Nutritional Assessment of Infants with Hypochromic Anemia

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IRON deficiency in infancy is almost always due to nutritional factors rather than to loss of blood. The occurrence of iron deficiency in infants between six months and five years of age can be attributed to either an increased requirement or an inadequate intake. In a previous publication[1] it was pointed out that iron deficiency developed more frequently in infants of low birth weight, twins, males and infants born to multiparous mothers, than would have been expected. These findings were interpreted as evidence that their relatively greater growth rate and/or reduced iron "stores" at birth predisposes them to the development of iron deficiency.

The present study is concerned with a dietary and biochemical assessment of the nutritional status of a similar group of infants in order to evaluate the role of iron intake in the pathogenesis of their deficiency.

MATERIALS AND METHODS

Twenty-seven infants with hypochromic anemia with a hemoglobin concentration of less than 9.0 gm. per 100 ml. were studied during a six-month period in the pediatric out-patient clinic. There were eighteen males and nine females; fifteen were Negro and twelve were white. They ranged in age from seven to thirty-six months, with a median of thirteen and a half months. The weight range was 7.5 to 14 kg. with a median of 9.7 kg. The distribution by birth weight and order was comparable to the series previously reported.

Dietary histories were taken by one of us (M.D.G.) who has had previous experience with infant feeding customs of this community. Typical daily food intakes based on the previous twenty-four hours and the frequency of food consumption during the preceding week were recorded. The nutrient intakes were calculated using published tables of food composition.[2,3]

Biochemical nutritional assessments consisted of determination of serum iron,[4] iron binding capacity,[5] calculation of iron saturation (serum iron/serum iron plus iron binding capacity), serum vitamin A,[6] serum ascorbic acid,[7] serum total tocopherols,[8] total serum proteins by a biuret method, and serum albumin following precipitation with 27.8 per cent sodium sulfite.

RESULTS

The dietary histories revealed a pattern of high milk intakes which averaged 42.5 ounces (1,255 ml.) per day. Fifteen infants had daily intakes of more than 1 quart and six drank 2 quarts a day or more. With few exceptions these infants drank fresh whole homogenized milk. Only three infants took nothing but milk. The most commonly used solid foods were crackers, bread, vegetables, fruits and potatoes.

In Table I, the foods consumed and the average daily intakes are recorded. Almost all the infants consumed a variety of solid foods, except three who ate none. Greatly differing feeding patterns were not observed.

The calculated intakes are presented in Table II. The medians and 25th and 75th

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TABLE I

The Pattern of Food Intake of Twenty-Seven Infants with Hypochromic Anemia

Food	No. of Infants	Average Daily Serving
Milk	27	1.4 qt.
Meat and eggs	21	1.0 oz.
Citrus fruits	16	6.0 oz.
Other fruits and vegetables	22	5.0 oz.
Potatoes and legumes	17	4.5 oz.
Cereals, plain	18	3.0 oz.
Cereals, iron fortified	7	1.5 oz.
Bread and crackers	23	1.7 slices or 7 crackers
Sweets (hard candy)	24	1.3 oz.

TABLE II

Calculated Nutrient Intakes of Twenty-Seven Infants with Hypochromic Anemia

Nutrient	Percentiles		
	25th	50th	75th
Calories (/kg.)	113	135	163
Protein (gm./kg.)	4.3	5.3	7.0
Calcium (mg.)	1,240	1,370	1,850
Phosphorus (mg.)	1,100	1,325	1,750
Vitamin A (I.U.)	2,400	3,200	4,300
Vitamin C (mg.)	18	26	57
Tocopherols (mg.)	4.0	8.0	11.0
Thiamine (mg.)	0.45	0.63	0.78
Riboflavin (mg.)	1.75	2.22	3.32
Niacin (mg.)	2.23	3.42	5.45
Fat (per cent of calories)	38.2	43.7	46.7
Iron (mg.)	2.4	4.4	6.1

percentiles are given to characterize the group. Occasional extremely low or high values occurred. Iron intakes are shown in Figure 1. The results of the biochemical assessments are presented in Table III.

TABLE III

Biochemical Findings in Twenty-Seven Infants with Hypochromic Anemia

Nutrient	No. of Infants	Mean ± Standard Error of Mean
Serum iron (μg./100 ml.)	27	58.4 ± 5.3
Iron saturation (%)	25	10.9 ± 0.87
Vitamin A (I.U./100 ml.)	19	117.6 ± 10.7
Ascorbic acid (mg./100 ml.)	20	0.73 ± 0.09
Total tocopherols (mg./100 ml.)	19	0.91 ± 0.10
Total serum proteins (gm./100 ml.)	26	6.16 ± 0.12
Serum albumin (gm./100 ml.)	26	4.15 ± 0.08

COMMENTS

The nutritional adequacy of the diets consumed by these iron-deficient infants can be evaluated by comparing their intakes with those of healthy infants. The recent data of Beal[9] from the Child Research Council, Denver, provide a suitable standard for comparison. The caloric intake of the anemic infants is much higher than that of the infants in Denver who had a median intake of 92 to 106 calories per kg. between six months and three years of age. It is possible that a single dietary history would give intakes which are greater than those actually consumed. However, milk supplied approximately 65 per cent of the calories, and the histories of milk intake appeared to be commensurate with our experience with many other infants from the same socioeconomic group. Milk intake is relatively easy to quantitate and we believe

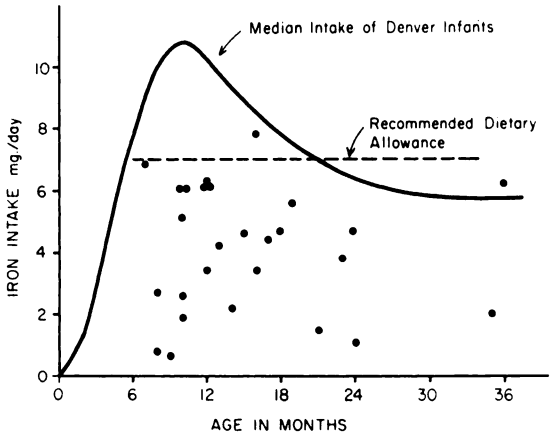

FIG. 1. Iron intake of twenty-seven iron-deficient infants plotted according to age and compared with the median intake of healthy infants[10] and the Recommended Dietary Allowance for this age group.[11]

these data to be valid. Most of these infants took their milk from a bottle, which was their constant companion by day, and was offered to them whenever they awoke at night.*

The intake of protein, calcium, phosphorus, riboflavin and vitamin A is likewise higher by 25 per cent than those of the infants in Denver, as all these nutrients are largely derived from milk.

By contrast, iron intake in these infants was lower than that in the healthy infants. The median iron intakes reported by Beal[10] are shown in Figure 1. Iron-fortified cereals furnished half of the iron intake at one year of age but were not consumed after the age of two years. The high iron intake in the infants between six and eighteen months of age in Beal's study is entirely due to the consumption of large amounts of infant cereal. The Recommended Dietary Allowance[11] for infants in this age group is 7 mg. per day. The iron intake of the present group, including the small amount consumed as iron fortified infant cereals and enriched flour, was approximately half of that reported by Beal. Only ten of the twenty-seven infants had an intake exceeding 5 mg. per day.

In seventeen infants, the intake of iron appeared grossly inadequate and can be considered to be of etiologic significance in the development of iron deficiency. In the other ten infants with an iron intake of more than 5 mg. per day, other etiologic influences probably should be considered as well. It was not possible to separate these ten infants from the rest of the group on the basis of birth weight or birth order, although one set of twins studied had an iron intake of 6.1 mg. per day. The utilization of oral radioactive iron for hemoglobin formation was also studied in this group of infants[12] and iron absorption was normal. They all responded normally to treatment with iron (as ferrous sulfate) administered orally in doses equivalent to 45 mg. per day. There was no apparent excessive loss of iron. The regularity of the dietary intake might be questioned, but this could not be definitely incriminated. It can only be concluded that the need for iron in these infants was greater than the amount provided by their intake.

The intake of thiamine in these infants is less than that of the Denver infants in many instances, but it is not so low as that associated with deficiency states. The intake of niacin has been recorded without consideration of the tryptophan content of a milk diet which, at these high protein intakes, is ample to meet the requirements for niacin. The vitamin A intake is ample and the serum concentrations are all within the normal range.

Although the dietary ascorbic acid is less than the Recommended Dietary Allowances or than the intake of the Denver infants, no serum concentrations of less than 0.15 mg. per 100 ml. were found and the average was in the acceptable range. The total tocopherol concentration in the serum was equivalent to adult normal values and only one infant had less than 0.50 mg. per 100 ml., the level associated with increased peroxide hemolysis. The serum protein concentrations are within normal limits for this age group as would be expected from the protein intake. In ninety similar infants, an albumin concentration of less than 3 gm. per 100 ml. was found in a single instance.

SUMMARY

Dietary histories on twenty-seven infants with hypochromic anemia show excessive milk consumption with high caloric intake. Their diets appeared to be adequate in all nutrients but iron. Seventeen of twenty-seven infants had a daily dietary intake of less than 5 mg. iron.

The presence of iron deficiency in ten infants having an iron intake of 5 to 7 mg. per day indicates that such an intake may be inadequate for infants predisposed to iron deficiency by rapid growth or depleted iron stores.

These studies emphasize the importance of iron-rich cereals and other foods in the diet of the infants for the prevention of dietary deficiency. There was no evidence of other dietary deficiencies among these anemic iron-deficient children.

* Such infants are called "milkoholics" by the pediatric house staff.

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