Protein Requirements and Intake

The protein requirements for infants and young children are higher than for older children and adults when expressed per kilo body weight, mainly attributable to the larger requirements for growth. Revised estimates for a safe intake are 1.09 kg/kg for 6 to 9 months of age and 1.02 kg/kg for 9 to 12 months, compared with about 0.8 kg/kg in adults.1 However, the requirements for energy when expressed per kilogram body weight are relatively higher. The energy need of a 9- to 12-month-old infant is 89 kcal/kg,2 almost 3 times the need of an adult with moderate physical activity (about 30 kcal/kg). Thus, the diet of a 9- to 12-month-old infant should contain protein at about 5% of the total energy content (1.02 g protein × 4 kcal/g/89 kcal), 5% is the level in human milk. As an infant changes from exclusive breastfeeding to a diet based on family food, the protein energy ratio will increase from the 5% in breast milk to 12 to 15%, the typical protein content of a family diet. If the diet is low in fat, which is often the case during the period of complementary feeding,3 the protein content is higher, about 15 to 20%. Assuming a 12-month-old infant with a weight of 10 kg and a recommended energy intake (89 kcal/kg) receiving a diet with 15% protein, this infant will receive a protein intake equal to 3.4 g/kg or more than 3 times the requirements for protein.

Dietary surveys from industrialized countries confirm that the protein intake is high during the complementary feeding period. In the Copenhagen Cohort Study4 the median protein intake in 12-month-old weaned infants was 3.2 g/kg (14%) and the 90th percentile was 4.7 g/kg (18%). The mean protein intake in children younger than 2 years was 3.3 g/kg in 4 of 5 European countries were higher than those from the Copenhagen Cohort Study, the highest being in Italy where the mean intake was 5.1 g/kg (19.5%).5 Assuming a standard deviation (SD) of 0.7 g/kg6 some of the infants have a very high protein intake. It is thus plausible that weaned infants in industrialized countries not being breastfed will have typically a protein intake 3 to 4 times above the requirements and that a small group will have intakes that are at least 5 to 6 times above the requirements. Do such high protein intakes have any adverse effects?

Renal Solute Load

Protein constitutes a considerable part of the solutes that must be excreted by the kidneys; in cows’ milk it is about 60%. In another article in this supplement Fomon describes the potential adverse effects of a high renal solute load.

Kidney Size and Glomerular Filtration Rate

A high protein intake increases glomerular filtration rate (GFR) and kidney size, but data on infants and young children are scarce. In a 6-month intervention study in adults a slight increase in protein intake of 18% resulting in a protein intake of 1.6 g/kg body weight increased GFR by 5% and kidney size by 2.5%.7 In adults the GFR reaches a maximum level at a protein intake of 2 g/kg.8 The increase in GFR and kidney size is an adaptive response to a high solute load, and the adverse effects of a high protein load in patients with kidney disease are probably not a problem in healthy individuals. Possible adverse effects of the high protein intake some infants receive have not been examined.

Plasma Amino Acids

A high protein intake results in high levels of amino acids in the blood. Branched-chain amino acids stimulate insulin secretion that stimulates growth during infancy.9 Many amino acids have specific metabolic effects eg, on the hormone system or on neurotransmitters. Behavioral effects of a high protein intake have been shown in preterm and term infants,9 but no similar studies have been performed in the complementary feeding period.

Insulin-Like Growth Factor-1 (IGF-1), Growth, and Adiposity

Rolland-Cachera has suggested that a high protein intake during early life increases the risk of developing obesity later in life. The proposed mechanism is that protein stimulates IGF-1 secretion and thereby protein synthesis and cell proliferation.5 The increased IGF-1 levels may then accelerate growth and increase muscle mass and adipose tissue. Such a mechanism might also explain why breastfeeding seems to protect against adiposity,10 because protein intake in breastfed infants is lower than in weaned infants. There are, however, no data available to show that a protein intake considerably above the requirements can stimulate IGF-1 secretion and thereby accelerate growth in healthy infants during the complementary feeding period. In a study of dietary factors affecting linear growth during the period from 5 to 10 months of age, we were surprised to find a positive association of protein intake with growth, even though the average protein intake was 13 to 14% and thereby far above the requirements.11

Conclusion

There are no data indicating that a protein intake 3 to 4 times above the requirements has any adverse effects, but only a few studies have focused on the small group of infants receiving a higher protein intake, more than 5 times the requirements. Such intakes might impair water homeostasis during illness and it can not be excluded that they have adverse effects immediately or later in life.

Research Recommendations

1. There is a need for more dietary surveys describing protein intake during the period of complementary feeding. These studies should include information on sources of protein, and focus on those with a high intake.
2. Does a high protein intake have long-term effects on renal growth and function?
3. Is there an effect of protein intake on the levels of serum IGF-1 in infants and young children? If so, does it have immediate or long-term effects on growth, body composition, and adiposity?
4. Do the high levels of certain plasma amino acids seen in infants with a high protein intake have any adverse effects?
5. Are there other metabolic effects—immediate or long-term—of an excessive protein intake?

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