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Role of Protein and Amino Acids in Infant and Young Child Nutrition: Protein and Amino Acid Needs and Relationship with Child Growth

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Summary Over a third of all deaths of children under the age of five are linked to undernutrition. At a 90% coverage level, a core group of ten interventions inclusive of infant and young child nutrition could save one million lives of children under 5 y of age (15% of all deaths) (Lancet 2013). The infant and young child nutrition package alone could save over 220,000 lives in children under 5 y of age. High quality proteins (e.g. milk) in complementary, supplementary and rehabilitation food products have been found to be effective for good growth. Individual amino acids such as lysine and arginine have been found to be factors linked to growth hormone release in young children via the somatotropic axis and high intakes are inversely associated with fat mass index in pre-pubertal lean girls. Protein intake in early life is positively associated with height and weight at 10 y of age. This paper will focus on examining the role of protein and amino acids in infant and young child nutrition by examining protein and amino acid needs in early life and the subsequent relationship with stunting.

Key Words protein, amino acids, protein quality, complementary foods, infant and young child nutrition

Protein and Amino Acid Needs

FAO/WHO requirements for protein and amino acids (across all age groups) have varied considerably over the years (*1–3*). Considerable research on requirements shows that intakes at which balance is achieved are variable in and across individuals being affected by variability in metabolic demand, genotype, and factors that affect phenotype as well as states of active growth, pregnancy and lactation. Efficiency of utilization (or net protein utilization), dietary intakes of other nutrients, lifestyle and environmental influences (including infection) could also alter the minimum protein requirement (*4*). The composition and pattern of amino acids in a diet is also important to generate a suitable mix that will match metabolic demand for protein synthesis and other needs. Compared to previous estimates, current protein requirements are lower in both adults and children; however, amino acid requirements remain the same in children and are significantly higher in adults (*4*). Effectively higher quality protein (to achieve the amino acid pattern) is required in smaller quantities. The essential amino acid requirements for adults are twice the previous recommendations with lysine requirements having increased 2.5 times from 12 mg/kg body weight to 30 mg/kg body weight in adults (*4*). In children, the essential amino acid requirements are only slightly lower (94% of previous estimate for lysine). Protein and amino acid requirements as defined by the current FAO/WHO 2007 report for all age groups are provided in Table 1. Interactions between energy deficit and protein needs also affect nitrogen equilibrium. These have been examined and reviewed extensively (*5*). Energy imbalance (both excess and deficit) affects body nitrogen balance. At a protein intake of 0.57 g/kg body weight, N equilibrium is achieved if energy intake is ~10–15% above that required (*2*, *3*). Conversely people in energy deficit need additional protein and a modest energy deficit increases protein needs by about 10% (*6*). Such fluctuations in needs are not accounted for in the estimation of requirements. Several other possible functions have an impact on protein and amino acid needs. In environments where individuals have persistent immune activation and where possibly a decline in intestinal absorptive capacity is present, while there are no overt clinical symptoms, there is still an increased demand for protein (*4*, *7*). Thus in vulnerable populations such as women and children commonly affected by acute and chronic infections, protein and amino acid

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Table 1. Protein and amino acid requirements.

	Protein requirements (g/kg per day) for		His	Ile	Leu	Lys	SAA	AAA	Thr	Trp	Val
Age (years)	Maintenance	Growth	Amino acid requirements (mg/kg per day)								
0.5	0.66	0.46	22	36	73	64	31	59	34	9.5	49
1–2	0.66	0.2	15	27	54	45	22	40	23	6.4	36
3–10	0.66	0.07	12	23	44	35	18	30	18	4.8	29
11–14	0.66	0.07	12	22	44	35	17	30	18	4.8	29
15–18	0.66	0.04	11	21	42	33	16	28	17	4.5	28
>18	0.66	0	10	20	39	30	15	25	15	4	26
			Scoring pattern (mg/g protein requirement)								
0.5			20	32	66	57	28	52	31	8.5	43
1–2			18	31	63	52	26	46	27	7.4	42
3–10			16	31	61	48	24	41	25	6.6	40
11–14			16	30	60	48	23	41	25	6.5	40
15–18			16	30	60	47	23	40	24	6.3	40
>18			15	30	59	45	22	38	23	6	39

Source: WHO 2007.

needs are likely to be greater. Growth rates (especially linear) are likely to be affected by repeated infections (bacterial and parasitic) with long-term implications including decreased productivity and functional deficits (*7*, *8*). Requirements of amino acids such as lysine are significantly higher in chronically undernourished adults suffering from intestinal infections (*9*, *10*).

Protein and Amino Acids in Child Health and Nutrition

Studies have shown a positive impact of incorporating high quality protein rich foods into the diets of young school children (*11*). An analysis of dietary and anthropometric data collected on Ghanaian children aged 2–13 y, found an association between protein quality and risk of being stunted (*12*) irrespective of energy. Total energy, total protein and total utilizable protein availability estimates have been independently significantly and negatively associated with prevalence of stunting in analyses of 200 countries ($p<0.001$). Total energy explains 41% of the variation in stunting, total protein explains 34% of the variation and utilizable protein (function of protein quality) 40% in prevalence of stunting. Controlling for total energy, utilizable (not total) protein is significantly associated with stunting (43% of the variation in stunting $p=0.006$ total energy and $p=0.017$ utilizable protein) (*13*). High protein intakes are reported in European children during the complementary feeding period (*14*) and are indicative of having a growth-stimulating role (especially that of linear growth) through effects on insulin-like growth factor (IGF-1). High quality proteins (e.g. milk) to complementary, supplementary and rehabilitation food products has also been found to be effective for growth. Individual amino acids such as lysine and arginine have been found to be factors linked to growth hormone release in young children via the somatotropic axis and high intakes are inversely associated with fat mass index in prepubertal lean girls. Protein intake in early life is positively associated with height and weight at 10 y of age. Furthermore, there is an effect of dietary restriction of single essential amino acids including leucine, lysine, methionine and threonine on plasma IGF-I production. A decrease in retro-peritoneal fat mass and an increase in lean body mass have been documented in rat models supplemented with L-arginine and conjugated linoleic acid. Further work needs to be done to examine these relationships more closely and to understand the role of protein and amino acids within the context of quality rather than quantity in infant and young child nutrition.

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