Subclinical Kwashiorkor in Adults: A New Age Paradigm

Nitin Kapoor1,2, Saptarshi Bhattacharya3, Navneet Agarwal4, Sambit Das5, Ganapathi Bantwal6, Vaishali Deshmukh7, Sanjay Kalra4

1Department of Endocrinology, Diabetes and Metabolism, Christian Medical College, Vellore, Tamil Nadu, India, 2Implementation Science Lab, Baker Heart and Diabetes Institute, Melbourne, Victoria, Australia, 3Consultant Endocrinologist, Apollo Centre for Obesity, Diabetes and Endocrinology (ACCODE), Indraprastha Apollo Hospitals, New Delhi, 4Department of Diabetology, DNA Sugar Clinic, Gwalior, Madhya Pradesh, 5Department of Endocrinology, St Johns Medical College and Hospital, Bengaluru, Karnataka, 6Department of Endocrinology, Deshmukh Clinic and Deenanath Mangeshkar Hospital and Research Centre, Pune, Maharashtra, 7Department of Endocrinology, Bharti Hospital, Karnal, Haryana, India

Abstract

Childhood protein-energy undernutrition (PEU) is a well-recognized problem and therefore a lot of work has been done to identify and manage paediatric PEU. Though there have been several reports of low protein consumption in adults from developing countries, PEU and its subtle forms (subclinical PEU) are not yet recognized as adult disorders. Physicians and public perception do not favour easy recognition and action. In this review, the authors provide a scoping review of the existing literature on this entity providing insights into its recognition, pathogenesis and management. Adult subclinical PEU is an enormous under-recognized challenge that can have detrimental consequences if not recognized and corrected in time. PEU has grave health and economic impact on the patient and society. Therefore, it is important to recognize subclinical PEU and prevent its progression to full-blown form.

Keywords: Adults, kwashiorkor, obesity, severe protein malnutrition, subclinical, undernutrition

INTRODUCTION

Malnutrition continues to be a major global public health problem in children and adults.[1] Malnutrition covers two spectrums of opposing nutrition status, that of undernutrition and over nutrition.[1] In this review, we will cover the undernutrition aspect in adults.

Undernutrition in developing countries is multifactorial and the programmes to counter it need to consider the demographic, socioeconomic, physiological and behavioural aspects of nutrition.[2,3] Social welfare programmes in countries like India, aimed at improving nutritional status, have been ineffective.[6] This confirms that the multifactorial dynamics of adult undernutrition are poorly understood.[7]

Childhood undernutrition is usually well-identified and perceived as a magnitude of a huge problem.[8-13] Childhood protein-energy undernutrition (PEU) or protein-energy malnutrition (PEM) is a widely discussed and accepted global problem.[8-16] However, though PEU is reported in adults,[17-19] it continues to be an under-recognized entity that does not receive the attention it should.[20]

Adult undernutrition includes both PEU and deficiency of micronutrients (vitamins and minerals).[1] It is associated with higher morbidity, mortality and disability, reduced productivity, lower intelligence quotient (IQ) and impaired economic growth and development.[7,13-27] While mineral and vitamin deficiency is a well recognized and accepted concern in adults, PEU is not.[20,28]

Chronic energy deficiency (CED), characterized by lean body mass with low energy storage, is one of the hallmarks of adult undernutrition.[29] CED decreases work capacity and if the earning member is affected, then CED can result in food insecurity, compromised economic capability, poverty and poor access to adequate healthcare.[30-33] The aetiology of the unique thin fat phenotype in South Asian countries, often prevalent in lean diabetes, is also linked to CED.[34-36]

Protein deficiency is an under-recognized and serious concern in Asian and African adults.[20] The recommended dietary

Access this article online

Quick Response Code:  
Website: www.ijem.in

DOI: 10.4103/ijem.ijem_42_22

Address for correspondence: Prof. Nitin Kapoor,
Department of Endocrinology, Diabetes and Metabolism, Christian Medical College, Vellore - 632 004, Tamil Nadu, India.
E-mail: nitin.endocrine@gmail.com

Submitted: 20-Jan-2022  
Accepted: 30-Mar-2022  
Revised: 22-Mar-2022  
Published: 04-Aug-2022

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Kapoor N, Bhattacharya S, Agarwal N, Das S, Bantwal G, Deshmukh V, et al. Subclinical kwashiorkor in adults: A new age paradigm. Indian J Endocr Metab 2022;26:213-22.
allowance (RDA) for protein for healthy Indian adults as per the Indian Council of Medical Research (ICMR) and National Institute of Nutrition (NIN) is 0.8 g per kg reference body weight (for India: 60 kg for men and 50 kg for women). However, an Indian adult’s dietary protein intake usually falls short of RDA to about 0.6 g per kg reference body weight. The 2015 Protein Consumption in Diet of Adult Indians: A General Consumer Survey (PRODIGY) found that nine out of 10 Indian adults consume an inadequate amount of proteins. PRODIGY brought to the limelight that protein consumption was very low in Indian adults. Though the RDA of protein is well delineated in India, and the protein sources are usually available and accessible, adult protein deficiency continues to pose a challenge to the public as well as the individual health of Indians. Just like PEU, subclinical PEU is largely under-recognized, under-diagnosed and therefore rarely reported. Adult subclinical PEU needs early detection and rectification to prevent its progress to PEU. There is an urgent need to infuse adult subclinical PEU awareness among the public and healthcare professionals.

Kwashiorkor

Epidemiology

Kwashiorkor is a type of PEU that is prevalent and amply reported across countries and societies in children from resource-challenged backgrounds. Kwashiorkor has been reported in sub-Saharan Africa, Southeast Asia including India and Central America and affects 6% to 25% of children depending on food availability and famine conditions. According to the 2019 United Nations Children’s Fund (UNICEF)/World Health Organization (WHO)/World Bank Group report, more than two-thirds of wasted and more than half of the stunted under-five children in the globe lived in Asia. Of the 49.5 million under-five wasted children in Asia, 16.6 million were severely wasted in 2018. As per India’s National Family Health Survey-4 (NFHS-4) data, under-five stunting and underweight children are most prevalent in the poorest and least in the richest sections of the society (51% vs. 22% for stunting and 49% vs. 20% for underweight). Kwashiorkor has also been reported in children from other well-off regions of the world.

The 2019 Food and Nutrition Security Analysis initiated jointly by the Government of India and the World Food Programme found that the average protein consumption in rural and urban India was 47.5 g/day and 47 g/day, respectively, which was lower than the 48 g/day and 50 g/day recommended by ICMR for rural and urban areas, respectively. A 2017 survey by Indian Market Research Bureau (IMRB) conducted in seven Indian cities, reported that 73% of urban rich were protein deficient and 93% were unaware of their RDA. These data show that PEU is also in the rich, highlighting the fact that the aetiology is more deep-rooted than just affordability.

Aetiology

Inability to afford a protein diet due to poverty or ignorance regarding the composition of food is the main cause of PEU in low-income countries. However, in India, often the cause of deficiency goes beyond affordability and ignorance to include issues like the gender gap with males in the family getting more nutrition than females. The aetiology of PEU in children from well-off families is not related to affordability. Frequent modifications in milk diet, perceived milk allergies, food faddism, unorthodox diets, malabsorptive syndromes and parental ignorance leading to predominantly cereal-based protein-poor weaning diet are common causes of kwashiorkor in children from an affluent background. Children brought up in an environment of significantly chaotic social environment were also found to be at risk of kwashiorkor.

Kwashiorkor usually starts during the weaning age and usually presents when the child is under five years. However, adult kwashiorkor has also been described in the literature. Kwashiorkor has been reported post bariatric surgery and/or short-gut syndrome. Zhu (2019) reported kwashiorkor in a 60-year-old alcohol-dependent male.

Adults following fad diets, starving to lose weight or having chronic illness or inflammation in the body are also at risk of developing PEU. Conditions, such as infections, trauma, burns, surgery and hyperthyroidism, that increase metabolic demands, can precipitate PEU.

Apart from medical causes and dieting/starving or following fad diets, dietary preferences and habits play a major role in causing adult PEU. The majority of Indians are vegetarians with a predominantly rice-based diet. Though the Indian diet across states is generally low in proteins, vegetarians consume lower protein than non-vegetarians. Up to 60% of the protein in Indian diets comes from cereals which are of relatively low quality and digestibility. The Study To Assess the dietary Carbohydrate content of Indian type-2 diabetes population (STARCH) survey from India found that 64.1% of all energy requirements were met by consuming starchy food, which was approximately 4.1% higher than the upper limit of RDA of 60%. Another nutrition survey from Asia found carbohydrate consumption exceeded the RDA in 58.0% of men and 60.0% of women. High carbohydrate intake was associated with low energy and protein intake. Dietary preference for high carbohydrates has also been reported in Africa and other parts of the world.

Additionally, all causes of PEU, including reduced intake, absorption and assimilation, do coexist and are important from a clinical viewpoint. Hence, it is important to understand the factors leading to undernutrition in adults. A case-control study from Bangladesh in the 18–45 year age group found that having more siblings [adjusted odds ratio (aOR), 1.39], higher score for mental health and psychological symptoms (aOR, 1.12), anaemia (aOR: 3.63) and high α-1 antitrypsin in stools (aOR 4.82) correlated positively with adult undernutrition. Undernourished adults had iron and zinc deficiency. On the other hand, older age (aOR, 0.90), having a low dietary
diversity score (aOR, 0.75), having low inflammatory markers such as C-reactive protein level (aOR, 0.82), not having Helicobacter pylori infection (aOR, 0.11) and proper hand hygiene before eating, cooking or serving food (aOR, 0.33) correlated with reduced odds of adult undernutrition.\textsuperscript{[29]} Other factors associated with adult undernutrition in the Asian population are female gender, lower education level, having no permanent employment, low family income and smoking.\textsuperscript{[56‑58]}

There are many other clinical situations where physicians may encounter PEU. Psychiatric disorders such as depression and anorexia result in poor food intake and can therefore precipitate PEU.\textsuperscript{[59,60]} PEU can be a presenting feature of undetected malignancy or can precipitate in patients undergoing treatment for malignancy (cancer cachexia).\textsuperscript{[59‑61]} Other than these, critically ill patients being managed in intensive care units (ICUs) or those hospitalized for a prolonged period are more likely to develop PEU.\textsuperscript{[62]} Secondary endocrine causes such as endogenous Cushing’s syndrome, chronic adrenal insufficiency, chronic steroid use, uncontrolled diabetes, hyperthyroidism and hypogonadism should be ruled out in patients where no other obvious cause can be identified.\textsuperscript{[48]}

PEU is increasingly being seen in patients infected with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and developing coronavirus disease 2019 (COVID-19).\textsuperscript{[63,64]} COVID-19 causes malnutrition in many ways. ICU admissions, prolonged hospital stays, loneliness during home isolations or hospitalizations in COVID wards and stress of the disease resulting in poor food intake during the disease can precipitate PEU.\textsuperscript{[63‑68]} The increased viral load and infection and inflammation associated with COVID-19 increase metabolic demand on the body and can therefore precipitate PEU.\textsuperscript{[69]} The risk of PEU is higher in patients who have obesity and diabetes.\textsuperscript{[69]} Obesity, an inflammatory state, is associated with increased COVID-19 risk and severity, and diabetes often becomes uncontrolled, thereby increasing inflammation and metabolic demand.\textsuperscript{[70,71]}

**Symptoms**

The word kwashiorkor often elicits vivid imagery of a severely undernourished child. The clinical presentations in children include the characteristic erosive crusting rash giving the flaky paint sign image with overall peripheral oedema.\textsuperscript{[14]} On the other hand, an adult with PEU may just be irritable, weak, fatigued, have low work capacity and apathy.\textsuperscript{[72]}

Sometimes, PEU in adults may be severe enough and mimic the classic presentation seen in children. There may be muscle shrinking, fat wasting with cachexia, most prominent in areas of fat deposit and protrusion of bones.\textsuperscript{[72‑75]} Patients may complain of dry skin, which looks pale, is thin and inelastic, and cold to touch.\textsuperscript{[72]} Dry hair and profuse hair loss may be a complaint in subclinical PEU, and on examination, there is thinning of the scalp.\textsuperscript{[72]}

Prolonged PEU may present as amenorrhoea (women), or gonadal atrophy and loss of libido in both sexes.\textsuperscript{[72,76‑77]} More severe cases may impair cognition; decrease blood pressure, pulse rate and cardiac output; and cause hypothermia which if unattended may cause death in rare cases.\textsuperscript{[72,75]} Anaemia, oedema, jaundice and petechiae may develop if there is organ failure affecting the kidney, heart or liver.\textsuperscript{[72,75]} This phenotype also explains the high prevalence of normal weight obesity and its associated metabolic complications in the Indian subcontinent.\textsuperscript{[78,79]}

**Signs**

Physicians have many tools at their disposal to elicit physical deficits in PEU. These tools test muscle mass, muscle strength and muscle function as a reflection of PEU.\textsuperscript{[80]} Various tools for diagnosing PEU and for eliciting underlying subclinical PEU are strength, assistance with walking, rising from a chair, climbing stairs, and falls (SARC-F) questionnaire, gait speed, grip strength, Timed Up and Go test (TUG) and short physical performance battery (SPPB). Imaging studies like dual-energy X-ray absorptiometry (DEXA) and bioelectrical impedance analysis (BIA) can be used to assess body composition and muscle mass. Anthropometric measures such as mid-arm circumference (MAC), body mass index (BMI), waist circumference, hip circumference, triceps skinfold and calf circumference are useful in assessing PEU.\textsuperscript{[81,82]}

DEXA and BIA are costly tests, not available at all centres and not routinely used in clinical practice for assessing PEU. Questionnaires are difficult to administer, especially in busy clinics. Instead, physicians rely on easy-to-use tools such as gait speed, grip strength and anthropometric measures. A patient who has three low anthropometric measures, viz., BMI, waist circumference and waist-to-height ratio, is likely to have PEU.\textsuperscript{[83]} MAC and calf circumference are other useful clinical tools to assess PEU.\textsuperscript{[84]}

**Subclinical Kwashiorkor**

Despite the availability of reliable diagnostic tools, it would be a disservice to humanity to wait for the onset of kwashiorkor before diagnosing and treating it. The right approach is to screen, diagnose and manage protein deficiency before it causes clinical dysfunction. A way to paraphrase this would be to state that subclinical protein deficiency should be tackled, to prevent clinical protein deficiency. This thought process suggests that the term subclinical kwashiorkor may be used, to drive home the point that if unchecked, protein deficiency may lead to kwashiorkor-like symptoms and signs.

**The definition of subclinical disease**

The subclinical disease is the time period from exposure to a causative agent/factor to the appearance of clinical symptoms.\textsuperscript{[85]} It is a stage where all pathological and biochemical changes are occurring.\textsuperscript{[85,86]} Though the word ‘subclinical’ has a connotation of being symptom-free, many subclinical diseases can be identified clinically. Subclinical hypothyroidism,\textsuperscript{[87]} and hypomania,\textsuperscript{[88]} for example, may have
subtle symptoms and signs which facilitate early diagnosis. A similar condition applies to subclinical adult kwashiorkor.

Subclinical PEU is rarely reported. However, considering that adult PEU has grave consequences, physicians and the public should understand that it is important to identify subclinical PEU. A history of deficient protein intake in a healthy or sick adult should raise a suspicion of subclinical PEU. Adults having malabsorption syndromes, kidney or liver disease are likely to have subclinical PEU before the symptoms actually manifest. Adults presenting with mild oedema, loss of muscle strength and inability to gain muscle mass in spite of appropriate exercise may have adult subclinical kwashiorkor, even in the face of normal biochemistry. Subclinical PEU may coexist in adults with mineral, vitamin or other nutrient deficiency.

**PUBLIC PERCEPTION**

There is very low priority and importance attached to adult protein malnutrition in the community. PRODIGY showed that the public was generally unaware that protein deficiency is a major concern as iron and calcium deficiency. Additionally, 93% of the Indian population was unaware of recommended daily protein requirement. The survey also showed that 97% of pregnant women, 96% of lactating mothers and 95% of adolescents were unaware of their recommended daily protein requirement. The recent ‘Right to Protein’, a nationwide public health awareness survey conducted across 16 cities in India found that misinformation led to low protein consumption. The majority of Indian women/mothers are unable to identify easily available protein-rich foods. About 78% of mothers believed that protein is only required for strenuous exercises and that lack of protein in the diet does not affect overall health.

Additionally, though physicians understand the importance of nutrition, they do not feel confident enough to address the nutritional aspect of patient management. A survey of 114 resident physicians found that majority agreed that routine primary care visits should include nutrition assessment (77%) and that they are obligated to discuss nutrition with their patients (94%). However, only 14% of them felt they had adequate training to provide nutrition counselling. Physicians who had previous exposure to nutrition assessment and counselling training had significant doubts regarding their effectiveness to provide nutritional support to their patients ($P = 0.03$). This shows that continued medical education (CME) covering nutrition assessment and counselling is required to improve physicians’ confidence to manage the nutritional requirement of their patients.

A qualitative study from Saudi Arabia showed that while the nurses felt that they could promote proper nutrition among the patients they care for, they do not have enough independence and power to provide nutritional support and counselling. This is worrying because the hospital and community nurses/social workers spend the maximum time with chronically ill hospitalized and discharged patients, respectively. Hence, they can provide an important link to screen, detect and manage subclinical PEU in this vulnerable population.

Another survey of older adults and diabetics showed that older adults were significantly unaware of the possibility that they are under-nourished. They failed to correct their nutritional deficit despite the efforts of their diabetics. This was because the diabetics usually recommended incorporating regular food products that the older adults were familiar with. They worked on providing diversity and palatability. Instead, those older adults who were prescribed protein-enriched food products improved their nutritional deficit without much coaxing. The survey showed that older adults may not be able to benefit from dietary recommendations usually provided to adults as they may have difficulty arranging wholesome meals for themselves. Hence, nutrient-rich food supplements are more likely to help this population.

**PROVIDER DISCORDANCE AND TOOLS**

The situation is compounded by the lack of consensus seen amongst healthcare professionals regarding the diagnosis and management of subclinical PEU. At least 22 malnutrition screening tools are available, all of which give widely varying estimates of PEU risk. There is no diagnostic tool for subclinical PEU. In such a situation, it is important to use available tools judiciously to identify the subclinical disease at the earliest. These diagnostic tools include history, physical examination and laboratory findings.

**History**

Diagnosis of subclinical PEU can usually be suspected from a carefully elicited history showing reduced intake due to poverty, starvation, following a fad diet, dieting for weight loss, chronic illness or due to eating disorders such as anorexia nervosa. Amenorrhoea in a non-pregnant woman of child-bearing age should raise a suspicion of undernutrition.

**Physical examination**

Anthropometric measures such as height, weight and BMI (BMI = weight in kg/height [m$^2$]), along with inspection of body fat distribution may aid in the diagnosis of subclinical PEU. Estimates of PEU risk.

| Measurement                  | Normal       | Subclinical PEM |
|------------------------------|--------------|-----------------|
| Normal weight (%)            | 90-110       | 85-90           |
| Body mass index (BMI)*       | 18.5-22.9    | <18.5           |
| Waist circumference*         | <90 cm in men and <80 cm in women |
| Waist-hip ratio*             | <0.9 in men and <0.8 in women |
| Body fat percentage**       | <25% in men and <30% in women |

*Asian values. **by dual-energy X-ray absorptiometry (DEXA) scan

| Table 1: Physical examination values commonly used to grade the severity of protein-energy undernutrition | Normal | Subclinical PEM |
|---------------------------------------------------------------|--------|-----------------|
| Normal weight (%)                                             | 90-110 | 85-90           |
| Body mass index (BMI)*                                         | 18.5-22.9 | <18.5           |
| Waist circumference*                                           | <90 cm in men and <80 cm in women |
| Waist-hip ratio*                                               | <0.9 in men and <0.8 in women |
| Body fat percentage**                                         | <25% in men and <30% in women |

*Asian values. ** by dual-energy X-ray absorptiometry (DEXA) scan
Laboratory tests

Laboratory tests may not be routinely performed to diagnose subclinical PEU. However, if dietary history does not show inadequate protein intake or if the physical examination is inconclusive, then laboratory tests may be required for diagnosis. Various laboratory parameters such as serum albumin and proteins, total lymphocyte count, serum cholesterol, various vitamin levels (especially vitamin D and vitamin E), mineral levels, urine creatinine, haemoglobin, routine and microscopy, urine culture, delayed hypersensitivity and 3-methylhistidine may aid in the diagnosis of subclinical PEU [Table 2].

Immune response involving CD4+ and CD8+ T lymphocytes may be decreased in subclinical PEU. Poor immune responses in subclinical PEU may be assessed by checking the values of C-reactive proteins and interleukins. Though initially serum compliments have been reported to be low in children with PEM, this has not been shown in more recent studies. Leptin levels may provide insight into the fat metabolism of a given individual [Table 2].

BRINGING OBJECTIVITY TO EVALUATION

Subclinical PEU is difficult to identify and diagnose. Loss of muscle mass, easy fatigability and reduced exercise capacity may be ignored or labelled as being due to other causes. Subtle changes in skin, hair and nail health may be missed, or ascribed to micronutrient deficiency. History, physical examination and anthropometric measurements are highly subjective tools as they rely heavily on the ability of the evaluator to assess and correlate. Though routine laboratory tests for nutritional assessment may provide the much-needed objectivity to evaluation, their incorporation into routine clinical practice is difficult. A single value/level of a biochemical test is often inconclusive and may require repeat serial evaluations to be able to correlate with subclinical PEU. This adds to the cost of treatment and may be difficult to implement in a country like India.

The Global Leadership Initiative on Malnutrition (GLIM) has recently published a consensus-based framework of phenotypic and causative criteria for evaluating adult malnutrition. International guidelines on adult malnutrition and GLIM agree that the aetiology of PEU can be classified under discrete criteria such as decreased intake; faulty absorption and assimilation of protein and energy intake; and inflammation due to any cause precipitating lean tissue catabolism. Inflammatory causes can be further categorized as severe inflammation caused by acute disease/injury; sustained inflammation caused by chronic diseases/conditions; chronic disease with no or minimal perceived inflammation; and chronic starvation unrelated to any disease.

This is a welcome step towards bringing objectively to protein malnutrition diagnosis and evaluation. Based on the above criteria, Table 3 enumerates the groups of adults at risk of subclinical PEU. Adults falling into any of the above categories should undergo assessment may provide the much-needed objectivity to evaluation.

Table 2: Common laboratory values that may help assess adult subclinical protein-energy undernutrition

| Laboratory parameter | Relation to prognosis |
|----------------------|-----------------------|
| Serum albumin (g/dL) | Each 2.5 g/L decrease in value increases mortality risk by 24-56% |
| Serum transferrin (mg/dL) | Role is controversial but if albumin is decreasing, decreasing transferrin value is indicative of worsening morbidity and mortality |
| Insulin growth factor-I | Hospitalized patients: Inverse correlation with life-threatening complications |
| Total lymphocyte count (per mL) | Values <1500/mL correlated with four times increased mortality risk |
| C-reactive protein | Hospitalized patients: Decreased levels predict short-term survival |
| Interleukins (IL) | Increase in soluble IL-2 receptors increases mortality risk |
| Urine creatinine | Decrease in muscle mass may be suspected of low levels |
| Cholesterol | Values <120 are associated with 10-fold increased risk of mortality |
| Delayed hypersensitivity reaction | Absence of normal response is associated with increased 3-year mortality |
| Leptin | Association with prognosis is unknown |

Table 3: Adults at risk of subclinical protein-energy malnutrition

| Category | Conditions |
|----------|------------|
| Starvation | Poverty |
| Chronic conditions | Chronic obstructive pulmonary disease (COPD) |
| | Cancer |
| | Chronic inflammatory gastrointestinal disease |
| | Renal or liver disease |
| | Inflammatory conditions such as rheumatoid arthritis |
| | Palliative/end of life care |
| | Stroke |
| | Parkinson’s disease |
| | Motor neurone disease |
| Acute illness | Diarrhoea |
| | Intensive care unit |
| | Burns |
| Debility/Age | Dementia |
| | Old age |
| | Frailty |
| | Immobility |
| Psychological/Neurological issues precipitating poor intake | Depression |
| | Living alone |
| | Alcohol/substance abuse |
| | Learning disabilities |
categories should be diligently scrutinized for subclinical PEU through meticulous history taking and comprehensive physical examinations and, if required, serial laboratory investigations.

**The Need for Motivation**

Irrespective of the screening and diagnostic criteria used for the identification of protein malnutrition, an important barrier to action is the diagnosis. To be effective, a public health strategy should sensitize the community towards the need for early diagnosis, prevention and management. This can be done by a variety of social marketing methods. Multiple motivational theories try to explain why health interventions have mixed impacts on the public. One of the simplest theories is a binary construct, which describes two opposing motivational strategies: the need for achievement, and fear of failure. The need to achieve protein sufficiency may carry less importance in an individual’s mind if he or she has not experienced the advantages of sufficiency. On the other hand, fear of protein malnutrition may be a greater driving force, if vivid imagery is used to portray the ill effects of this condition.

**Management and Call to Action**

Physicians should understand that PEU screening is just the tip of the iceberg in PEU management. Screening has to be followed up with proper evaluation, replacement of deficit, supplementation if required, monitoring and creating awareness. It requires acceptance and compliance from both the patient and the physician. Both must understand that if subclinical PEU is not halted in time, it can have a devastating effect on the health and quality of life (QoL) of the patient. \(^{25}\)

PEU can be typically corrected by supplementing the protein-energy requirement in proportion to the need to meet the deficit. \(^{100}\) However, this is often not enough because when PEU is caused by disease-related poor nutrition, then the therapeutic effect of supplementation is blunted. \(^{109}\) Judicious management of the deficit and strict monitoring is required in many patients to correct the deficit and prevent over-supplementation and its adverse outcomes. \(^{100}\) Hence, individualized or personalized nutrition support is often required to meet the nutrition deficit. \(^{108,109}\) Individualized nutrition support can help reduce the risk of progression to PEU, and improve muscle strength and QoL. \(^{111}\)

Every effort should be made to monitor the diet of such patients, make them aware of the affordable and easily available protein options \(^{112,113}\) (Table 4), teach them portion size to be taken and give necessary supplementation if required. \(^{25}\) Protein portion sizes will vary daily with the dish and other accompaniments; and also vary with gender and family size, \(^{114}\) and therefore these parameters need to be considered when helping patients assess the portion size. Despite these differences in portion sizes, on the whole, protein should provide 10–15% of the total calorie requirement of the patient. \(^{115}\) Rough portion size for different proteins for sedentary adults \(^{115}\) as listed in Table 4 can act as a guide during a discussion with the patient.

The healthcare professional may also need to understand the patient’s socioeconomic condition, resources available, ability to cook, access to food, ability to self-feed, mental state, functional limitations and other such factors to individualize the nutrition support programme and plan supplementation. \(^{25}\) Dieticians and nutritionists can play a strong role in individualizing nutrition support and should be an integral part of the medical team managing the patient.

The Protein Paradox study shows that protein awareness is very poor in India. Therefore, social media and other health platforms, right from public health centres to tertiary care centres, need to run protein awareness programmes. These programmes should include knowledge about RDA in terms of portion size and highlight the easily accessible \(^{112,113}\) (Table 4) and affordable protein options. The programmes should generate awareness to self-diagnose subclinical PEU. Patients should be able to recognize common symptoms (e.g. fatigue, hair fall, dry skin and hair), and understand that they are likely to have subclinical or clinical PEU if being treated for a chronic illness. They should be able to assess if they are taking the RDA or falling short of it and be able to add the required protein quantity to their meals and see if their symptoms are improving. However, simultaneously they should be encouraged to reach out to their physicians, dieticians and nutritionists to assess if they have subclinical PEU. Needless to say, it is important to stress that prevention is better than cure and it is important to detect and correct subclinical PEU to prevent its progression to detrimental PEU.

As with the loss of fat, that may increase the potential toxicity of fat-soluble molecules, even albumin plays a very important role in binding to several hormones and drugs. The presence of low albumin as may be found in patients with PEU may have implications in interpreting albumin-bound hormones, understanding the toxicity profile of albumin-bound drugs and also understanding these changes after improvement of albumin.

There is an unmet need to provide nutritional education, maybe in form of nutritional CME, to physicians as there is substantial providers’ discordance and varying perceptions regarding adult undernutrition. \(^{116}\) Additionally, nurses, dieticians, social workers and nutritionists should be integrated into patient care to provide nutrition support and counselling.

Addressing subclinical PEU will require a cohesive and multidimensional effort of all key players such as the government, media, nutritionists, doctors, food industry, food experts and public and educational institutions. \(^{20}\) Moreover, further studies are needed to know the precise impact of treating subclinical PEU in preventing rapid deterioration during a crisis. A very similar analogy is poor dietary calcium intake in postmenopausal Indian women, which despite having
normal serum calcium may predispose to the development of fragility fracture and can be prevented by prophylactically supplementing adequate calcium.

The Association with Sarcopenia, Sarcopenic Obesity and Osteoporosis

The association between low protein intake and low muscle mass and strength is well established. Sarcopenia, a condition referred to as a combination of either low muscle mass, low muscle strength and/or poor muscle function is commonly seen in the elderly population. Sarcopenia is part of the spectrum encompassing PEU and is more commonly seen in the elderly. Moreover, sarcopenia may also be associated with underlying osteoporosis and osteoarthritis together known as the MOAN syndrome (musculo-osteo-arthro-neuropathic).[117] In the Indian thin fat phenotype, this may further be associated with increased visceral adiposity despite having a lower BMI.[119] This entity will then be called sarcopenic obesity. The above-mentioned various phenotypes highlight the importance of evaluating different body composition components in people suspected of PEU, which are often interlinked.

Moreover, the association of PEU along with low muscle mass may further be linked to poor bone strength. This triad is commonly seen in the elderly population, together referred to as the MOAN syndrome.[117] This highlights the close link between these four organ systems and their contribution to the poor health-related QoL in these individuals. Furthermore, a higher body fat percentage, which is often commonly present in people with poor muscle mass, was initially thought to be protective against bone fragility. However, more recent literature has suggested that this does not hold true in those with morbid obesity.[119]

Summary

PEU is thought to be a childhood problem. However, it can occur in adults. Protein undernutrition is very common in Indian adults. And hence subclinical PEU is also likely to be very common. Adult subclinical PEU and protein undernutrition is a surprising find and is largely preventable and treatable because the cause is not affordability but basic ignorance regarding RDA and easily accessible protein sources. Hence, every effort should be made to generate awareness in the public, physicians and other healthcare workers regarding the existence of subclinical PEU, detect it at the earliest, treat it and prevent its progression to clinical PEU.

Ethics compliance

Not required as it is a review article.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.
REFERENCES

1. Dukhi N. Global Prevalence of Malnutrition: Evidence from Literature. IntechOpen. 2020. doi: 10.5727/intechopen.92006.

2. Subramanian SV, Smith GD. Patterns, distribution, and determinants of under- and overnutrition: A population-based study of women in India. Am J Clin Nutr 2006;84:633–40.

3. Griffiths PL, Bentley ME. The nutrition transition is underway in India. J Nutr 2001;131:2692–700.

4. Misra A, Singhal N, Sivakumar B, Bhagat N, Jaiswal A, Khurana L. Nutrition transition in India: Secular trends in dietary intake and their relationship to diet-related non-communicable diseases. J Diabetes 2011;3:278–92.

5. Green R, Milner J, Joy EJ, Agrawal S, Dangour AD. Dietary patterns in India: A systematic review. Br J Nutr 2016;116:142–8.

6. Rai RK, Kumar S, Sekher M, Pritchard B, Rammohan A. A life-cycle approach to food and nutrition security in India. Public Health Nutr 2015;18:944–9.

7. Rai RK, Fawzi WW, Bromage S, Barik A, Chowdhury A. Underweight among rural Indian adults: Burden, and predictors of incidence and recovery. Public Health Nutr 2018;21:669–78.

8. Müller O, Krawinkel M. Malnutrition and health in developing countries. CMAJ 2005;173:279–86.

9. Kramer CV, Allen S. Malnutrition in developing countries. Paediatr Child Health 2015;25:422–7.

10. Pingale S, Patil VW, Hire M, Katkade A. Prevalence of kwashiorkor, marasmus, marasmic kwashiorkor and age wise distribution of malnourished tribal children of Town Dhaagoda, District-Nandurbar of Maharashtra State, India. Res J Pharm Technol 2014;7:59–63.

11. Bhutia DT. Protein Energy Malnutrition in India: The Plight of Our Under Five Children. J Family Med Prim Care 2014;3:63–7.

12. Gopalan C, Ramalingaswami V. Kwashiorkor in India. Indian J Med Res 2012;136:108.

13. Fitzpatrick M, Ghosh S, Kurpad A, Duggan C, Maxwell D. Lost in aggregation: The geographic distribution of kwashiorkor in eastern democratic Republic of the Congo. Food Nutr Bull 2018;39:512–20.

14. Liu T, Howard RM, Mancini AJ, Weston WL, Paller AS, Drolet BA, et al. Kwashiorkor in the United States: Fad diets, perceived and true allergy, and milk allergy, and nutritional ignorance. Arch Dermatol 2001;137:630–6.

15. Katz KA, Maliberg MH, Honig PJ, Yan AC. Rice nightmare: Kwashiorkor in 2 Philadelphia-area infants fed Rice Dream beverage. J Am Acad Dermatol 2005;52 (5, Supplement):S69–72.

16. Lee HJ, Km KH, Park HJ, Lee KH, Lee GH, Choi EJ, et al. A case of lethal kwashiorkor caused by feeding only with cereal grain. Clin Exp Pediatr 2008;51:329–34.

17. Custer A, Custer D, Shao P, Kirollos H. Secondary kwashiorkor disease in a patient with gastric bypass surgery and short gut syndrome. Am J Pediatr 2008;51:329–34.

18. Zhu B. Kwashiorkor in an adult from alcohol dependence and severe underfeeding. Case Rep 2021;22:e928468. doi: 10.12659/AJCR.928468.

19. Boutin D, Cante V, Levillain P, Piguel X, Guillet G. Adult kwashiorkor: A rare complication of bariatric surgery. Ann Dermatol Venereol 2015;142:99–103.

20. Right to Protein. Protein Paradox | Right To Protein. Published 2021. [Last accessed on 2021 May 02]. Available from: https://righttoprotein.com/initiative/protein-paradox.html.

21. Letamo G, Navaneetham K. Prevalence and determinants of adult under-nutrition in Botswana. PLoS One 2014;9:e102675. doi: 10.1371/journal.pone.0102675.

22. Nubé M, Van Den Boom GJ. Gender and adult undernutrition in developing countries. Ann Hum Biol 2003;30:520–37.

23. Cordeiro LS, Wilde PE, Seme H, Levinson FJ. Household food security is inversely associated with undernutrition among adolescents from Kilosa, Tanzania. J Nutr 2012;142:1741–7.

24. WHO. Repositioning nutrition as central to development: A strategy for large-scale action-orientation. World Bank. Published 2006. Available from: https://documents.worldbank.org/en/publication/documents‑reports/documentdetail/185651468175733998/Repositioning-nutrition-as-central-to-development-a-strategy-for-large‑scale‑action‑orientation. [Last accessed on 2021 Apr 29].

25. Holdowaya J, Anderson L. What more can community nurses do to manage adult malnutrition. Br J Community Nurs 2019;24:Suppl 7:S6–10.

26. Uyar S, Görs A, Kük M, Özer H, Koker G, Bostan E, et al. Could Insulin and hemoglobin A1C levels be predictors of hunger-related malnutrition/undernutrition without disease? Clin Lab 2019;65. doi: 10.7754/Clin. Lab. 2018.181211.

27. Zheng W, McLerran DF, Rolland B, Zhang X, Inoue M, Matsuo K, et al. Association between body-mass index and risk of death in more than 1 million Asians. N Engl J Med 2011;364:719–29.

28. Huskisson E, Mazzini S, Ruf M. The role of vitamins and minerals in energy metabolism and well-being. J Int Med Res 2007;35:277–89.

29. Fahlim SM, Das S, Gazi MA, Alam MA, Mahfuz T, Ahmed E. Evidence of gut enteropathy and factors associated with undernutrition among slum-dwelling adults in Bangladesh. Am J Clin Nutr 2020;111:657–66.

30. Jose S. Adult undernutrition in India: Is there a huge gender gap? Econ Polit Wyk 2011;46:95–102.

31. Fernald LC. Socio-economic status and body mass index in low-income Mexican adults. Soc Sci Med 2007;64:2030–42.

32. Florêncio TM, Ferreira HS, de França AP, Cavalcante JC, Sawaya AL. Obesity and undernutrition in a very-low-income population in the city of Maceió, northeastern Brazil. Br J Nutr 2001;86:277–84.

33. Ramachandran N. Persisting Undernutrition in India: Causes, Consequences and Possible Solutions. Springer India; New Delhi 2014. doi: 10.1007/978-81-322-1832-2.

34. Kapoor T. Thin Fat Obesity: The Tropical Phenotype of Obesity. In: Feingold KR, Anawalt B, Boyce A, et al., editors. Endotext. MTText.com., Inc.; 2000. Available from: http://www.ncbi.nlm.nih.gov/books/NBK568563/. [Last accessed on 2021 Jun 07].

35. Kapoor N, Fuler J, Paul TV, Thomas N, Oldenburg B. The BMI-adiposity conundrum in South Asian populations: Need for further research. J Biosoc Sci 2019;51:619–21.

36. Oommen AM, Kapoor N, Thomas N, George K. Prevalence and clinical characteristics of individuals with newly detected lean diabetes in Tamil Nadu, South India: A community-based cross-sectional study. Int J Diabetes Dev Ctries 2019;39:680–4.

37. ICMR. Nutrient Requirements for India: Recommended Dietary Allowances. Published online 2020. Available from: https://www.nin.res.in/nutrition2020/RDA_short_report.pdf. [Last accessed on 2021 Apr 04].

38. Mahajan M. Indian Medical Gazette-Reference | Diet (Nutrition) | Diet & Nutrition. Scribd. Published 2015. Available from: https://www.scribd.com/document/436130975/Indian-Medical-Gazette-Reference. [Last accessed on 2021 May 02].

39. Trehan I, Manary MJ. Management of severe acute malnutrition in low-income and middle-income countries. Arch Disease Child 2015;100:283–7.

40. Manary MJ, Heikens GT, Golden M. Kwashiorkor: More hypothesis testing is needed to understand the aetiology of oedema. Malawi Med J 2015;100:283–7.

41. UNICEF/WHO/World Bank. Levels and trends in child malnutrition. Published 2019. Available from: https://www.who.int/nutgrowthdb/jme-2019-key-findings.pdf?ua=1. [Last accessed on 2019 Sep 02].

42. NFHS-4. India Fact Sheet 2015-2016. Ministry of Health and Family Welfare, Government of India. Published 2016 2015. Available from: http://rchiips.nic.in/nfs/dh/NFHS4/India.pdf.

43. Government of India. Food and Nutrition Security Analysis, India, 2019. Published online 2019. Available from: http://mospi.nic.in/sites/default/files/publication_reports/document281%29.pdf. [Last accessed on 2021 May 04].

44. Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M, et al. Maternal and child undernutrition: Global and regional exposures and health consequences. Lancet 2008;371:243–60.

45. Rai RK. Factors associated with nutritional status among adult women in rural India: A systematic review. Br J Nutr 2015;113:1565–76.

46. Benjamin O, Lappin SL. Kwashiorkor. In: StatPearls. StatPearls Publishing; 2021. Available from: http://www.ncbi.nlm.nih.gov/books/NBK507876/. [Last accessed on 2021 Apr 28].

47. Saunders J, Smith T. Malnutrition: Causes and consequences. Clin Med (Lond) 2010;10:624–7.

Kapoor, et al.: Subclinical kwashiorkor in adults
96. Kalousova M, Dusilova-Sulkova S, Zakiyanov O, et al. Vitamin D binding protein is not involved in vitamin D deficiency in patients with chronic kidney disease. BioMed Res Int 2015;2015:492365. doi: 10.1155/2015/492365.

97. Vetter ML, Herring SJ, Sood M, Shah NR, Kalet AL. What do resident physicians know about nutrition? An evaluation of attitudes, self-perceived proficiency and knowledge. J Am Coll Nutr 2008;27:287-98.

98. Khalaf A, Westergren E, Ekblom Ö, Al-Hazzaa HM, Berggren V. Nurses’ views and experiences of caring for malnourished patients in surgical settings in Saudi Arabia – A qualitative study. BMC Nurs 2014;13:29.

99. Beelen J, Vasse E, Ziyalan C, Janssen N, de Roos NM, de Groot LC. Undernutrition: Who cares? Perspectives of dietitians and older adults on undernutrition. BMC Nutrition 2017;3:24.

100. Leij-Halfwerk S, Verwijs MH, van Houdt S, Borkent JW, Guaitoli PR, Pelgrim T, et al. Prevalence of protein-energy malnutrition risk in European older adults in community, residential and hospital settings, according to 22 malnutrition screening tools validated for use in adults≥65 years: A systematic review and meta-analysis. Maturitas 2019;126:80-89.

101. Thomas N, Kapoor N, Velavan J, Vasan KS. A Practical Guide to Diabetes Mellitus. 8th ed. Jaypee Brothers Medical Pub; New Delhi 2018.

102. Weir CB, Jan A. BMI Classification Percentile and Cut Off Points. In: StatPearls. StatPearls Publishing; 2020. Available from: http://www.ncbi.nlm.nih.gov/books/NBK541070/. [Last accessed on 2020 Feb 16].

103. Omran ML, Morley JE. Assessment of protein energy malnutrition in older persons, Part II: Laboratory evaluation. Nutrition 2000;16:131‑40.

104. Gerrits VA, Maclver NJ. Role of T cells in malnutrition and obesity. Front Immunol 2014;5. doi: 10.3389/fimmu.2014.00379.

105. de van der Schueren MA, Keller H, GL Consortium, Cederholm T, Barazzoni R, Compher C, et al. Global Leadership Initiative on Malnutrition (GLIM): Guidance on validation of the operational criteria for the diagnosis of protein-energy malnutrition in adults. Clin Nutr 2020;39:2872-80.

106. Cederholm T, Barazzoni R, Austin P, Ballmer P, Biolo G, Bischoff SC, et al. ESPEN guidelines on definitions and terminology of clinical nutrition. Clin Nutr 2017;36:49-64.

107. Jensen GL, Mirtallo J, Compher C, Dhaliwal R, Forbes A, Grijalba RF, et al. Adult starvation and disease-related malnutrition: A proposal for etiology-based diagnosis in the clinical practice setting from the International Consensus Guideline Committee. JPEN J Parenter Enteral Nutr 2010;34:156-9.

108. Schuetz P, Fehr R, Baechli V, Geiser M, Deiss M, Gomes F, et al. Individualised nutritional support in medical inpatients at nutritional risk: A randomised clinical trial. Lancet 2019;393:2312-21.

109. Weijs PJ, Looijaard WG, Beishuizen A, Girbes ARJ, Oudemans-van Straaten HM. Early high protein intake is associated with low mortality and energy overfeeding with high mortality in non-septic mechanically ventilated critically ill patients. Crit Care 2014;18:701. doi: 10.1186/s13054-014-0701-z.

110. Baumgartner A, Hasenboehler F, Cantone J, Hersberger L, Bargetzi A, Bargetzi L, et al. Effect of nutritional support in patients with lower respiratory tract infection: Secondary analysis of a randomized clinical trial. Clin Nutr 2021;40:1843-50.

111. Ha L, Hauge T, Spanning AB, Iversen PO. Individual, nutritional support prevents undernutrition, increases muscle strength and improves QoL among elderly at nutritional risk hospitalized for acute stroke: A randomized, controlled trial. Clinical Nutrition 2010;29:567-73.

112. Salis S, Joseph M, Agarwala A, Sharma R, Kapoor N, Irani AJ. Medical nutrition therapy of pediatric type 1 diabetes mellitus in India: Unique aspects and challenges. Pediatr Diabetes 2021;22:93-100.

113. Marinangeli CP, Curran J, Barr SI, Slavin J, Puri S, Swaminathan S, et al. Enhancing nutrition with pulses: Defining a recommended serving size for adults. Nutr Rev 2017;75:990-1006.

114. Sharma V, Chadha R. Assessment of portion sizes of food items commonly consumed by urban Indian adults: A preliminary study. Curr Res Nutr Food Sci J 2020;8:182-96.

115. NIN. DIETARY GUIDELINES FOR INDIANS: A Manual. National Institute of Nutrition. Published 2011. Available from: http://ninindia.org/DietaryGuidelinesforNINwebsite.pdf. [Last accessed on 2019 Sep 03].

116. Behara AS, Peterson SJ, Chen Y, Butsch J, Lateef O, Komanduri S. Nutrition support in the critically ill: A physician survey. JPEN J Parenter Enteral Nutr 2008;32:113-9.

117. Kalra S, Kumar V, Kapoor N. The MOAN (Musculo-Osteo-Arthro-Neuropathic) syndrome. Prim Care Diabetes 2022;72:373-4.

118. Kapoor N, Jiwanmall SA, Nandyal MB, Kattula D, Paravathareddy S. Prevalence of protein-energy malnutrition risk in European older persons: Part I: Nutritional screening. Diabetes Metab Syndr Obes 2020;13:3261‑7.

119. Jose A, Cherian KE, Nandyal MB, Jiwanmall SA, Kattula D, Paul TV, et al. Trabecular bone score and bone mineral density in postmenopausal women with morbid obesity-a clinical paradox. Med Sci (Basel) 2021;9:69. doi: 10.3390/medscir0400069.