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Diversity and Nutrient Composition of the Diets of Breastfed Infants

Emzirilen Bebeklerde Besinsel Çeşitlilik ve Besin İçeriği

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ABSTRACT Objective: Many studies have examined the quality of diets in children; however, most were conducted either in industrialized countries, where breastfeeding rates are low, or in socioeconomically disadvantaged populations. The primary aim of our study was to determine the diversity and nutritional composition of the diets of healthy breastfed infants. The secondary aim was to determine dietary macronutrient and micronutrient intake via meal and snack patterns. **Material and Methods:** We recruited 130 infants aged 9-12 months who attended the well child outpatient clinic. Data were collected using 3-day dietary records completed by the mothers. Daily nutrient intake was calculated using computer software (Ebispro, Stuttgart, Germany; Turkish version: BeBis, Vers 6.1). Means and standard deviations were calculated using descriptive statistics for nutrient intake and mean daily intakes were compared with the recommended dietary allowance/adequate intake reference values. **Results:** Median energy intake was 810 kcal/day. Carbohydrate, lipid, and protein provided was approximately 45%, 43%, and 12% of the total daily energy. Intakes below the recommended daily intakes were found in 100% for niacin, 98% for iron, 96% for pantothenic acid and biotin, 91% for vitamin E, 87% for iodine, 67% for folate, 60% for vitamin C, 48% for manganese, 41% for magnesium, and 31% for zinc. Sodium intake was high in 93% of cases. Seventy five percent of the infants met the minimum dietary diversity. Breakfast was found to contribute the greatest proportion of energy as well as macronutrients and micronutrients acquired during the day. **Conclusions:** The study describes in detail both the quality and quantity of diets of a sample of breastfed Turkish infants not consuming fortified foods. Concerns regarding low intake of antioxidants, iron, iodine, niacin, pantothenic acid, biotin, folate, manganese, and magnesium as well as excessive intake of energy, protein, and sodium should be addressed.

Keywords: Nutritional assessment; micronutrients; infant; breastfeeding

ÖZET Amaç: Çocuklarda beslenme kalitesi araştırılmış olmasına karşın çalışmalar ya emzirme oranlarının düşük olduğu endüstriyel ülkelerde yapılmış ya da sosyoekonomik olarak dezavantajlı popülasyonlarda yürütülmüştür. Bu çalışmanın birincil amacı emzirilen sağlıklı bebeklerin besinsel çeşitliliğini ve besin içeriğini belirlemektir. İkinci amacımız ise beslenmedeki mikro ve makrobesin içeriğini yemek ve atıştırma örüntülerine göre belirlemektir. **Gereç ve Yöntemler:** Hedef örneklemi çocuk sağlığı izlem polikliniğine başvuran yaşları 9-12 ay arasında değişen 130 bebeğin anneleri oluşturmaktadır. Veriler anneler tarafından doldurulan 3 günlük beslenme kayıtları ile toplanmıştır. Günlük besin alımı bilgisayar yazılımı kullanarak hesaplandı (Ebispro, Stuttgart, Germany; Turkish version: BeBis, Vers 6.1). Besin alımı için ortalama ve standart sapma tanımlayıcı istatistik kullanılarak hesaplandı ve ortalama günlük besin alımları önerilen günlük alım miktarı/yeterli alım referans değerleriyle karşılaştırıldı. **Bulgular:** Ortanca enerji alımı 810 kkal/gün'dür. Karbonhidrat, yağ ve protein toplam günlük enerjinin sırasıyla yaklaşık %45, %43 ve %12'sini oluşturmaktadır. Niasin için %100, demir için %98, pantotenik asit ve biotin için %96, E vitamini için %91, iyot için %87, folat için %67, C vitamini için %60, manganez için %48, magnezyum için %41 ve çinko için %31 önerilen günlük alımın altında saptanmıştır. Sodyum alımı olguların %93'ünde yüksektir. Bebeklerin %75'i beslenme çeşitliliğini karşılamaktadır. Kahvaltı enerji, makro ve mikro besinlere en çok katkıda bulunan öğündür. **Sonuç:** Çalışma, desteklenmiş tamamlayıcı besin tüketmeyen anne sütü ile beslenen bir Türk bebek örnekleminin, beslenme nitelik ve miktarını ayrıntılı olarak tanımlamaktadır. Düşük antioksidan, demir, iyot, niasin, pantotenik asit, biotin, folat, manganez, magnezyum alımı ve fazla enerji, protein ve sodyum alımı irdelenmelidir.

Anahtar Kelimeler: Besinsel değerlendirme; mikrobesin öğeleri; bebek; emzirme

Nutrition has a significant impact on health and poor feeding practice is associated with risk of developing adult obesity, undernutrition in children, and noncommunicable diseases.[1-3] Interventions to reduce the risk of obesity in later life and undernutrition include the timely introduction of high quality complementary foods containing micronutrients but not excessive protein, based on the principles of responsive feeding.[1-6]

Studies published from industrialized countries found dietary supplements and enriched or fortified foods to be significant contributors to micronutrient intake.[7-15] The Feeding Infants and Toddlers Study (FITS) conducted in 2002 and replicated in 2008 assessed the usual nutrient intake and food consumption patterns of United States (US) children in a large national sample.[7,8] The results indicated that the diets of US children were nutritionally adequate overall, except for iron and zinc in older infants and vitamin E in toddlers and preschoolers.[8] The percentage of infants aged 9-11.9 months who were currently breastfeeding at the time of the study was 20.9% ± 1.9% in 2002, and 36.7% ± 5% in 2008.[15]

The South Asia study found that 15%–71% of children did not meet the minimum requirements for dietary diversity.[16] An analysis of Demographic and Health Surveys data from 46 countries found that the proportion of children aged 6–23 months receiving the minimum acceptable diet was 16% in Africa and 26% in Asia, compared with 43% in Latin America.[17]

According to the Turkish Demographic and Health Survey 2013, 30% of children were exclusively breastfed at 6 months and 12% of the infants commenced complementary feeding before this age.[18] The prevalence of wasting (weight for height z score [WHZ] < −2]), underweight (WAZ < −2), stunting (height for age z score < −2), and overweight were reported to be 2%, 2%, 10%, and 11%, respectively, in children under 5 years of age.[18] However, in Turkey, studies on complementary feeding of infants are limited.[19,20]

The primary aim of our study was to determine the diversity and nutritional composition of the diets of healthy breastfed infants using complementary feeding indicators, and to determine whether traditional family foods in Turkey are adequate to meet the needs of infants who are still breastfed, since this has not been addressed in detail before. Our secondary aim was to determine dietary macronutrient and micronutrient intake via meal and snack patterns.

MATERIAL AND METHODS

This cross-sectional institution-based study was conducted at the Ministry of Health Marmara University Pendik Training and Research Hospital in Istanbul between May 2012 and September 2012. Istanbul is the largest city in Turkey and Pendik is the city's fifth most crowded district with a population of 646,375 people.

The target sample was the mothers of predominantly breastfed infants aged 9 to 12 months who attended the well child outpatient clinic. The sample size was determined using the one study group versus population formula and assuming an alpha cut-off of 0.05, power of 80%, and an incidence of optimal complementary feeding practice of 14%. The calculated sample size was 108 mother–infant pairs. Mothers who brought their babies to the well child clinic were enrolled randomly using a computer-generated random number table. Premature, low birth weight babies, and babies with chronic health conditions were excluded.

A wealth index was constructed based on information collected about the properties of the household, heating sources, household income, years in education, and working status of the parents.[21,22]

A total of 130 mothers were approached, considering a dropout rate of 20%. Ten infant mother dyads who did not meet the inclusion criteria were excluded, and 14 were later excluded because of incomplete 3-day dietary records. Twenty four infants consuming formula were among the infants excluded. Two infants who consumed only a negligible amount of formula (median 28 cc) were included. The final analysis was performed on 106 infant–mother dyads.

At age 9 and 12 months, the infants visited the clinic where anthropometric measurements were made. They were weighed naked to the nearest 0.1 kg using an electronic baby scale (Seca 354), length was measured using an infantometer (Seca 207), and z scores were calculated using WHO Anthro v3.2.2 software. Data were collected using 3-day dietary records completed by the mothers. Each mother was asked to keep nonconsecutive 3-day food records including two weekdays and one weekend day. The amounts of each food consumed are estimated in reference to a common size container like cups, and spoons. Respondent mothers are trained by the research dietitian before participating the study. In addition, a manual providing written instructions on how to record the diet were provided. After the records were completed, each report is also carefully reviewed by the research dietitian with the parent for clarification and accuracy (the in depth review took 30 minutes). Breast milk volume was used to estimate the volume of milk based on the duration of each feed and was recorded with an allowance for 10 mL/min to a maximum of 100 mL/feed.[23]

Data analyses were mainly based on indicators for assessing infant and young child feeding practices, as well as to determine the macronutrient and micronutrient intake of the children. The minimum dietary diversity can reflect the micronutrient density of the diet of young children in poor settings and refers to the proportion of children aged 6 to 23 months receiving foods from at least four of the seven food groups.[2,24] The seven food groups include: (1) grains, roots, and tubers, (2) legumes and nuts, (3) dairy products, (4) meat, (5) eggs, (6) vitamin A-rich fruits and vegetables (>130 retinol equivalents of vitamin A per 100 g), and (7) other fruits and vegetables. Food variety score was defined as the number of different food items an infant ate in 1 or 3 days. The minimum meal frequency refers to the proportion of children aged 6–23 months receiving complementary foods the minimum number of times or more. Night feeds and between-meal feeds of breast milk were not considered as a meal or a snack.

Daily nutrient intake was calculated using computer software (Ebispro, Stuttgart, Germany; Turkish version: BeBis, Vers 6.1). The data source of this software was 97% Bundeslebensmittelschluessel; German Food Code and Nutrient Data Base; Version II.3; and 3% USDA. Using the same software, the daily consumption of each food (g) was assessed and the nutrient composition of the diets was calculated. The recommended dietary allowance (RDA) and the adequate intake (AI) were used in the assessment of the diets.[25]

STATISTICAL METHODS

Analyses were conducted using SPSS software version 15. Means and standard deviations were calculated using descriptive statistics for demographic characteristics, nutrient intake, and dietary sources of total energy, macronutrients, and micronutrients. Mean daily intakes were compared with the RDAs/AI reference values, and the prevalence of inadequate intakes, defined as the percentage with mean daily intakes below the RDSs/AI are provided. Student's *t*-test or Mann–Whitney *U* test was used to compare these parameters between the groups where necessary. One-way ANOVA was used to compare the contribution of each meal. A Levene test was used to assess the homogeneity of the variances. When an overall significance was observed, pairwise post hoc tests were performed using Tukey's test. An overall p-value of less than 0.05 was considered to show a statistically significant result.

Ethical approval was obtained from the university's Research Ethics Committee. Informed consent was obtained from all the parents of the participants included in the study. Reported research was conducted in accordance with the principles set forth in the Helsinki Declaration 2008.

RESULTS

The ages of the mothers and fathers were 28.8 ± 5.5 and 32.5 ± 6.3 years, respectively. Ninety mothers (84.9%) were housewives. The mean education years of the mothers and fathers were 8 ± 3.6 years and 8.8 ± 3.9 years, respectively. Most of the infants were from middle and high socioeconomic status (61% and 37%, respectively).

The mean age of the infants was 9.7 ± 1.3 months and 53 (50%) were male. All were within the normal values of weight and length according to the WHO growth charts. Seventy percent of the infants were exclusively breastfed for 4 months, 51.2% were exclusively breastfed for 6 months (median 6 months), and 48.8% were predominantly breastfed for 6 months.

The mean daily intakes of macronutrients are shown in Table 1. The median energy intake was 810 kcal/day (847 ± 247 kcal for boys and 818 ± 219 kcal for girls). Carbohydrate, lipid, and protein provided approximately 45%, 43%, and 12% of total daily energy. Mean polyunsaturated fat and cholesterol intakes were 2.8 ± 1.6 mg/day (median, 2.2 mg) and 164 ± 91 mg/day (median, 167 mg), respectively.

TABLE 1: Mean daily intakes for macronutrients estimated from 3-day food records.

Macronutrients	Mean ± SD (%)
Energy (kcal)	832.2 ± 232.5
Protein (g)	25.3 ± 9.2
Fat (g)	39.9 ± 13.4
Carbohydrate (g)	91.8 ± 26

Median breast milk intake was 363 cc/day. Approximately 38% of the infants received ≥500 cc breast milk. All the infants received an average of 160 g dairy products per day.

In the current study, the mean daily intake of energy from breast milk and complementary food was 305 and 505 kcal, contributing to 37.5% and 62.5% of the total energy, respectively. Mean protein intakes were above the RDAs in 99% of the infants. Breast milk and complementary foods provided approximately 0.4 and 2.1 g/kg per day of protein intake, respectively. Protein from complementary food was a major contributor to protein intake. Protein from dairy products was significantly higher in females (0.43 versus 0.54 g/kg, $p = 0.017$). Weight for age z score was not significantly different between the high versus low protein intake groups ($p > 0.05$). Although the growth parameters were significantly higher in boys, energy and macronutrient composition of the diets were not significantly different according to gender ($p > 0.05$).

Mean daily intakes of vitamins were compared with the RDAs/AI reference values. The proportion of children with intakes below the RDA or AI is shown in Table 2. On average, intakes of vitamins A, B_1, B_2, B_6, and B_{12} were adequate. Intakes below the AI/RDAs were found in 100% for niacin,

TABLE 2: Mean daily intakes for vitamins and the proportion of infants with intakes below the RDA/AI.

Vitamins	Min	Max	Mean ± SD	Percentage of infants <RDA
Vitamin A (mg)	150.8	5398.1	924.7 ± 642.4	12.3
Vitamin E (mg)	0.5	9.8	2.9 ± 1.5	90.6
Vitamin C (mg)	7.25	132.4	50.3 ± 24.05	60.4
Vitamin D (µg)	0.03	1.3	0.49 ± 0.24	100
Vitamin B1 (thiamine) (mg)	0.13	0.77	0.41 ± 0.13	27.4
Vitamin B2 (riboflavin) (mg)	0.25	1.68	0.85 ± 0.31	2.8
Vitamin B6 (pyridoxine) (mg)	0.2	2.05	0.92 ± 0.29	0.9
Niacin (mg)	0.05	2.5	0.96 ± 0.5	100
Pantothenic acid (mg)	0.05	2.5	0.96 ± 0.5	96.1
Biotin (µg)	0.15	7.5	2.9 ± 1.4	96.1
Folate (µg)	18.8	173.2	72.3 ± 33.0	67
Vitamin B12 (µg)	0	5.12	1.3 ± 0.8	21

***RDA/AI:** Recommended Daily Allowance/Adequate Intake.

96% for pantothenic acid and biotin, 91% for vitamin E, 60% for vitamin C, 67% for folate, and 100% for vitamin D. Infants receiving at least four food groups had significantly higher levels of vitamins E, B_1, B_2, B_{12}, and folate ($p < 0.001$).

Mean daily intakes of minerals were compared with the RDAs/AI reference values. The proportion of children with intakes below the RDA or AI is shown in Table 3. On average, intakes of calcium, phosphorus, potassium, and copper were adequate. Intakes below the AI/RDAs were found in 98% for iron, 87% for iodine, 48% for manganese and biotin, 41% for magnesium, and 31% for zinc. Sodium intake was above the RDA in 93% of the infants when 370 mg was taken as the cut-off value (this was 91.5% when the cut-off was taken as 400 mg). Infants receiving at least four food groups had significantly higher values for minerals ($p < 0.001$).

Mean daily distribution of macronutrients according to meals and snacks are shown in Table 4. Breakfast was found to contribute the greatest proportion of energy, protein, fat, and micronutrient (except vitamin C) intake ($p < 0.001$). Carbohydrate intake was not different at breakfast, dinner, and night, followed by lunch and snacks. Importantly, energy, fat, and carbohydrate intake was not different at dinner and night. In terms of energy intake, dinner and night was second to breakfast, and energy intake at lunch was not different compared with morning snacks. In terms of protein intake, dinner was second to breakfast, followed by lunch, night, and snacks. Fat intake was greatest at dinner and night after breakfast, followed by lunch and snacks.

Iron, zinc, calcium, vitamin E, folate, and vitamin B_6 intakes were greatest at breakfast. Vitamin C intake was not different with regards to mealtimes. Vitamin A intake was greater at breakfast than in snacks but equal in main courses. Midmorning snack micronutrient intakes were equal to those of the afternoon snack but lower than those of the main meals. Night micronutrient intakes were equal to those of noon and afternoon snacks but lower than those of breakfast and dinner.

MEAL FREQUENCY

Main meal frequency was 2.8 ± 0.4 (median, 3) and snack frequency was 1.4 ± 0.7 (median, 1.3). Approximately 72% of children received 3 meals/day and 26% received 2 meals/day. Approximately 73% of infants met the minimum meal frequency (3–4 meals/day) and 80% (n=85) of children received at least 1 snack/day.

The food variety score was less than 4 in approximately 25% (n=26) of the infants, meaning that 75% of the infants met the minimum dietary diversity. The overall mean food variety score was 4.5 ± 0.8 (median 4.5). The length for age z score was significantly higher in infants whose food variety score was ≥4 groups/day ($p = 0.04$).

TABLE 3: Mean daily intakes for minerals and the proportion of infants with intakes below the RDA/AI/

Minerals	Min	Max	Mean ± SD	Percentage of infants <RDA
Calcium (mg)	131.0	1184.3	575.3 ± 217.9	3.8
Phosphorus (mg)	177.8	1124.6	506.6 ± 189.2	8.5
Magnesium (mg)	27.8	194.4	85.8 ± 33.9	40.6
Iron (mg)	0.71	11.9	4.9 ± 2.6	98.1
Zinc (mg)	1.24	9.2	3.9 ± 1.5	31.1
Sodium (mg)	264.5	2184.6	836. 0 ± 451	6.6
Potassium (mg)	294.3	2176.7	107.5 ± 385	16
Manganese (mg)	0	2.62	0.7 ± 0.5	48.1
Copper (µg)	0	1.05	0.5 ± 0.2	12.3
Iodine (µg)	0	199.6	90.2 ± 33.5	87

***RDA/AI:** Recommended Daily Allowance/Adequate Intake.

TABLE 4: Mean daily intakes and average percentage contributions of macronutrients in meals and snacks.

	Breakfast	Morning snack	Lunch	Afternoon snack	Dinner	Night (Evening snack)
Energy (kcal)	224 ± 98	89 ± 52	118 ± 61	114 ± 56	163 ± 85	151±71
%	27%	10%	14%	13%	19%	17%
Protein (g)	8 ± 3.7	1.5 ± 1.2	4.2 ± 3.1	2.9 ± 1.8	6.1 ± 4.4	3.2 ± 1.9
%	32%	6%	15%	11%	23%	13%
Fat (g)	12.2 ± 6.2	4.2 ± 3.1	5.4 ± 3.2	4.9 ± 2.9	7.1 ± 4.5	7.5 ± 4.1
%	31%	10%	12%	13%	16%	18%
Carbohydrate (g)	20.5 ± 9.9	11.2 ± 7.2	13.1 ± 7.9	14.2 ± 7.8	18.5 ± 10.6	17.5 ± 8.3
%	22%	12%	13%	15%	18%	20%
Iron (mean ± SD) median	1.7 ± 1.3 (1.2)	0.4 ± 0.7 (0.1)	0.8 ± 0.8 (0.6)	0.4 ± 0.5 (0.3)	1.1 ± 1.1 (0.8)	0.7 ± 0.9 (0.2)
Zinc (mean ± SD) median	1.3 ± 0.7 (1)	0.2 ±0.2 (0.2)	0.7 ± 0.4 (0.5)	0.4 ± 0.3 (0.4)	0.9 ± 1 (0.7)	0.5 ± 0.4 (0.4)
Calcium (mean ± SD) Median	163 ± 123 (107.5)	52.8 ± 59 (40.6)	73.3 ± 78.6 (50)	89.2 ± 64.9 (76.1)	112.6 ± 83.8 (92)	114.6 ± 77.4 (101.1)
Vitamin C (mean ± SD) Median	7.4 ± 10.1 (4.8)	7.6 ± 6.9 (6)	8.3 ± 11.8 (5)	11 ± 14.1 (8)	10 ± 9.7 (7.6)	9.6 ± 6.2 (8.8)
Vitamin E (mean ± SD) Median	0.9 ± 0.5 (0.8)	0.2 ± 0.3 (0.03)	0.8 ± 0.6 (0.8)	0.3 ± 0.3 (0.2)	0.7 ± 0.8 (0.5)	0.1 ± 0.2 (0.04)
Vitamin A (mean ± SD)	216.7 ± 141	77.6 ± 68.6	237.7 ± 299.7	100.2 ± 123	184.1 ± 249	144 ± 189.9
Median	(190.3)	(66.7)	(131.9)	(69.7)	(112.5)	(117.3)
Folate (mean ± SD) Median	29.5 ± 16.4 (26.3)	3.9 ± 5.9 (0.7)	14.1 ± 11.2 (11.7)	10.1 ± 11.3 (7.4)	15.4 ± 14.3 (12)	2.7 ± 4.8 (0.23)
Vitamin B6 (mean ± SD) Median	0.2 ± 0.2 (0.2)	0.1 ± 0.1 (0.1)	0.1 ± 0.1 (0.1)	0.1 ± 0.1 (0.1)	0.2 ± 0.1 (0.2)	0.2 ± 0.1 (0.2)

Grains, dairy products, and fruit/vegetables were the most frequently consumed complementary foods. Meat and egg consumption was moderate. Median egg and red meat consumption was approximately 18 (22 ± 17 g/day) and 5 g/day (10 ± 14 g/day), respectively, but it was negligible for poultry (2.6 ± 6.4 g/day) and fish (3.6 ± 8.8 g/day).

Consumption of legumes and vitamin A-rich fruits/vegetables was low. Although total vegetable consumption was approximately 26 g/day, green vegetable consumption was low (1.5 g/day). Total fruit consumption was approximately 89 g/day, but fruits rich in vitamin A were negligible.

Infants of mothers with lower education had a lower food variety score, but this difference was not significant ($p > 0.05$). The food variety score did not differ with respect to the socioeconomic status or gender.

DISCUSSION

To our knowledge, this study is the first to describe in detail both the quality and quantity of diets of a sample of Turkish infants. The major difference from other studies is that our study was performed in predominantly healthy breastfed children all within the normal values of the WHO growth charts regarding weight and length.

The findings presented in this study suggest that the median intakes of energy and protein were higher than the published requirements; the major contributor to protein intake was from complementary food and the family food patterns determined the average intakes of vitamin B, vitamin A, and calcium, but were inadequate for iron, antioxidants (vitamins E and C), vitamin D, niacin, pantothenic acid, biotin, folate, magnesium, manganese, and iodine. Sodium intake was above the RDA. Breakfast contributed the greatest proportion of energy, macronutrients, and micronutrients. Our findings also indicated that appro- ximately 73% of infants met the minimum meal frequency and 75% met the minimum dietary diversity. Dairy products, grains, and fruit/vegetables were the most frequently consumed complementary foods. On the other hand, consumption of meat, eggs, legumes, and vitamin A-rich fruits/vegetables was moderate to low.

TOTAL ENERGY REQUIREMENT

Similar to other studies, energy intake was higher than the recommended values.[8,12] Previous studies showed that energy intake was 810 kcal/day in girls and 886 kcal/day in boys, and the mean energy intake of US infants exceeded the estimated energy requirement by 23% for infants aged 7–12 months.[9,11] Another previous study also showed a higher energy intake (933 kcal/day).[20]

In our study, the mean energy intake from complementary food (505 kcal) was higher than the recommended intake, contributing to 62.5% of the total energy. Several agencies have defined the recommended intake of energy from complementary foods. The WHO recommends an intake of 300 kcal/day from complementary foods at 9-11 months of age, providing 50% of total energy in 10- to 12-month-old breastfed infants, whereas the Institute of Medicine recommends an intake of 281 kcal in 7- to 12-month-old infants.[2,3] Friel et al. reported that the mean daily energy intake from complementary food at age 7-12 months was 326 kcal, contributing to 49% of the dietary reference intake (DRI).[12] Butte et al. suggested that discrepancies between the reported energy intake and the estimated intake may reflect a true overconsumption of energy or, more likely, overreporting due to caregivers' inaccurate estimate of portion sizes.[8] Devaney et al. suggested that it may be difficult to estimate the amount actually consumed compared with the amount offered.[9] If the reason for reports of higher energy intake was overconsumption, we would expect that the infants should be overweight or obese. However, all the infants in our study were within the normal values of the WHO growth charts regarding weight and length. Although overreporting due to caregivers' inaccurate estimate of either the portion sizes or the amount of food actually consumed may explain the results, consistent reporting of higher energy consumption from most studies on complementary feeding may indicate that infants need additional energy for optimal growth. These suggestions should be explored further in future studies.

Changes in time of day of energy and nutrient intake may have implications. Two previous studies, one in infants and one in toddlers, addressed this issue.[13,26] Ziegler et al. reported no significant difference in energy across mealtimes and showed that breakfast provided less than 20% of the daily energy intake.[13] Skinner et al. showed that snacks provided about 25% of toddlers' daily energy intake.[26] In our study, breakfast was found to contribute the greatest proportion of energy, macronutrient, and micronutrient intake, except carbohydrates and vitamin C. Meals and snacks contributed 53% and 47% of the daily energy intake, respectively. An almost equal proportion of energy, lipid, and carbohydrate intake was observed at dinner and night.

MACRONUTRIENT COMPOSITION

The American Academy of Pediatrics recommends supplying 30% to 40% of energy from fat in a child's diet.[2] In the current study, fat contributed 40% of the diets of 69% of the infants, which is higher than previously reported intakes.[11,12] In line with our results, Aktac et al. showed that the mean fat and carbohydrate intake constitute 41% and 45.6% of the total daily energy, respectively.[20] These differing results may be explained by higher breastfeeding rates in our study.

In this study, the mean protein intake was 25.3 ± 9.2 g/day (median, 24 ± 2.7 g/kg per day), providing approximately 12% of the total daily energy. The mean protein intake exceeded the recommendations in 99% of the infants. Complementary food was a major contributor to protein intake and was higher than the usual intake. In line with our findings, mean protein intake found in previous studies were similar to our results, and energy and protein consumption were reported to be higher than the usual intakes.[8,11,12,20]

Studies have shown an association between high protein intake (>14% of the total energy consumption) and the development of obesity later in life due to stimulation of insulin-like growth factor, which results in rapid growth and increased fat accumulation.[4-6,27] However, Tang and Krebs found that in breastfed infants, a higher protein intake from meats was associated with greater linear growth and weight gain without excessive adiposity, suggesting that high protein intake may differ between breastfed and formula-fed infants as well as the source of protein.[28] In this study, approximately 23% of the infants consumed levels of protein greater than 14% of the total energy. Although the weight for age z score was not significantly different between the high versus the low protein intake groups, our study could not determine long-term differences.

MICRONUTRIENT COMPOSITION

Food patterns have been shown to supply adequate amounts of vitamins A, B_1, B_2, B_6, and B_{12}. However, in line with previous reports, iron, vitamin E, and vitamin C are the most problematic micronutrients to ingest via complementary foods.[8,16,17] Vitamin D intake was also very low, providing further evidence for the widely accepted recommendation of supplementing all breastfed infants with vitamin D beginning within a few days of birth. On average, intakes of calcium, phosphorus, potassium, and copper were adequate. Sodium intake was above the RDA in 93% of the infants. However, intake of iron, magnesium, manganese, and iodine were below the AI/RDAs.

Median red meat consumption was approximately 5 g/day, and 32% of the infants had not consumed red meat in the past 3 days. In addition, 69% of the infants consumed less than 14 g meat. Furthermore, fish and poultry were not consumed by 79% and 74% of the infants, respectively. Egg was the most frequently consumed iron-rich complementary food, and only 7.5% of the infants had not consumed egg. However, the median egg consumption was 18 g, and only 11% of the infants consumed more than 50 g of egg per day. Similar to our findings, egg consumption was reported as 18 ± 18 g in a study by Aktac et al.[20]

In order to meet the requirements for iron and zinc, it is recommended that meat, poultry, fish, or eggs are eaten daily, or as often as possible.[2] The addition of 25 g of meat to a homemade vegetable meal was shown to prevent a decline in hemoglobin levels in infants.[29] In line with our findings, previous studies also reported that meat is the least common complementary food consumed and intakes of zinc, iron, and vitamin E were low.[7-9,12,20,30-32]

In a study by Fox et al., 100% fortified juice and infant cereals were the most important sources of vitamin C after formula and breast milk.[14] In the same study, it was also found that infant cereals and enriched grain products were the most important contributors to iron intake in toddlers.[14] The authors suggested that, even when all types of meat, poultry, and fish were considered, they contributed less than 1% of iron to the diets of 6- to 11-month-old infants.[14]

Although the percentage of infants consuming meat was higher than in previous studies, the average portion of meat reported here was smaller than the recommended levels of intake, thereby supplying inadequate iron amounts. Therefore, supplementation of 1 mg/kg of iron in accordance with the Iron-like Turkey program should be strongly encouraged by health professionals.

Consistent with our results, a study in Switzerland showed that infants who did not receive iodine-enriched complementary foods were at risk of inadequate iodine intake.[33] Therefore, inadequate iodine intake should not be underestimated and future studies should focus on iodine deficiency in infants.

FOOD PATTERNS

In the current study, dairy products (161 g), fruits (89 g), grains (29 g), and vegetables (26 g) were the most frequently consumed complementary foods after breast milk (363 cc). Meat and egg consumption was moderate. Although the total fruit and vegetable consumption was high, consumption of red meat, legumes, and vitamin A-rich fruits/vegetables was low, and was negligible for poultry and fish. It was shown that 79% of infants did not consume fish. In line with our results, a Canadian study reported that 78%-99% of the infants did not consume fish in their first year of life [12]. Similar to our findings, previous studies have shown dairy products, fruit and vegetables are the most frequently consumed complementary foods.[11,20]

Our findings are also in line with the Demographic and Health Survey 2013, reporting that foods consumed during the past 24 h by infants aged 10 to 11 months were 80% dairy products, 76% grains, 73% fruit and vegetables, 40% eggs, 24% meat, fish, and poultry, and 9% legumes.[18]

CONSUMPTION OF DIETARY FIBER

Although a daily recommended fiber intake has not been determined among infants aged 6–12 months, previous guidelines recommended a gradual increase to 5 g/day by the first year[2]. In the current study, the mean dietary fiber intake was 5.1 ± 3.1 g (median, 4.4 g), which is in line with the relatively high consumption of fruit, vegetables, and grains.

SODIUM INTAKE

The maximum recommended sodium intake is 370 mg/day and the maximum UK recommendation for sodium is 400 mg/day in children up to the age of 12 months [2,34]. In the current study, sodium intake was above the RDA in about 93% of the infants when 370 mg was taken as the cut-off value. The results from the current study are consistent with the National Health and Nutrition Examination Survey, which showed that sodium intake was high in US infants and toddlers [10].

MINIMUM MEAL FREQUENCY

Our findings indicate that 73% of the infants were meeting the minimum meal frequency, and that 80% received at least one snack per day. However, approximately 25% of the infants were fed below the minimum meal frequency. Onyango et al. found that although the minimum meal frequency was generally better than the dietary diversity, less than half the sample studied in Azerbaijan, Dominican Republic, Haiti, India, and all sub-Saharan African countries achieved the minimum meal frequency.[35]

DIETARY DIVERSITY

Minimum dietary diversity is considered an important indicator of adequate micronutrient density.[36] In this study, the minimum dietary diversity score was below 4 in approximately 25% of the infants, meaning that 75% met the minimum dietary diversity. The overall mean food variety score was 4.5 ± 0.8 (median, 4.5). Similar to our results, Aktaç et al. showed that 71% of infants met the minimum dietary diversity.[20] Our results showed a higher percentage of infants meeting the minimum dietary diversity compared with those in Africa, Asia, and Latin America.[17]

The length for age z score was significantly higher in infants whose food variety score was ≥4 groups/day. Infants receiving at least four food groups had significantly higher levels of vitamin E, vitamin B_1, vitamin B_2, folate, vitamin B_{12}, and minerals, except iodine. Our results support the finding that minimum dietary diversity is an indicator associated with attained length.[37,38] However, we should also note that although 75% of the infants were meeting the minimum dietary diversity, inadequate intake of iron is still a problem. Krebs et al. showed that consumption of meat and iodine were associated with reduced likelihood of stunting, and suggested ani mal source foods as the main factor associated with linear growth.[39] Thus, besides meeting the minimum dietary diversity, consumption of animal products in particular should be encoura ged.

Mothers of lower education were considered a significant predictor of poor dietary diversity, and inadequate meal frequency across the world.[16] In the current study, infants of mothers from a lower education had a lower diversity score, but this was not statistically significant. The diversity score did not differ with respect to the socioeconomic status or gender.

The present study has some limitations, including its cross-sectional design and the mothers' difficulty in estimating the amount actually consumed by their infants rather than the amount offered. In addition, the data on the nutrient requirements of infants is limited and we did not measure micronutrient levels. Although the sample size employed is adequate, it is obtained from a single geographic location and institution limiting its generalizability.

However, this study is a baseline assessment of nutrient quality in healthy, predominantly breastfed infants and is useful for policy makers, pediatricians, and researchers to develop guidelines to improve complementary feeding practices where fortified foods are not consumed. The strengths of this study include the use of 3-day dietary recall data. Intakes based on 3-day food records are suggested to be within 5% of the estimated energy requirements.[40] The collection of detailed dietary intake data also allowed food sources of micronutrients and macronutrients to be described, and the nutritional adequacy of the diet was also assessed using quantitative information on the amount of food fed. Moreover, recent WHO recommendations regarding infant feeding indicators were used in the analyses. Although this study is cross-sectional in design, the participants were randomly enrolled.

In conclusion, concerns regarding low intake of antioxidants, iron, iodine, niacin, pantothenic acid, biotin, folate, manganese, and magnesium, as well as the excessive intake of energy, protein, and sodium, should be addressed. It is also a concern that portions actually being consumed by the infants fail to meet the recommended requirements. Thus, the use of supplements for deficient micronutrients should be considered.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

***Idea/Concept:** Perran Boran, Şule Aktaç; **Design:** Perran Boran, Şule Aktaç; **Control/Supervision:** Perran Boran, Şule Aktaç; **Data Collection and/or Processing:** Perran Boran, Şule Aktaç; **Analysıs and/or Interpretation:** Perran Boran, Şule Aktaç; **Literature Review:** Perran Boran, Şule Aktaç; **Writing the Article:** Perran Boran, Şule Aktaç; **Critical Review:** Perran Boran, Şule Aktaç; **References and Fundings:** Perran Boran.*

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