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Review Article

Protein deficiency among adults: A review on a silent epidemic on rise in India

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Abstract

Peptide bonds hold together the amino acids that make up a protein. In the gastrointestinal system, peptidases and proteases hydrolyze food protein to create amino acids, dipeptides, and tripeptides. These breakdown products are either absorbed by enterocytes or consumed by bacteria in the small intestine. Amino acids that are not broken down by the small intestine must flow via the portal vein before they can be synthesized by skeletal muscle and other tissues. They are also used to manufacture low-molecular-weight metabolites with important physiological functions in a cell-specific way. Protein malnutrition can result in stunting, anemia, physical weakness, oedema, vascular dysfunction, and decreased immunity.

Keywords: Protein deficiency, Epidemic, Nutrition, Amino acids, Dietary requirements.

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1. Introduction

The body cannot synthesize nitrogen or sulfur, the amino acids produced as hydrolysis of complex proteins provide nitrogen, hydrocarbon skeletons, and sulfur—essential components of organisms—and cannot be replaced by any other nutrients, including lipids and carbohydrates. Amino acids are essential building blocks for the production of proteins, peptides, and low-molecular-weight molecules of major physiological relevance (such as glutathione, creatine, nitric oxide, dopamine, serotonin, RNA, and DNA).[1] While glutamine in arterial blood is the mammalian small intestine's primary source of energy in the post-absorptive state, glutamine, dietary glutamate, and aspartate are the main metabolic fuels for this organ when fed.[2]

Furthermore, glutamine provides approximately 50% of ATP in lymphocytes and 35% in macrophages.[3] As a result, amino acids are required for an organism to survive, grow, develop, reproduce, and lactate. Metabolic disorders, kwashiorkor (caused by a severe shortage of protein), and marasmus (caused by a severe loss of both protein and energy) are stark instances of this in humans, particularly in many youngsters from developing nations. Elderly adults, particularly those in rich countries, have less severe forms of dietary protein deficiency (e.g., the home-bound elderly), making them more susceptible to viral and metabolic disorders.[4] Extensive dietary amino acid and protein intake, as well as excess dietary supplementation, represent the other end of the nutrition continuum and can also harm human health, particularly in those with renal or hepatic impairment.[5] Understanding of amino acid biological chemistry and nutrition serves as the basis for improving proposed values for human protein dietary needs and appreciating the potential health impacts of dietary protein. Nitrogen balance studies have long been used to assess human dietary protein and amino acid requirements.[6]

Over the past 30 years, experts have used amino acid tracers and the nitrogen-balancing approach to determine the dietary requirements of nutritious amino acids, or amino acids whose carbon skeletons are either not produced by animal cells or are synthesized inadequately. The dietary requirements of animals, including humans, for synthesisable amino acids have received more attention in recent years.[7,8] The primary purpose of this review is to highlight previous studies on human dietary protein intake as well as contemporary concerns regarding protein nutrition's

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influence on health, particularly the preservation of adult skeletal muscle mass and function.

Protein in the diet is an effective preference for avoiding or managing the advancement of impairment since it may lessen the age-related loss of muscle mass and function. An amino acid score can be used to determine nutritional value. The current definition of this notion is the concentration of the limiting amino acid in the meal protein represented as a percentage of the concentration of the same amino acid in a reference amino acid pattern,[10] which was first proposed by Block and Mitchell in 1946.[9] Adjusting for the digestibility of the protein source can help the amino acid score be more accurate. As a result, mixed vegetable protein diets may have a digestibility range of 65-85%.[11] resulting in Protein Digestibility-Corrected Amino Acid Score (PDCAAS). Lysine is the most limiting amino acid in cereal protein, and it is also present at much lower quantities in most plant diets.[12,13] Legumes have a high lysine content and few sulfur-containing amino acids, whereas animal products have significant amounts of these amino acids but little tryptophan. Using the 1985 W.H.O.-F.A.O.-U.N.U. amino acid requirement pattern[14] for adults as a reference, wheat flour's amino acid score would exceed one hundred. As a consequence, there would be no problem assessing the quality of plant protein in adults, and wheat's nutritional value would be comparable to that of premium animal protein sources such as eggs, milk, and other dairy products or meat. However, following the revised 2007 W.H.O.-F.A.O.-U.N.U. pattern[15] for scoring would provide a wheat protein grade of fifty or lower. As a result, a diet rich in cereal poses a risk of lysine deficiency.(**Table 1**)

To allow the body to produce tissue protein molecules, the food we consume must have the nine vital amino acids in the correct ratios and concentrations. Although required for body protein synthesis, the remaining eleven amino acids contained in dietary proteins are considered optional since the body can synthesize them from other carbon and nitrogen sources. Protein and nitrogen demand estimates are used interchangeably since protein nitrogen meets the majority of the body's nitrogen needs.

The W.H.O.-F.A.O.-U.N.U. meeting[15] recently updated the estimated daily demand for total protein in humans based on N balance tests at varying N intakes conducted internationally in a variety of environments and age groups. The safe requirement is 0.83 g/kg/day, a ten percent greater than the 1985 W.H.O.-F.A.O.-U.N.U. guidelines. Adults have an estimated average protein requirement of 0.66 g/kg/day.[14] This implies that under the updated guidelines, people whose protein intakes were rated only somewhat acceptable under the prior recommendations would slip into the insufficient category.

Dietary protein quality would have had little practical impact on adult human protein nutrition because previous estimates of adult indispensable amino acid requirements were so low that adequate amounts could be obtained from almost any diet. Driven by the work of the late Dr. Vernon Young, the re-evaluation of the indispensable amino acid requirement was based on two factors: first, the constraints of the method for measuring indispensable amino acid requirements from nitrogen status projections;[16] and second, the results of experiments based on tracer studies and predicted obligatory amino acid losses.[17-19] On the basis of the indicator of amino acid technique,[20] more modern and exact methods of establishing daily vital amino acid requirements were put forward.

Table 1: Requirements of dietary indispensable amino acid (IAA) in adult humans[14,15]

	2007 FAO/WHO/UNU *		**1985 FAO/WHO/UNU +**	
Amino Acid	**Mg/kg/d**	**Mg/g Protein**	**Mg/kg/d**	**Mg/g Protein**
Isoleucine	20	30	10	15
Leucine	39	59	14	21
Valine	26	39	10	15
Lysine	30	45	12	18
Methionine+ cysteine	15	22	13	20
Phenylaline + Tyrosine	25	38	14	21
Threonine	15	23	7	11
Tryptophan	4	6	3-5	5
Histidine	10	15	8-12	15
Total IAA	184	277	93-5	141

The amount of energy consumed and demands are established by the consumption of energy, which is determined by activity and potential adaptations to chronically altered intakes, where as protein requirements are expressed as a fixed requirement based on body weight, regardless of any antecedent adaptations that may or may not exist.[21] Protein intakes in populations can be assessed in relation to factors that influence energy requirements, such as age, gender, and lifestyle, if the amount of protein consumed can be expressed as the ratio of protein energy to total energy consumption. As a result, while calculating the PE ratio is an effective way to determine how much protein a population eats, it is also necessary to consider the population's antecedents, BMI, level of physical activity, and the amount of relatively empty calories, such as fats and sweets, that they consume. Diets that are assumed to meet energy requirements can be utilized to detect possible protein shortages. Energy requirements are determined by the population's age and amount of activity, whereas protein requirements stay constant. The PE ratio for the need is calculated by dividing the energy demand by the protein requirement. Sedentary male and female adults had a mean adult PE ratio of 0.073 and 0.075, respectively. Based on these findings, twentyseven percent, and thirty-two percent of the countryside inactive population's male and female members, respectively, are at risk of consuming protein-deficient diets (assuming a normal distribution). Individuals' PE ratios will fall as the population grows more active since their need for energy will increase. In this case, the chance of having a bad diet would be greatly reduced. It is thought that the quality protein contained in tribal communities' diets enhanced their chances of eating food that was insufficient.

2. Discussion

Protein deficits are responsible for a wide range of clinical diseases. This nutritional deficit, which is frequently exacerbated by low energy intake, can affect any population at any age due to disease or poor diets.[22] In addition to stunted growth, cardiac difficulties, and an increased risk of infectious illnesses, dietary protein shortages can alter metabolic profiles in humans, such as dyslipidemia and hyperglycemia, and exacerbate deficiencies in other nutrients, such as vitamin A and iron. Protein is essential for the small intestine to digest and absorb nutrients from food, transport minerals like iron, vitamin A, and long-chain fatty acids, and transport compounds like cholesterol and triacylglycerols in the blood. It additionally oxidizes nutrients including glucose and fatty acids into water and CO2.[23-25]

As a result, protein and micronutrient deficiencies, such as vitamin A, iron, zinc, and folate, remain important dietary difficulties in developing countries. Inadequate arginine supply in newborns indicates a severe AA deficiency, which is potentially deadly. The following symptoms are indicative of a human protein deficiency:

1. Reduced skeletal muscle and body protein production and enhanced proteolysis.
2. Low blood albumin and plasma amino acid concentrations;
3. Endocrine imbalance;
4. Lower insulin, GH, IGF-I, and thyroid hormone levels;
5. Impaired anti-oxidant responses and increased oxidative stress.
6. Advanced aging.
7. Maternal protein insufficiency can cause inborn growth restriction and long-term negative consequences on postnatal development, metabolism, and health, including increased risk of obesity, infection, and cardiovascular abnormalities.
8. Young children may experience stunted growth. impaired development (including cognitive development) of the young
9. Problems with the transport, storage, and absorption of nutrients, such as vitamins, minerals, amino acids, glucose, and fatty acids
10. Physical weariness, weakness, headaches, fainting, and muscular atrophy.
11. Impaired immunological response; frequent infections;
12. Higher incidence of sickness and mortality from communicable diseases.
13. Hypertension, circulatory abnormalities, and heart failure.
14. Periorbital and peripheral oedema, resulting in swelling in the hands, feet, legs, and tummy.
15. Retention of tissue fluids.
16. Symptoms may include reduced neurotransmitter production, anxiety, depression, irritability, and insomnia.
17. Reduced fertility, loss of libido, and embryonic loss.
18. Symptoms may include bone and calcium loss, tooth abnormalities, hair loss and breakage, reduced pigment production, gray hair, skin atrophy, dryness, peeling, and paleness.

Inadequate protein diet during pregnancy and the postnatal period has profoundly deleterious impacts on people, as evidenced by processes such as fetal and neonatal programming. This nutritional deficit not only impairs fetal and infant development, but it also increases the risk of metabolic syndrome, which encompasses diabetes, obesity, and hypertension, and affects adult quality of life. Notably, stunting in both boys and girls will have negative consequences for human physical strength and society, as well as the health (including reproductive health) of those affected and future generations.[27] Protein malnutrition exacerbates sarcopenia and impairs muscle growth and performance in the elderly.

Adult malnutrition is common in India, and it is commonly caused by food deprivation, which is described as ingesting insufficient amounts of high-calorie and nutrient-dense meals. As a result, assessing how much a person is undernourished needs knowing how much of various food categories are missing from their diet. In developing countries, the link between high-quality food production, accessibility, and consumption is becoming more important. Protein quality, or its digestibility and ability to meet humans' essential amino acid requirements, is connected to demand. This is especially critical in India, where there is a risk of a protein shortage due to the low-quality protein present in cereal-based diets and food subsidy programs. To decrease human health risks, it will be critical to produce and provide high-quality protein on a sustainable basis. Despite increased milk production, India's underprivileged continue to eat little of it. However, the production of leguminous grains, which have superior soil-improvement and climatic resistance properties, has declined. This allows farmers with limited resources to consume more nutritious food. However, there are concerns about plant protein's nutritional value, which might be especially important in cases where environmental intestinal dysfunction already has an influence on nutrient absorption.

In the Indian context, grains with relatively low digestibility and quality account for around 60% of diet protein. Over the last 25 years, the National Nutrition

Monitoring Board has undertaken several surveys on Indians' diets and protein intakes in both urban and rural regions, as well as among slum dwellers and tribal communities. According to research, disadvantaged individuals in slums, tribal communities, and sedentary rural Indian populations consume around 1 gm/kg/day of protein (mostly from grains). Given the high proportion of cereal-based protein in their diets, the quality of protein consumption in India's rural and tribal groups is worrying. According to estimates, even if urban residents eat a lot of cereal, protein quality improves when they consume more than 200 millilitres of milk (or milk product equivalents) each day. Because about 65% of the population lives in rural regions and 7% lives in tribal areas, we considered this technique was adequate for evaluating the risk of undernutrition. In any case, in a transitional situation, the survey results should be read with caution. According to the National Sample study Organization (NSSO) study[28] in India, grains provide around 66% of protein to the rural population and 56% to the urban population. The survey evaluates nutritional intakes based on household food spending.

Furthermore, several of the reported diets had micronutrients and other dietary components that were below optimal amounts. For example, the NNMB study found that fruit and vegetable intake was insufficient in tribal and rural surveys.[29,30] Because not all micronutrient levels are energy dependent, it is difficult to quantify the optimum usage of protein under these conditions. A significantly more robust functional definition of risk would be possible if protein consumption could be linked to a physiological outcome, but this is exceedingly difficult to do. Moreover, there are so many environmental risks that it is difficult to pinpoint protein as the cause of poor performance or a negative outcome; however, research on the lysine requirements of malnourished Indians before and after intestinal parasite eradication[20,31] suggests that environmental stressors exist.

3. Conclusion

The amount and quality of protein in a cereal-based diet is an essential aspect of dietary concerns. During pregnancy, just increasing cereal eating ensures calorie intake but not protein intake. To summarize, rural and tribal adult populations have a significantly greater frequency of low body mass index (BMI), sometimes approaching 50%, despite the fact that a larger percentage of individuals are at danger of ingesting insufficient protein. This is a substantial burden that must be addressed in poor communities; it entails not just raising protein intake but also the entire quality of the diet.

To summarize, adequate consumption of high-quality protein is required for human growth, development, and health. A prudent way to ensure that children and adults get a balanced quantity of dietary amino acids is to consume a variety of plant- and animal-based foods. There is no standard protein intake that works for everyone, regardless of age. Instead, people should adjust their protein and nutrient intake according to their health, physiological needs, and metabolic rates. Maintaining skeletal-muscle protein synthesis, mass, and function (including physical strength), as well as improving insulin sensitivity, alleviating age-related sarcopenia, and lowering white-fat accretion, all require an adequate supply of both essential amino acids and synthesizable amino acids. People can benefit from moderate to strenuous exercise by eating plenty of lean meat, which contains vitamins, minerals, and high-quality dietary protein. Misconceptions concerning amino acids and protein intake in humans persist as a result of a lack of study understanding. The growth, development, and health of adults as well as children are all dependent on ingesting adequate high-quality protein from animal products (such as lean meat and milk). To avoid unfavorable health consequences, protein consumption should be limited within specified upper limits.

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None.

5. Conflict of Interest

None.

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