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SYSTEMATIC REVIEWS

Indian perspective on childhood malnutrition: Prevalence, pathophysiology, risk factors, and prevention

Malvika Mishra, Yashwant Kumar Rao, Dharmsheel Shrivastav, Prashant Tripathi, Desh Deepak Singh

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Abstract

BACKGROUND

Childhood malnutrition contributes over half of the childhood mortality around the world, predominantly in South-Asian and sub-Saharan countries.

AIM

To summarize the childhood malnutrition epidemiology along with the comorbid factors associated with it and its management within the community.

METHODS

The data collection process involved conducting a comprehensive search using specific keywords such as child nutrition disorders and India with Boolean operators. The search was conducted in the Scopus and PubMed electronic databases.

RESULTS

Inadequate energy consumption initiates pathological alterations in the form of growth retardation, fat, visceral, and muscle loss, a reduction in basal metabolic rate, and a significant reduction in total energy expenditure. It has become evident that malnutrition shows an increased prevalence and incidence rate, despite available guidelines for the management of malnutrition.

CONCLUSION

Malnutrition can be a major player in the establishment of severe infections that result in significant post discharge mortalities in children. Future trials are required to fill the prime gaps in knowledge regarding the identification of other contributory factors in the pathogenesis of malnutrition and post-discharge infection. New biomarkers for early detection of malnutrition should be the priority of the scientific community for the early management of malnutrition.

Key Words: Malnutrition; Severe acute malnutrition; Management; Pathophysiology; Childhood

Core Tip: Childhood malnutrition, a leading cause of global childhood mortality, especially in South-Asian and sub-Saharan countries, demands urgent attention. This review consolidates malnutrition epidemiology, its associated factors, and community-based management. Despite available guidelines, inadequate energy intake leads to severe complications. Addressing knowledge gaps and identifying new biomarkers are pivotal for effective early detection and management of malnutrition-induced severe infections in children.

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INTRODUCTION

Acute malnutrition is prevalent among children aged below 5 years and affects 47 million children, along with 1 million deaths annually worldwide. According to the United Nations Children's Fund (UNICEF) 2024 report, in East Asia and the Pacific, 59 million (45%) young children are not getting the nutrition and variety they need to grow and develop to their full potential because of a lack of a balanced diet[1,2]. Nutrition has been a global priority for children for many years. For decades, affected children with acute malnutrition were managed by supplementation of fortified milk products. The breakthrough introduction of ready-to-use therapeutic foods (RUTF) and ready-to-use supplementary foods (RUSF) changed the scenario of acute malnutrition management completely after endorsement from the World Health Organization (WHO) and the United Nations through the Community Management of Acute Malnutrition (CMAM) Programme[3]. In many countries, only a few nutrition indicators are regularly tracked, and even fewer pay attention to the diversity of symptoms of malnutrition. Over the past ten years, India has seen considerable improvements in several health metrics. Inequality and uneven development have increased during the past ten years, especially in the fields of child nutrition, education, and health (Figure 1).

In low- and middle-income countries, malnutrition is a significant public health issue. Around 165 million under-five children are stunted, 52 million are wasted, and 17 million are severely wasted worldwide[4]. Asia is home to more than two-thirds of the wasted children and more than half of the stunted children.

A wide range of clinical disorders, including wasting or stunting, marasmus, kwashiorkor, and micronutrient deficiencies, fall under the umbrella term of malnutrition. A weight-for-height Z-score (WHZ) that is more than three SDs below the mean, a mid-upper arm circumference (MUAC) that is less than 115 mm, or the development of nutritional oedema are all considered signs of severe acute malnutrition (SAM). Marasmus is the medical term for moderate acute malnutrition (MAM) or SAM without bilateral pitting oedema. The term "kwashiorkor" is used when there is bilateral pitting oedema. Despite enormous efforts and progress in maternal and child malnutrition, a significant burden of SAM persists. In a recent study, it was reported that a slight decrease in wasting is seen in countries with low income (from 15.9% to 14.2%) while a slight increase in wasting was found in countries with middle income (from 3.3% to 4.7%). In total, 50 million children aged under 5 years remain wasted worldwide[5,6]. In a recent report, it was seen that the disease burden of SAM is likely to aggravate during the pandemic of coronavirus disease 2019, showing 6.7 million additional children at risk of wasting in the year 2020[7]. The present review assessed the prevalence and pathophysiology of malnutrition and focused on current management approaches for such affected children.

MATERIALS AND METHODS

A comprehensive search was conducted using PubMed and Scopus, applying keywords such as "child nutrition disorders," "India," "malnutrition," and "risk factors," with Boolean operators to refine results. The inclusion criteria focused on peer-reviewed articles, clinical studies, and reports published between relevant years, addressing malnutrition’s prevalence, risk factors, pathophysiology, and management. Data were synthesized under key themes, including prevalence, management strategies, and developmental consequences.

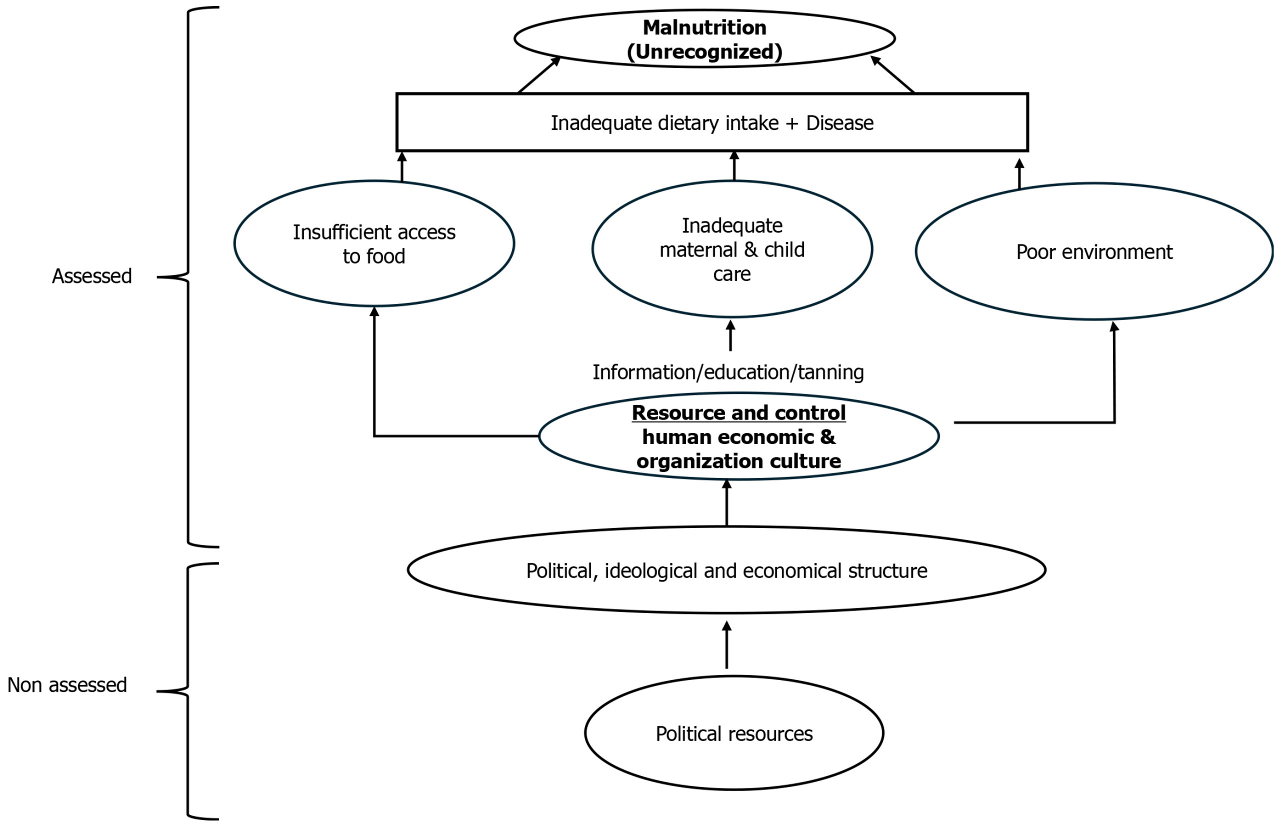

Figure 1 Conceptual framework of child malnutrition.

RESULTS

Prevalence of malnutrition in children- in Indian scenario

For several previous years, the malnutrition prevalence has decreased, however, it is around 155 million stunted children and 52 million wasted children worldwide[8].

Currently, India is on the way to reducing to target for impaired growth and development of children although approximate 34.7% of < 5 years of children are still under the phase of stunning which is much greater than the Asia region (21.8%) In the case of wasting, nothing has achieved by India, In India 17.3% of children under 5 years of age affected, which is higher than the average for the Asia region (8.9%)[9]. According to the fifth in the series of surveys, the National Family Health Survey (NFHS) 2019-2021, In India neither the population's neither health nor nutritional status have appreciably improved. The most recent statistics show that 19.3 percent of children are wasted, 7.7 percent are highly wasted, and 35.5 percent are stunted. In addition, 3.4% of children are overweight, which is higher than the NFHS-4 average of 2.1%[10]. According to NFHS-4, the prevalence of anemia in children under the age of five has dramatically increased, going from 58.6 percent to 67.1 percent. In India, it has been seen that 57% of women are anemic at childbearing age[11]. The double burden of malnutrition has been studied in numerous ways, including underweight and obesity in mothers, obesity and thinness in children[12]. SAM is a major death factor and increases the case fatality rate in children who already have complications of common illnesses like diarrhea and pneumonia[13]. For the management of SAM, WHO and UNICEF recommend two major approaches: (1) Hospital-based approach - for clinical management as per WHO criteria; and (2) Home-based approach - the use of RUTF or medical nutrition therapy as part of integrated public health response to acute malnutrition without medical complications[14].

Criteria for the assessment or diagnosis of malnutrition include specific measures such as the WHZ, MUAC, and the presence of bilateral pitting edema. Children with a WHZ below -2 or -3 standard deviations from the WHO child growth standards are considered wasted or severely wasted, respectively. Additionally, a MUAC of less than 115 mm in children aged 6–59 months is a key indicator of SAM.

Pathophysiology

General physiological changes: SAM induces a series of adaptive responses in the body. Growth restriction occurs as the body prioritizes essential functions over growth. There's a significant loss of fat, muscle, and visceral mass as the body catabolizes these tissues for energy. The basal metabolic rate decreases as a survival mechanism to conserve energy, leading to an overall reduction in energy expenditure[15,16].

Hormonal and metabolic alterations: Malnutrition causes substantial alterations in the endocrine system. It leads to reduced production of several crucial hormones, including insulin, triiodothyronine, and insulin-like growth factor-1. These hormonal changes subsequently impact the body's ability to regulate blood sugar and ultimately affect cell growth.

Conversely, growth hormone and cortisol levels rise, promoting the breakdown of tissues for energy and maintaining blood glucose levels. These hormonal shifts contribute to the catabolic state characteristic of malnutrition[17,18].

Electrolyte imbalances: Malnutrition disrupts the body's electrolyte balance. Sodium retention occurs, while intracellular potassium is depleted. In kwashiorkor, a form of severe malnutrition, cell membrane permeability increases, exacerbating these imbalances. The activity of the glycoside-sensitive, energy-dependent sodium pump is reduced, further compromising cellular homeostasis[19].

Immune system effects: The immune system is severely impacted by malnutrition. Atrophy of the thymus, lymph nodes, and tonsils impairs cellular immunity. There's a reduction in CD4 clusters of differentiation, although CD8-T cells remain relatively normal. The loss of delayed hypersensitivity, poor phagocytic activity, and lower levels of secretory IgA collectively weaken the body's defense against pathogens, increasing susceptibility to infections[20].

Neurological effects: Malnutrition has profound effects on the developing brain. It leads to a decrease in the number of neurons, synapses, dendritic arborization, and myelination, resulting in an overall reduction in brain size and thinning of the cerebral cortex. These structural changes translate into functional deficits, including delays in cognitive and motor development. Critically, if malnutrition occurs after 3-4 years of age, some of these neurological impacts may become permanent, underscoring the importance of early intervention[21-23].

Management of children with SAM

Facility based management of children with SAM: Currently, SAM-affected children in India are cared for by Nutrition Rehabilitation Centers (NRCs); however, due to the dearth of NRCs, most SAM children never receive any treatment[23]. Most SAM children admitted to NRCs do not have any medical conditions. There is already a way to help and enhance more SAM kids in India[24]. To ensure that children with SAM receive quick and high quality care, efforts are being made at the national level to identify the procedures that need to be followed. The facility-based care is implemented through a network of 262 NRCs[25]. Admission requires either edema, MUAC 115 mm, or a W/H score of less than -3Z. The appetite test is administered to all children, for 14-21 days, the children are housed in the facility, and they are given locally produced F-75 and F100[26]. The youngsters are freed after recovering a normal appetite and weight. A child is registered under the ICDS program after being released, and home visits are utilized to monitor the kid's well-being[27].

Community based management of children with SAM: Except for those experiencing complications, no SAM child needs to be admitted to the hospital. It has been discovered that home based management with RUTF is linked to better outcomes than traditional hospital therapy[28]. There is sufficient evidence that such SAM children can be successfully managed at the home level, and it has been noted that between 60% and 90% of SAM cases, identified by active case finding in the community, are without medical issues[29]. Since children experience fewer hospital-acquired infections and obtain continuity of care after discharge, home-based management of SAM children using medical nutrition therapy provides many more benefits[30]. It also benefits mother by giving them more time to spend with their families and lowering the possibility of siblings being neglected. Additionally, mothers can receive guidance on better feeding and care techniques in their local environments while also managing other family obligations[31].

Possible risk factors for SAM: Factors like low birth weight, sociodemographic traits, inadequate nutrition, improper feeding techniques, incomplete immunization, political and environmental instability, emergency situations, and a high prevalence of infectious diseases are considered risk factors for SAM (Figure 2)[32,33].

Research indicates that children suffering from SAM face a higher risk of developmental issues compared to those who receive adequate breast milk and additional nutritional supplements[34]. The risk factors such as feeding practices, water availability, sanitation, and hygiene conditions plays a critical roles in occurrence of SAM in infant and young child[35]. Islam *et al*[36] have established that when caregiver's education level is low, child stands a higher risk of becoming wasted[36,37]. Children of illiterate parents have a higher risk of SAM especially when it has to do with the caregiver[38].

Developmental consequences of childhood malnutrition

Beginning at conception, disease and insufficient food intake are major contributors to early childhood malnutrition, with the first 24 months of life having the highest risk of a fall in length-for-weight[39]. More than 200 million children under the age of five are thought to be living below their full developmental potential on a global scale[40]. A child who is malnourished starts a "vicious cycle" in which she/he becomes more prone to illness and infection, which can subsequently cause malnutrition to increase[41]. Illness can temporarily reduce infants' appetite and nutrient absorption, while increasing catabolism, which diverts nutrients from growth to the immune response, potentially hindering psychomotor and cognitive development[42].

Prevention of SAM

Giving adequate nutrition and disease prevention: Due to its importance to the early childhood developmental phase, exclusive breastfeeding should not be compromised in the fight against SAM[32]. However, preventative intervention is propelled by nutrition education. Encouragement of supplementing programs and treatment of micronutrient deficiencies by dietary approaches such as dietary diversity through home gardens or other techniques like micronutrient fortification[43].

Therapeutic foods for SAM prevention: F75 and F100 are exclusive dairy products that are typically utilized in inpatient settings to treat SAM. Inpatient treatment facilities administer the F75 to children who need to be stabilized. Children receiving inpatient care typically get 80 to 100 kcal/kg/day across eight to twelve meals per day for three to seven days [44]. The F100, which is administered during the recovery stage of inpatient therapy for SAM, provides children with

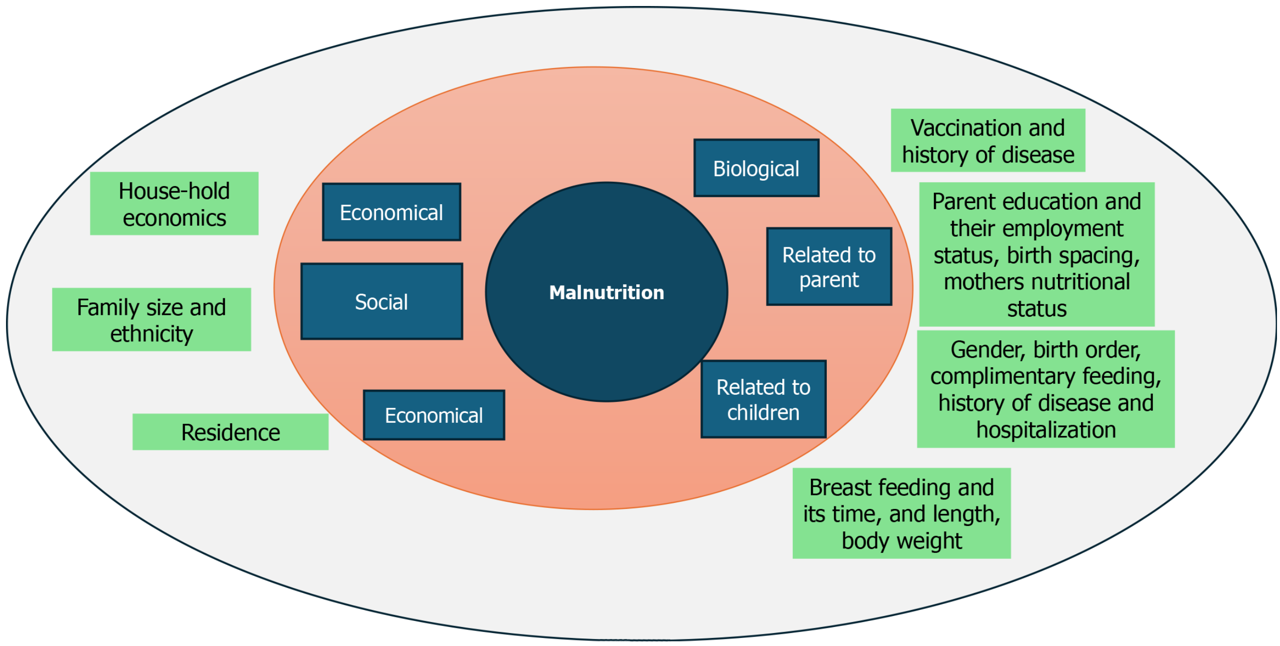

Figure 2 Contributory risk factors of malnutrition in children.

around 100-200 kcal/kg/day for three-four weeks[45]. F75s and F100s are not kept at a temperature of 25 °C for very long since they need some preparation, as well as because of their high moisture content[44].

In addition, these foods are not distributed to caretakers for home preparation (UNICEF catalog). Community-based treatment methods have benefited enormously from the creation of ready-to-use foods (RUFs)[46]. Unlike F75s and F100s, RUTFs are ready to eat without preparation and are more nutrient-dense than typical household foods, with a very low moisture content that makes them resistant to microbial growth[47].

To treat MAM and SAM, treatment centers provide a variety of items, including formulated biscuits, bars, and pastes like RUTFs, RUSFs, LNS (Lipid-based nutritional supplements and specialized products like Plumpy Sup, Plumpy'Nut, and Plumpy'Doz. Specifically, Plumpy'Doz and Plumpy Sup aimed at treating MAM, and Plumpy'Nut intended for treating both MAM and SAM in infants. Children receive one to two 92 g sachets daily for MAM and two to three sachets per day for SAM treatment. Plumpy'Nut is formulated to meet all a child's daily nutritional needs for SAM treatment (Nutriset), while families may also receive Super Cereal Plus (formerly Corn Soy Blend Plus Plus or CSB++) as part of their food rations to help prevent MAM (Table 1)[48].

Moderate malnutrition is treated with RUTF: Due to strong evidence supporting their effectiveness in treating SAM, RUFs are now being considered for use in supplemental feeding programs aimed at managing moderate malnutrition [48]. Given its success in expanding coverage through decentralized community-based care, the CMAM model may find wider application in supplemental feeding programs. RUTF was initially created as a therapeutic meal for severe malnutrition, but it has also been used to treat moderate and mild malnutrition. More recently, it has been extensively disseminated to at-risk groups in order to prevent malnutrition[46]. The nutritional content and micronutrient profile of RUTF and RUSF are quite similar. For treating SAM, RUTF must meet the full daily nutritional requirements of the child, with the dosage adjusted based on weight. In cases of moderate malnutrition, RUTF is administered as a standard 500 kcal/day ration, regardless of the child’s weight, to supplement their daily diet[46].

DISCUSSION

SAM is a life-threatening condition requiring immediate attention, affecting millions of children worldwide. Understanding its impact is crucial for early action and prevention. Factors such as infant feeding practices, hygiene, and caregiver education significantly influence the risk of SAM. Childhood malnutrition starts a detrimental cycle leading to heightened vulnerability to illnesses, impairing physical and cognitive development. It's evident that over 200 million children globally aren't reaching their developmental potential, with malnutrition significantly hindering learning capabilities[49].

Preventative strategies against SAM encompass a multi-pronged approach involving adequate nutrition, disease prevention, and educational interventions. Exclusive breastfeeding, coupled with nutritional education, plays a pivotal role. Therapeutic foods like F75 and F100, administered in inpatient settings, aid stabilization and recovery, respectively, but face challenges in distribution and preparation. RUFs, such as RUTFs, exhibit promise in community-based therapy due to their ease of use and high nutrient density. These RUFs, including Plumpy'Nut and others, are proving effective in preventing and treating various degrees of malnutrition, contributing to children's nutritional needs[50]. Furthermore,

Table 1 List of items given at the treatment centers

List of items
RUTFs like formulated bars, pastes, or biscuits
RUSFs
LNS
Plumpy'Doz, Plumpy Sup, and Plumpy'Nut, which are common RUFs used to prevent or treat MAM and SAM, are given to supplement children's diets:
Plumpy'Doz, designed to prevent or treat MAM in infants
Plumpy Sup, designed to treat MAM in infants
Plumpy'Nut, designed to treat MAM or SAM in infants

RUTFs: Ready-to-use therapeutic foods; RUSFs: Ready-to-use supplementary foods; LNS: Lipid-based nutritional supplements; MAM: Moderate acute malnutrition; SAM: Severe acute malnutrition.

RUTFs have shown potential in treating moderate malnutrition, expanding their role beyond severe cases. The success of the CMAM approach indicates the possibility of broader applications in supplemental feeding programs. The nutritional equivalence of RUTFs and RUSFs is highlighted, offering insight into dosage and application, thereby broadening their usage in addressing varying degrees of malnutrition[51].

CONCLUSION

SAM remains a critical issue in low- and middle-income countries, despite ongoing efforts. Innovative management strategies and reliable biomarkers for early detection and treatment are urgently needed. Addressing the dual burden of malnutrition-undernutrition and overnutrition-among vulnerable populations, especially women and children, is crucial. The review emphasizes the importance of enhanced public health policies, targeted nutrition programs, and community-based interventions to mitigate malnutrition's impact and improve health outcomes. A comprehensive approach is essential to reduce malnutrition's prevalence and its long-term effects on global health.

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FOOTNOTES

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