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ABSTRACT

Nutrition is well-recognized as a necessary component of educational programs for physicians. This is to be valued in that of all factors affecting health in the United States, none is more important than nutrition. This can be argued from various perspectives, including health promotion, disease prevention, and therapeutic management. In all cases, serious consideration of nutrition related issues in the practice is seen to be one means to achieve cost-effective medical care. These modules were developed to provide more practical knowledge for health care providers, and in particular primary care physicians. This module is designed to provide information for the physician which will assist in the counseling of new mothers about the feeding practices necessary for proper growth and development of the newborn infant including nutritional needs, nutritional risks, assessment of nutritional status, and nutritional planning for the first year. Included are the learning goals and objectives, self-checks of achievement with regard to goals, and references for the physician and for the physician to give to the patient. The appendices include nutritional content of formula and milk, characteristics of various commercial infant formulas, a chart of recommended feeding practices, growth graphs, and a chart of biochemical methods. (CW)

# 4 Normal Diet: Age of Dependency

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Nutrition in Primary Care

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## The Nutrition in Primary Care Series Contains These Modules:

1. Nutrient Content of Foods, Nutritional Supplements, and Food Fallacies
2. Appraisal of Nutritional Status
3. Nutrient and Drug Interactions
4. Normal Diet: Age of Dependency
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# 4 Normal Diet: Age of Dependency

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# 4 Normal Diet: Age of Dependency

Nutrition in Primary Care

## Tables and Figures

## Introduction

Managing the health care of the infant during the first year of life will be one of your frequent concerns. Because appropriate nutrient intake and feeding practices are necessary for proper growth and development of the newborn infant, you should be able to provide appropriate nutritional counseling to mothers.

Interestingly, infant feeding practices vary widely from country to country, culture to culture, even family to family -- yet infants grow and thrive. It does not necessarily follow, however, that *all* feeding regimens promote *optimal* health, growth, and development or that one particular feeding regimen is optimal for all infants.

The physiological needs of the infant — birth through 1 year of life — are discussed in this module, along with the optimal means of meeting these needs that allow for variation among nationality, culture, and/or individual preference. The nutritional needs of prematurely born infants are not discussed.

For detailed information regarding the nutritional requirements of prematurely born infants, please refer to the American Academy of Pediatrics, Committee on Nutrition, "Statement on the Nutritional Needs of Low-Birth-Weight Infants" (*Journal of Pediatrics*, 60:519–530, October, 1977).

## Goals

*As a result of this unit of study on the infant through the first year of life, you should be able to:*

1. *Identify his nutritional needs;*
2. *Identify his nutritional risks;*
3. *Assess his nutritional status; and*
4. *Formulate a nutritional counseling plan for him through his first year.*

## Nutritional Requirements During Infancy

Nutritional requirements for infants have been studied through use of balance studies, growth studies, incidence of deficiency states, and extrapolation from animal and human adult studies. Table 4–1 shows the recommended dietary allowances (RDA) for healthy infants aged 0 to 6 months and 6 to 12 months.

### Infants 0 to 6 months

**For adequate growth and development, the newborn needs approximately 52 kilocalories per pound (115 kilocalories per kilogram) body weight per day.**

#### Kilocalories

The human infant will not grow and thrive optimally without adequate kilocalories in the diet. But how many are enough? How many are too much?

Although initial kilocalorie reserves may vary with birth weight, the kilocalorie need of normal newborns through the first 6 months of life is approximately 52 kilocalories per pound (115 kilocalories per kilogram) body weight per day (Table 4–2). These values should be used as points of reference since individual growth and development needs vary. For example, an infant consuming 60 kilocalories per pound (132 kilocalories per kilogram) body weight per day who gains weight appropriately for his length may cease to gain weight upon consuming only 45 kilocalories per pound (100 kilocalories per kilogram) per day. However, another infant may be able to achieve appropriate weight gain easily by consuming 45 kilocalories per pound (100 kilocalories per kilogram) per day. Appropriate kilocalorie intake is best indicated through the assessment of growth and development.

Table 4–1 Recommended Daily Dietary Allowances for the Infant

| Nutrient | 0-6 Months | 6-12 Months |
|---|---|---|
| Calories | 115 kcal/kg | 105 kcal/kg |
| Protein | 2.2 grams/kg | 2.0 grams/kg |
| Vitamin A | 420 R.E. | 400 R.E. |
| Vitamin D | 400 I.U. | 400 I.U. |
| Vitamin E | 3 mg | 4 mg |
| Ascorbic Acid | 35 mg | 35 mg |
| Folacin | 30 μg | 45 μg |
| Niacin | 6 N.E. | 8 N.E. |
| Riboflavin | 0.4 mg | 0.6 mg |
| Thiamin | 0.3 mg | 0.5 mg |
| Vitamin $B_6$ | 0.3 mg | 0.6 mg |
| Vitamin $B_{12}$ | 0.5 μg | 1.5 μg |
| Calcium | 360 mg | 540 mg |
| Phosphorus | 240 mg | 360 mg |
| Iodine | 40 μg | 50 μg |
| Iron | 10 mg | 15 mg |
| Magnesium | 50 mg | 70 mg |
| Zinc | 3 mg | 5 mg |

Reproduced from *Recommended Dietary Allowances*, Ninth Edition (1980), with the permission of the National Academy of Sciences, © 1980, Washington, D.C

**Table 4–2** Caloric Expenditure for Infants 0 to 6 Months

| | Kcal/Kg |
|---|---|
| Basal Metabolic Rate | 50 |
| Activity | 15 |
| Cold Stress | 10 |
| Specific Dynamic Action | [illegible] |
| Fecal Loss | 1[illegible] |
| Growth | 2[illegible] |
| | 120 |

From Sinclair, J C , et al "Supportive Management of the Sick Neonate Parenteral Calories, Water, and Electrolytes" *Pediatric Clinics of North America*, 17 863, 1970 Used with permission of W B Saunders Company, © 1970, Philadelphia, PA

### Protein

The protein requirement for the infant has been estimated to be 0.9 gram per pound (2 0 grams per kilogram) body weight per day with an advisable intake set at 1 gram per pound (2.2 grams per kilogram) body weight per day to allow for individual variation and variation of amino acid composition of different protein sources Protein intake greater than 25 to 40 grams per pound (6 to 9 grams per kilogram) body weight per day may prove harmful by providing excessive acid and renal osmotic loads. Growth may actually be inhibited by too much protein

### Carbohydrate

Protein should not supply a substantial portion of the approximate 115 kilocalories per kilogram required daily. What portion of the kilocalorie requirement should be supplied by carbohydrate? Does the type of carbohydrate matter?

The kilocalorie content of human milk is derived as follows: 7% from protein, 55% from fat, and 39% from carbohydrate. To provide suitable substrate for energy and growth, approximately 7% to 16% of the total kilocalories should be supplied by protein, 30% to 55% by fat, and 30% to 63% by carbohydrate. Most infant formulas will provide this distribution (see the section on meeting the infant's nutritional needs and Appendix A at the back of this module).

Intestinal disaccharidases are present in substantial amounts at term to allow adequate absorption of carbohydrates. The frequent, loose, acidic stools of the breast-fed infant may reflect a lactose load that somewhat exceeds the intestinal enzyme capacity of lactase. This does not appear to affect weight gain and resolves at 1 to 2 months. Severe diarrhea may temporarily reduce intestinal enzymes, particularly lactase, so that a substitution with sucrose or maltose may be needed for several days to several weeks. Use of monosaccharides is recommended only with careful surveillance, the amount of monosaccharide necessary to meet kilocalorie requirements will provide an osmolar load 2 times that of serum osmolality and this may induce osmotic diarrhea.

### Fat

The infant requires only 3% of kilocalorie intake to be supplied as the essential fatty acid linoleic acid (approximately 135 milligrams per pound, or 300 milligrams per kilogram body weight) to prevent essential fatty acid deficiency symptoms. Adequate linoleic acid is provided in breast milk and commercial formulas. Why is it suggested that 30% to 55% of the total kilocalories be supplied by fat? Fat provides an efficient source of kilocalories and a vehicle for the absorption of the fat-soluble vitamins. Fat is digested more slowly than protein or carbohydrate and thus provides greater satiety.

### Vitamins and Minerals

Recommended intake levels of vitamins and minerals are listed in Table 4–1. Human milk and infant formulas generally provide adequate amounts of these nutrients when consumed in amounts that meet caloric needs. Appropriate levels for vitamin and mineral supplementation, when required, are found in the section on meeting the infant's nutritional needs. Emphasis should be placed on avoiding chronic intake of excessively large amounts of vitamins (in excess of 10 times the recommended dietary allowances), particularly the fat-soluble vitamins A, D, E, and K, since they are stored by the body and may reach toxic levels.

*Iron*

**The recommended dietary allowance for iron is 10 milligrams per day in the first 6 months of life and 15 milligrams per day in the second 6 months.**

The metabolic requirement for iron has been estimated at 0.55 milligram per day during the first year of life. Yet the recommended dietary allowance during the first 6 months of life is 10 milligrams per day. Why the apparent discrepancy? Iron stores built during fetal development are probably adequate through the first 4 to 6 months of life. Needs for iron based on tissue composition and growth probably amount to 0.55 milligram per day spread evenly over the first year of life. Medical care and patient (parent) compliance are usually more consistent during the first 6 months of life than during the second 6 months. Thus, a daily intake of 10 milligrams, based on an average 10% absorption rate and an allowance for natural variation, is recommended during the first 6 months.

*Fluoride*

Tooth enamel is being formed during fetal life and infancy. A fluoride intake of 0.25 milligram per day is recommended in areas where the fluoride content of the water is 0.3 parts per million (ppm) or less or for infants who do not consume fluoridated water or commercial formulas which contain fluoride.

### Infants 6 to 12 Months

Due to the gradual decrease in metabolic rate and rate of growth from birth to 1 year of age, kilocalorie needs at 6 months decrease to 48 kilocalories per pound (105 kilocalories per kilogram) body weight per day and again decrease at approximately 1 year to 45 kilocalories per pound (100 kilocalories per kilogram) per day. Protein needs decrease to 0.9 gram per pound (2.0 grams per kilogram) per day for the 6- to 12-month-old infant.

Iron stores developed during fetal life may become depleted with the rapid growth and development of tissues during the first 6 months. Recommended intake during the infant's second 6 months increases to 15 milligrams per day, particularly if iron intake during the first 6 months is unknown or possibly marginal. The recommendations for vitamin and mineral intake for the 6- to 12-month-old infant are shown in Table 4–1.

## Developmental Needs During Infancy

**Recent recommendations not to introduce feeding of solid foods early in life have a strong psychomotor basis. Development of tongue extrusion and associated reflexes, suck and swallow response, and head control are necessary before the baby will take solid foods physiologically.**

Developmental progress of the infant is often inappropriately measured by the degree of progress in feeding and by the acceptance of foods other than human milk or infant formula. What are the characteristics of psychomotor development related to nourishing the infant?

The integration of tongue extrusion and associated reflexes into coordinated swallowing action does not begin until 2 to 5 months of age and is not complete until 6 to 7 months. Early spoon feedings may interfere with the suck or swallow response causing awkwardness in feeding. This can include incomplete forming of lips around the nipple with leaking from the corners of the mouth, occasional choking, and air swallowing. Initial spoon feedings, even when offered at 4 months, stimulate sucking movements of the tongue and extrusion of the foods offered. Choking may occur on food which reaches the pharynx.

Head control, based upon development and strength of neck muscles, is not generally complete until 5 months, at which time the infant may demonstrate eagerness for feedings as well as satiation. For these reasons, the feeding of solid foods is not recommended until 6 months. Even at this age, the ability to consume spoon feedings will not be sufficient to provide more than 100 to 200 kilocalories per day. Use of infant feeders (which plunge food into the mouth) and mixing solids with formula in the bottle should be discouraged! Feeders interfere with the suck and swallow mechanism. Feeders may also reduce the intake of human milk or formula which supplies a more appropriate combination of nutrients than formula plus solid food. Formula plus solid food may also increase kilocalorie intake and support excessive weight gain.

Although human milk or commercial formulas may supply adequate nutrition economically for infants through 1 year of life, adequate nutrition may also be supplied through appropriate combinations of milk, infant formulas, and infant foods (see section on meeting the infant's nutritional needs). By 8 months of age, biting will have replaced mouthing, and hand-to-mouth coordination will be sufficiently sophisticated to allow finger foods such as crackers, bits of fruit, and bits of cooked vegetables.

By 9 months, increased control over jaw, lips, and tongue allow the infant to drink from a cup. Use of a cup should be encouraged to allow total weaning from the breast or bottle at 12 to 14 months. Extending nipple feedings (bottle more so than breast) may interfere with tooth eruption and normal oral flora (encouraging breakdown of enamel). Infants should be discouraged from constant dependence upon the bottle as a "pacifier" because of the increased length of time food substances, particularly carbohydrates, are in contact with tooth enamel.

## Meeting the Infant's Nutritional Needs

### Formula or Human Milk

The contents of human milk, cow's milk, and various infant formulas are shown in Appendices A and B.

#### Kilocalories

**Human milk and commercial formulas contain approximately 20 kilocalories per ounce. To support the growth needs of the infant, 20 to 40 ounces should be consumed daily during the first 6 months of life and 40 to 50 ounces daily during the second 6 months of life depending on the amount of strained foods consumed.**

Human milk and commercial formulas contain approximately 20 kilocalories per ounce (0.67 kilocalorie per milliliter). Based upon a kilocalorie need of 52 kilocalories per pound (115 kilocalories per kilogram) body weight during the first 6 months of life, the daily infant needs approximate 2.75 ounces per pound, or 6 ounces per kilogram (180 milliliters per kilogram) of human milk or formula. During the second 6 months of life when kilocalorie needs decrease to 48 kilocalories per pound (105 kilocalories per kilogram), the daily infant needs decrease to 2.25 ounces per pound, or 5 ounces per kilogram (150 milliliters per kilogram) or less depending upon intake of solid foods.

For example, a 3-month-old infant who at the 50th percentile weighs 13 pounds 3 ounces (6.0 kilograms) needs 690 kilocalories. A little over 34 ounces (1 liter) of human milk or formula will meet this kilocalorie requirement. A 6-month-old infant who at the 50th percentile weighs 17 pounds 3 ounces (7.8 kilograms) needs 820 kilocalories or 40 ounces (1.22 liters) of formula. Means of achieving adequate kilocalories may vary among individual infants depending on development and parental preferences.

#### Protein

**Most commercial formulas contain between 1.5 and 2.0 grams protein per deciliter supplying between 2.7 and 3.6 grams of protein per 120 kilocalories. This will more than adequately meet the infant's needs of 0.9 to 1.0 gram per pound (2.0 to 2.2 grams per kilogram) body weight if adequate kilocalories are consumed.**

Sources of protein in commercial formulas include cow's milk (predominantly casein), modified cow's milk (casein with demineralized whey added to approximate human milk), soy, and meat (see Appendix B). Protein concentration ranges from 1.1 gram per deciliter in human milk to 2.9 grams per deciliter in meat-based formula. Most commercial formulas contain between 1.5 and 2.0 grams protein per deciliter, supplying between 2.7 and 3.6 grams of protein per 120 kilocalories This will more than adequately meet protein needs. Cow's milk contains 3.6 grams protein per deciliter which is more than 3 times the protein content of human milk.

The relatively high protein content of cow's milk, combined with the higher mineral content, may present some hazard due to the high renal osmotic load when given in large amounts to infants less than 6 months of age.

The relatively high curd tension of protein in untreated cow's milk as it is acidified in the infant's stomach may cause difficulty in digestion before 1 year of age. Evaporated cow's milk is heated sufficiently during processing to decrease curd tension. Evaporated cow's milk may be diluted with water (3 ounces or 100 milliliters of evaporated milk to 4.5 ounces or 130 milliliters of water) and mixed with 2 teaspoons (10 milliliters) of corn syrup to provide a more suitable food in terms of protein and kilocalorie distribution.

### Carbohydrate

Human milk and most formulas made with cow's milk contain the carbohydrate lactose (see Appendix B). Portagen (Mead Johnson) is a casein-based formula which contains the carbohydrates sucrose and corn syrup solids (dextrose, maltose, and polysaccharides). Soy protein formulas generally contain sucrose or sucrose and corn syrup solids. Cho-Free (Syntex) has no carbohydrate as its name implies. Pregestimil (Mead Johnson) contains glucose as the primary carbohydrate and should be initiated cautiously due to its high osmolar load. Human milk contains 7.2 grams of carbohydrate per deciliter. Most formulas contain 6.8 to 7.2 grams per deciliter (see Appendix A).

### Fat

**Human milk contains more fat than cow's milk and its fat is better absorbed. Skim milk and 2% milk are not recommended for consumption by infants.**

Although human milk fat and cow butterfat have a similar ratio of the various fatty acids, human milk is better absorbed (85% to 90%) than butterfat (65% to 75%) by infants. This is most likely due to the position of the various fatty acids in the triglyceride molecule. Most commercial formulas, which are casein- and soy-based, contain a combination of soy, coconut, and corn oils. Formulas which contain soy oil as the only source of fat may have inadequate tocopherol to polyunsaturated fat ratios and may need vitamin E supplementation. Portagen and Pregestimil (Mead Johnson) contain medium chain triglycerides (MCT) as the major source of fat with corn oil added to provide essential fatty acids. Meat Base Formula (Gerber) contains approximately 50% meat fat and 50% sesame seed oil. Human milk contains approximately 4.5 grams of fat per deciliter, while most formulas contain between 3.6 and 3.8 grams of fat per deciliter.

Milks containing lower percentages of fat, such as skim milk and 2% milk, are not recommended during infancy as they encourage consumption of large amounts of solid food. Skim milk will not provide essential fatty acids or sufficient kilocalories and may supply an excessive renal solute load if consumed in amounts sufficient to supply adequate kilocalorie intake.

### Minerals

**Absorption of calcium by the infant is enhanced if the amount of calcium in the feeding is twice that of phosphorus. Iron in human milk is much more available for absorption than iron in commercial formulas. Fluoride content of human milk is variable and does not reflect maternal intake.**

The calcium to phosphorus ratio of human milk is 2 to 1, a distribution which enhances calcium absorption. The commercial formulas that most closely approximate this ratio are PM 60/40 (Ross) and SMA (Wyeth). Most commercial formulas range between 1:2 to 1.4:1.

Human milk contains approximately 0.5 to 1.0 milligram of iron per liter which is approximately 50% absorbed. Most commercial formulas contain 12 to 18 milligrams of iron per liter which at 10% absorption will more than adequately provide the infant's iron requirement of 0.55 milligram per day. Occasionally, iron-fortified formulas have been associated with colic, fussiness, diarrhea, and constipation. Formulas without iron fortification will not meet the infant's need for iron and should be given with an iron supplement. Formulas that are not fortified with iron are shown in Table 4–3.

**Table 4–3** Formulas Not Fortified With Iron

| |
|---|
| Similac Without Iron (Ross) |
| Enfamil Without Iron (Mead Johnson) |
| Cow's Milk (Evaporated, 2%, and skim) |
| Similac LBW (Ross)* |
| Enfamil Premature Formula (Mead Johnson)* |
| Similac PM 60/40 (Ross) |
| Probana (Mead Johnson) |

*Not available to public

The fluoride content of human milk is variable and does not appear to reflect maternal intake. The fluoride content of commercial formulas is also variable and may reflect the factory supply of water. More recently, formula manufacturers have attempted to reduce the fluoride content of infant formulas to prevent the possibility of intakes of fluoride greater than 0.1 milligram per kilogram body weight per day and the risk of fluorosis.

### Vitamins

The vitamin content of human milk, cow's milk, and commercial formulas is compared to the recommended dietary allowances for each vitamin in Appendix A. Vitamin allowances are generally met when the infant is consuming 1 liter of formula; 1 liter is an amount appropriate for an infant weighing at least 12 pounds 4 ounces (5.6 kilograms).

## Supplements

**Supplementation of breast-fed babies is subject to much debate. Many feel that supplementation with iron, vitamin D, and fluoride is beneficial.**

The need for nutritional supplementation varies with the feeding plan (see Table 4–4). Infants fed a commercially prepared formula that is iron-fortified need no supplementation unless daily intake is less than 700 milliliters (23 ounces) for an extended period. This may occur in infants born near the 5th percentile for weight since they may not consume enough formula to supply a full complement of the recommended allowances until 5 months. This may also occur in infants receiving more than 50% of total kilocalorie intake from infant foods.

As formula manufacturers reduce the fluoride content of their products (to prevent inadvertent excess ingestion of fluoride), it may be necessary to supplement with 0.25 milligram per day in areas where the fluoride content of water is 0.3 ppm or less.

Supplementation of breast-fed babies with vitamin D, iron, and fluoride is subject to much debate. Human milk contains appreciable amounts of water-soluble vitamins. Vitamin D supplementation is recommended by some due to the infrequent occurrence of rickets in breast-fed infants. The fluoride content of human milk appears to be low regardless of maternal intake, and supplementation is frequently recommended. There appears to be no ill effect from supplementation with appropriate amounts of either vitamin D (400 IU per day) or fluoride (0.25 milligram per day). New ideas seem to appear yearly, so read your medical journals for the most recent thinking on the topic of supplementation.

Iron supplementation is another important issue. Although 50% of the iron found in breast milk (0.5 to 1.0 milligram per liter) is absorbed, it still may not supply the infant's requirement of 0.55 milligram per day. Anemia has been reported in breast-fed infants. However, supplementing the diet of the infant with iron may interfere with the bacteriostatic effect of lactoferrin, saturating iron-binding sites and providing free iron substrate for utilization by gastrointestinal microflora. Nevertheless, a supplement of 15 milligrams per day of iron is recommended for the breast-fed infant after the first 6 months of life.

Iron and fluoride are generally not found together in 1 supplement. Fluoride is usually combined with a multivitamin preparation or found in combination with vitamins A, C, and D. The additional quantities of vitamins A, C, and D, when given with fluoride, are not sufficient to cause harmful side effects. Hypervitaminosis A is observed when doses 10 times above normal are administered over a prolonged period of time. Excess vitamin C is excreted in the urine. Iron may be given as a separate supplement (7.5 to 8.0 milligrams per 0.3 milliliter dose).

The use of evaporated milk and whole milk requires iron and vitamin C supplementation. Fluoride supplementation in areas where water contains 0.3 ppm or less of fluoride is also recommended when evaporated or whole milk is consumed.

## Infant Foods

**As the diet changes from predominantly breast milk or formula to predominantly solid foods, infant foods should be incorporated gradually into the diet to provide variety and adequate nutrient intake.**

The nutrient value of infant foods may be seen in Table 4–5. Three level tablespoons of dry cereal mixed with 2 ounces of formula will provide 7 milligrams of iron considerably less expensively and with fewer kilocalories than will wet-pack cereal-fruit combinations (5 milligrams iron per 9 tablespoons or 1 jar). Iron-fortified cereals that are specifically prepared for infants should be continued through 18 months.

Four ounces of fruit juice or 2 jars of strained fruit will provide an adequate daily intake of vitamin C. Based on average vitamin A content of various strained vegetables, less than one-half jar will provide an adequate daily intake of vitamin A.

Generally, strained vegetable and meat combinations have little more to offer nutritionally than plain vegetables. High-meat dinners (vegetable-meat combinations that are high in protein) supply approximately 8 grams of protein per jar. However, the quality of protein is variable, and the quantity may be unnecessary if appropriate amounts of formula or milk are also given.

Table 4–4 Supplementation of Diets of Infants and Toddlers

| Milk or Formula | Desirable Daily Supplements Vitamin D 400 IU | Vitamin C[a] 20 mg | Iron[b] 7 mg |
|---|---|---|---|
| Human milk | + | – | + |
| Cow's milk | | | |
| Whole, homogenized, D-fortified[c] | – | + | + |
| Evaporated | – | + | + |
| 2% D-fortified[d] | – | + | + |
| Skim, D-fortified[e] | – | + | + |
| Commercially prepared formula, iron-fortified | – | – | – |

[a]Instead of a vitamin supplement, foods may be given to supply vitamin C
[b]Instead of an iron supplement, infant cereal may be given
[c]Not recommended before 7 to 12 months of age.
[d]Not recommended before 1 year of age
[e]Not recommended before 2 years of age.

From Fomon, S., et al : "Recommendations for Feeding Normal Infants" *Pediatrics*, 63(1). 52-59, 1979 Used with permission of American Academy of Pediatrics, © 1979, Chicago, IL

**Table 4–5** Nutrient Values of Infant Foods

| Food | Household Measure | Calories (kilo-calories) | Protein (grams) | Carbo-hydrate (grams) | Fat (grams) | Calcium (milli-grams) | Phos-phorus (milli-grams) | Iron (milli-grams) | Vitamin A (inter-national units) | Vitamin B (milli-grams) |
|---|---|---|---|---|---|---|---|---|---|---|
| Cereal, dry | 9 Tablespoons | 85 | 3 | 15 | 1.2 | 140 | 160 | 21 | -- | -- |
| Cereal, with fruit | 9 Tablespoons, 4 1/2 ounce jar | 110 | 3 | 22 | 1 | 20 | 75 | 5 | -- | -- |
| Fruit juice | 4.2 ounce can | 75 | .5 | 18 | .2 | 10 | 15 | .8 | 30 | 52 |
| Fruit | 9 Tablespoons, 4 1/2 ounce jar | 110 | .5 | 27 | .2 | 10 | 15 | .5 | 200 | 17 |
| Vegetable | 9 Tablespoons, 4 1/2 ounce jar | 53 | 2.2 | 10 | .3 | 40 | 40 | .8 | 4,000 | 8 |
| Vegetable/meat combinations | 9 Tablespoons, 4 1/2 ounce jar | 70 | 3 | 10 | 2 | 20 | 40 | .7 | 1,000 | 3 |
| Egg yolks | 9 Tablespoons, 3 1/2 ounce jar | 180 | 9 | 1 | 4 | 30 | 80 | 1.2 | 200 | 3 |
| High meat dinners | 9 Tablespoons, 4 1/2 ounce jar | 110 | 8 | 10 | [illegible] | 20 | 150 | 1.1 | 2,400 | 5 |
| Meat | 7 Tablespoons, 4 1/2 ounce jar | 120 | 13 | .5 | 1 | 30 | 30 | .5 | 120 | 6 |
| Desserts | 9 Tablespoons, 4 1/2 ounce jar | 120 | 1 | 25 | | | | | | |

Note Nutrient values for junior meats (7 Tablespoons per jar) and also high-meat dinners (9 Tablespoons per jar) are similar to values for similar strained products Junior fruits, vegetables, vegetable/meat combinations, and desserts (15 Tablespoons per jar) are similar to values for similar strained products per unit weight basis

Strained meats and egg yolks are generally grainier in texture and may be less well accepted than other strained foods. The average value of protein content is 12 grams per jar, the average iron content is 1 milligram per jar which is heme-iron and therefore well absorbed.

Strained desserts provide kilocalories, unnecessary variety, and minimal amounts of vitamins and minerals. They appeal primarily to the adult palate, foster unnecessary food-reward patterns in family discipline, and should be discouraged from use.

"Junior" foods are prepared with a chunky texture but are similar in nutritional value to strained foods.

Either commercially prepared or home-prepared foods may be used for infant feeding. Care should be taken in the preparation of infant foods in the home, considering the following points:

- Strained foods not specifically prepared for infants may be high in lead, salt, and sugar content.
- Fresh, frozen, or packaged foods without salt or sugar added should be used.
- Foods should be prepared without the addition of salt, sugar, or other seasonings.
- Some foods such as dried beans and peas may be difficult to digest unless *thoroughly* cooked.
- All utensils used in the preparation and storage of foods should be *thoroughly* cleaned.
- Once foods are prepared, they may be frozen in plastic ice cube trays, or divided into individual portion sizes and stored in plastic freezer bags.
- Foods may be stored in the freezer for 3 to 4 weeks. If they are refrigerated only, they should be used within 24 hours of preparation.

As the diet changes from predominantly breast milk or formula to predominantly sol foods, infant foods should be incorporated gradually into the diet to provide both variety and adequate nutrient intake. If the infant is weaned from breast milk to a vegetarian diet which does not include dairy products, supplementation with vitamin D (400 IU per day), vitamin $B_{12}$ (4μg/day), or calcium (250 milligrams per day) is necessary. The infant should be fed complementary proteins in order to ingest high-biological value protein (see Module 1 on nutrient content of foods for additional discussion of complementary proteins for vegetarian food practices). If the child is fed a vegetarian diet, whole grains and legumes should be thoroughly cooked, blended or mashed, and strained, nut butters must be made smooth to prevent choking and allow for better digestion. Fruits or fruit juices should be consumed to prevent constipation. To provide adequate iron, beans, dark-green leafy vegetables, egg yolk, and iron-fortified grains and formulas should be consumed.

Appendix C provides an excellent comprehensive table which summarizes the recommended feeding practices (milk, formula, infant foods, and nutritional supplements) for infants from birth to 1 year of age. Also included in the table are nutritional assessment guidelines appropriate for each age group.

Appendix D, Table 4–10 includes a description of the symptoms, causes, and formula or food treatments for several common feeding problems in the infant. These problems include spitting, regurgitation, vomiting, diarrhea, constipation, colic, allergy, undernutrition, obesity, and anemia.

## Nutritional Assessment During Infancy

**Success in estimating and meeting nutritional needs is determined through assessment of growth and development of the infant. Parameters for assessment include anthropometric, biochemical, and dietary intake data.**

Although guidelines for nutritional intake of infants are based on physiological needs of the "reference fetus" and "reference infant," each infant should be individually assessed for nutritional status. There are 3 basic parameters for nutritional assessment of infants:

- Anthropometric (height, weight, head circumference, triceps skinfold),
- Biochemical (serum, urine), and
- Dietary intake.

## Anthropometric Measurements

**Anthropometric data are the simplest to obtain and are probably the most useful in assessing the infant's nutritional status. Routine measurements of body weight are essential.**

Anthropometric data are the simplest to obtain and are probably the most useful in assessing the infant's nutritional status. (Methods of measurement are described in Fomon, 1974, pp. 34-37 listed in the Bibliography at the back of this module.) Weight is best obtained using a beam balance which is accurate to 10 grams and which is regularly calibrated. Weight should be measured monthly or bimonthly for the healthy infant. Nutritional assessment during the first month of life is primarily accomplished through measurements of body weight alone. At this age, weight changes are greater and more easily measured than other growth parameters Table 4–6 includes a brief statement of the nutritional goals for weight gain for the infant. These guidelines were originally established for ill or low-birth-weight infants; however, they may be generally applicable to all infants.

Increments in weight should approximate 26 ± 5 grams per day for females and 31 ± 5 grams per day for males during the first 3 months of life. This will decrease to 21 ± 6 grams per day at 3 to 6 months for both sexes, 15 ± 5 grams per day at 6 to 9 months, and 12 ± 6 grams per day at 9 to 12 months.

Measurement of length during the first year should be taken in the supine position, preferably through the use of a fixed headboard and movable footboard with the legs held firmly in an extended position. Length should be measured and recorded monthly or bimonthly and evaluated with weight measurements.

Head circumference is best measured with a narrow, flexible measuring tape applied firmly around the head above the supraorbital ridges, across the most prominent part of the frontal bulge, and over the part of the occiput which gives a maximum measurement of head circumference. Monthly increments in head circumference should approximate 3.6 centimeters during the first month of life, 1.65 centimeters per month during the second and third months, 1 0 centimeter per month during the fourth through the sixth month, 0.63 centimeter per month during the seventh through the ninth month, and 0.43 centimeter during the tenth through the fourteenth month.

Skinfold measurements are probably the least accurate of anthropometric measurements in the infant but may be obtained through the use of an approved skinfold caliper. Skinfold thickness actually decreases between 6 months and 3 years due to changes in body proportion and redistribution of fat stores.

Various growth charts have been devised. Those used most frequently are:

- The National Center for Health Statistics Growth Charts, 1976, Monthly Vital Statistics Report, Vol. 25, No. 3, Suppl. (HRA) 76-1120, Health Resources Administration, Rockville, MD, based

Table 4–6 Nutritional Goals During Infancy

1. Initial weight loss < 10% birth weight.
2. Daily weight loss < 2% previous day's weight.
3. Low weight reached in 2 to 8 days.
4. Birth weight regained in 1 to 2 weeks.
5. Weight gain should approximate 4.5 to 6.8 grams per pound (10 to 15 grams per kilogram) per day.

From Rickard, K and Gresham, E "Nutritional Considerations for the Newborn Requiring Intensive Care" *Journal of the American Dietetic Association*, 66 594, 1975 Used with permission of the American Dietetic Association, © 1975, Chicago, IL

on data from the Fels Research Institute in Yellow Springs, Ohio, available through Ross Laboratories, subsidiary of Abbott Laboratories,
- The Children's Medical Center, Boston, anthropometric chart available through Mead Johnson Laboratories, and
- The Wetzel Grid by N.C. Wetzel, available through the Newspaper Enterprise Association, 1200 West Third St., Cleveland, OH 44113.

See Appendix E, Figures 4–2 to 4–7, for samples of growth grids.

Care should be taken in the interpretation of anthropometric data. Data should be plotted accurately at the infant's exact age. Data should be evaluated serially and in concert with length, weight, and head circumference measurements. An infant whose weight, length, and head circumference plot at the 95th percentile is not obese. The infant is simply heavier, taller, and growing at a faster rate than 95% of the infants at that age. However, if the infant's weight plots at the 95th percentile but length and head circumference each plot at the 50th percentile, there should certainly be some concern that the infant may be receiving more kilocalories than it is expending for normal growth and development.

The table in Appendix C indicates appropriate nutritional assessment guidelines for infants, birth to 1 year of age. This table is an excellent addition to your fingertip library.

## Biochemical Measurements

**Evaluation of an infant's hemoglobin and hematocrit is necessary. Biochemical tests are valuable in confirming clinical observations.**

The biochemical indices for evaluating nutritional status may be seen in Appendix F. Rarely is it necessary to evaluate more than hemoglobin and/or hematocrit since anemia is the most frequent nutritional deficiency seen in infants in the population of the United States. In most instances, biochemical studies merely confirm clinical observations. Biochemical assessment of nutritional status should vary with environmental conditions. For example, evaluation of serum lead values and screening tests for lead poisoning are appropriate for children from older sections of a city, vitamin D and alkaline phosphatase values are more appropriate for assessment of infants living in predominantly cloudy climates, vitamin C levels are more appropriate for assessment of children living in areas where fresh fruits and vegetables may be unavailable due to economic conditions.

Anthropometric evaluation may indicate the need for assessment of various biochemical parameters. For example, poor weight gain may indicate the need to evaluate serum total protein, albumin, and blood urea nitrogen. Roentgenograms of the wrist are helpful in determining bone age and interpreting anthropometric data.

## Dietary History Analysis

**Dietary intake data are essential to elicit and evaluate. Assessment of intake may confirm biochemical and clinical findings. When interviewing parents, your questions should be open-ended and nonthreatening.**

Dietary intake data may also indicate the need for assessment of various biochemical parameters. For example, in an infant with a history of limited milk and dairy product consumption, the need to evaluate vitamin D and serum alkaline phosphatase is indicated.

A diet history at best yields subjective data. However, it is the source of some of the most valuable information. It may confirm the nutritional assessment gleaned from clinical findings. Therefore, the technique of interviewing is of utmost importance. Open-ended, nonthreatening questions are better than closed-ended or judgmental questions. Closed questions usually clue parents to the preconceived response. For example, the question "How much water does your baby drink?" assumes the baby is being given water, and parents may respond "3 or 4 ounces" even if the baby has been given no water. The parents have been clued that the baby should have water. The question "Have you given the baby any water?" may elicit the anticipation of judgment "Have I done the right thing?" Questions directed toward the behavior, likes, dislikes, etc. of the infant and questions which are open-ended tend to be less judgmental or threatening. For example, "Has the baby ever taken any water for you?" places emphasis on what the infant has or has not done, not on what the parents have or have not done. A positive response then indicates asking "How much water does the baby take?"

Answers to open-ended questions such as "What, if anything, does the baby take besides breast milk (or formula)?" will tell you much more and lead to other more direct questions than closed-ended questions. Judgmental attitudes or words of correction while taking the diet history often lead to the inhibition of further responses and are best postponed until the end of the interview.

When assessing nutritional status through the evaluation of dietary intake, you may want to send a questionnaire and food record sheet to the parents a week prior to the infant's scheduled visit (a sample questionnaire for both the breast-fed and bottle-fed infant is included in Figure 4–1, pages 16 & 17 With either the office interview or the written questionnaire, it is necessary to evaluate the dietary information (use nutrient information in Tables 4–1 and 4-5 and Table 4–7 in Appendix A). Generally, if the infant's needs are met for kilocalories, protein, calcium, vitamin D, iron, vitamin C, and fluoride, the diet is adequate for all nutrients.

## Summary

Nutritional needs during the first year of life vary among infants. In general, daily kilocalorie needs are 48 to 52 kilocalories per pound or 105 to 115 kilocalories per kilogram body weight, and protein needs are 0.9 to 1.0 gram per pound or 2.0 to 2.2 grams per kilogram body weight per day. Although controversial, it appears that supplementation of the infant's diet with iron and fluoride is warranted and is without harmful side effects. Success in estimating and meeting nutritional needs is determined through assessment of growth and development.

## Test Your Knowledge

Mrs. Smith brings 2-month-old baby John into your office. He now weighs 11 pounds (5.0 kilograms). He is 22½ inches long (57 centimeters), and his head circumference is 15¼ inches (38¾ centimeters). Mrs. Smith has filled out most of the questionnaire prior to the office visit You have clarified questions she left unanswered (see the completed questionnaire in Figure 4–1) Answer the following questions:

1. How many kilocalories per kilogram is this infant consuming?

2. At what percentile is this infant for weight? ______ Length? ______ Head circumference? ______

3. Is the infant consuming too many kilocalories with his present diet?

4. What is most likely the cause of the colic and spitting?

   a. Immaturity of gastrointestinal tract
   b. Chalasia
   c. Allergy to formula
   d. Overfeeding
   e. Pyloric stenosis

5. Does the infant have constipation?

6. What do you suggest to alleviate the gastrointestinal symptoms?

7. What are the potential nutritional problems in this case?

Answers to these questions appear within the next several pages.

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**Figure 4–1** Nutrition Questionnaire

A. Name John Smith

Date of Birth 5/17/79 Gestational Age ? (term)

Birth Information: Weight 7# (3.2 kg) Length 19½" (50 cm) Head Circumference ?

B. How would you describe the baby's appetite? excellent__ good ✓ fair__ poor__

How would you describe the baby's growth? excellent__ good ✓ fair__ poor__

C. If you are breast feeding, please answer the following questions:

1. How many wet diapers does the baby have in a 24-hour period?__________
2. How often does the baby stool?__________
3. Does the baby have constipation? yes__ no__ diarrhea? yes__ no__
4. How often does the baby usually feed? day__________ night__________
5. How long does the baby usually feed?__________
6. Does the baby completely empty one breast at a feeding? yes__ no__ unsure__
7. Does the baby nurse from both breasts at each feeding? yes__ no__
8. Have you had any problems with sore__, inflamed__, or cracked__ nipples?
9. Does the baby seem satisfied with breast milk only? yes__ no__ unsure__
   Does the baby seem to need supplemental feedings? yes__ no__ unsure__
10. Is the baby fussy or irritable? yes__ no__
11. How do you feel? well-rested__ tired__ exhausted__ irritable__
12. Please record all foods you eat for a 24-hour period on the enclosed form.
13. Are you taking any vitamin supplements? yes__ no__ What kind?__________

D. If you are bottle feeding, please answer the following questions:

1. What kind of milk or formula does the baby take? Similac

Figure 4-1 (continued)

2. Has the baby had any problems with this milk or formula? yes ✓ no__
   If yes please describe the problem: colic, Spitting (spits about 1½ oz. feeding)
3. How is the milk or formula prepared for the baby? ready to feed ✓
   13 ounces concentrated formula plus 13 ounces of water

   no tablespoons powdered formula plus ______ ounces of water
4. How many wet diapers does the baby have in a 24-hour period? 5-7
5. How often does the baby stool? once every 2 days (very firm but not dry or pellet)
6. Does the baby have constipation? yes ✓ no__ diarrhea? yes__ no ✓
7. How often does the baby usually feed? day 6, 10, 2, 6 night 10 pm 2 am
8. How much formula does the baby usually take at one time? 6-7 oz.
9. Does the baby seem satisfied with milk or formula only? yes__ no ✓ unsure ✓
   Does the baby seem to need supplemental feedings? yes ✓ no__ unsure ✓
10. Does the baby take vitamin or mineral supplements? yes__ no ✓
    If so, what kind? ______

E. If supplemental feedings are given each 24-hour period, please answer the following questions:

| What kind of feedings are given? | How much? |
|---|---|
| Formula Similac | 36-40 oz. a day (spits up about 4 oz. total) |
| Cereal all kinds | 2 Tbsp 2 times/day |
| Fruit banana, applesauce | ¼ jar / day |
| Vegetable carrots, greenbeans | ¼ jar / day |
| Meat none | — |
| Juice apple juice | 2 oz. / day |
| Water ______ | 2 oz. / day |

Date: 7/20/79

Signed: Mrs A. Smith

## Answers

1. | | |
|---|---|
| Average 29 ounce formula | 580 kilocalories |
| 4 Tbsp cereal | 40 kilocalories |
| 1/4 jar fruit | 28 kilocalories |
| 1/4 jar vegetables | 13 kilocalories |
| 2 oz juice | 38 kilocalories |
| | 699 kilocalories |

   -699 kilocalories divided by 11 pounds = 64 kilocalories per pound body weight

   -699 kilocalories divided by 5.0 kilograms = 140 kilocalories per kilogram body weight

2. Between the 25th and 50th percentile for all 3 parameters.

3. No. Kilocaloric needs often increase in a stepwise rather than smooth curve fashion. Weight gain is following birth percentile and increasing evenly with length and head circumference. Kilocalories consumed through complex starches (cereals and vegetables) are probably not efficiently digested and absorbed but are excreted in the feces.

4. a. Probably not, unless infant was born prematurely, as the gastroesophageal sphincter and normal peristalsis are usually well developed by 2 months, but may take as long as 4 months.

   b. Probably not as true chalasia is relatively rare.

   c. Possibly since infant has both colic and spitting, though more reliable symptoms of allergy are not present.

   d. Most likely, since the infant needs only 5 ounces every 4 hours to achieve caloric needs and strained foods are not appropriate at this age.

   e. Most likely not, since the spitting is not projectile in nature, does not involve total emptying of the stomach, and has not affected weight gain.

5. No, not in the strict sense since the consistency of the stool is important in assessing the pathology of constipation.

6. Discontinue all solid foods. If symptoms do not subside in 3 to 4 days, decrease amount of formula given to 5 ounces every four hours or more frequently if appetite warrants. Consider changing formula to soy or meat base only if symptoms persist beyond the above measures.

7. a. Anemia, since formula used is not fortified, and cereal is not providing adequate levels; straining with stools may cause some blood loss.

   b. Obesity, due to overfeeding.

   c. Esophagitis due to chronic spitting up of formula.

# Appendix A

Table 4–7 Human Milk, Formula, Cow's Milk Constituents Compared to RDA

| Nutrient | RDA 0-6 mo. | RDA 6-12 mo. | Human Milk per deciliter | Formula (average) per deciliter | Cow's Milk per deciliter |
|---|---|---|---|---|---|
| Protein (gm) | 2.2 kg (1.0/lb) | 2.0 kg (0.9/lb) | 1.2 | 1.8 | 3.5 |
| Carbohydrate (gm) | * | * | 7.2 | 7.0 | 4.8 |
| Fat (gm) | * | * | 4.5 | 3.7 | 3.8 |
| | | | per liter | per liter | per liter |
| Calcium (mg) | 360 | 540 | 340 | 500-600 | 1,200 |
| Phosphorus (mg) | 240 | 400 | 140 | 450-455 | 920 |
| Iodine (mg) | 35 | 45 | 30 | 40-69 | 50 |
| Iron (mg) | 10 | 15 | 0.5 | tr. or 12-15 | 0.5 |
| Magnesium (mg) | 60 | 70 | 40 | 40-48 | 120 |
| Zinc (mg) | 3 | 5 | 3-5 | 2-4 | 4 |
| | | | per liter | per liter | per liter |
| Vitamin A (IU) | 1,400 | 2,000 | 1,900 | 1,700-2,500 | 1,850 |
| Vitamin D (IU) | 400 | 400 | 22 | 400-423 | 400 |
| Vitamin E (IU) | 4 | 5 | 1.8 | 8-12 | 1.3 |
| Ascorbic Acid (mg) | 35 | 35 | 43 | 55 | 5.5 |
| Folacin (mg) | 50 | 50 | 52 | 50-100 | 55 |
| Niacin (mg) | 5 | 8 | 1.5 | 7-8 | 1.0 |
| Riboflavin (mg) | 0.4 | 0.6 | 0.36 | 0.6-1.0 | 1.9 |
| Thiamin (mg) | 0.3 | 0.5 | 0.16 | 0.4-0.6 | 0.3 |
| Pyridoxine (mg) | 0.3 | 0.4 | 0.1 | 0.3-0.4 | 0.4 |
| Vitamin $B_{12}$ (mg) | 0.3 | 0.3 | 0.3 | 1.5-2.0 | 4 |

*No RDA for carbohydrate and fat has been established

Table 4–8 Various Characteristics of Commercial Infant Formulas

| Formula | Company | Carbohydrate | Protein | Fat |
|---|---|---|---|---|
| Enfamil | Mead Johnson | Lactose | Nonfat milk | Soy and coconut oils |
| Similac | Ross | Lactose | Nonfat milk | Soy, coconut, and corn oils |
| SMA | Wyeth | Lactose | Electrodialized whey and nonfat milk | Oleo, coconut, oleic (safflower) and soybean oils |
| Similac PM 60/40 | Ross | Lactose | Partially demineralized whey and nonfat milk | Coconut and corn oils |
| Isomil | Ross | Sucrose, corn starch, corn syrup solids | Soy protein isolate | Soy, coconut and corn oils |
| Neo-Mull-Soy | Syntex | Sucrose | Soy protein isolate | Soy oil |
| Nursoy | Wyeth | Sucrose, corn syrup solids | Soy protein isolate | Oleo, coconut, oleic (safflower) and soy oil |
| ProSobee | Mead Johnson | Sucrose, corn syrup solids | Soy protein isolate | Soy oil |

| Stool Characteristics | Explanations |
|---|---|
| Formed, greenish-brown with very little free water around the stool | Milk formulas are similar and interchangeable. An iron-supplemented formula provides the daily requirement for iron. |
| Similar to breast milk stool; small volume, pasty, yellow with some free water | Relatively low renal solute load; low in sodium but supplies the daily requirement and is used for normal babies. Whey/casein ration similar to breast milk (60:40). Also used in long-term management of renal or heart disease. |
| Mushy, yellow-green with more free water than cow's milk stools | Soy formulas are based on soy products. Since they do not contain milk products or lactose, they are used both for milk protein hypersensitivity or lactose intolerance. |

Table 4-8 (continued)

| Formula | Company | Carbohydrate | Protein | Fat |
|---|---|---|---|---|
| Cho-Free | Syntex | None | Soy protein isolate | Soy oil |
| Portagen | Mead Johnson | Sucrose, corn syrup solids | Sodium caseinate | Fractionated coconut oil, medium chain triglycerides (MCT), corn oil (trace) |
| Meat Base Formula (MBF) | Gerber | Sucrose, modified tapioca starch | Animal (beef heart) | Animal fat, sesame seed oil |
| Pregestimil | Mead Johnson | Dextrose, tapioca starch | Enzymatically hydrolyzed 8 casein | Fractionated coconut stool oil, medium chain triglycerides (MCT), corn oil (trace) |
| Evaporated milk* | Variety | Lactose, added corn syrup | Casein | Butterfat |

*Evaporated milk must be diluted and carbohydrate added to make an appropriate formula for infants: 3 oz (100 ml) milk + 4.5 oz (130 ml) water + 2 teaspoons (10 ml) corn syrup.

| Stool Characteristics | Explanations |
|---|---|
| Similar to soy formula stools, depending on carbohydrate added | Cho-Free is a carbohydrate-free formula, only 12 kilocalories per ounce. Carbohydrate may be added to formula or supplied by intravenous fluids. |
| Similar to cow's milk formula stools | Pancreatic or liver disease causes interference in fat absorption. Long chain triglycerides are absorbed through the lymphatic system and require a certain amount of bile and pancreatic enzymes. MCT are absorbed directly into portal circulation. Portagen is indicated for an infant with pancreatic or liver disease or with immature fat absorption capabilities. |
| Large volume, formed, brown, strong smelling stool | MBF is used for infants with multiple allergies. It is milk-free, soy-free, egg-free, and corn-free. |
| Low volume, green mucus stool | Composed of simple structures which are easily absorbed; glucose, MCT oil, and hydrolyzed casein; this is used in malabsorption cases. Has a high intestinal osmotic load. Start at half-strength and gradually increase to full strength. |
| Similar to other cow's milk formulas | Vitamin C and iron supplements necessary; Vitamin D supplements necessary with some unfortified brands. |

# Appendix C

Table 4–9 Recommended Feeding Practices and Nutritional Assessment Guidelines for Infants, Birth to 1 Year of Age

| | 0 to 3 months | 3 to 6 months |
|---|---|---|
| Milk and Formula | Breast milk or iron fortified formula should be provided throughout the first year. Plain boiled water may be offered daily. Bottles should be sterilized for the first 3 months or longer. | Continue providing breast milk or iron-fortified formula. |
| Infant Food | Do not begin until 4 to 6 months of age. | May introduce plain (not mixed, sweetened, or spiced) strained or puréed texture foods singly, each for a 5 to 7 day period to rule out allergy. Start with cereals or grain products, vegetables, fruits and juices, then meats. Start with 1 to 2 teaspoons and progress as appetite indicates. Amount taken should not decrease milk intake to less than 32 ounces/day. |
| Supplementation | 10 milligrams of iron/day unless using iron-fortified formula. 0.25 milligrams fluoride/day unless water > 0.3 parts per million; 400 I.U. vitamin D/day if breastfed; multivitamin daily if milk intake < 23 ounces for an extended time; 35 milligrams vitamin C/day if using evaporated milk formula; 4 micrograms vitamin $B_{12}$/day, 500 milligrams of calcium/day to mother if breastfeeding and is a vegan (no milk or milk products included in a vegetarian diet). | Same as during 0 to 3 months. |
| Nutritional Assessment | Plot and evaluate weight, length, and head circumference. Take diet history and evaluate for kilocalories/kilogram, protein/kilogram, iron, and vitamin D intake. If breastfeeding, take mother's diet history and evaluate for fluid, kilocalories, protein, water soluble vitamins. | Same as 0 to 3 months, include evaluation of infant-food intake. Obtain hemoglobin/hematocrit values if history or physical exam suggest possibility of depleted iron stores (4 to 6 months). |

| 6 to 9 months | 9 to 12 months |
| --- | --- |
| Continue providing breast milk or iron-fortified formula. | Continue providing breast milk or iron-fortified formula until first birthday. Begin offering small amounts of fluids from cup. All fluids by cup by 12 to 14 months. Avoid sweetened beverages which decrease appetite for more nutritious foods. |
| By 8 months, allow finger foods such as bits of peeled, cooked fruit or vegetable bits, dry toast, zwieback. Avoid raw vegetables, nuts, popcorn, etc. Avoid sweetened or spicy foods. Egg yolk may be offered at this time. Foods may be coarsely ground as tolerated. | Continue offering variety of foods; continue offering finger foods. Whole egg may be offered at 1 year of age. Avoid raw vegetables, nuts, popcorn, skins, or seeds of fruits. Avoid sweetened, fatty, or spicy foods. |
| 15 milligrams of iron/day unless using iron-fortified formula and/or 6 tablespoons iron-fortified infant dry cereal. Other supplementation same as during 0 to 3 months. | Same as during 6 to 9 months. |
| Same as during 3 to 6 months. | Same as during 3 to 6 months. |

**Table 4–10** Common Feeding-Related Problems, Their Symptoms, Causes, and Treatments in the Infant

| Problem | Symptoms | Cause | Treatment |
|---|---|---|---|
| Spitting | Amount of formula lost is minimal; usually resolves by 2 to 3 months of age; no weight loss. | 1. immaturity of gastrointestinal tract | 1. no formula change<br>2. verbal encouragement |
| Regurgitation | Effortless explusion of gastric contents; amount of formula lost can be significant; usually occurs immediately after feeding--both liquids and solids--generally in supine but also in prone or upright positions. | 1. immaturity or dysfunction of the gastroesophageal sphincter (gastroesophageal reflux)<br>2. seldom allergy | 1. no formula change<br>2. position infant upright (40 to 60°) after feeding for a 40 to 60 minute period<br>3. give 1 to 2 teaspoons of strained food<br>4. careful physical exam (esophagitis, blood loss-anemia, bronchitis, or pneumonia secondary to aspiration)<br>5. seldom allergy elimination |
| Vomiting | Forceful explusion gastric contents; acute or chronic weight loss. | 1. acute--infectious agent<br>2. chronic bilious--mechanical obstruction<br>3. chronic blood stained--esophagitis, gastritis, gastric, or duodenal ulcer<br>4. chronic with other allergic symptoms | For all causes:<br>1. usually no formula change<br>2. careful physical exam<br>3. if allergy, change protein source to soy or meat-based formula |
| Diarrhea | Duration less than 2 weeks | 1. gastroenteritis; infectious agent | 1. fluid and electrolyte replacement |
| | Duration greater than 2 weeks<br>1. acute gastritis preceding | 1. secondary disaccharidase deficiency | 1. change to sucrose/maltose or monosaccharide containing formula |
| | 2. onset coinciding with new food | 2. specific food intolerance (i.e., gluten) | 2. omission of offending food or food substance |
| | 3. stool containing blood or pus | 3. infectious agent and/or protein sensitivity | 3. no formula change if infectious agent unless secondary lactose intolerance; if sensitivity, change to commercial formula if using whole cow's milk; change to soy or meat-based formula if using commercial cow-milk protein formula |

Table 4-10 (continued)

| Problem | Symptoms | Cause | Treatment |
|---|---|---|---|
| Diarrhea (continued) | 4. increased fluid content of stool decreased pH (less than 5.5) beyond the normal stools during the first 6 weeks of life<br>5. large, bulky, pale, oily stool | 4. osmotic gradiant caused by unabsorbed carbohydrate, drawing excess fluid into intestine<br>5. fat malabsorption | 4. change to sucrose/maltose or monosaccharide containing formula (carefully monitor when giving formula with osmolaity greater than 300 milliosmole/liter)<br>5. change to medium chain triglyceride containing formula |
| Constipation | Hard, dry stool, pellet-like, difficult to expel; usually inadequate size and passed infrequently, although infrequency alone is not necessarily constipation. | 1. usually functional or secondary to early addition of solids particularly cereals (complex starches), but may be congenital aganglionic megacolon and anorectal anomalies, hypothyroidism, Hirschsprung's disease, anal fissure | 1. careful physical assessment<br>2. discontinue solids if appropriate<br>3. add 1 teaspoon of carbohydrate to 4 ounces of water or formula 1 or 2 feedings per day |
| Colic | Crying for several hours, withdrawing legs onto abdomen, and passage of large amounts of flatus; usually occurs during first 3 weeks but can occur later; usually resolves by age 3 months. | 1. hunger, food allergy, lactose intolerance, fat malabsorption, central nervous system immaturity, gastroesophageal reflux, parental attitudes (uneasiness with newborn, nervousness, stress, etc.) usually 1 of the latter 3 causes<br>2. if other symptoms of gastrointestinal disease also present, may be symptoms of other disease entity above | 1. give small, frequent feedings, and offer parents reassurance<br>2. if disease (allergy or malabsorption) present, treat accordingly--changing protein source (to soy or meat-base formula); changing carbohydrate (to sucrose or maltose containing formula); changing fat source (to MCT formula) depending on disease entity |
| Allergy | Recurrent colic abdominal pain, vomiting; wheezing, congestion, subsiding with elimination of suspected food; atopic eczema (more reliable signs of allergic diathesis); wheezing without infection; urticarial reactions to specific foods. | 1. allergic diathesis | 1. allergy skin tests<br>2. allergy elimination regimen:<br>a. eliminate all foods except breast milk or formula<br>b. if symptoms do not subside, change to soy formula and continue with soy formula for 4 to 5 days unless symptoms markedly increase<br>c. if symptoms increase or do not subside, consider environmental allergens and change to meat-base formula<br>d. when infant food is appropriate, begin foods singly for a 4 to 5 day period as with formula |

Table 4-10 (continued)

| Problem | Symptoms | Cause | Treatment |
| --- | --- | --- | --- |
| Undernutrition | Growth retardation, failure to gain appropriate amounts of weight: apathy, developmental lags, poor appetite | 1. inadequate intake due to inaccurate dilution of formula, inadequate production of breast milk, inappropriate feeding technique, or systemic disease | 1. determine kilocalorie intake and method of formula preparation and feeding<br>2. determine if systemic disease is present<br>3. evaluate parenting behaviors |
| Obesity | Rate of weight gain greater than rate of gain in length and head circumference. | 1. inaccurate dilution of formula, excessive intake, inappropriate feeding practices (infant feeders, bottle used for appeasement, high kilocalorie solids given frequently, etc.) | 1. limit caloric intake to 120 kilocalories/kilogram for 0 to 6 months, 100 kilocalories/kilogram for 6 to 12 months, usually accomplished by:<br>a. decrease formula intake to 24 to 32 ounces/day<br>b. use plain unsweetened water and juice<br>c. encourage plain fruits and vegetables<br>d. eliminate sweetened fruits and desserts |
| Anemia | Hemoglobin less than 11 grams/100 milliliters; transferrin less than 15% saturated. | 1. poor iron intake (often secondary to excessive intake of iron-deficient milk) with depletion of iron stores; most common after 6 months of age | 1. severe anemia: 8 milligrams iron 3 times daily until normal serum values are achieved, then normal daily dose<br>2. mild anemia: as above (usually much shorter period of time)<br>3. normal dose: 7 milligrams/day |

## Appendix E–1

**Figure 4–2** A Growth Graph for Infants of Various Gestational Ages (Combined Sexes)

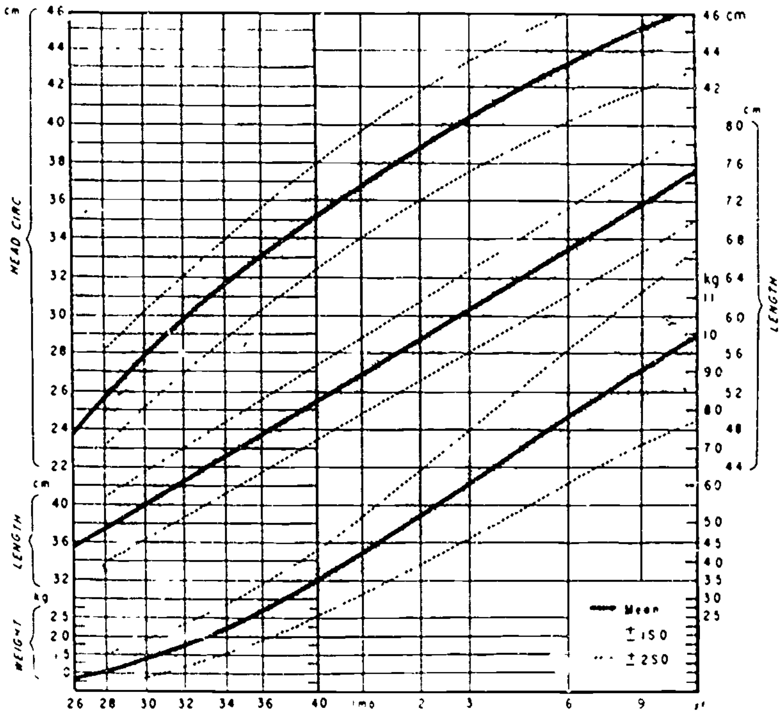
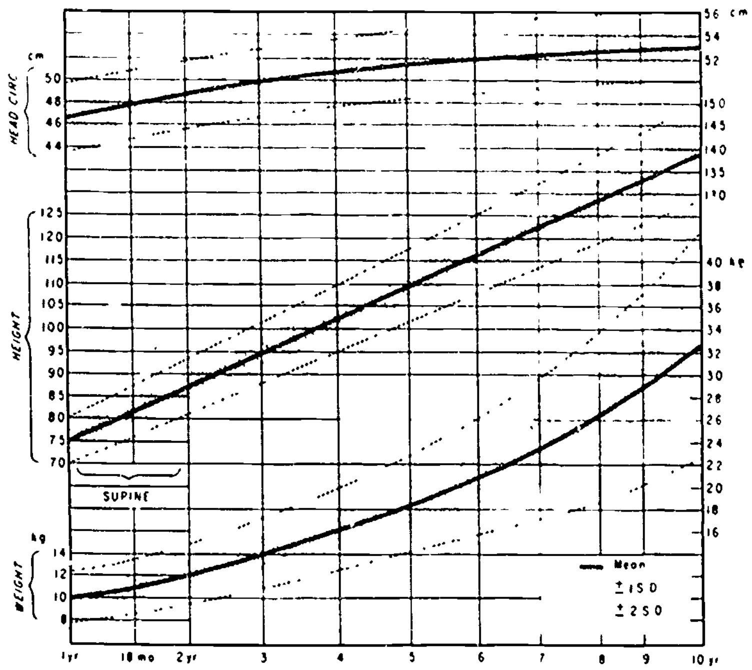



**Figure 4–3** A Growth Graph for Youth of Various Ages (Combined Sexes)

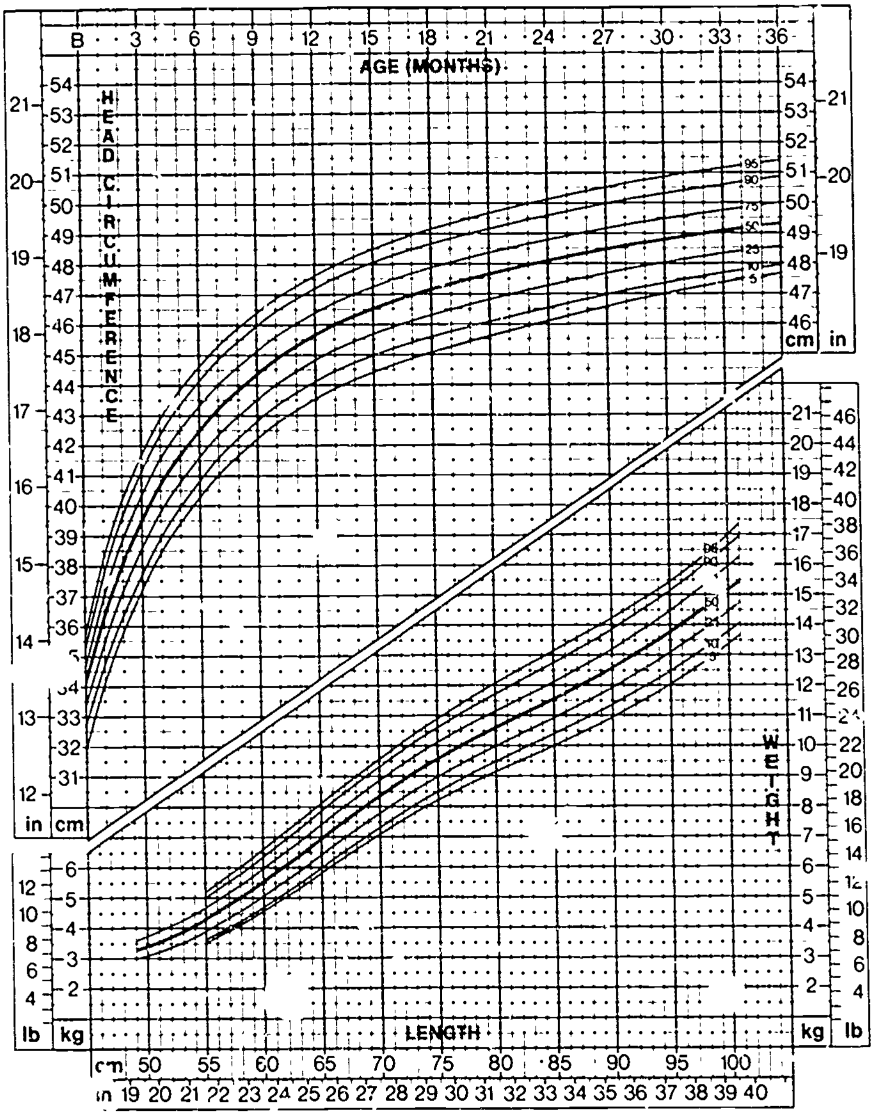



Figures 4–2 and 4–3 from Babson, S G and Benda, G.I., "Growth Graphs for the Clinical Assessment of Infants of Varying Gestational Age." *The Journal of Pediatrics*, 89.5, 814-820, 1976 Used with permission of The C.V Mosby Company, © 1976, St. Louis, MO.

# Appendix E–2

**Figure 4–4** Girls: Birth to 36 Months Physical Growth NCHS Percentiles

Courtesy of Ross Laboratories




| DATE | AGE | LENGTH | WEIGHT | HEAD C |
|---|---|---|---|---|
| | BIRTH | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

| DATE | AGE | LENGTH | WEIGHT | HEAD C |
|---|---|---|---|---|
| | | | | |
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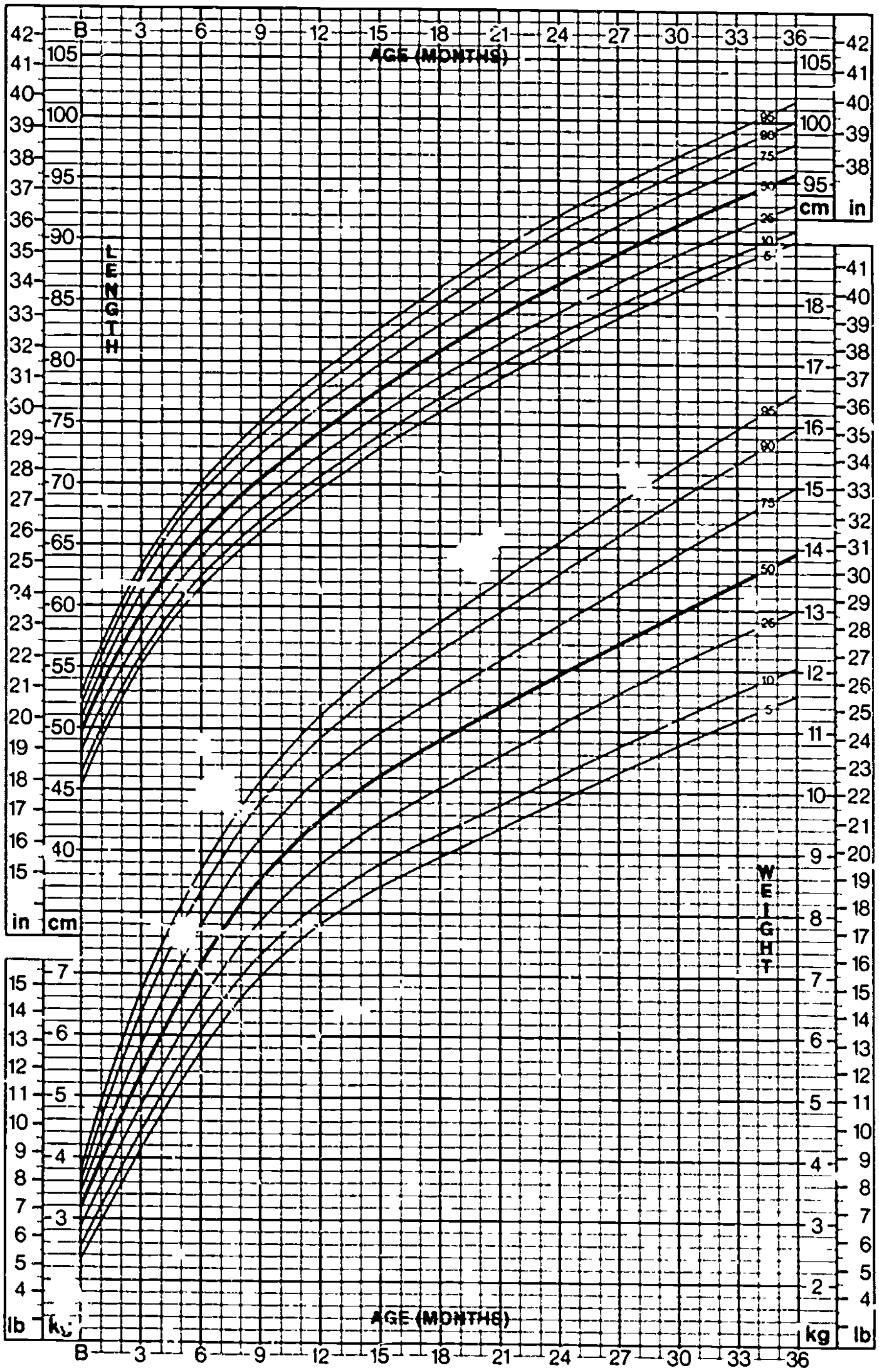
| | | | | |
| | | | | |

## Appendix E–3

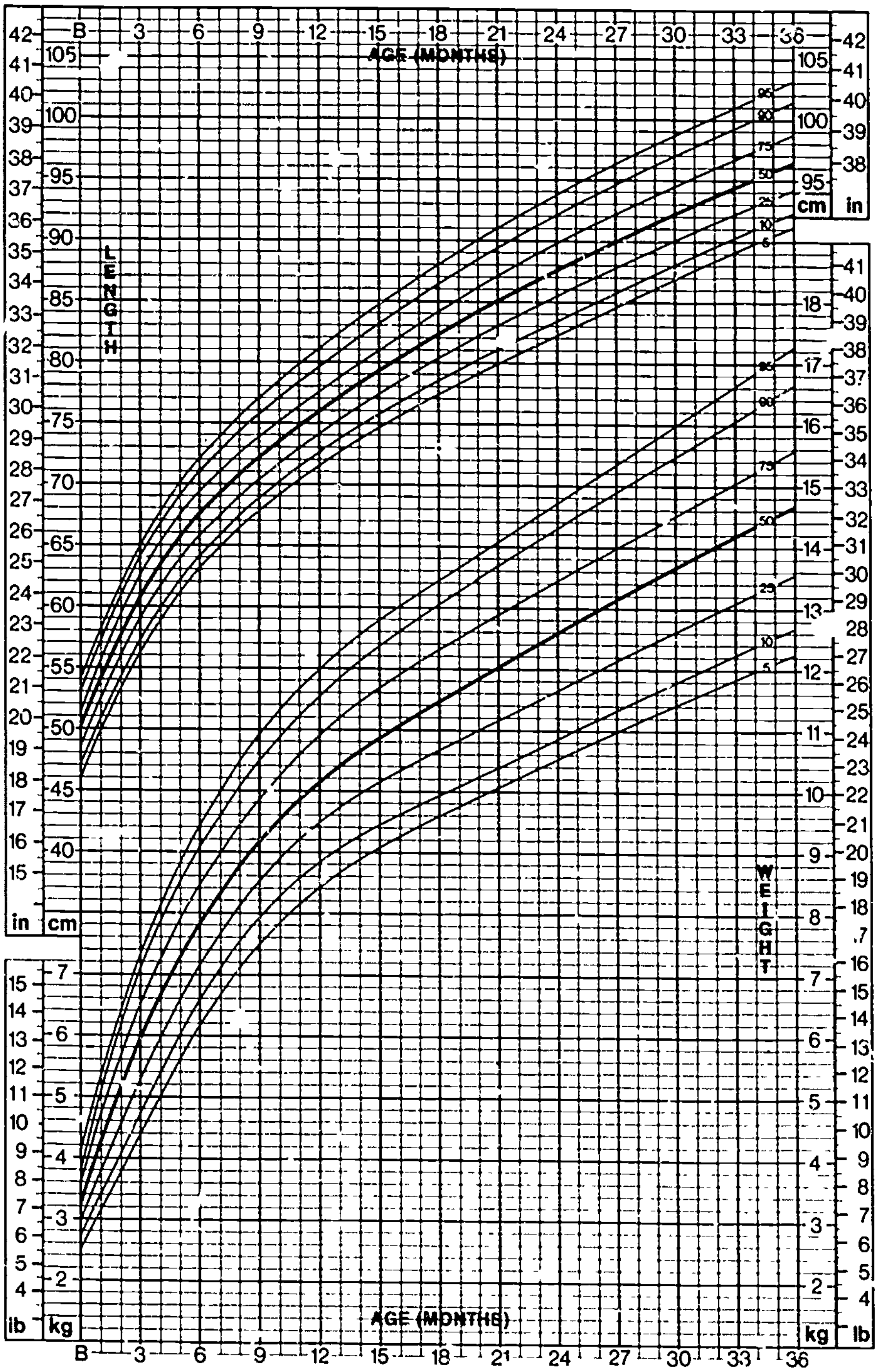
**Figure 4–5** Girls: Birth to 36 Months Physical Growth NCHS Percentiles



# Appendix E–4

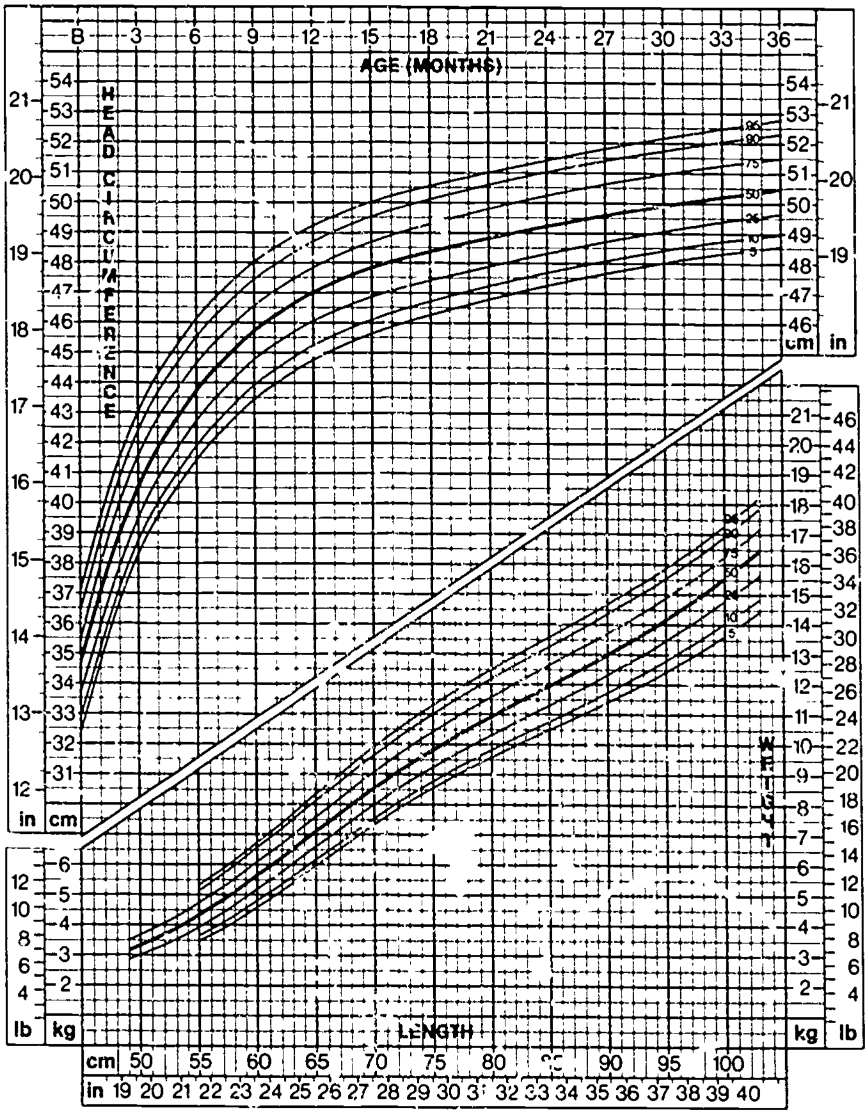
**Figure 4–6** Boys: Birth to 36 Months Physical Growth NCHS Percentiles

Courtesy of Ross Laboratories



## Appendix E-5

**Figure 4–7** Boys: Birth to 36 Months Physical Growth NCHS Percentiles




Courtesy of Ross Laboratories

| DATE | AGE | LENGTH | WEIGHT | HEAD C |
|---|---|---|---|---|
| | BIRTH | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

| DATE | AGE | LENGTH | WEIGHT | HEAD C |
|---|---|---|---|---|
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| | | | | |

Figures 4–4 through 4–7 adapted from Hamill, P V V , Drizd, T A , Johnson, C L , Reed, R B , Roche, A.F., Moore, W M "Physical Growth, National Center for Health Statistics Percentiles." *American Journal of Clinical Nutrition*, 32:607 629, 1979 Data from the National Center for Health Statistics (NCHS), Hyattsville, MD

# Appendix F

## Table 4–11 Biochemical Methods and Remarks Regarding Interpretation

| Substance | Method | Quantity Required | Comment |
|---|---|---|---|
| Hemoglobin (blood) | Cyanmethemoglobin (O'Brien et al., 1968a) | 20 μl | Concentration of hemoglobin less than 11.0 g/100 ml for children below 10 years of age and less than 12.0 g/100 ml for older children (less than 13.0 g/100 ml for males over 14 years of age) indicates anemia (See Part II, Chap. 4) |
| Hematocrit (blood) | Capillary tube (O'Brien et al., 1968b) | 40 μl | Hematocrit less than 34 for children below 10 years of age and less than 37 for older children (less than 41 for males over 14 years of age) indicates anemia (see Part II, Chap. 4) |
| Iron and iron-binding capacity (serum) | Manually by method of Fischer and Price (1964) or automated (Garry and Owen, 1968) | 200 μl<br>100 μl | Concentration of iron, iron-binding capacity and percent saturation of transferrin may require different interpretation in infants than in older individuals (See Part II, Chap. 4) |
| Free erythrocyte porphyrins (blood) | Method of Piomelli et al. (1976) with filter paper disc | 100 μl | Free erythrocyte porphyrin/hemoglobin ratio greater than 5.5 μg/g indicates iron deficiency |
| Total protein (serum) | Microbiuret manually (O'Brien et al., 1968c) or automated (Failing et al., 1970) | 50 μl | With manual method, a serum blank is desirable |
| Albumin (serum) | Electrophoresis on cellulose acetate (Fomon et al., 1970) | 10 μl | Concentration of albumin less than 2.9 g/100 ml suggests poor protein nutritional status |
| Ascorbic acid (plasma) | 2,6 Dichloroindophenol reaction manually (O'Brien et al., 1968d) or automated (Garry et al., 1974) | 20 μl<br>50 μl | Concentration less than 0.3 mg/100 ml suggests that recent dietary intake has been low |
| Vitamin A (plasma or serum) | Fluorometry (Garry et al., 1970, or Thompson et al., 1971) | 200 μl | Concentration less than 10 μg/100 ml suggests deficiency and concentration less than 20 μg/100 ml indicates low stores |
| Alkaline phosphatase (serum) | Liberation of p-nitrophenol manually (O'Brien et al., 1968e) or automated (Morgenstern et al., 1965) | 100 μl | Activity greater than 25 Bodansky units/100 ml is suggestive of rickets |
| Inorganic phosphorus (serum or plasma) | Modification of method of Fiske and Subba Row (1925) manually (O'Brien et al., 1968f) or automated | 50 μl | Concentration less than 4.0 mg/100 ml is abnormal and suggestive of rickets. However, normal concentration does not rule out the presence of rickets |
| Urea nitrogen (serum) | Urease manually (O'Brien et al., 1968g) or diacetyl monoxime manually or automated (Marsh et al., 1965) | 100 μl<br>50 μl | Concentration less than 8 mg/100 ml suggests low recent dietary intake of protein. However, concentrations as low as 3.5 mg/100 ml are sometimes found in breastfed infants |
| Cholesterol (serum) | Manually by method of Carr and Drekter (1956) or automated (Levine and Zak, 1964) | 100 μl | Concentration of cholesterol more than 230 mg/100 ml indicates hypercholesterolemia (See Part II, Chap. 2) |
| Lipoproteins (serum) | Agarose electrophoresis (Laboratory Methods Committee, 1974) | 100 μl | For interpretation, see Fredrickson and Levy (1972) |
| Creatinine (urine) | Alkaline picrate manually (O'Brien et al., 1968h) or automated | 100 μl | Serves as reference for other urine determinations |
| Riboflavin (urine) | Fluorometry (Horwitz, 1970a) | 2 ml | Excretion less than 250 μg/g of creatinine suggests low recent dietary intake |
| Thiamin (urine) | Thiochrome fluorometry (Horwitz, 1970b) | 10 ml | Excretion of less than 125 μg/g of creatinine suggests that dietary intake has been low for weeks or months |
| Iodine (urine) | Automated ceric ionarsenious acid system (Garry et al., 1973) | 5 ml | Excretion of less than 50 μg/gm of creatinine suggests low recent dietary intake |

From *Nutritional Disorders of Children, Prevention, Screening, and Followup*. U.S. Department of Health, Education, and Welfare, Public Health Service, Health Services Administration, Bureau of Community Health Services, Rockville, MD. References within table are listed in *Nutritional Disorders of Children*, pp. 53-55

## Some Abbrevations Used in the Nutrition in Primary Care Series

| | |
|---|---|
| ATP | adenosine triphosphate |
| c | cup |
| cc | cubic centimeter |
| CNS | central nervous system |
| FDA | Food and Drug Administration |
| gm | gram |
| IBW | ideal body weight |
| IU | International Units |
| kcal | kilocalorie |
| kg | kilogram |
| lb | pound |
| lg | large |
| MCV | mean corpuscular volume |
| MDR | minimum daily requirement |
| med | medium |
| mEq | milliequivalent |
| mg | milligram |
| MJ | megajoule |
| ml | milliliter |
| oz | ounce |
| RDA | Recommended Dietary Allowances |
| RE | retinol equivalents |
| sl | slice |
| sm | small |
| Tbsp | Tablespoon |
| TPN | total parenteral nutrition |
| tsp | teaspoon |
| USDA | United States Department of Agriculture |