SUPPLEMENT ARTICLE

Sources of Supplemental Iron Among Breastfed Infants During the First Year of Life

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ABSTRACT

OBJECTIVES. Primary prevention of iron deficiency requires adequate iron intake. Although recommendations exist to promote adequate intake of iron among infants through iron-rich foods and iron supplements, few studies have examined adherence to these recommendations. Our objectives were to describe the consumption of iron-rich foods, oral iron supplements, and iron-fortified formula among US infants and to assess adherence to iron-intake recommendations.

METHODS. We analyzed data from the Infant Feeding Practices Study II, a longitudinal study of mothers and infants followed from late pregnancy through the first year of their infant's life. Mothers completed near-monthly questionnaires that assessed how frequently they fed their infants breast milk, formula, infant cereals, and meats in the previous 7 days and whether their infants were given an oral iron supplement ≥3 times per week during the previous 2 weeks. We examined use of iron-fortified formula among infants who consumed formula; intake of cereal, meat, oral iron supplements, and formula among infants consuming any breast milk; and whether 6-month-old breastfed and mixed-fed (breast milk and formula) infants consumed sources of supplemental iron with recommended frequency.

RESULTS. At 6 months of age, 18% of the term breastfed and mixed-fed infants had not received infant cereal or meat in the previous 7 days, and 15% had not received infant cereal, meat, regular iron supplements, or formula; among solely breastfed infants, 23% had not received infant cereal, meat, or regular iron supplements. Fifty-eight percent of the mixed-fed infants and 70% of the solely breastfed infants received <2 daily servings of infant cereal, meat, or formula combined and did not receive oral iron supplements ≥3 times per week. Among preterm breastfed and mixed-fed infants, none received oral iron supplements ≥3 times per week before 3 months of age, 2% received them at 3 months, and 13% received them at 10.5 months.

CONCLUSIONS. Our findings indicate that recommendations regarding iron intake among breastfed infants are not being followed by a substantial proportion of mothers. *Pediatrics* 2008;122:S98–S104

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Key Words
breastfeeding, complementary feeding, dietary iron, infant feeding

Abbreviations
AAP—American Academy of Pediatrics
IFPS—Infant Feeding Practices Survey
WIC—Special Supplemental Nutrition Program for Women, Infants, and Children
CI— confidence interval

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IRON DEFICIENCY, THE most common nutritional deficiency, has negative effects on children's motor and mental development that may not be reversible with iron treatment.[1,2] Iron deficiency can also increase lead absorption, an additional cause of neurologic and developmental deficits.[3] *Healthy People 2010* objective 19-12a is to reduce the prevalence of iron deficiency among 1- to 2-year-old US children to 5%[4] from an estimated prevalence of 7% as of 1999–2000.[5]

Primary prevention of iron deficiency among infants means ensuring that they have an adequate intake of iron. Because infants typically use iron stores present at birth within their first 6 months of life, the American Academy of Pediatrics (AAP) recommends that infants' daily intake of iron increase from 0.27 mg at birth to 11.0 mg after 6 months of age.[3] Iron fortification of infant formula reduces the risk for iron deficiency among formula-fed infants; however, the AAP and others recommend that infants be fed breast milk exclusively during these early months, in part because breast milk provides infants with immunologic factors in addition to nutrients.[6–8] Although iron is absorbed efficiently from breast milk, the iron concentration of breast milk is inadequate to meet the increased iron requirement of infants aged ≥6 months.[3] Therefore, the AAP recommends that term breastfed infants receive ~1 mg of iron per day for each kilogram of body weight (1 mg/kg per day), preferably from food, beginning at ~4 to 6 months of age.[3] Good dietary sources of iron include iron-fortified infant cereal and meat. The AAP recommends an

average of 2 servings per day from these sources. If term breastfed infants are unable to consume sufficient iron from their diet after 6 months of age, they should be given a daily oral iron supplement containing 1 mg of iron per kilogram of body weight.[3,6]

Infants born prematurely (before 37 completed weeks' gestation) are at particular risk for iron deficiency, because they are born with lower iron stores and grow faster during infancy than term infants; consequently, their iron stores are often depleted by 2 to 3 months of age.[3,9] The AAP recommends that preterm breastfed infants be given an oral iron supplement of 2 mg/kg per day starting at 1 month of age, with supplementation continuing through 12 months of age.[3]

Although there are recommendations to promote adequate intake of iron among infants, few studies have examined adherence to these recommendations during the first year of life. Our objectives in this study were to (1) describe the consumption patterns of iron-rich foods or regular use of oral iron supplements among infants receiving any breast milk, (2) determine the prevalence of iron-fortified formula use among infants receiving any infant formula, and (3) identify infants at increased risk of receiving no supplementary iron. We hope that our findings will inform efforts to improve parents' adherence to medical recommendations regarding their children's iron intake during infancy.

METHODS

Study Sample

We analyzed data from the 2005–2007 Infant Feeding Practices Study II (IFPS II), a longitudinal study conducted by the US Food and Drug Administration that recruited nearly 5000 pregnant women from a national consumer opinion panel consisting of 500 000 households throughout the United States. To be eligible to participate in the study, mothers had to be healthy and at least 18 years of age, and their infants had to be singletons born at ≥35 weeks' gestational age, weigh ≥5 lb at birth, and have no medical problems that would interfere with feeding. With the exception of a brief telephone interview near the time that infants were born, all data were collected via mailed questionnaires sent to the mothers once during the third trimester of their pregnancy and approximately monthly through their infant's first year of life (see the article by Fein et al[10] in this supplement for additional study details).

Potential subjects in our study included 3033 infants born at ≥35 weeks' gestation whose mothers completed the neonatal questionnaire. Of these, we excluded 4 whose gestational age at birth was reported as ≥45 weeks and 27 whose mothers did not complete any subsequent questionnaires, which reduced our sample to 3002 infants. We also excluded infants from analyses for a particular age group if their mother did not complete a questionnaire for that period or did not report infant feeding data, use of oral iron supplements, or whether any infant formula used was iron fortified. As a result, sample sizes of infants in particular age groups ranged from a high of 2250 infants near 3 months of age to a low of 1743 infants near 10.5 months of age. The sample size for our primary age group of interest for this study, infants near 6 months of age, was 1984. Most of our analyses focused on infants who breastfed any amount. The number of breastfed infants in our study sample decreased from 1373 at 2 months to 620 at 10.5 months. At 6 months of age, 1007 breastfed infants were in our sample.

Most of the mothers completed the questionnaires shortly after receiving them, but others waited several weeks or months before completing some of them. To be sure that the feeding data reflected the infants' correct age at the time of feeding, we grouped the feeding data according to the age of the infants when the questionnaire was completed rather than by their age when the questionnaire was sent. We categorized infants' ages as 1 month (3 to <7 weeks), 2 months (7 to <11 weeks), 3 months (11 to <15 weeks), 4 months (15 to <19 weeks), 5 months (19 to <24 weeks), 6 months (24 to <29 weeks), 7.5 months (29 to <36 weeks), 9 months (36 to <43 weeks), and 10.5 months (43 to <51 weeks). If a mother completed 2 questionnaires while her infant was within a particular age category, we used data from the first questionnaire completed.

Study Variables

Breast Milk and/or Formula Consumption, Iron-Rich Food Consumption, and Oral Iron-Supplement Use

Infant food-consumption measures were derived from the food-frequency data collected on each questionnaire, which asked about foods that the infants consumed in the previous 7 days. Infants were assigned to 1 of 3 categories on the basis of their consumption of breast milk and infant formula: breastfed only, mixed fed (breast milk and infant formula), or formula fed only. Among infants who received any formula, we examined use of iron-fortified formula. Among infants who received any breast milk, we examined patterns of consumption of iron-rich foods, oral iron supplements, and iron-fortified formula, and we estimated the percentage of them who consumed these sources of iron with recommended frequency.

Our estimates of infants' consumption of iron-rich foods were based on maternal reports of the infants' consumption of infant cereal and either meat or combination meat dinners at least once over the previous 7 days. We assumed that all infant cereal was iron fortified and considered infant formula to be iron fortified if an infant's mother reported usually using a formula that was "with iron." Infants were categorized as receiving an oral iron supplement if their mothers reported giving them iron drops or pills at least 3 times per week during the previous 2 weeks.

No Supplemental Iron Source

We identified patterns of infant cereal, meat, iron-fortified formula, and oral iron-supplement use among breastfed and mixed-fed infants. We categorized infants as receiving no regular supplemental iron-rich food source if their mothers reported giving them neither

infant cereal nor meat in the previous 7 days. We categorized infants as receiving no regular supplemental iron from any source if their mothers reported giving them no infant cereal, meat, or iron-fortified formula during the previous 7 days and no oral iron supplement ≥3 times per week over the previous 2 weeks.

Adequate Frequency of Iron Intake From Supplemental Iron Sources

We also examined whether the frequency of iron intake from supplemental iron sources was adequate at 6 months of age among a subset of term breastfed (n = 644) and mixed-fed (n = 329) infants. Three infants were excluded from this analysis because their mothers did not report the number of ounces of formula they usually drank at each feeding in the previous 7 days. We summed the frequency of daily intake of infant cereal, meat, and iron-fortified formula. For this analysis, frequency of cereal and meat consumption was based on the number of times the food was given, and frequency of iron-fortified formula consumption was based on the number of 8-oz servings of iron-fortified formula given to the infant. We defined an adequate intake frequency for supplemental iron sources as either the combined consumption of infant cereal, meat, or iron-fortified formula (mixed fed only) at least 2 times per day in the previous 7 days or the consumption of an oral iron supplement ≥3 times per week in the previous 2 weeks.

Demographics and Other Variables

Additional independent variables we considered in our analyses included maternal age (18–24, 25–29, 30–34, or ≥35 y), maternal education (high school graduate or less, some college, or college graduate), maternal race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, Asian/Pacific Islander, or other/unknown), parity (1 or ≥2), poverty index ratio (<185%, 185%–349%, or ≥350%), and infant enrollment in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) anytime in the first year of life (yes or no). The poverty index ratio is the ratio of annual family income to the appropriate poverty-threshold values used by the US Census Bureau, with <185% indicating that the reported income made the infants eligible for WIC benefits to low-income families according to WIC eligibility guidelines.

Statistical Analyses

We examined term and preterm infants separately in all analyses. We examined sociodemographic characteristics at each infant age interval, because our study population changed over time as mothers discontinued breastfeeding and either did or did not respond to questionnaires. We determined the percentage of infants at each age interval who consumed infant cereal, meat, iron-fortified formula, oral iron supplement, no supplemental iron-rich food source (ie, infant cereal or meat), or no supplemental iron source (ie, infant cereal, meat, iron-fortified formula, or supplements). For infant cereal and meat, we calculated the median frequency of daily consumption among infants at each age interval and then determined the percentage of breastfed and mixed-fed infants who consumed these supplemental iron sources an average of at least twice per day.

To determine the likelihood of infants at 6 months of age not consuming regular supplemental iron-rich foods or not consuming regular supplemental iron from any source, we used multiple logistic regression adjusting for maternal age, maternal education, maternal race/ethnicity, household poverty index ratio, parity, and infant WIC participation. We excluded black infants from this analysis because only 20 black infants were breastfed at 6 months of age, and all of them received infant cereal, meat, iron-fortified formula, or regular iron supplements. We also examined the association between various maternal characteristics and the likelihood that infants consumed no regular supplemental iron source at 7.5 and 9 months of age and among breastfed-only infants. We considered associations significant at P values of <.05 and performed all calculations by using SAS 9.1 (SAS Institute, Inc, Cary, NC).

RESULTS

Demographic Characteristics of the Study Sample

Infant feeding data were available at 6 months of age for 1984 infants. Compared with mothers who did not provide feeding data (n = 1018) for infants at 6 months, those who did so (n = 1984) were older (mean age: 29.3 vs 27.6 years) and more likely to be college educated (42% vs 24%), non-Hispanic white (85% vs 77%), and at ≥350% of the poverty index ratio (25% vs 18%).

Of the 1984 infants for whom data were available, we categorized 661 (33.3%) as breastfed only, 346 (17.4%) as mixed fed, 971 (48.9%) as formula fed only, and 6 (<0.01%) as receiving neither breast milk nor formula. Of the 1317 infants receiving any infant formula, 98% were using iron-fortified formula. The percentage of infants receiving iron-fortified formula was similarly high among term and preterm infants and among formula-fed and mixed-fed infants (data not shown).

At 6 months of age, 31 preterm and 976 term infants were either formula fed or mixed fed. The majority of mothers of the term infants were 25 to 34 years old, college graduates, non-Hispanic white, and multiparous (Table 1). Although more than one third of the term infants were from households at <185% of the poverty index ratio, only one quarter of them were enrolled in WIC. Similar demographic patterns were evident among infants whose mothers completed the questionnaires when infants were near 7.5 and 9 months. The distribution of demographic characteristics among preterm infants was similar to that among term infants except that a smaller proportion of the preterm infants were non-Hispanic white.

Supplemental Iron Sources Among Term Infants Receiving Any Breast Milk

During their first year of life, approximately one third of the term infants who were breastfed were also fed iron-fortified infant formula (Table 2). More than 26% of

TABLE 1 **Distribution of Characteristics of Mothers Who Breastfed or Mixed Fed Their Infants at 6 Months of Age**

	Term ($N = 976$), %	Preterm ($N = 31$), %
Maternal characteristics		
Age, y		
18–24	12.0	6.5
25–29	36.5	29.0
30–34	32.9	35.5
≥35	18.7	29.0
Education		
High school graduate or less	13.5	3.2
Some college	31.5	35.5
College graduate	52.7	61.3
Missing[a]	2.4	0.0
Race/ethnicity		
Non-Hispanic white	87.4	71.0
Non-Hispanic black	2.1	6.5
Hispanic	4.1	6.5
Asian/Pacific Islander	3.1	16.1
Other/unknown	3.1	0.0
Parity		
1	22.9	29.0
≥2	76.3	71.0
Missing[a]	0.8	0.0
Poverty index ratio		
<185%	35.4	16.1
185%–349%	39.3	48.4
≥350%	25.3	35.5
Infant WIC participation		
No	75.6	80.6
Yes	24.4	19.4

[a] Infants with missing data on maternal education or parity were excluded from the regression analysis ($n = 30$).

them were fed infant cereal at 4 months, and almost 80% were fed infant cereal at 6 months. From months 4 through 10.5, the median frequency of daily cereal intake among infants who consumed cereal was 1.00 (6-month interquartile range: 1.00–2.00). Very few infants were fed meat before 5 to 6 months of age, and the proportion of infants who were fed meat increased with age. At 6 months, 14% of the infants consumed meat, and the median frequency of daily meat intake among infants who consumed meat was 1.00 (6-month interquartile range: 0.29–1.00) for those aged 5 to 10.5 months. The proportion of infants who received a regular oral iron supplement also increased with age, from 2.6% at 1 month to 8.4% at 10.5 months. At 6 months, ~5% of the infants were receiving an oral iron supplement at least 3 times per week.

At 6 months of age, 18% of the term breastfed or mixed-fed infants had no regular supplemental iron-rich food source in their diets, and 15% received no supplemental iron from any source. Among the infants who were breastfed only, 23% had no regular supplemental iron source in their diets. (The higher percentage of no regular iron source among breastfed-only infants is because mixed-fed infants are no longer in the denominator.) Among all infants receiving any breast milk, 58% received supplemental iron sources with inadequate frequency (including 70% of breastfed-only infants and 35% of mixed-fed infants). At 7.5 months, 47% of the infants consuming any breast milk received supplemental iron sources with inadequate frequency (including 56% of breastfed-only infants and 27% of mixed-fed infants).

Oral Iron-Supplement Use Among Late-Preterm Infants Receiving Any Breast Milk

Among late-preterm infants who were breastfed or mixed fed, none were reported to have received oral iron supplements at 1 or 2 months of age, and the percentage reported to have received supplements ≥3 times per week increased gradually thereafter from 2.0% at 3 months to 13% at 10.5 months (Table 3); however, the confidence intervals (CIs) for supplement use by preterm infants were very wide because of the small number of preterm infants in our study.

Associations Between Demographic Characteristics and No Supplemental Iron-Rich Food Source or No Supplemental Iron Source Among Infants Receiving Any Breast Milk

We could not estimate the association between black race and the likelihood of no supplemental iron-rich food source or no supplemental iron source of any kind

TABLE 2 **Percentage of Term Breastfed or Mixed-Fed Infants Who Consumed Various Sources of Supplemental Iron or No Supplemental Iron Source in the Previous 7 Days, According to Infant Age**

Infant Age, mo (wk)	*n*	Infant Cereal, % (95% CI)	Meat, % (95% CI)	Iron-Fortified Formula, % (95% CI)	Oral Iron Supplement ≥3 Times per wk, % (95% CI)[a]	No Supplemental Iron-Rich Food Source, % (95% CI)[b]	No Supplemental Iron Source, % (95% CI)[c]
1 (3 to <7)	1349	2.3 (1.5–3.3)	0.0	39.4 (36.7–42.0)	2.6 (1.8–3.6)	97.7 (96.8–98.4)	58.7 (56.0–61.4)
2 (7 to <11)	1373	5.5 (4.3–6.8)	0.3 (0.1–0.7)	37.8 (35.2–40.4)	3.4 (2.5–4.5)	94.4 (93.0–95.6)	58.4 (55.8–61.0)
3 (11 to <15)	1324	8.2 (6.8–9.9)	0.3 (0.0–0.8)	32.9 (30.3–35.5)	4.5 (3.5–5.8)	91.8 (90.2–93.2)	61.2 (58.5–63.8)
4 (15 to <19)	1140	26.6 (24.0–29.3)	0.4 (0.1–0.9)	33.9 (31.1–36.7)	4.6 (3.4–5.9)	73.3 (70.6–75.8)	51.6 (48.6–54.5)
5 (19 to <24)	1104	59.1 (56.2–62.1)	4.3 (3.1–5.6)	33.4 (30.6–36.3)	5.6 (4.3–7.1)	40.2 (37.3–43.2)	30.3 (27.6–33.1)
6 (24 to <29)	976	79.4 (76.7–81.9)	14.0 (11.9–16.4)	33.0 (30.1–36.0)	5.3 (4.0–6.9)	18.3 (16.0–20.9)	15.4 (13.1–17.6)
7.5 (29 to <36)	863	83.2 (80.5–85.6)	38.7 (35.4–42.0)	30.6 (27.5–33.8)	6.7 (5.1–8.6)	11.2 (9.2–13.5)	8.8 (7.0–10.9)
9 (36 to <43)	761	79.2 (76.2–82.1)	69.5 (66.1–72.8)	30.0 (26.7–33.4)	7.2 (5.5–9.3)	5.8 (4.2–7.7)	5.0 (3.6–6.8)
10.5 (43 to <51)	620	68.2 (64.4–71.9)	85.2 (82.1–87.9)	28.7 (25.2–32.5)	8.4 (6.3–10.9)	4.4 (2.9–6.3)	4.0 (2.6–5.9)

[a] Over the previous 2 weeks.

[b] No infant cereal or meat consumed by the infants.

[c] No infant cereal, meat, oral iron supplement, or iron-fortified formula consumed by the infants.

TABLE 3 **Percentage of Late-Preterm Breastfed or Mixed-Fed Infants Who Consumed Various Sources of Supplemental Iron or No Supplemental Iron Source in the Previous 7 Days, According to Infant Age**

Infant Age, mo (wk)	*n*	Infant Cereal, % (95% CI)	Meats, % (95% CI)	Iron-Fortified Formula, % (95% CI)	Oral Iron Supplement ≥3 Times per wk, % (95% CI)[a]	No Supplemental Iron-Rich Food Source, % (95% CI)[b]	No Supplemental Iron Source, % (95% CI)[c]
1 (3 to <7)	42	9.5 (2.7–22.6)	0.0	59.5 (43.3–74.4)	0.0	90.5 (77.4–97.3)	38.1 (23.6–54.4)
2 (7 to <11)	58	5.2 (1.1–14.4)	0.0	58.6 (44.9–71.4)	0.0	94.8 (85.6–98.9)	39.7 (27.1–53.4)
3 (11 to <15)	51	11.8 (4.4–23.9)	0.0	52.9 (38.5–67.1)	2.0 (0.1–10.5)	88.2 (76.1–95.6)	45.1 (31.1–59.7)
4 (15 to <19)	45	24.4 (12.9–39.5)	0.0	46.7 (31.7–62.1)	4.4 (0.5–15.2)	75.6 (60.5–87.1)	40.0 (25.7–55.7)
5 (19 to <24)	39	51.3 (34.8–67.6)	5.1 (0.6–17.3)	48.7 (32.4–65.2)	5.1 (0.6–17.3)	48.7 (32.4–65.2)	33.3 (19.1–50.2)
6 (24 to <29)	31	74.2 (55.4–88.1)	12.9 (3.6–29.8)	45.2 (27.3–64.0)	6.5 (0.8–21.4)	25.8 (11.9–44.6)	12.9 (3.6–29.8)
7.5 (29 to <36)	28	89.3 (71.8–97.7)	28.6 (13.2–48.7)	35.7 (18.6–55.9)	3.6 (0.1–18.4)	10.7 (2.3–28.2)	3.6 (0.1–18.4)
9 (36 to <43)	27	85.2 (66.3–95.8)	70.4 (49.8–86.3)	37.0 (19.4–57.6)	11.1 (2.4–29.2)	3.7 (0.1–19.0)	3.7 (0.1–19.0)
10.5 (43 to <51)	23	78.3 (56.3–92.5)	82.6 (61.2–95.1)	39.1 (19.7–61.5)	13.0 (2.8–33.6)	8.7 (1.1–28.0)	8.7 (1.1–28.0)

[a] Over the previous 2 weeks.

[b] No infant cereal or meat consumed by the infants.

[c] No infant cereal, meat, oral iron supplement, or iron-fortified formula consumed by the infants.

among infants at 6 months of age because all black mothers who breastfed (n = 20) provided additional infant cereal, meat, iron-fortified formula, or iron supplements to their infants. Among the other infants, the likelihood of receiving no infant cereal, meat, or iron-fortified formula or of receiving no regular iron supplements of any kind did not differ according to any of the maternal or infant demographic characteristics included in this analysis. When we limited our model to breastfed-only infants, we still found no association between receiving no supplemental iron source and any of the demographic characteristics studied (data not shown). Because the demographic profile of study participants changed slightly over the course of the study, we also examined these associations when the infants were 7.5 and 9 months of age and still observed no associations between any demographic characteristics and either outcome (data not shown).

DISCUSSION

To our knowledge, this study was the first to examine the extent to which US breastfed and mixed-fed infants consume various sources of supplemental iron and the first to estimate the percentage of US infants who consume no supplemental iron during their first year of life. The AAP recommends that term breastfed infants receive ~1 mg of iron per day for each kilogram of body weight, preferably from foods such as iron-fortified infant cereal and meat, beginning at ~4 to 6 months of age. If term breastfed infants are unable to consume sufficient iron from their diet after 6 months of age, they should be given a daily oral iron supplement. The preterm breastfed infant should be given an oral iron supplement of 2 mg/kg per day starting at 1 month of age, with supplementation continuing through 12 months of age.[3,6] Our findings indicate that a substantial proportion of mothers of breastfed infants do not follow AAP recommendations regarding the introduction of infant cereal or meat or the use of iron supplements. Among term infants who were breastfed only, 23% had no supplemental iron source at 6 months, and 70% received infant cereal, meat, or iron supplements less frequently than recommended. Only 6.5% of the mothers of late-preterm breastfed-only infants and mixed-fed infants followed recommendations to give their infants oral iron supplements ≥3 times per week at 6 months, none did so during their first 2 months, and ≤13% did so at any period from 7.5 to 10.5 months.

Although we did not examine patterns or adequacy of iron intake among formula-fed infants, we did find that nearly all formula consumed by infants in the study was iron fortified, indicating that most US mothers who give their infants formula are following recommendations to use iron-fortified formula rather than low-iron formula. Our finding that 98% of formula-fed infants who received iron-fortified formula was substantially higher than the 82% found among formula-fed infants in the 1993–1994 IFPS.[11] The increased use of formula that is iron fortified may be attributable to the removal from the market of low-iron formula in recent years.

In an analysis of data from the 2002 Feeding Infants and Toddlers Study, Fox et al[12] found that only 2% of infants aged 6 to 11 months consumed iron supplements regularly, whereas we found that 5% to 8% of breastfed infants in a similar age range did so. Much of this difference is likely because Fox et al reported supplement use among all infants, including those who were formula fed exclusively, whereas we reported supplement use among infants who were breastfed or mixed fed. In addition, Fox et al analyzed data from a nationally representative sample of infants, whereas the infants in our survey were disproportionately white and of a higher socioeconomic status than the national average (see ref 10). Despite these differences in the makeup of the 2 study populations, our results show that most US infants still do not receive oral iron supplements regularly.

We were unable to estimate the associations between maternal race and consumption of supplemental iron, because only 20 black women who breastfed participated in the IFPS II, and all of their infants received infant cereal, meat, iron-fortified formula, or regular iron supplements at 6 months of age. When we limited our analysis to all other racial/ethnic groups, we found no demographic characteristics associated with consum-

ing no supplemental iron-rich food source or no supplemental iron source at 6 months among term breastfed or mixed-fed infants, suggesting that all groups may be at approximately equal risk for iron deficiency. Thus, it is imperative that pediatricians and other health care providers instruct all parents with children under their care about the iron requirements of infants and their need for supplementary iron.

Although the IFPS II sample was drawn from a consumer opinion mail panel distributed throughout the United States, it was not nationally representative; women who participated were more likely to be non-Hispanic white and to have higher socioeconomic status (see ref 10). In addition, because the IFPS II required a high level of commitment by study participants, our sample may have been unrepresentative of US mothers in other ways that we are unable to identify. Similarly, even within our study sample, mothers who responded to particular questionnaires may have had a different demographic profile from those who did not. We found, for example, that on the 6-month questionnaire, data were more likely to be missing for the infants of mothers who were younger, not college educated, of lower socioeconomic status, and of a racial/ethnic group other than non-Hispanic white. Thus, our estimates of intake of iron sources at 6 months of age may not represent the intake of the sample of infants who entered our study.

Another limitation to this study is that because mothers only reported how frequently their infants consumed infant cereal and meat but not how much they consumed, we were unable to estimate their infants' actual daily iron intake from these foods. In addition, because infants' consumption of various dietary sources of iron was assessed for only the previous 7 days rather than the entire period between each survey, the IFPS II data did not reflect changes in infants' feeding patterns within survey periods or their infrequent consumption of the selected iron sources.

The strengths of our study included our use of data from 1 of the largest studies of infant feeding in the United States, in which dietary data were collected nearly monthly for a recall period of the previous 7 days. The relatively long recall period minimized the influence of unusual or atypical food consumption that might skew the results of surveys with a 1-day recall period, and the immediacy of the recall period minimized the potential for recall error reported for studies in which subjects were asked to recall food eaten in the more distant past.[13] Another strength of our study is that it included late-preterm infants, a population that is often overlooked.

CONCLUSIONS

The AAP Section on Breastfeeding recommends exclusive breastfeeding for the first 6 months of life, with continued breastfeeding for 1 year and beyond as mutually desired by infant and mother. For primary prevention of iron deficiency, the AAP recommends that term breastfed infants be introduced to iron-rich foods by ~6 months of age[6] and that preterm infants begin receiving a daily oral iron supplement at 1 month of age.[3] We found that many term and preterm infants have not been meeting these recommendations and, thus, could be at risk for iron-deficiency anemia and the adverse developmental effects associated with it.

Because pediatricians typically see infants regularly at routine clinic visits, they have a unique opportunity to inform parents about their developing infant's need for iron and to tailor recommendations to the specific needs of each infant. Pediatricians and other pediatric care providers should not assume that breastfed or mixed-fed infants are consuming adequate amounts of iron. Mothers should be encouraged to breastfeed exclusively for approximately the first 6 months of their infant's life and also should be informed about appropriate introduction of iron-rich foods to their infant at ~6 months of age. In the United States, iron-fortified infant cereal is often the first food other than breast milk or formula given to infants, and meat is generally introduced into their diet much later (see ref 14). Both infant cereal and meat, however, are good sources of iron and can be among the first complementary foods to which infants are introduced.[3,15]

Pediatricians also should ensure that parents are advised to give oral iron supplements to breastfed infants aged ≥6 months who are not consuming at least 2 daily servings of iron-rich food, to give oral iron supplements to all preterm infants between the ages of 1 and 12 months, and to give only iron-fortified formula to infants receiving formula.

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