Solae Science Series

The Role of Soy Protein in Global Child Nutrition

Protein Supports Growing Bodies

Childhood is a critical time for good nutrition to support growth. A baby's weight doubles by five months and quadruples by two years. Height doubles by three or four years. During childhood, growth is slower and steadier than in infancy. Longitudinal studies reveal that most girls reach peak height velocity around age 12-13 while this occurs in boys 2-3 years later[1]. Height accrual continues, but most children are within 2.5 centimeters of their final adult height three years after the growth peak. Growing bodies need ample protein and other nutrients in order to develop to their potential.

Protein needs vary throughout the lifecycle as it is the primary tissue-repair and growth nutrient in the body. Adequate protein is especially important during times of rapid growth, such as infancy, childhood and adolescence[2]. Found in the foods we eat and in our bodies, proteins are made up of twenty-two different amino acids that can be arranged in a myriad of ways to create thousands of different proteins. Of these amino acids, nine are dietary essentials, that is, they must be obtained through foods. The remaining thirteen are termed "nonessential" because the body can make them from other nutrients[3]. Humans need a constant supply of protein to repair cells that are worn out or damaged.

A child's body is growing, developing, and demanding high quality nutrition, even if it is smaller and requiring a lower absolute amount of protein than adults.

The amount of protein we should eat is relative to body weight. As age increases, the rate of growth slows, and the amount of protein needed per kilogram body weight decreases. Height and weight continue to accrue; however, both energy and protein needs increase not only to fuel growth, but also to serve as hormones and other components critical for child and adolescent development. The table quantifies the amount of protein needed to support growth and development throughout childhood (adapted from World Health Organization[4]).

Protein Deposition in Children[4]

Age (yrs)	Weight (kg)		Total Protein (kg)		Protein Deposition (g/kg per day)	
	Male	Female	Male	Female	Male	Female
4	20.9	17.8	2.7	2.2	0	0
5	19.5	18.7	2.6	2.2	0.007	0.022
6	20.2	20.5	2.8	2.5	0.032	0.039
7	22.7	23.0	3.1	2.8	0.048	0.048
8	26.6	26.1	3.6	3.3	0.055	0.051
9	31.6	29.7	4.2	3.8	0.056	0.050
10	37.4	33.8	4.9	4.3	0.054	0.047
11	43.6	38.1	5.6	4.9	0.050	0.043
12	49.9	42.5	6.4	5.5	0.045	0.037

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Adequate amounts of amino acids of an appropriate pattern must be provided in the diet in order to meet the demand for protein synthesis and other metabolic pathways to support growth and maintenance[4]. Recent research suggests that current protein recommendations do not meet the needs of healthy, growing children[5]. The U.S. protein recommendations for children are slightly higher than those of international health organizations, World Health Organization (WHO) and Food and Agriculture Organization (FAO)[6, 7]. In contrast, recommendations in Japan, India and China exceed U.S. and other international organizations. The Institute of Medicine recommends that both quality and quantity are important aspects of protein needs during childhood. The 2010 Dietary Guidelines Advisory Committee Report also notes the importance of high-quality protein for children, due to high growth and development demands[8]. The Report also recommends a shift to a more plant-based diet and consuming lean sources of protein for reducing risk of chronic disease and ensuring nutrient adequacy[8].

The PDCAAS methodology takes into consideration three important parameters: 1) the food protein's essential amino acid profile, 2) correction for the protein's digestibility, and 3) the ability of the protein to supply the FAO/WHO's amino acid requirements for 2-5-year-olds.[6]

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Soy Protein is High-Quality, Complete Protein

The incorporation of soy into children's diets provides an excellent source of high quality, complete protein, while also being low in saturated fat. In addition to providing needed protein, many fortified soy foods are also good sources of important nutrients for growing children, such as calcium, vitamin D and fiber. In fact, numerous nitrogen balance studies* have demonstrated that when fed in nutritionally appropriate amounts to human subjects, soy protein is comparable in quality to that of egg, dairy and other animal proteins[9-14]. What's more, soy protein is valued for its unique position as the only widely available plant-based complete protein.

Protein quality is a measure of protein bioavailability, and its evaluation is a means of determining the capacity of food proteins to satisfy the body's metabolic demands for amino acids and nitrogen. Protein digestibility-corrected amino acid score (PDCAAS) is the scientific method for assessing protein quality recommended by the FAO and WHO in their 1991 Joint Expert Consultation's Protein Quality Evaluation[6]. The highest possible score using the PDCAAS method is 1.0. Soy protein isolates—like dairy and egg protein—has the highest attainable PDCAAS of 1.0.

* Nitrogen balance studies test specific nitrogen intakes (diet) and analyze nitrogen losses. Application of simple equation yields nitrogen balance.

Childhood Obesity is a big concern

Overweight and obesity are global problems. The increases in overweight and obesity among children internationally over the past three decades indicate that childhood obesity is a global 'epidemic'[27, 28]. According to the WHO, there are now more people suffering overweight related problems than malnutrition. Overweight and obesity are now dramatically on the rise in low- and middle-income countries, particularly in urban settings[29]. Childhood obesity is associated with a higher risk of premature death and disability in adulthood[30]. Current estimates of childhood overweight and obesity range from 12% to over 30% in developed countries and from 2% to 12% in developing countries[27]. According to the WHO, 6.9% (about 4 million) of preschool children are overweight in Latin America[28]. In Africa, this number is even higher, where 8.5% (about 13 million) of preschool children are overweight[28].

While excess weight is unhealthy for anyone, in no other population segment is it more of a concern than in children. Overweight children face serious adverse physical and mental effects into adulthood[31] such as social isolation, low physical activity, diminished school performance and unhealthy dieting. Health promotion efforts will help decrease diet-related risks of chronic diseases such as cardiovascular disease (CVD), type 2 diabetes, and cancer[32]. Overweight children are more likely than normal-weight children to become obese adults[32]. It has been estimated that the probability of an obese child remaining so into adulthood is 20% at age 4, and increases to 80% by adolescence[33].

Clearly, preventing overweight and obesity at a young age is essential. In adults, consumption of soy protein may favorably affect lipid absorption, blood glucose levels, fatty acid metabolism and other physiological changes associated with excess weight[54]. Although no studies have been conducted to examine the effect of energy-restricted diets containing soy protein among children, the positive results found with adult populations is suggestive of potential beneficial effects in children as well[35, 54, 55]. The inclusion of soy protein in the diets of young children may be of benefit in combating overweight and obesity in this population.

Soy fiber delivers health benefits associated with both soluble and insoluble fibers.

Average dietary fiber intake among children ages 3-5 years and 6-11 years is 11.4 grams per day and 13.1 grams per day, respectively[24], which does not achieve the recommendations for these ages groups set forth by the American Academy of Pediatrics of 25-31g/day, depending on age and gender. The 2005 Dietary Guidelines for Americans recommends getting 14 grams of fiber per each 1,000 calories consumed per day[7]. Unlike other protein foods such as meat, fish and eggs, several soy foods provide fiber along with high-quality, lean protein. Additionally, soy fiber ingredients can be added to products to augment fiber content.

Obese children and adolescents have an increased risk of CVD. According to the Korean National Health and Nutrition Examination Survey, approximately 60% of Korean obese children and adolescents had at least one CVD risk factor[34]. Approximately 13% of overweight children have elevated systolic blood pressure and 9% have elevated diastolic blood pressure[35]. Lipid level abnormalities are among the most common obesity-related medical conditions[35]. The lifestyle behaviors associated with CVD risk factors begin in childhood[36].

Behaviors that impact the risk of CVD are learned, and begin in early childhood. Primary among the lifestyle factors that affect this risk are dietary habits[36]. The published research to date indicates that the inclusion of soy protein in the diets of children has an overall beneficial effect on total cholesterol, with some improvement in triglycerides and maintenance of healthy high density lipoprotein (HDL) cholesterol levels[37, 38]. In children with familial hypercholesterolemia, an 8-week study where 15-20g of soy protein was substituted for animal protein daily produced a more beneficial effect on cholesterol levels than a standard low fat diet[39]. A similar study of 6-12-year old children receiving 20g of soy protein daily resulted in a significant increase in HDL cholesterol, and significant reductions in plasma triglycerides and very low density lipoprotein (VLDL) cholesterol levels[40]. A longer-term study found that substituting soy protein (at a 0.25-0.5g/kg body weight level) for animal protein in a low-fat diet decreases total cholesterol and low density lipoprotein (LDL) cholesterol levels in children and teens—beyond what the standard low-fat diet treatment can accomplish alone[41].

Consequences of Childhood Obesity

Metabolic:	Mechanical:
• diabetes mellitus	• obstructive sleep apnea syndrome
• hypertension dyslipidemia	• orthopedic disorders
• non-alcoholic fatty liver disease	

Since dietary modifications are frequently the preferred first line of treatment for hypercholesterolemia in children, incorporating foods containing soy into the diets of these children may be an effective method for improving the results of a treatment diet, as well as maintaining a heart-healthy diet[41]. Including soy products in school lunches is an effective way to provide lower fat, high-quality protein to children, regardless of the child's need for a specifically heart-healthy diet. Schools may also offer soymilk as an alternative to cow's milk upon request. Research has shown that the substitution of soy protein for some of the traditional protein sources in school lunches is effective in improving the nutritional quality of the lunch entreés, specifically by decreasing calories and fat content[22].

The majority of fat and saturated fat in school menus comes from meat and dairy products. Soy protein can be added to lower the fat and saturated fat content of entrees and thus, improve the nutritional quality of meals served in institutional settings[22]. Like other protein sources, soy protein is more satiating than carbohydrates. As such, soy protein containing foods can help keep a child feeling fuller, longer, than a meal devoid of high-quality protein[21, 23, 42]. In fact, research demonstrated that schoolchildren consuming a high protein meal during lunch ate less at next meal[21]. Eating soy at meal or snack-times is easy and very child-friendly. There are many soy products that children will readily accept, including flavored soymilk, soy and meat blends, meat-alternatives, soy nuts and nut butter, soy yogurt, soy cereal, and soy-containing baked goods such as waffles and bread. The inclusion of soy at any meal/snack time needn't be any more difficult than preparing and serving standard fare, given the variety, quality and convenience of soy foods widely available.

Incorporation of soy protein or fiber can lower the glycemic index of a food, when compared to the same food without fiber or protein. Low glycemic index foods may be an effective way to promote weight loss, improve lipid profile and improve postprandial glycemic control. Thus, soy may play a role in blood glucose regulation and provide more options to individuals suffering from diabetes or who are diagnosed as pre-diabetic.

While food choice and caloric consumption are only a part of the overweight/obesity equation, they are recognized as major factors[43]. For very young children, these factors are relatively easily modified by adult caregivers. In many cases of childhood overweight, slowing weight gain while the child "grows into" his or her weight is preferred over a restrictive weight loss regimen—especially as the first line of treatment. Achieving this slow-down usually entails substituting lower-calorie foods and beverages for their higher-calorie counterparts, decreasing electronic media time and increasing physical activity[44].

Soy protein is low in fat and saturated fat, and is cholesterol-free.

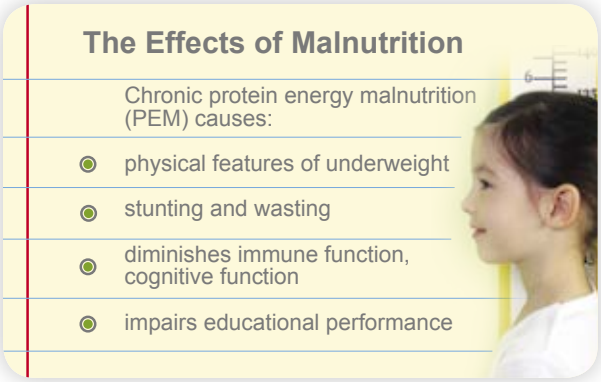
When used in place of meat proteins, soy protein-based meat-alternatives decrease the caloric and fat content of meals at home or in school feeding programs[22, 23]. What's more; soy protein is the only nutritionally complete source of vegetable protein that is widely available.

Soy protein is an excellent source of high quality protein.

Foods containing soy protein are a source of all the essential amino acids, and many are fortified with vitamins and minerals such as riboflavin, folic acid, vitamin D and calcium. As such they can be used as the major source of protein for children[26].

Soy protein is a satiating protein

Research has confirmed that protein is more satisfying than either carbohydrate or fat, and as such, is a key player in weight maintenance and weight loss efforts [15, 16]. Evidence supports that eating high-protein foods helps suppress appetite and food intake in humans[17]. The mechanisms by which a higher protein diet can help regulate body weight are multi-factorial[18]. Although evidence for an association between protein intake and weight among children is limited, several studies suggest that protein is the most satiating macronutrient for children as well[19-21].



Protein-energy malnutrition is a public health concern

According to the WHO[45], "Children are the most vulnerable members of society and to allow their development to be affected by poor nutrition is to perpetuate the vicious cycle of poverty and malnutrition, and to waste human potential."

Malnutrition, as it refers to undernutrition, is thus a health outcome as well as a risk factor for disease and exacerbated malnutrition. It can increase the risk both of morbidity and mortality as depicted in the figure. Although it is rarely the direct cause of death (except in extreme situations, such as famine), child malnutrition was associated with 54% of child deaths (10.8 million children) in developing countries in 2001[46]. Malnutrition that is the direct cause of death is referred to as "protein-energy malnutrition[46]."

The WHO Global Database on Child Growth indicates protein-energy malnutrition affects more than a third of the world's children[47]. A total 80% of the children affected live in Asia, with the majority in southern Asia, 15% in Africa, and 5% in Latin America. Children suffering from protein-energy malnutrition exhibit wasting, stunting, and underweight. The WHO estimates that 2 out of 5 children in developing countries are stunted[47]. This condition also diminishes immune function, cognitive function and impairs educational performance[48].

Protein-containing complementary foods

Complementary foods have long been proposed as a component of young child feeding interventions because of their potential to alleviate common barriers to optimal feeding in resource-poor areas[49]. Processed complementary foods can supply appropriate levels of nutrients in a fortified cereal/legume mixture and provide a precooked, instant product that may be easily prepared 1 serving at a time, thus avoiding storage of leftovers. Use of processed complementary foods has been widespread and successful in improving growth and micronutrient status in many countries[50].

Guidelines for complementary feeding[46]

It should be timely, such that foods are introduced when the need for energy and nutrients exceeds what can be provided through breastfeeding. Complementary foods should provide sufficient energy, protein, and micronutrients to meet a growing child's nutritional needs. The foods should be properly stored, prepared, and fed to ensure they are safe for consumption. Lastly, complementary foods should be provided to meet a child's signals of appetite and satiety in an age-appropriate feeding method[46].

Soy can be tasty and nutritious

People of all ages have food preferences specific to taste, texture, and aroma—children are no exception. Although motivated by different factors in each stage of childhood, picky eating is a hallmark of the toddler years. Protein is of particular concern because the texture of meat is often rejected in these early years. In Western populations, soy is not commonly offered to children, thus children are not exposed to appreciable levels of soy-containing foods[52]. However, Asians are more likely to consume relatively high levels of soyfoods throughout life. Soy consumption is traditional in the diets of Asian children, especially in North and Southeast Asia, and it is estimated that 95% of Asian children consume soy foods before the age of 18 months[53].

From the day a baby is born until he reaches adulthood, his protein needs are significantly higher per kilogram of body weight than adults' needs. A child's body is growing, developing, and demanding high quality nutrition, even if it is smaller and requiring a lower absolute amount of protein than adults. Foods containing soy protein are a source of all the essential amino acids, and many products are fortified with vitamins and minerals such as riboflavin, folic acid, vitamin D and calcium, as such they can be used as the major source of protein for children[26]. Soy foods made with Solae™ soy proteins can take a child's eating experience from yuck to yum while providing key nutrients needed for children.

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