Nutrient Intakes of Infants and Toddlers

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ABSTRACT

Objectives To assess the nutrient adequacy of the diets of US infants and toddlers 4 to 24 months of age.

Design Descriptive analysis of the usual nutrient intakes of infants and toddlers using 24-hour recall data from the 2002 Feeding Infants and Toddlers Study.

Subjects A national random sample of 3,022 infants and toddlers, with 2 days of recall available for 703 sample members. Sample sizes by age were: infants 4 to 6 months (n=862), infants 7 to 11 months (n=1,162), and toddlers 12 to 24 months (n=998).

Statistical Analyses Performed Using the personal computer version of the Software for Intake Distribution Estimation, we estimated (where applicable) the percentage of infants and toddlers with usual intakes below the estimated average requirement, compared the means of usual nutrient intake distributions with adequate intake levels, and compared the 99th percentile of usual intake distributions with tolerable upper intake levels.

Results For infants under 12 months of age, mean usual intakes exceeded the adequate intake for all nutrients. For toddlers 12 to 24 months of age, the estimated prevalence of inadequacy was low for most nutrients; however, 58% of toddlers had usual vitamin E intakes less than the estimated average requirement. Mean energy intake exceeded the estimated energy requirement by 10% for infants 4 to 6 months, 23% for infants 7 to 12 months, and 31% for toddlers 12 to 24 months of age. The discrepancy between mean energy intake and the estimated energy requirement for infants 4 to 6 months of age was larger for infants fed solids than for infants consuming only breast milk or formula. Fiber intakes of toddlers were below the adequate intake.

Applications Studies should examine whether parents overreport foods consumed by infants and toddlers, and whether infants and toddlers are consuming more energy than required. Additional research is indicated to substantiate some of the new Dietary Reference Intakes for infants and children 1 to 3 years of age.

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Compared with other population subgroups, less is known about the dietary status of US infants and toddlers, especially how subgroups of different ages vary in their food consumption and nutrient intakes. Data from the 1994 to 1996 and 1998 Continuing Survey of Food Intakes by Individuals (CSFII) have been used to produce estimates of nutrient intakes for children, but they examine only two age groups of infants and toddlers—children under age 1 and children 1 to 2 years of age (1). Moreover, the published tables using CSFII data omit breastfeeding children from the analysis and do not provide estimates of usual nutrient intakes. In addition, existing comparisons of nutrient intakes with dietary recommendations use the 1989 Recommended Dietary Allowances (2), which have since been replaced by a new set of dietary standards called the Dietary Reference Intakes (DRIs) (3-7).

Longitudinal data on food and nutrient intakes of infants 2 to 24 months of age have been used in analyses of nutrient intakes, juice consumption, transitions in infant feeding, and meal patterns of infants and toddlers (8). The sample, however, was small and was limited to middle- and upper-income white children in Tennessee.

In contrast, the Feeding Infants and Toddlers Study (FITS) is a rich data set that provides detailed information on food and nutrient intakes of a large sample of US infants and toddlers, as well as on growth and developmental milestones, feeding practices and patterns, and household characteristics. This article focuses on the nutrient intakes of subgroups of infants and toddlers, and addresses two specific research questions: (a) What are the characteristics of the usual nutrient intake distributions of infants and toddlers by age? and (b) Do infants and toddlers have nutritionally adequate diets? That is, do they consume enough nutrients to meet their requirements without having excessive consumption?

DATA AND METHODS

Subjects

The FITS was based on a stratified random sample drawn from the New Parent Database maintained by Experian (9) and includes 3,022 infants and toddlers 4 to 24 months of age, with oversampling of two age subgroups—infants 4 to 6 months and infants 9 to 11 months of age. Final sample sizes by age were: 862 infants 4 to 6 months, 483 infants 7 to 8 months, 679 infants 9 to 11 months, 374 toddlers 12 to 14 months, 308 toddlers 15 to 18 months, and 316 toddlers 19 to 24 months of age. Children under 12 months of age are called infants; children 12 to 24 months of age are called toddlers. This article focuses on three age groups—infants 4 to 6 months, infants 7 to 11 months, and toddlers 12 to 24 months of age—that correspond to the age groups specified by the DRIs (3-7). Sample weights adjust for the oversampling, nonresponse, and undercoverage of some subgroups of children not included in the sample frame. A detailed discussion of the sample design, data collection methodology, and study procedures is presented by Devaney and colleagues (10).

Data Collection Methods

The FITS consisted of up to three separate interviews, all conducted by telephone from March to July 2002: (a) household interview, (b) 24-hour dietary recall, and (c) second-day 24-hour dietary recall for a random subsample of respondents. The household interview provided information on family demographic and socioeconomic characteristics, such as household composition, family income, and age and employment status of the parents. A total of 3,224 respondents completed the household interview. Although any adult in the household could respond to the household interview, respondents primarily were parents.

After the completion of the household interview, we sent respondents an instruction booklet to aid in responding to the 24-hour dietary recall. Approximately 7 to 10 days later, an interviewer called the household again to conduct the 24-hour dietary recall and to ask additional questions on breastfeeding, introduction of foods, and growth and developmental milestones. Of the 3,224 parents or caretakers agreeing to participate in the FITS, 3,022 completed the 24-hour dietary recall.

A random subsample of respondents (n=703) completed a second 24-hour dietary recall 3 to 10 days after the first recall to calculate usual nutrient intake and to support assessments of nutrient adequacy. This second dietary recall was conducted on a different day of the week than the first recall. Respondents received a check for $20 as an incentive to complete the first 24-hour dietary recall and a $5 gift certificate for baby and toddler goods to complete the second 24-hour dietary recall.

We used the Nutrition Data System for Research (NDS-R) from the University of Minnesota Nutrition Coordinating Center (NCC) (11) to collect the 24-hour dietary recalls. The NDS-R prompts for food detail, preparation, and ingredients in a multiple-pass format. Interviewers asked parents (or the most knowledgeable adult) about all foods and liquids that the infant or toddler consumed from midnight through midnight on the previous day. The dietary recall also asked about the use of vitamin and mineral supplements. If children were in day care, interviewers asked parents to call the child care providers and obtain detailed information about the foods their child consumed. If this was not possible, interviewers obtained permission from the parent to call the caregiver directly to complete the child's recall. In all but a few cases, the parent or guardian obtained the dietary recall information directly from the provider. The interviewer obtained the additional information on foods consumed from other caregivers within 72 hours of the original interview.

Dietetic professionals reviewed all 24-hour recalls for missing foods, unrealistic quantities reported, supplement use including brand name and type, and breastfeeding status. Many brand-name baby foods were not in the nutrient database. We constructed a list of the missing baby foods, obtained nutrient information when possible, and sent the list to the NCC to have the database updated.

Nutrient calculations were performed using the NDS-R software (version 4.03), developed by the NCC (11). If an analytic value was not available for a nutrient in a food, the NCC calculated the value based on other nutrients in the same food, on a product ingredient list, or on the nutrient content of similar foods. Accordingly, no missing values remained for the foods consumed by our subjects.

For exclusively breastfed infants under 7 months of age, we assumed an intake of 780 mL of breast milk per day, and for infants who consumed both breast milk and formula, we subtracted the volume of formula from 780 mL to obtain an estimate of the quantity of breast milk consumed (4,12). For infants 7 months of age and older, we used 600 mL per day as the quantity of breast milk for those being fed only breast milk as their milk intake (4). For infants 7 months of age and older who consumed both breast milk and formula, we subtracted the volume of formula from 600 mL to estimate the quantity of breast milk consumed.

Analytic Methods

Usual Nutrient Intake. Infants and toddlers vary considerably in the amount of food they eat from day to day, but their usual intakes, rather than intakes for a day or two, affect their growth and development. To account for the day-to-day variation in nutrient intake, we used the personal computer version of the Software of Intake Distribution Estimation (Iowa State University, available at: http://www.public.iastate.edu/~elvis/pcside/download.htm. Accessed March 2003.). Using methods developed by Nusser and colleagues (13), this program provides estimates of the percentiles of usual nutrient intake distributions, as well as estimates of the proportion below or above defined cutoff values. Nutrient intakes included intakes from foods, beverages, and supplements.

Assessing Usual Nutrient Intake. We used methods recommended by the Institute of Medicine to assess the usual nutrient intakes of infants and toddlers (14). For nutrients with an Estimated Average Requirement (EAR) and Recommended Dietary Allowance (RDA), and a symmetrical requirement distribution, the recommended approach is to use the EAR cut-point method (14-15). With this method, the proportion of the population with usual intakes less than the EAR is an estimate of the proportion of the group with inadequate intakes—intakes that do not meet nutrient requirements.

For infants and toddlers, requirements for many nutrients are expressed in terms of an adequate intake (AI). For infants up to 6 months of age, the AI is usually based on the daily mean nutrient intake provided by human milk for those healthy, full-term infants who are exclusively fed breast milk, although in the second 6 months after birth, it is based on intake from the combination of breast milk and complementary foods. For nutrients with an AI, methods for assessing nutrient adequacy are limited. In particular, the AI cannot be used to determine the proportion of individuals in a group with inadequate nutrient intakes (14). For such nutrients, we present estimates of the percentiles of the usual intake distributions and compare the AI with the mean of the usual intake distribution. Population subgroups with mean intakes at or above the AI can be assumed to have nutritionally adequate diets (14). Three nutrients—iron, protein, and zinc—do have an EAR and RDA for infants 7 to 11 months of age. In these cases, we used the EAR cut-point method to assess nutrient adequacy.

In the case of energy, dietary requirements are expressed in terms of estimated energy requirements (EER). The EER for infants and toddlers is defined as the sum of the dietary energy intake predicted to maintain energy balance for an individual's age and weight, plus an allowance for energy deposition to account for the fact that

Table 1. Usual nutrient intake distributions of infants: Micronutrients

Nutrient	Infants 4 to 6 months: AI[a] and usual intake percentiles							Infants 7 to 11 months: AI and usual intake percentiles						
	AI	10th	25th	Median	Mean	75th	90th	AI	10th	25th	Median	Mean	75th	90th
Antioxidants														
Vitamin C (mg/d)	40	45	55	72	77	92	115	50	62	78	99	104	124	152
Vitamin E (mg/d)	4	7	8	9	9	10	12	5	6	7	9	10	11	14
B vitamins														
Thiamin (mg/d)	0.2	0.2	0.3	0.5	0.6	0.7	1.0	0.3	0.5	0.7	0.8	0.9	1.1	1.3
Riboflavin (mg/d)	0.3	0.4	0.6	0.9	0.9	1.1	1.4	0.4	0.8	1.0	1.2	1.3	1.5	1.8
Niacin (mg/d)	2	2	4	7	7	9	11	4	6	8	10	11	13	16
Vitamin B-6 (mg/d)	0.1	0.1	0.3	0.4	0.4	0.6	0.8	0.3	0.5	0.6	0.8	0.8	1.0	1.2
Folate (μg/d)	65	49	68	120	124	157	191	80	107	140	179	208	235	320
Vitamin B-12 (μ/d)	0.4	0.4	0.6	1.3	1.3	1.8	2.4	0.5	0.8	1.3	1.7	1.9	2.4	3.3
Bone-related nutrients														
Calcium (mg/d)	210	284	361	486	505	613	743	270	395	484	599	632	741	906
Phosphorus (mg/d)	100	111	177	326	340	457	578	275	311	393	497	528	626	780
Magnesium (mg/d)	30	33	45	64	69	85	109	75	74	91	112	117	137	166
Vitamin D (μg/d)	5	0.7	1.3	7.1	6.4	9.5	11.4	5	2.3	5.3	7.6	7.7	9.8	12.8
Micronutrients														
Vitamin A (μg RAE[b])	400	490	562	627	664	737	889	500	507	600	734	774	908	1,092
Vitamin K (μg/d)	2.0	2	8	43	41	58	78	2.5	21	36	52	56	69	92
Iron (mg/d)	0.27	1.5	6.4	11.6	12.0	16.4	21.8	11 (6.9)[c]	7.8	11.3	15.2	15.9	19.6	24.8
Zinc (mg/d)	2	1.6	2.5	4.3	4.3	5.6	6.9	3 (2.5)[c]	3.2	4.3	5.5	5.7	6.8	8.3

Data from 2002 Feeding Infants and Toddlers Study.
Note. Intakes are from food and supplements.
[a]AI=adequate intake.
[b]RAE=retinol activity equivalent.
[c]Recommended dietary allowance (estimated average requirement).

infants and toddlers are growing (7). The EER equations were used to estimate the distributions of EERs for the three subgroups of infants and toddlers, and we compared the EER distributions with the distributions of usual energy intake to assess the adequacy of energy intakes.

For nutrients with established tolerable upper intake levels (ULs) and for which the Nutrition Data System provides data on the form of the nutrient on which the UL is based, we calculated the proportion of toddlers with usual intake from food and supplements exceeding the UL. Finally, for toddlers 12 to 24 months of age, the DRIs also include acceptable macronutrient distribution ranges (AMDR) for the intakes of fat, protein, and carbohydrate as a percentage of energy intake (7). We examined the proportion of toddlers with usual intakes that fall outside the AMDRs.

RESULTS

Table 1 presents estimates of the usual intake distributions of micronutrients for infants 4 to 6 months and 7 to 11 months of age. Nutrient intake includes intakes from foods, beverages, and supplements. For all nutrients, the mean usual intake for both age groups of infants exceeded the AI. In fact, for most nutrients the 10th percentile of the usual intake distribution either equaled or exceeded the AI for both age groups. Only two nutrients in Table 1, iron and zinc, have an EAR for infants 7 to 11 months of age. The EAR for iron is 6.9 mg/day, and the EAR for zinc is 2.5 mg/day. The estimated prevalence of inadequacy (percentage of infants with usual intakes less than the EAR) was 7.5% for iron and 4.2% for zinc (not shown in table).

Table 2 shows estimated usual intake distributions of micronutrients for toddlers 12 to 24 months of age and, where appropriate, the estimated percentages of toddlers with inadequate usual intakes and the percentage at risk of excessive intake levels. The prevalence of inadequacy was low (<1%) for most nutrients, with the exception of vitamin E. For vitamin E, the estimated proportion with inadequate intakes was 58%. Mean intakes exceeded the AI for calcium and vitamin D and were slightly lower than the AI for vitamin K. For nutrients with ULs, the percentage with usual intakes exceeding the UL was less than 1% for most nutrients. The exceptions were vitamin A and zinc, for which 35% and 43% of toddlers, respectively, had usual intakes exceeding the UL.

Both the mean and median usual intakes of energy, as well as the estimated percentiles of the usual energy intake distribution, were above the comparable percentiles of the EER distributions (Table 3). For infants 4 to 6 months of age, mean usual energy intake was about 10% higher than the mean EER; for infants 7 to 11 months, mean usual energy intake was 23% higher than the mean EER; for toddlers 12 to 24 months of age, mean usual energy intake was 31% higher than the mean EER. To examine whether usual energy intakes differed by whether or not the mother worked outside the home, we examined distributions of usual nutrient intake for both groups and found no consistent pattern or significant differences in mean usual energy intake.

Table 4 presents data on usual intakes of fat, carbohydrate, and protein. For infants 4 to 6 months of age, mean usual intakes exceeded the AI for all three of these ma-

Table 2. Usual nutrient intake distributions of toddlers 12 to 24 months

Nutrient	Dietary reference intakes				Usual intake percentiles						Inadequate/excessive usual intake	
	EAR[a]	RDA[b]	AI[c]	UL[d]	10th	25th	Median	Mean	75th	90th	% <EAR	% >UL
Antioxidants												
Vitamin C (mg/d)	13	15	...	400	35	54	82	91	118	159	<1	<1
Vitamin E (mg/d)	5	6	...	200[e,f]	2	3	4	5	7	9	58	<1[e,f]
B vitamins												
Thiamin (mg/d)	0.4	0.5	...	ND[g]	0.7	0.9	1.1	1.2	1.4	1.7	<1	NA[h]
Riboflavin (mg/d)	0.4	0.5	...	ND	1.2	1.5	1.8	1.8	2.2	2.6	<1	NA
Niacin (mg/d)	5	6	...	10[f]	7	9	12	13	16	20	3	...[f]
Vitamin B-6 (mg/d)	0.4	0.5	...	30	0.7	0.9	1.2	1.3	1.6	1.9	<1	<1
Folate (μg/d)	120	150	...	300[f]	163	211	286	318	387	512	2	2.5[f]
Vitamin B-12 (μg/d)	0.7	0.9	...	ND	1.9	2.6	3.5	3.7	4.6	5.7	<1	NA
Bone-related nutrients												
Calcium (mg/d)	...	...	500	2,500	539	709	918	939	1,146	1,367	NA	<1
Phosphorus (mg/d)	380	460	...	3,000	616	768	952	968	1,151	1,342	<1	<1
Magnesium (mg/d)	65	80	...	65[i]	122	149	180	184	215	250	<1	<1
Vitamin D (μg/d)	...	...	5	50	3.8	5.6	7.9	8.7	11.2	14.8	NA	<1
Micronutrients												
Vitamin A (μg, RAE[j])	210	300	...	600[k]	365	481	642	694	846	1,076	1	35
Vitamin K (μg/d)	...	...	30	ND	16	21	28	34	40	58	NA	NA
Iron (mg/d)	3.0	7.0	...	40	5.1	6.7	9.0	9.8	12.0	15.5	<1	<1
Zinc (mg/d)	2.5	3.0	...	7	4.5	5.4	6.6	6.9	8.1	9.8	<1	43

Data from 2002 Feeding Infants and Toddlers Study.

Note. Intakes are from food and supplements.

[a]EAR=estimated average requirement.

[b]RDA=recommended dietary allowance.

[c]AI=adequate intake.

[d]UL=tolerable upper intake level.

[e]As α-tocopherol; applies to any form of supplemental α-tocopherol.

[f]The tolerable upper intake levels for vitamin E, niacin, and folate apply to synthetic forms obtained from supplements, fortified foods, or a combination of the two. The percentage above the tolerable upper intake level could not be determined for niacin because the nutrient database does not include values for synthetic niacin in food.

[g]ND=not determined.

[h]NA=not applicable.

[i]Applies to intake from a pharmacological agent only and does not include intake from food and water.

[j]RAE=retinol activity equivalent.

[k]As preformed vitamin A only.

Table 3. Estimated energy requirements and usual intake of food energy, infants and toddlers

Age group	Percentiles of usual intake and requirement distributions (kcal)							
	5th	10th	25th	50th	75th	90th	95th	Mean
Infants 4 to 6 months								
Usual intake	532	554	589	670	762	863	936	690
EER[a]	481	501	562	622	683	763	824	629
Infants 7 to 11 months								
Usual intake	626	680	772	884	1,021	1,176	1,291	912
EER	568	588	649	729	810	891	931	739
Toddlers 1 to 2 years of age								
Usual intake	814	899	1,046	1,220	1,419	1,633	1,782	1,249
EER	707	729	828	931	1,050	1,171	1,211	950

Data from 2002 Feeding Infants and Toddlers Study.

Note. Intakes are from food and supplements.

[a]EER=estimated energy requirement.

Table 4. Usual nutrient intake distributions: Macronutrients

	Usual intake			Usual intake as percentage of energy intake		
	Fat (g/d)	Carbohydrate (g/d)	Protein (g/d)	Fat	Carbohydrate	Protein
Infants 4 to 6 months: AI[a] and usual intake distributions						
AI	31	60	1.52 g/kg/d or 9.1 g/d	NA[b]	NA	NA
10th	28	57	9	35	41	6
25th	31	65	11	40	43	7
Median	34	81	14	45	47	8
Mean	34	84	14	45	48	8
75th	37	98	17	50	52	9
90th	39	117	20	55	57	10
Infants 7 to 11 months: AI and usual intake distributions						
AI	30	95	1.1 g/kg/d[c]	NA	NA	NA
10th	26	92	14	29	49	8
25th	30	106	17	32	52	8
Median	34	123	21	35	56	9
Mean	35	127	23	35	56	10
75th	40	145	27	39	59	11
90th	46	171	34	42	63	13
% <EAR[d]	NA	NA	1	NA	NA	NA
Toddlers 12 to 24 months: EAR, AMDR,[e] and usual intake distributions						
EAR or AMDR	NA	100	0.88 g/kg/d	30-40	45-65	5-20
10th	31	114	31	26	46	12
25th	37	136	38	29	49	14
Median	45	162	46	33	53	15
Mean	46	165	47	33	53	15
75th	54	192	56	37	58	17
90th	63	225	65	40	61	19
% <EAR	NA	5	<1	38[f]	12[f]	3[f]

Data from 2002 Feeding Infants and Toddlers Study.

Note. Intakes are from food and supplements.

[a]AI=adequate intake.

[b]NA=not applicable.

[c]This is an estimated average requirement, not an AI.

[d]EAR=estimated average requirement.

[e]AMDR=acceptable macronutrient distribution range.

[f]Percent with usual intakes outside of the AMDR.

cronutrients. For infants 7 to 11 months of age, mean usual intakes of fat and carbohydrate were above the AI, and the estimated prevalence of inadequate protein intake (below the EAR of 1.1 g/kg/day) was 1%.

For both fat and carbohydrate, a substantial percentage of toddlers had usual intakes outside of the AMDR (Table 4). In particular, 38% of toddlers had usual fat intakes that fell outside the AMDR of 30% to 40% of energy, 29% had usual fat intakes less than 30% of energy, and 9% had usual fat intakes exceeding 40% of energy.

Usual intakes of dietary fiber for toddlers 12 to 24 months of age were far below the AI set for fiber (Table 5). Mean usual intake of fiber was 8 g/day. Even the 90th percentile of usual fiber intake was less than the AI.

To determine the effect of the methods used to impute the amount of breast milk consumed by breastfeeding infants on assessing nutrient intakes, Table 6 presents estimates of mean intakes of food energy and selected nutrients for subgroups of infants 4 to 6 months of age defined on the basis of breastfeeding status and whether or not they consumed solid foods. For young infants not fed solid foods, mean energy intakes were less than the mean EER for breastfeeding-only infants, close to the mean EER for formula-fed and breastfed infants, and higher than the mean EER for infants fed only formula. For young infants fed milk products and solid foods, mean energy intakes exceeded the EERs. The largest difference between mean energy intake and the EER was for formula-fed infants who also consumed solid foods. Mean intakes of calcium exceeded the AI for all subgroups, with the largest difference again observed for formula-fed infants consuming solids. Mean intakes of iron exceeded the AI for all subgroups except exclusively breastfed infants, although mean intakes of zinc exceeded the AI for infants consuming formula and were close to or less than the AI for infants whose source of milk was breast milk only (Table 6).

DISCUSSION

The FITS is the first national study to assess the nutrient adequacy of the diets of infants and toddlers using the DRIs. Overall, the results suggest that the diets of US infants and toddlers are nutritionally adequate, and suggest that current feeding practices of US children provide a strong nutritional foundation, with negligible risk of

Table 5. Usual intake of dietary fiber

Adequate and usual intake distributions (g/d)	Infants 4 to 6 months	Infants 7 to 11 months	Toddlers 12 to 24 months
Adequate intake	NA[a]	NA	19/17[b]
10th	0	3	5
25th	0	4	6
Median	1	6	8
Mean	2	6	8
75th	4	8	10
90th	5	10	12

Data from 2002 Feeding Infants and Toddlers Study.

Note. Intakes are from food and supplements.

[a]NA=not applicable.

[b]The adequate intake for children aged 1 to 3 years is 19 g/d, based on a recommendation of 14 g fiber/1,000 kcal and a median intake of 1,372 kcal/d for 1 to 3-year-old children in the Continuing Survey of Food Intakes by Individuals. Adjusting for the lower median energy intake of the 12 to 24-month-old FITS toddlers leads to an adjusted adequate intake of 17 g/d.

nutrient deficiency. Several aspects of the results, however, warrant additional discussion. These include reported energy intakes that exceeded estimated requirements, the high intakes of infants up to 1 year of age relative to the AIs, the high apparent prevalence of toddlers with vitamin E intakes below the EAR, the low fiber intakes of toddlers, and significant proportions of toddlers with intakes exceeding the UL for vitamin A and zinc.

A potentially important finding was that the energy intakes of the FITS participants seemed to exceed their requirements as calculated using the Institute of Medicine equations for the EERs, and the difference between intakes and the EERs increased with age. Possible limitations of data collection could have led to errors in estimated energy intake and/or requirements. The first of these relates to methods used to estimate energy intake. Although we provided visual aids to help parents or guardians estimate the quantities of foods consumed by their child, they may have overreported intakes. This would be in contrast to the general finding of underreporting among adults (16), yet it is conceivable that this could occur. An unconscious wish to portray their child as eating well could be associated with a tendency to overestimate intakes by infants and toddlers. Furthermore, it may be difficult for parents to estimate the amount actually consumed rather than the amount offered. Losses associated with food spillage, spitting up, and so on may be substantial. However, it should be noted that the estimates of nutrient intake obtained in the FITS are consistent with published estimates from the CSFII data for toddlers 12 to 24 months of age. In particular, mean energy intake from the FITS was 1,244 kcal, compared with 1,256 kcal from the CSFII (1), suggesting that overreporting of intakes for infants and toddlers may be a common problem with 24-hour dietary recall methods.

A second possibility for our finding that energy intakes exceeded requirements is that the calculated EERs are underestimates. The EER equations for infants and toddlers vary by age, and include the child's weight. Age was likely estimated accurately, because the child's date of birth was reported, but weight may have been underestimated. Assuming that weight is assessed at well-baby visits to a doctor or clinic, it is probable that most children would have gained weight between the time they were last measured and the date of the FITS interview. Using higher weights in the EER calculations would have resulted in higher values for the EER, and therefore a smaller difference between the EER and reported intake. For example, a difference in weight of 1 kg (2.2 lb) would increase the EER by 89 kcal (7). This would also mean that the FITS participants would be at higher weight-for-age percentiles than assessed from the data.

It is also possible that at least part of this difference between energy intakes and the EER could reflect the consumption of more energy than required. The growth data provide some support for this suggestion, because median weight-for-age was slightly above the 50th percentile of the Centers for Disease Control and Prevention growth charts (17). Furthermore, if weight were underestimated, as suggested previously, the median weight for age would be even higher. In this regard, the prevalence of pediatric obesity has increased dramatically in recent years (18). Although undoubtedly multifactorial in etiology, excessive energy intake would contribute to an increased prevalence of obesity.

Nonetheless, the discrepancy between reported energy intakes and the EERs from the FITS and other national data sets is implausibly high, especially for toddlers. For example, toddlers' mean intake exceeded the EER by about 300 kcal/day, which would be projected to lead to an excess weight gain of at least 1 lb every 2 weeks, or at least 25 lb per year. Thus, even if toddlers were consuming more than required, overconsumption cannot account for the entire discrepancy between reported intakes and the EERs. We suspect that overreporting and possible higher body weights are the main determinants of the discrepancy between the EER and mean energy intake.

The difference between energy intakes and the EER for infants 4 to 6 months of age was greater for infants fed solid foods than for infants consuming milk products and no solid foods. To some extent, this finding reflects the assumption of 780 mL as the quantity of breast milk consumed by breastfeeding infants 4 to 6 months of age. This quantity was not adjusted downward when infants also consumed solid foods, yet the literature suggests that energy from human milk declines as energy from solid foods increases (19,20). However in this age group, the largest discrepancy between mean energy intakes and the mean EER was observed for formula-fed infants who also consumed solids, and in this case the quantities reported of formula and solids were from parent or guardian reports. Although formula-fed infants are expected to have higher energy intakes than breastfed infants, the difference was about 14 %, compared with an expected difference of only 7% to 8% (7), suggesting either overreporting or overconsumption among young infants fed formula and solid foods.

The high mean micronutrient intakes of the majority of infants participating in the FITS likely reflects two factors, reported high energy intakes and the consumption of infant formulas. If respondents overreported food intakes of infants, at least some of the estimated intakes of other nutrients would also be overstated. We have no way to estimate the extent to which overestimation of food intake inflated estimates of intake of other nutrients as well. However, even if food intakes were not overestimated, formula intake contributes to high nutrient intake relative to the AI. Compared with breast milk, infant formula contains higher concentrations of most nutrients.

Table 6. Mean intakes of selected nutrients by source of milk, infants 4 to 6 months old

	Breast milk		Breast milk and formula		Formula	
	Breast milk only	Breast milk and solids	Breast milk and formula only	Breast milk, formula, and solids	Formula only	Formula and solids
Energy (kcal/d)						
EER[a]	613	625	605	610	595	638
Mean intake	565	667	604	713	645	729
Calcium (mg/d)						
AI[b]	210	210	210	210	210	210
Mean intake	261	339	379	484	559	617
Iron (mg/d)						
AI	0.27	0.27	0.27	0.27	0.27	0.27
Mean intake	0.24	5.18	4.90	11.14	10.95	17.40
Zinc (mg/d)						
AI	2.0	2.0	2.0	2.0	2.0	2.0
Mean intake	1.4	1.8	3.1	3.5	5.6	5.6
Sample sizes (unweighted)	109	111	31	91	84	428

Data from 2002 Feeding Infants and Toddlers Study.
Note. Intakes are from food and supplements.
[a]EER=estimated energy requirement.
[b]AI=adequate intake.

In some cases, the higher nutrient content of formula is intended to compensate for lower bioavailability (eg, of calcium) relative to human milk (4), or to address specific concerns (eg, fortification with iron to prevent anemia). Regardless of the reasons for the higher nutrient content of formula, the high nutrient intakes of infants relative to the AI should not be interpreted as reflecting enhanced or superior nutrition: indeed, if recommended breastfeeding practices were more widely adopted, lower nutrient intakes of most nutrients would have been observed among infants.

Although nutrient intakes from the FITS data include intake from all foods and supplements, supplement intakes contribute little to overall daily nutrient intake and do not explain the high mean intakes of infants relative to the AI. The percentage of daily nutrient intake accounted for by supplement intake ranged from a low of zero for food energy to a maximum of 1.9% for vitamin B-6, and, for most nutrients, the average share of total daily intake accounted for by supplements was less than 1%.

The one exception to the general finding that micronutrient intakes were adequate was vitamin E, for which the prevalence of apparently inadequate intakes was 58% among toddlers 12 to 24 months of age. This finding must be interpreted with great caution. Because there were no data available in infants and children to set an EAR, the adult EAR was extrapolated downward to derive EARs for children ages 1 and above according to differences in metabolic body size (3). If vitamin E intakes were assessed accurately in population surveys, one would expect the population prevalence of inadequate intakes (the percentage below the EAR) to approximate the proportion with low plasma vitamin E levels (used to set the EAR). However, data from the third National Health and Nutrition Examination Survey (NHANES III) show that although a majority of age/gender subgroups had intakes below the EAR, fewer than 5% had low plasma vitamin E levels (3). Because underreporting of foods consumed seems not to be an issue for infants and toddlers, possible reasons for the apparent discrepancy between inadequate dietary intakes and adequate nutritional status from the standpoint of biochemical tests include the difficulty in assessing the types and amounts of fats and oils added during cooking and the variability in food composition databases. In any case, our data are consistent with those of NHANES III, and do not suggest cause for concern regarding toddlers' vitamin E status.

Toddlers who participated in the FITS had fiber intakes well below the AI, as has also been observed in other surveys (CSFII). The AI for adults is based on a fiber intake associated with chronic disease prevention (7). Whether that endpoint is appropriate for young toddlers could be questioned. For example, a commonly used pediatric recommendation for children over the age of 2 years is for fiber intakes to be equal to (or greater than) their age plus 5 g/day (21).

The relatively high percentage (29%) of toddlers with usual total fat intakes below the AMDR for toddlers of 30% to 40% of energy might suggest a potential cause for concern. However, although low-fat diets in children may be associated with reduced intake of certain micronutrients, and the energy content of fat may be important for younger children with low food intakes (7), neither of these concerns was borne out in the FITS toddlers. Both micronutrient and energy intakes were adequate. Accordingly, efforts to increase toddlers' fat intakes do not seem warranted on these grounds.

Finally, significant proportions of toddlers had usual intakes greater than the UL for vitamin A and zinc (35% and 43%, respectively), findings that are consistent with results from NHANES III. The UL for zinc for infants and children was based on a study in which no adverse effects on copper metabolism were seen in full-term infants receiving formulas containing about 4.5 mg zinc/day. The method used to set the UL resulted in a narrow margin between the RDA and the UL (less than two times the RDA) for zinc in young children. At this point, only one case report of zinc-induced copper deficiency exists in the literature, and that was a case in which a toddler received 16 to 24 mg zinc/day for many months (6).

The method used to set the UL for vitamin A also resulted in a narrow margin between the RDA and the UL in young children (6). The finding that a high proportion of toddlers had reported vitamin A intakes that exceeded the UL reinforces the need to avoid unwarranted supplementation, but it also points to the need for better data with which to set appropriate ULs for infants and children.

APPLICATIONS

- Overall, infants and toddlers seem to have adequate nutrient intakes. Accordingly, parents of otherwise healthy children need not be concerned that their young children are at risk of nutrient deficiency.
- Whether the high energy intakes relative to estimated requirements are a real phenomenon or not, they provide additional support for the need for parent education about appropriate infant and toddler feeding practices. They also reinforce the importance of encouraging health professionals to monitor the weight gain of infants and toddlers, and to refer possible problems to dietetics professionals.
- Given the lack of clinical evidence to support results that might otherwise suggest either inadequate consumption of vitamin E, fat, or fiber, or excessive consumption of vitamin A and zinc, additional research to better substantiate some of the new DRIs for infants and children 1 to 3 years of age appears warranted, most notably the EAR for vitamin E, the AMDR for fat, the AI for fiber, and the UL for vitamin A and zinc. At this point, major changes in toddlers' food intakes, such as large increases in vitamin E or fiber intake, an increase in fat intake, or a reduction in zinc intake, do not seem warranted.

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