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EDUCATIONAL PAPER

Basic concepts in nutrition: Nutritional needs of children and adolescents

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Learning objectives:

- To be aware of the importance of adequate nutrition during the growth period;
- To know normal nutritional needs in growing children and adolescents;
- To be familiar with methodological problems connected with establishing nutritional needs in children and adolescents.

Introduction

The supply and utilisation of nutrients are of greater biological relevance during early childhood than during any other period of life. In adults, the nutrient supply must cover maintenance requirements and the needs for physical activity. In contrast, children need large additional energy and substrate intakes for body growth. Healthy newborn infants double their body extremely rapidly in only 4—5 months after birth, and in preterm infants even in only about 6 weeks, which requires a very high substrate supply per kg bodyweight. The quantity and quality of nutrient supply during early life modulates the differentiation of tissues and organs and has short- and long-term consequences for health.

Nutrient requirements for growth and development

The rapid growth of infants and children, who double their body weight within only 6 weeks in utero and within 4—5 months after birth, respectively, depends on very large nutrient supplies per kg body weight. Healthy young infants need about 3 times more energy per kg body weight than adults, primarily due to the added metabolic requirements for growth. Premature infants who grow at rates similar to normal intrauterine growth have even greater metabolic needs (Table 1). Further growth spurts occur during the preschool age and during puberty, respectively (Table 2).

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Table 1 Estimated energy needs per day of a parenterally fed premature infant, with about half of the caloric needs determined by the requirements for growth

Maintenance requirement	
Basal metabolism	34+50 kcal/kg (day 1: 34, day 6: 42, weeks 2—4: 50 kcal/kg)
Physical activity	15 kcal/kg
Thermoregulation	10 kcal/kg
Additional requirement for growth	
Growth (material deposited + cost of synthesis)	45 kcal/kg
Thermogenic effect	8 kcal/kg
Estimated total requirement	92—108 kcal/kg

Enterally fed infants have some 10—15% higher energy requirements due to relatively inefficient absorption at this age.

Table 2 Mean body weights (kg) and lengths (cm) of European children (adapted from Ref. 17)

Age		Weight [kg]		Length [cm]	
Years	Months	Males	Females	Males	Females
	1	4.0	4.0	53.0	52.5
	3	6.0	5.5	60.0	59.0
	6	8.0	7.5	67.5	66.0
	9	9.0	8.5	71.5	70.0
1	0	10.0	9.5	75.7	74.0
1	6	11.5	11.0	82.0	80.5
2	0	12.5	12.0	87.5	86.0
2	6	14.0	13.0	92.0	90.5
3	0	15.0	14.0	96.0	95.0
3	6	15.5	15.0	99.0	98.0
4	6	17.5	17.0	106.5	105.5
5	6	19.5	19.5	112.5	111.5
6	6	22.0	21.5	119.0	118.0
7	6	24.5	24.0	124.5	123.5
8	6	27.0	27.0	130.5	129.0
9	6	30.0	30.5	135.5	135.0
10	6	33.0	34.0	140.5	140.5
11	6	36.5	37.5	145.5	146.5
12	6	41.0	43.0	150.5	153.0
13	6	47.0	48.0	157.5	158.0
14	6	53.0	50.5	160.5	163.0
15	6	58.0	52.5	162.0	166.5
16	6	62.5	54.0	162.5	168.0
17	6	64.5	54.5	163.0	169.0

In developing and growing organisms, marginal nutrient supplies are usually more critical than in steady state situations during adulthood. The ability to effectively utilise and compensate for unbalanced supplies is severely limited in young children due to small endogenous stores of a number of relevant substrates, and in many cases also due to immature metabolic pathways and physiologic functions. Examples are the limited ability for cysteine synthesis in young infants, which results in an essential need for a cysteine supply, and the low capacity to concentrate in urine which results in more immediate risks of limited water intakes as well as excessive salt or protein supplies.

In addition to the effects of nutrition on growth, body composition and body functions, evidence accumulates for long-term effects of nutritional and metabolic factors during critical time periods of development on later physiologic and metabolic processes, a phenomenon referred to as ''metabolic imprinting'' or ''metabolic programming''.[2] The rate of death from all cardiovascular disease and from coronary heart disease (Fig. 1) in adulthood was found to be significantly related to body weights at birth, and standardised coronary heart disease mortality was also closely related to weight at 1 year. Epidemiological studies have indicated long-term effects of early nutrition on the prevalence of obesity in later life and on the later risk for diabetes, hypertension, and hypercholesterolemia.

A lasting effect of calcium intake during childhood and adolescence on bone mineral density and the risk of fractures at old ages has been reported (Fig. 2). These findings indicate the potential of influencing long-term health and life expectancy by optimal feeding strategies in early

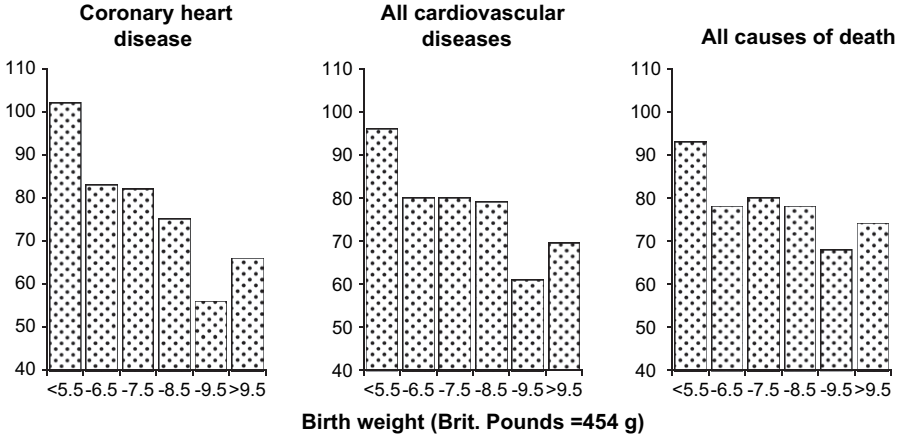

Figure 1 Epidemiological evidence for a relation between early growth and long-term health in 10,141 men born between 1911 and 1930 in Hertfordshire, UK. Low birth weight predicted a marked and significant risk increase for death from coronary heart disease and from the sum of all cardiovascular diseases between the ages of 20 and 74 years (drawn from Ref. 2).