Nutrition and Growth in Infancy

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1. Introduction

Whereas no direct information on intrauterine growth and nutrition can be obtained, postnatal growth and nutrition and their interactions are accessible to study by exact measurements.

There seems to be little question about the causative factor in this relationship; growth appears to be affected by nutrient intake: In the presence of adequate nutrition, a healthy infant will grow normally; in malnutrition and overnutrition, failure to thrive and excessive weight gain appear to be caused by inappropriate food availability.

It seems that an infant will voluntarily take the amount of food that will allow him to grow adequately. Are actual body size or target size or even a target body composition and its changes during maturation the driving forces of food intake? We have to treat both food intake and growth as independent entities until we know more about the causative factors in that relationship.

We are on safe ground if we consider the growth of normal infants of a well-defined population; first, breast-fed infants and then infants fed various formulas ad libitum. Model considerations on the interrelationship of growth and nutritional requirements follow. Finally, we shall comment on the impact of some single nutritional factors on growth disorders.

2. Food Intake and Growth of Normal Infants under Controlled Conditions

The considerations to follow will refer mainly to studies by Fomon and associates between 1966 and 1975. Normal full-term Caucasian infants with birth
weights of 2500 g or more were enrolled between ages 6 and 9 days in prospective studies of food intake and growth. Nearly all the subjects were children of students or younger staff members of the University of Iowa, living continuously at home with their parents. The infants were either breast-fed or received ready-to-feed infant formulas *ad libitum*, and in both instances adequate intake of vitamins and minerals was provided. Specified strained foods in limited amounts were introduced from age 28 days. Daily amounts of formula ingested and consumption of strained food were calculated from the weight of bottles, cans, or jars before and after use.

From careful determinations of length and weight (Fomon, 1974b) at regular intervals (ages 8, 14, 28, 42, 56, 84, 112, and in one study also 140 and 168 days), daily gains in weight and length could be computed.

2.1. Growth of Breast-Fed Infants

This study of Fomon *et al.* (1970) comprised 149 infants, 83 males and 66 females, of whom 70% completed a 4-month observation period. Except for one formula feeding per day (Similac®, 67 kcal/100 ml), which not all parents elected to give, the infants were breast-fed.

Figure 1 indicates the 10th, 50th, and 90th percentiles of weight and length of the 58 male and 46 female infants who completed the 4-month study. With one exception (10th weight percentile at age 28 days) all percentile values for weight and length were higher in male than in female infants during the whole observation period. There appears to be an unexpectedly broad interval between the 50th and 10th weight percentile in male infants lasting from age 8 to 56 days, and in female infants from age 42 to 112 days, which will be discussed later (Section 2.2).

Table 1 provides the 10th, 50th, and 90th percentile values of increments in weight and length for specified age intervals. Rates of growth may change significantly in any individual between short-term observation periods (Figure 2), but there is a tendency to equilibrate for preceding high or low gains during successive growth periods. This is demonstrated by the following phenomenon: summation of all the short-term gains at the 10th percentile results in a lower value than the 10th percentile gain for the total (8 through 112 days) intervals, and vice versa: Summation of the 90th percentile gains during successive short-term interval gives a higher result than the 90th percentile gain for the total observation period.

Gain in weight was larger and increase in length slightly larger in boys than in girls. Weight gain per unit of gain in length was greater in males than in females between 8 and 112 days of age.

For two major reasons nutrient intake of these breast-fed infants was not evaluated: The natural environment could have been disturbed by weighing infants precisely before and after nursing and by collecting samples of breast milk. Also composition of breast milk is known to change between feedings and even during nursing (Tarján *et al.*, 1965; Hall, 1975), prohibiting any accurate determination of nutrient consumption at the breast.

For an insight into the interplay between growth and nutrient intake, it is necessary to rely on observation of bottle-fed infants, whose food consumption and food composition were carefully recorded during the corresponding growth intervals.