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Review Article

The Essential Role of Right Amount and Quality of Protein for Ensuring Child Growth and Maintenance of Bone and Muscle Mass

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Abstract

Protein is a vital macronutrient, essential for growth, tissue repair, and immune function. However, the impact of elevated protein intake during childhood and adolescence remains controversial. While high protein intake in older adults is often recommended for maintaining muscle mass and preventing frailty, excessive intake in younger populations has raised concerns about potential health risks, particularly related to obesity. This review aims to update current literature on the long-term effects of protein consumption in children and adolescents (ages 4-18) and to explore emerging methods for evaluating protein metabolism in this age group. The RDA for protein varies based on age, sex, and activity level. Generally, it is suggested that children consume about 0.95-1.3 grams of protein per kilogram of body weight per day, depending on age and specific requirements. In many developed countries, children and adolescents often consume protein at levels 2-3 times higher than the RDA, potentially leading to both positive and negative health outcomes. Protein is critical for normal growth and development during childhood and adolescence. Adequate intake supports muscle development, immune function, and the production of hormones. Studies suggest that elevated protein intake may be linked to increased Fat-Free Mass Index (FFMI), which is beneficial for muscle development and overall body composition. High protein diets have been associated with increased satiety, which can help in managing appetite and potentially reducing overall caloric intake, thus contributing to healthier weight maintenance. Some evidence suggests a correlation between high protein intake in infancy and childhood and increased risk of obesity later in life. This association may be due to the overactivation of growth pathways and increased insulin-like growth factor-1 (IGF-1) levels. Excessive protein intake has been hypothesized to strain kidney function, especially in individuals with pre-existing kidney conditions. However, current evidence in healthy children and adolescents is inconclusive. This narrative review emphasizes the need for a nuanced understanding of protein intake in children and adolescents, considering both the benefits and potential risks associated with high protein consumption. As research evolves, dietary guidelines may need to be adjusted to reflect the latest findings.

Keywords

Protein Intake, Children, Adolescent, Body Composition, BMI, FMI, FFMI, Right Amount and Quality of Protein, Protein for Bone and Muscle

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1. Introduction

For children and adolescents to be healthy, operate properly, and develop to their full potential, nutrition is crucial [1]. Specifically, diet plays a major role in preventing disease, particularly chronic conditions like obesity and Type II Diabetes Mellitus (T2DM) [2-4]. The two initial years of life have been highlighted as a vital window that may influence health later in life [3, 5, 6]. Increased adipogenesis and a lifetime risk of obesity have been associated with high protein intake in infancy [3, 6]. In response to this issue, regulatory organizations lowered the protein levels in infant formula (IF) in an effort to better replicate human milk for infants who cannot be breastfed [7-9].

For both baby and Follow-On Formulas (FOF), the Commission Delegated Regulation (EU) 2016/127 [10] presently allows a minimum and maximum protein concentration of 1.80 g and 2.50 g per 100 kcal, respectively. The maximum levels of the previous rule (2006/141/EC) (3 g/100 kcal) are exceeded by these values.

For later life stages and groups, more protein consumption is recommended in order to promote good health benefits, whereas a reduced protein diet may be beneficial for infants [11-13]. 1.2 to 2.0 g/kg body weight per day is recommended by Dietitians of Canada (DC), the American College of Sports Medicine (ACSM), and the Academy of Nutrition and Dietetics (Academy) for physically active individuals in order to support metabolic adaption, repair, remodeling, and protein turnover. In comparison to the Recommended Dietary Allowance (RDA) of 0.8 g/kg bw/d for non-pediatric populations, this range suggests an increase of around 0.4-1.2 g/kg bw/d [14, 15]. For short periods of time during vigorous exercise or when reducing energy consumption, higher intakes may also be recommended [14]. In a similar vein, experts propose that increasing protein consumption to 1.2 to 2.0 g/kg bw per day or more—well above recommended levels—may be a useful nutritional strategy for older persons looking to avoid the detrimental effects of age-related muscle loss on their health [11, 16]. Increasing the amount of protein consumed by this demographic can help healthy older persons keep their independence and live better. This may promote cardiovascular function, avoid sarcopenia, preserve energy balance, aid control weight, and enhance muscular health [11, 16].

Despite the growing body of evidence and attempts to clarify optimal protein intake levels for specific populations, there is a lack of data available assessing optimal protein intake in pediatric populations older than infants (<1 year) and toddlers (1-3 years), according to the age group classification used by the European Food Safety Authority (EFSA) [17]. Hörnell et al. [18] reviewed scientific information on the short- and long-term health consequences of varied quantities of protein consumption from 0 to 18 years of age, and identified a total of 23 research that investigated the impact on growth and body composition. Six studies, however, solely looked at the influence of protein consumption after the age of four and its impacts on later life (two interventional studies and four prospective cohorts); none looked at protein intake beyond the age of ten. However, given that the supplementation in both cases lasted for just seven days, it is interesting that the interventional studies may be categorized as short-term [19, 20].

Increased protein intakes may be helpful to support appropriate development after children and adolescents between the ages of 4 and 18 reach the current recommended intake, or conversely, they may raise the risk of disorders later in life. It has been suggested that there are some crucial windows for protein consumption, such as when switching to a family diet [21]. This stage is typically marked by a sharp rise in protein consumption, mostly from switching to cow's milk, which has a protein concentration of roughly 5.15 g/100 kcal, or roughly twice that of IF or FOF [22].

In Western Europe and the US, trends in protein intake among children and adolescents are typically two to three times higher than dietary recommendations [21, 23-25]. However, the factorial technique is used to compute these suggestions with information from nitrogen balance investigations [26, 27]. The literature has extensively examined nitrogen balance deficits, which arise from an inclination to overestimate nitrogen intake and underestimate excretion. This results in a positive net balance and could lead to an overestimation of one's actual needs [28, 29]. This raises the question of whether the current protein guidelines are appropriate or if they underestimate the true needs of kids and teenagers. Further study is needed to determine optimal protein consumption levels, potentially critical time windows, and if the current guidelines should be reassessed.

This narrative review is divided into four sections to address these issues. The present trends in protein intake in developed nations are outlined in the first part and are contrasted with dietary recommended intakes for every age group. The next section discusses the accuracy of existing protein guidelines, given that protein consumption is likely to exceed them.

Suggestions in addition to fresh methods for evaluating kids' protein metabolism. The information that is now available on the effects of protein intake on later life in children and adolescents (ages 4 to 18) is thoroughly examined in the third section. Based on the main outcomes of the studies—body mass index, body composition, and insulin sensitivity—the findings have been arranged into three categories. Finally, a brief section that examines the function of protein in picky eaters—a complicated behavior marked by refusal to eat—has been added.

2. Recent Trends in Protein Intake

The majority of individuals in Western Europe and the

United States consume more protein than is advised in their diets, based on the evidence that is currently available [15, 26, 30]. Table 1 shows how the recommendations for protein consumption vary slightly depending on the health authority making them for the pediatric population (those under the age of 18). The two most often quoted recommendations are Dietary Reference Intakes (DRIs) from the US Institute of Medicine (IoM) [30] and Dietary Reference Values (DRVs) from the EFSA [26]. The most often mentioned recommendations are the RDA and the Population Reference Intake (PRI), which denote the average daily dietary intake amount sufficient to fulfill nutritional needs and prevent deficiencies in almost all (97.5%) of the healthy individuals in a population, are the most frequently cited recommendations, despite the fact that they cover a variety of terms [15, 31].

However, beyond the dietary recommendations to prevent deficiency, there are no guidelines for an “optimal” protein intake in pediatric population for promoting healthy growth and development.

Table 1. *Current recommendations for protein requirements, estimated by age and sex, for children.*

	EFSA [1]			DRI [2]			
	AR (g/kg bw/d)	PRI (g/kg bw/d)	PRI (g/d)	EAR (g/kg bw/d)	RDA (g/kg bw/d)	RDA (g/d)	AMDR (%E) [3]
4-8 years	0.72	0.89	19.30	0.76	0.95	19	10-30%
9-13 years	0.72	0.90	34.50	0.76	0.95	34	10-30%
14-17 years, boys	0.71	0.88	53.25	0.73	0.85	52	10-30%
14-17 years, girls	0.69	0.85	46.50	0.71	0.85	46	10-30%

[1] From Ref. [26]. [2] From Ref. [15]. [3] From Ref. [30]. AMDR, Acceptable Macronutrient Distribution Range; AR, Average Requirement; DRI, Dietary Reference Intakes; EAR, Estimated Average Requirements; EFSA, European Food Safety Authority; PRI, Population Reference Intake; RDA, Recommended Dietary Allowance.

Particularly in industrialized nations, trends in children's and adolescents' protein consumption are often two to three times higher than suggested, with the majority of these proteins coming from animal sources [21, 23-25]. Based on data from the National Diet and Nutrition Survey (NDNS) [25] (n ≈ 1000; 500 adults and 500 children), which was performed in the United Kingdom (UK) between 2016 and 2017, it was determined that the mean protein intake was 52.9 and 64.5 g/d in the corresponding age groups of 4-10 years and 11-18 years. Protein consumption was 1.40 and 2.39 times greater for these ages in terms of PRI. The consumption of protein is significantly greater in other European nations.

The National Dietary Survey on the Child and Adolescent Population in Spain (ENALIA) [24], which included 1862 participants, found that average intakes ranged from 74.45 (4-8 years) to 93.6 g/d (14-17 years), with 3.88-1.88-fold higher values than PRI, respectively. It should be noted that the contribution of protein to total energy consumption for children aged 4-17 years was as high as 17.8%. Similar findings have been reported in the US, where the National Health and Nutrition Examination Survey 2001-2014 (NHANES) [23] (n = 15.829; 2-80 years) revealed average intakes that ranged from 59.7 g/d in those 4-8 years to 79.75 g/d in those 14-18 years. It is noteworthy that 0.96% of children aged 2-3 years had values above the specific.

Protein has an acceptable Macronutrient Distribution Range (AMDR) of 10-30%E, however among Spanish children aged 1-3, this value was 12.1%. Although the maximum limit of AMDR (35% E) in adults has been linked to a risk for prediabetes and type 2 diabetes, AMDR expresses a range of protein intakes in the context of a complete diet [11, 15, 32]. AMDR should therefore be used with caution. Finally, original research extracted from cohorts, like the Generation R [33] or Dortmund Nutritional and Anthropometric Longitudinal Design (DONALD) study [21], revealed similar, greater protein consumption, in agreement with these national dietary surveys.

In conclusion, there are currently no recommendations for a "optimal" protein intake that exceeds these recommendations to support healthy growth and development, despite observational research consistently showing that children's average protein intake is two to three times higher than the dietary intakes that are recommended to prevent deficiency in 97.5% of the population.

3. Recommended Dietary Protein Intakes: A Conversation

The minimal consistent daily consumption required to avoid deficiencies is the definition of an adult's nutrient requirements [15]. However, this idea becomes much more crucial for youngsters, as proper growth and development should be supported by nutrients [34]. Using information from nitrogen balance studies, the factorial technique is used to determine the recommended protein consumption for kids and teens, taking into account their needs for both growth and maintenance [26, 27]. However, there are a number of methodological and data interpretation issues with the nitrogen balance technique that have been extensively covered elsewhere [29, 35] for estimating protein recommendations. In summary, this method tends to overestimate intake of nitrogen and underestimate excretion, which produces an excessively favorable net balance and, hence, an underestimating of needs. Furthermore, it takes a few days for the measuring procedure to adjust to the protein consumption amount that is tested, and more time is required for the related readings. To evaluate the zero balance, this procedure needs to be performed at least three times for protein intake levels [28, 29]. In addition, the limitations of data interpretation have been thoroughly investigated, leading to an independent reanalysis of nitrogen balance studies to establish alternative adult reference values [28]. However, this method remains the "gold standard" for figuring out protein needs [26, 30].

Emerging methods such as D3-Creatine, 5N End-Product, and Indicator Amino Acid Oxidation (IAAO) are being used to evaluate protein metabolism in children [29]. These three strategies, which include minimally invasive approaches for study participants in a free-living setting, can be used with vulnerable groups, including youth and young adults. In particular, Elango et al. [36] had previously examined the IAAO approach in children ages 6 to 10 years, and its findings are probably less prone to inaccuracy than those from nitrogen balance tests [28, 29, 36, 37].

Elango et al. [36] contend that school-age children (6-10 years old) in good health now have significantly underestimated protein requirements. Estimated Average Requirements (EAR) and RDA for protein were found to be 1.3 and 1.55 g/kg bw/d, respectively; these values are much higher than the DRI values for protein (71.0% and 63.2% higher, respectively). Furthermore, the authors used two distinct approaches to report identical findings in adults: the IAAO method and a reanalysis of the available nitrogen balance data using non-linear regression [28, 37].

The methodologies constitute a much-needed area of research and are a big step forward in assessing the life factors that influence protein intake [29]. On the basis of this data, new methods for evaluating protein metabolism in children underline the necessity of reassessing the advice that is now in place. These guidelines seem to be underestimating the amount of protein that youngsters need consume, and they also neglect to take into account other aspects of life.

4. Impacts of Protein Intake in Healthy Children and Adolescents

Consumption of protein is essential for children's and adolescents' healthy growth and development. Even though protein is necessary for good health overall, consuming too much or too little of it can have long-term consequences for their wellbeing. The following are some important details on how eating protein affects children and adolescents in good health over the long term:

1. Development and Growth: Sufficient consumption of protein is essential for healthy growth and development in childhood and adolescence. The components of all tissues, including muscles, bones, skin, and organs, are proteins. Development might be delayed and growth can be hindered due to inadequate protein consumption.
2. Body Composition: Consuming protein modifies the amount of fat and muscle in the body. Lean muscle mass development is aided by a balanced protein intake and frequent exercise, both of which are critical for general strength and metabolic health. However, consuming too much protein, particularly from foods heavy in saturated fats, can lead to obesity and unhealthful weight gain.
3. Bone Health: The development and preservation of bones depend on protein. Sufficient amounts of calcium and vitamin D, in addition to an adequate protein consumption, promote bone health and lower the risk of osteoporosis and fractures in later life. But if it's not balanced with enough calcium intake, consuming too much protein—especially from animal sources—may raise calcium excretion and perhaps jeopardize bone health.
4. Metabolic Health: Protein helps to keep blood sugar levels in check and regulate metabolism. Consuming a balanced diet of proteins can help avoid insulin resistance and lower the chance of developing type 2 diabetes in later life. Excessive consumption of protein, particularly from processed or high-fat sources, has been linked to metabolic problems and insulin resistance.
5. Cardiovascular Health: The kind and origin of protein ingested can affect the state of cardiovascular health. Diets rich in plant-based proteins—like those found in nuts, seeds, and legumes—have been linked to a decreased risk of heart disease. On the other hand, due to their high cholesterol and saturated fat content, diets heavy in red and processed meats—sources of animal-based proteins—may raise the risk of cardiovascular disease.
6. Kidney Function: For healthy kidneys, a sufficient protein diet is generally safe. To lower the risk of future kidney damage, people with pre-existing kidney disorders may need to moderate their protein intake. Overindulgence in protein can strain the kidneys and eventually cause renal failure.
7. Nutritional Imbalances: If one concentrates too much on protein consumption, other important nutrients may be overlooked, which can result in nutritional imbalances. Throughout childhood and adolescence, a well-balanced diet comprising a range of food groups is crucial for

fulfilling overall nutritional requirements.

In conclusion, although protein is essential for adolescent and child growth and development, it's critical to guarantee a balanced intake from a range of sources to promote long-term health and wellbeing. A customized nutrition plan that satisfies particular needs can be created by speaking with a healthcare professional or registered dietitian to ascertain an individual's protein requirements. (FMI).

5. Optimal Protein Consumption in Picky Eaters

Picky eating, often referred to as "fussy," "selective," or "choosy" eating, is a complicated behavior defined by the rejection of a significant portion of both recognized and novel foods, leading to the consumption of an inadequate variety or quantity of foods [83-85]. Picky eaters (PE) are difficult to define, quantify, and look into the true effects of because there isn't a single, widely agreed-upon definition. In spite of this, a number of research have recently [83-85] addressed the topic.

Picky eating is typically linked to far lower intakes of meats, fruits, and vegetables [84-88]. Energy and macronutrient intakes are comparable across PE and non-PE, as are dairy intakes [84, 85].

But in five out of ten studies, protein intakes were considerably lower in PE compared to non-PE, according to Samuel et al. [84]. Five out of seven studies [87-90] that focused mainly on children aged three or older revealed noticeably reduced protein consumption in PE. It might imply that as people age, this habit intensifies and results in a diet of low quality.

As a result, Taylor et al. [85] described the diets of children ages 10 and 13 in both a cross-sectional and longitudinal manner, indicating that children with chronic PE (beginning at age 3) displayed more noticeable variations at every age. In terms of protein intake, the group who continued PE ingested 10% less protein than the group that did not continue PE. Nonetheless, dietary protein intakes were frequently higher than the EFSA dietary recommendations in all age categories in the majority of studies [84, 85].

Causal inferences are hampered by the paucity of longitudinal research on the anthropometric traits and body composition of picky eater children [91-94]. In a recent research, the European Longitudinal Study of Pregnancy and Childhood (ELSPAC-CZ) cohort's 346 PE participants and 1722 non-PE participants were found. Grulichova et al. [92] published this analysis.

The modified models revealed negative correlations with height (PE were on average 0.8 cm shorter than non-PE) and weight (PE were on average 2.3 kg lighter than non-PE). These findings are consistent with those from the 7420 children in the Avon Longitudinal Study of Parents and Children (ALSPAC) [93]. PE were first detected at the age of three, and measurements of height and weight were taken seven times between the ages of seven and seventeen.

In this instance, the models projected that, at each age, males with chronic PE would weigh roughly 1.5-2.5 kg and females with persistent PE would weigh 1.0-1.5 kg less than non-PE. The findings indicated that height was negatively correlated with chronic PE in both females (1.0-1.5 cm shorter) and boys (1.5-2.0 cm shorter). On the other hand, DXA measured body composition five times between the ages of 9 and 17. The findings indicated that male children who were consistently picky had a lower lean mass index—by roughly 0.1 kg/m^2—than non-picky children at all age groups starting at age 11. However, there was no evidence of any differences in girls. Furthermore, there was no correlation found between fussy eating and either sex's FMI or body fat percentage.

A study included in the Generation R prospective cohort (4191 children) provided data in support of this theory, indicating that 4 year olds who are fussy eaters may be more likely to be underweight at 6 years old and to have a lower fat-free mass. In particular, the fussy eating profile was associated with a reduced BMI-SDS, mostly because FFMI decreased rather than FMI [94].

The effects of oral nutritional supplements (ONS) have been investigated in this population as a way to enhance growth and nutritional status. Four randomized controlled trials (RCTs) with children who exhibited fussy eating patterns used dietary counseling (DC) in addition to ONS as an intervention; the results were compared to a control group that received DC only [95-98]. A metanalysis was conducted to demonstrate changes in growth parameters based on these RCTs [99]. Weight characteristics indicate that, in comparison to the group receiving DC alone, the intervention group in the four RCTs exhibits significantly higher weight increase, weight-for-age z-scores, and weight-for-height z-scores at 30, 60, and 90 days. On the other hand, the ONS + DC group showed a faster height rise in three of the four RCTs [99]. In particular, Sheng et al. [95] showed no significant difference between the intervention and control group.

There have also been reports of further advantages from obtaining ONS + DC. For example, the intervention group's appetite grew much more than the control group's [96]. According to Ghosh et al. and Alarcon et al., the ONS + DC group had a considerably reduced incidence of upper respiratory tract infections than the control group over the study period [96, 97]. Similarly, studies have evaluated the impact of a high-protein ONS diet on young, healthy individuals who are short and lean [100-102]. In a study conducted by Lebenthal et al. [100], 171 short and thin children between the ages of 3 and 9 years were given a high-protein ONS diet (24.5 g protein/serving) for six months. Height-SDS and weight-SDS considerably improved for "good" formula drinkers (intake of $\geq$ 50% of the recommended dose of one serving/day), with no change in BMI-SDS compared with ‘poor’ consumers and the placebo group [100].

Similar findings were found in the follow-up trial by Yackbovitch-Gavan et al. [101], indicating that a high-protein

ONS diet for a year was an effective intervention to promote the linear development of these children without affecting their BMI. On the other hand, a similar technique in prepubertal boys (10-14.5 y) who were short and slim revealed a shift in their body composition [102]. The intervention involved two phases: a double-blinded intervention with a high-protein ONS (36 g protein/serving) diet or placebo for 6 months, and later, an open-label, extended 6-month diet including ONS, for all the participants. When compared to "poor" formula users and the placebo group, "good" formula users demonstrated noticeably higher weight-SDS, BMI-SDS, fat-free mass, and muscular mass [102].

Nevertheless, it should be mentioned that while the body composition described by the authors could be relevant to with PE children, the presence of picky eating or any other behavior related to the refusal to eat adequately was not assessed [100-102].

The evidence that is now available has some flaws. First, there are very few RCTs (four papers found) evaluating ONS in PE. Since protein makes up 12% to 15% of the total energy in the ONS, which is a well-balanced blend of macro and micronutrients, it's possible that the collection of nutrients—rather than simply the protein—is responsible for the health advantages. Finally, because only anthropometric parameter changes—not body composition, or FMI and FFMI—were evaluated, it is impossible to determine whether the changes are primarily attributable to alterations in either measure.

Overall, poorer intake of fruits and vegetables and higher intake of free sugar are indicators of a poor diet, even while PE children appear to have adequate protein intakes [85-88]. According to the most recent data, PE tend to be shorter and have less lean mass than their colleagues who aren't picky [91-94]. This suggests that in order to support healthy growth and development, PE may benefit from early identification and intervention. Well-designed RCTs are necessary to determine whether they might gain from consuming more protein as a dietary intervention.

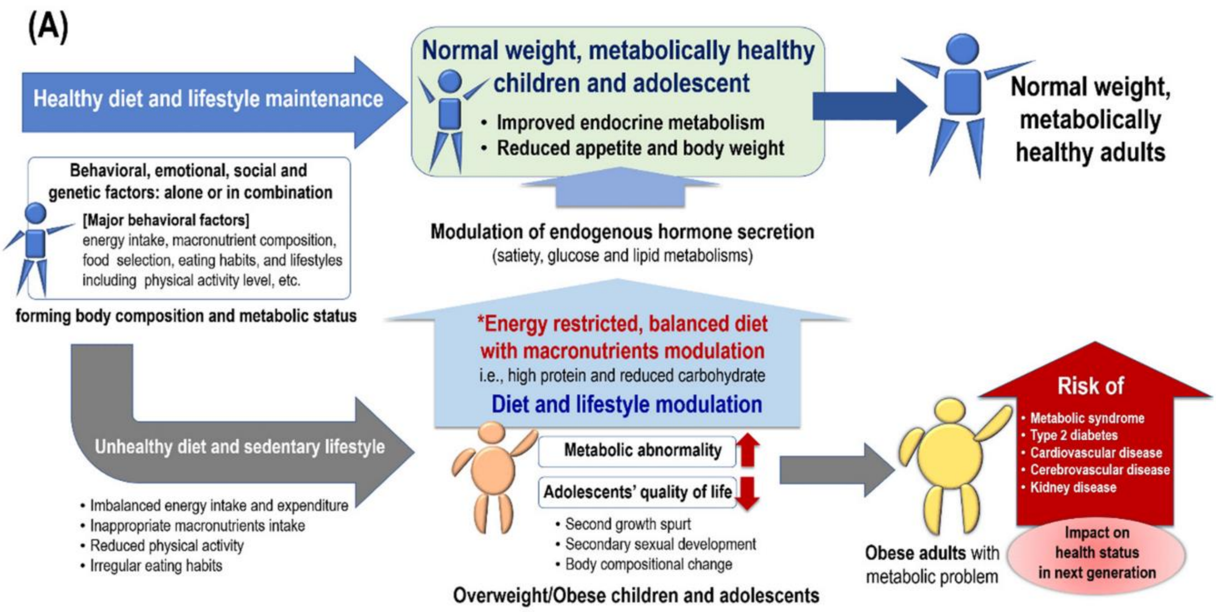

Figure 1. *Impacts of Dietary Macronutrients and Protein Impact in Children and Adolescent [103].*

6. Protein Is Essential for Child Growth and the Maintenance of Bone and Muscle Mass

The Right Amount And Quality Of Protein Are Crucial For Ensuring Proper Development And Health, Here's a general guideline:

6.1. Amount of Protein

1. Infants (0-12 months): Infants require about 1.5 grams of protein per kilogram of body weight per day.
2. Children (1-3 years): Children in this age group need approximately 1.1 grams of protein per kilogram of body weight per day.
3. Children (4-13 years): Protein needs slightly decrease to about 0.95 grams of protein per kilogram of body weight per day during this period.
4. Adolescents (14-18 years): Adolescents have higher protein needs due to growth spurts. They generally require around 0.85 to 0.9 grams of protein per kilogram of body weight per day.

6.2. Quality of Protein

The quality of protein is determined by its amino acid composition and digestibility. Proteins from animal sources are considered high-quality proteins as they contain all essential amino acids in adequate amounts. Examples include meat, poultry, fish, eggs, and dairy products. Plant-based protein sources, such as beans, lentils, nuts, seeds, and whole grains, can also provide adequate protein when consumed in combination to ensure all essential amino acids are obtained.

6.3. Tips for Ensuring Adequate Protein Intake

1. Include Protein-Rich Foods in Meals: Incorporate sources of protein in each meal and snack. This could include lean meats, poultry, fish, eggs, dairy products, legumes, nuts, and seeds.
2. Offer Variety: Provide a variety of protein sources to ensure a diverse intake of essential amino acids.
3. Consider Timing: Distribute protein intake evenly throughout the day rather than consuming large amounts in one meal.
4. Monitor Growth and Adjust Intake: Keep track of your child's growth and consult with a pediatrician or dietitian if there are concerns about growth or nutritional adequacy.
5. Encourage Healthy Eating Habits: Promote a balanced diet that includes a variety of nutrient-rich foods, not just focusing solely on protein.

It's important to note that individual protein needs may vary based on factors such as activity level, growth rate, and overall health status. Consulting with a healthcare provider or a registered dietitian can provide personalized recommendations tailored to a child's specific needs.

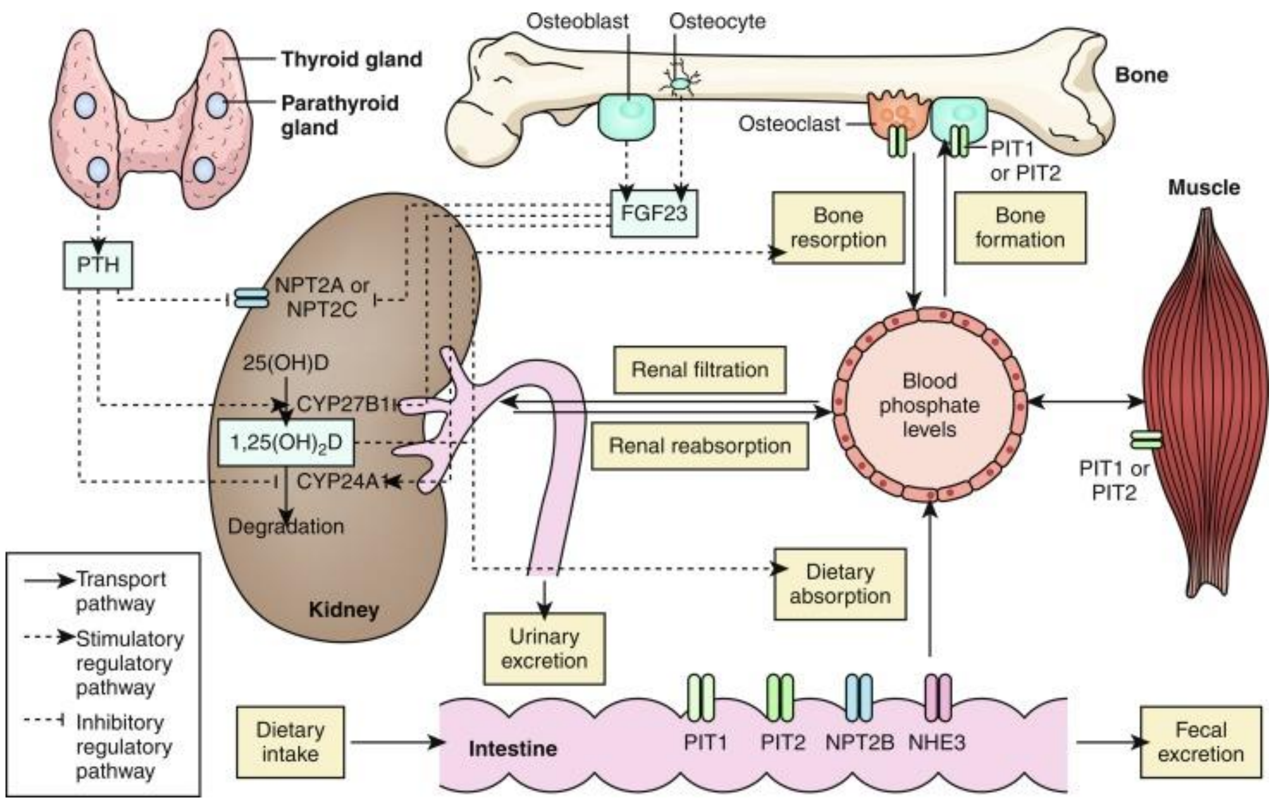

Figure 2. *Right Amount And Quality Of Protein Are Crucial For Ensuring Proper Development [104].*

7. Conclusions

In summary, the evidence on protein consumption and its effects on later life in healthy children and adolescents between the ages of 4 and 18 is comprehensively summarized in this narrative review. The principal conclusions are: Research employing observational data has consistently demonstrated that children eat, on average, two to three times as much protein as is recommended in the diet. There are currently no standards for a "optimal" protein intake that promotes healthy growth and development in the pediatric population, other from the intakes required to prevent deficiencies. There is a need for a reassessment since new techniques for assessing children's protein metabolism suggest that current protein requirements may be exaggerated. When the protein level rises beyond 15-20% E, the research advises exercising caution. This stage of life may benefit from high protein intake in the following ways: • There appears to be a positive correlation between high protein intake and increased BMI, which is mainly explained by an increase in FFMI rather than FMI; • Protein intake may modulate the GH-IGF-I axis, increasing IGF-I levels during puberty and early adolescence, which may promote the development of bone and lean mass; and • In children who have fussy eating habits, higher nutrient intake, including protein, is linked to positive changes in weight and height parameters.

Author Contributions

Shah Alam: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Asma Ferdousi: Conceptualization, Data curation, Methodology, Project administration, Supervision, Validation, Visualization

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Conflicts of Interest

The authors declare no Conflicts of Interest.

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