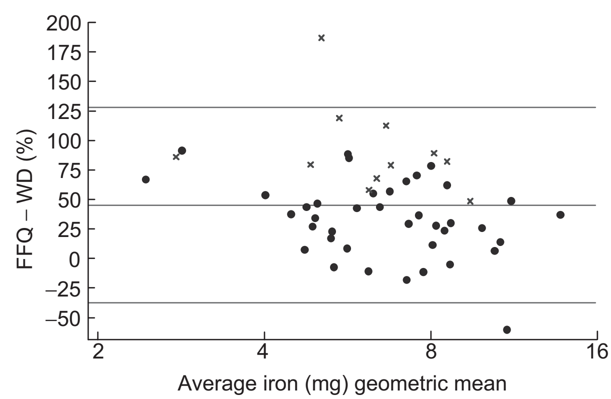

Fig. 2 The Bland–Altman plot for iron intake, according to whether there was a major milk change or not (●, no major milk change; ×, major milk change). WD, weighed diary

with the exceptions of Ca and Cu (Table 4). Similarly, the range of MD was narrowed to 9–43 %, and for those six nutrients present at high levels in formulas compared with cow's milk, the MD were lower than those for the whole diet. For the eleven infants denoted as major milk changers, the differences in composition between cow's milk and formulas were associated with a wider distribution of points in the Bland–Altman plots for the six nutrients specified above. The Bland–Altman plots for energy and Fe are shown in Figs 1 and 2. The effect of a major change in milk feeding on intakes is illustrated in the plot for Fe, a mineral frequently cited as present in sub-optimal quantities in the diets of older infants[20].

Discussion

We have compared the dietary intakes assessed by a newly developed FFQ with those assessed by WD at around 12 months of age. Although the FFQ-assessed intakes tended to be higher than those from the WD, there was reasonable to good ranking of intakes for most nutrients.

The WD was completed after the FFQ. Because of the changes in milk feeding around 12 months of age, we considered nutrient intakes from non-milk foods and drinks as well as nutrients from the whole diet. The rank correlation coefficients for nutrients from non-milk foods

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and drinks were generally higher than those for nutrients from the whole diet, with the majority of correlation coefficients above 0·5. Given the importance of milk as a component of the diet for most infants and the very different nutrient compositions of formulas *v.* cow's milk, this may indicate that the differences in nutrient intakes between methods for those micronutrients present at high levels in formulas that we observed, were greater than they would have been if the FFQ and the WD had assessed diet over the same period. Similarly, the range of Bland–Altman MD (%) was smaller for nutrients from non-milk foods and drinks than nutrients from the whole diet, suggesting that the differences were influenced by changes in the pattern of milk consumption between the periods assessed by the FFQ and the WD.

Comparison with other studies

We are not aware of any other FFQ validation studies of energy and nutrient intakes at 1 year of age from the UK. However, our correlation coefficients were comparable with those from other FFQ relative validation studies for young children from countries which might be expected to have similar feeding practices to those in the UK[3–5,21]. Although our FFQ measures of intake were higher than those from the WD, the MD (%) between the FFQ and the WD for energy and macronutrients were all less than 25 %, and both the FFQ and the WD produced median energy intakes (450 *v.* 387 kJ/kg, respectively) that were higher than the energy requirements/kg for 12-month-old infants derived from doubly labelled[22] studies (334 kJ). Higher FFQ-assessed intakes in infants have been noted by Andersen[3], who reported a difference of 25 % in energy intakes between a semi-quantitative FFQ and 7 d weighed record in Norwegian children at 1 year. These differences in intakes between methods may arise from difficulties in describing portion size and/or frequency in response to the FFQ[3].

Strengths and weaknesses

We studied a stratified random sample of infants, who were representative of the SWS population, which in turn is comparable to the UK population[7]. The quality of the information in our FFQ was enhanced by collecting data over a short recall period, recording both brand information and amount and frequency of consumption of all foods and drinks, and the use of trained personnel to administer the questionnaire.

A weakness of our study is that the WD was completed after the FFQ was administered. Although the interval between dietary assessments was short there were significant changes in patterns of milk consumption over this time that may have led to an underestimation of the level of agreement between the FFQ and the WD. In the absence of an alternative feasible method and in common with other UK infant dietary studies[14,23], both the FFQ and WD estimated human milk intake using an algorithm relating length of suckling to intake; this could have also contributed to the overestimation in intakes in our study.

Conclusion

The FFQ is appropriate for use in large epidemiological studies and is a useful instrument for the assessment of infant diet at around 1 year of age. The comparison of nutrient intakes assessed by the FFQ and the WD showed that the ranking of infants according to nutrient intake was comparable for both methods. While there were differences between methods in estimates of energy and nutrient intakes, the magnitudes of the differences were small to moderate for energy and macronutrients. The level of agreement between methods was influenced by the effect of a change in infants' milk consumption in the period between assessments, and may be underestimated in our study.

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Conflict of interest: None of the authors has any conflicting interests.

Authors' contributions: S.E.B. devised the FFQ; H.M.I., K.M.G., C.M.L., S.M.R. and L.D.M. planned the diary study; L.D.M. carried out the fieldwork and, with S.M.R., was responsible for the nutritional analysis; H.M.I. performed the statistical analysis. L.D.M. wrote the first draft of the manuscript with contributions from all individual authors.

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References

1. Serdula MK, Alexander MP, Scanlon KS & Bowman BA (2001) What are preschool children eating? A review of dietary assessment. *Annu Rev Nutr* **21**, 475–498.
2. Klohe DM, Clarke KK, George GC, Milani TJ, Hanss-Nuss H & Freeland-Graves J (2005) Relative validity and reliability of a food frequency questionnaire for a triethnic population of 1-year-old to 3-year-old children from low-income families. *J Am Diet Assoc* **105**, 727–734.
3. Andersen LF, Lande B, Arsky GH & Trygg K (2003) Validation of a semi-quantitative food-frequency questionnaire used among 12-month-old Norwegian infants. *Eur J Clin Nutr* **57**, 881–888.
4. Parrish LA, Marshall JA, Krebs NF, Rewers M & Norris JM (2003) Validation of a food frequency questionnaire in preschool children. *Epidemiology* **14**, 213–217.
5. Blum RE, Wei EK, Rockett HRH, Langliers JD, Leppert J, Gardner JD & Colditz GA (1999) Validation of a food frequency questionnaire in Native American and Caucasian

children 1 to 5 years of age. *Matern Child Health J* **3**, 167–172.
6. Marriott LD, Robinson SM, Poole J, Borland SE, Godfrey KM, Law CM, Inskip HM & The SWS Study Group (2008) What do babies eat? Evaluation of a food frequency questionnaire to assess the diets of infants aged 6 months. *Public Health Nutr* **11**, 751–756.
7. Inskip HM, Godfrey KM, Robinson SM, Law CM, Barker DJP, Cooper C & The SWS Study Group (2006) Cohort profile: The Southampton Women's Survey. *Int J Epidemiol* **35**, 42–48.
8. Robinson S, Marriott L, Poole J, Crozier S, Borland S, Lawrence W, Law C, Godfrey K, Cooper C, Inskip H & The SWS Study Group (2007) Dietary patterns in infancy: the importance of maternal and family influences on feeding practice. *Br J Nutr* **98**, 1029–1037.
9. Gregory JR, Collins DL, Davies PSW, Hughes JM & Clarke PC (1995) *National Diet and Nutrition Survey: Children Aged 1.5 to 4.5 Years*. vol. 1: *Report of the Diet and Nutrition Survey*. London: HMSO.
10. Marriott LD, Foote KD, Bishop JA, Kimber AC & Morgan JB (2003) Weaning preterm infants: a randomised controlled trial. *Arch Dis Child* **88**, F302–F307.
11. Lanigan JA, Wells JCK, Lawson MS & Lucas A (2001) Validation of food diary method for assessment of dietary energy and macronutrient intake in infants and children aged 6–24 months. *Eur J Clin Nutr* **55**, 124–129.
12. Lagstrom H, Jokinen E, Seppanen R *et al*. (1997) Nutrient intakes by young children in a prospective randomized trial of a low-saturated fat, low-cholesterol diet. The STRIP Baby Project. *Arch Pediatr Adolesc Med* **151**, 181–188.
13. Heinig MJ, Nommsen LA, Peerson JM, Lonnerdal B & Dewey KG (1993) Intake and growth of breast-fed and formula-fed infants in relation to the timing of introduction of complementary foods: The DARLING Study. *Acta Paediatr* **82**, 999–1006.
14. Mills A & Tyler H (1992) *Food and Nutrient Intakes of British Infants Aged 6–12 Months*. London: HMSO.
15. Paul AA, Black AE, Evans J, Cole TJ & Whitehead RG (1988) Breastmilk intake and growth in infants from two to ten months. *J Hum Nutr Diet* **1**, 437–450.
16. Holland B, Welch AA, Unwin ID, Buss DH, Paul AA & Southgate DAT (1991) *The Composition of Foods*, 5th ed. Cambridge: The Royal Society of Chemistry.
17. Willett W (1998) *Nutritional Epidemiology*, 2nd ed. Oxford: Oxford University Press.
18. Bland JM & Altman DG (1986) Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* **i**, 307–310.
19. Cole TJ (2000) Sympercents: symmetric percentage differences on the 100 $\log_e$ scale simplify the presentation of log transformed data. *Stat Med* **19**, 3109–3135.
20. Hopkins D, Emmett P, Steer C, Rogers I, Noble S & Emond A (2007) Infant feeding in the second 6 months of life related to iron status: an observational study. *Arch Dis Child* **92**, 850–854.
21. Williams PL & Innis SM (2005) Food frequency questionnaire for assessing infant iron nutrition. *Can J Diet Pract Res* **66**, 176–182.
22. Butte NF (2005) Energy requirements of infants. *Public Health Nutr* **8**, 953–967.
23. Ong KK, Emmett PM, Noble S, Ness A, Dunger DB & The ALSPAC Study Team (2006) Dietary energy intake at the age of 4 months predicts postnatal weight gain and childhood body mass index. *Pediatrics* **117**, e503–e508.