

MALNUTRITION: A MAJOR HEALTH ISSUE IN CHILDREN UNDER AGE OF FIVE

Abstract

There are three primary kinds of childhood malnutrition which are wasting, stunting, and kwashiorkor. Significant wasting and kwashiorkor are jointly known as severe acute malnutrition. These three conditions largely impact young infants under five who live in Low and middling class nations. In this instance, "severe malnutrition" is used to better correctly describe these problems to take into account contributions of persistent poverty and bad living conditions having numerous shortcomings of dietary instability, inadequate maternal and foetal nutrition, lack of sanitation, lack of hygiene, a high incidence of contagious diseases and environmental offences, and poor nutrition during early life and infancy. Childs who suffer from extreme under nutrition are more likely to become unwell or pass away, typically from severe infectious diseases. In order to identify International growth standards are used to diagnose severe malnutrition and provide therapeutic endpoints. Malnutrition can be addressed using ready-to-eat foods, effective infection treatments, and the provision of health care packages.

Keywords: Malnutrition; Wasting; Marasmus; Kwashiorkor; Enteropathy

Authors

Yogesh P Nikam

Department of Pharmaceutical Sciences
Rashtrasant Tukadoji Maharaj Nagpur
University
Nagpur, Maharashtra.

Prakash R Itankar

Department of Pharmaceutical Sciences
Rashtrasant Tukadoji Maharaj Nagpur
University
Nagpur, Maharashtra, India.

Suhas R Dhaswadikar

Department of Pharmaceutical Sciences
Rashtrasant Tukadoji Maharaj Nagpur
University
Nagpur, Maharashtra, India.

Snehal S Patil

Department of Pharmaceutical Sciences
Rashtrasant Tukadoji Maharaj Nagpur
University
Nagpur, Maharashtra, India.

Satish S Meshram

Department of Pharmaceutical Sciences
Rashtrasant Tukadoji Maharaj Nagpur
University
Nagpur, Maharashtra, India.

Anil B Badnale

Department of Pharmaceutical Sciences
Rashtrasant Tukadoji Maharaj Nagpur
University
Nagpur, Maharashtra, India.

I. INTRODUCTION

There is no recognised meaning for the phrase "malnutrition.". It's been employed to describe a variety of dietary excesses, deficits, or imbalances that have an appreciably detrimental effect on physical attributes, functionality, and clinical results (1). Malnutrition can take many different forms, such as Stunting, characterised by slower linear growth, wasting (incorporating marasmus, a term for both mild and severe wasting), characterised by reduced bodily tissue mass and other physiological anomalies, as well as kwashiorkor, characterised by Oedema all throughout the body. A person's body mass index (BMI) or the presence of oedema are now used to classify their level of malnutrition, but neither factor identifies the cause of their condition or the precise nutritional deficiencies they are experiencing. As a result, this categorization can successfully screen for and identify malnutrition, but it does not take into account the biological diversity among children or every possible nutrient shortage in a child. The prevalent macronutrient and micronutrient shortages as well as potential infections are the focus of current empirical therapy techniques, which are unaffected by these changes (2). The phrase "protein-energy malnutrition," formerly utilised to characterise children suffering from severe wasting and kwashiorkor, has been replaced by "severe acute malnutrition." It is crucial to emphasise the complex causes of severe malnutrition and its strong link to death (3), as well as how multiple kinds of malnutrition frequently coexist in the identical child throughout time (4) and how this increases the risk of death (5). Protein energy deficiency was characterised by Olsen et al. as nutritional deprivation in children in underdeveloped nations (6). However, all phrases allude to paediatric undernutrition as a condition of a kind of diet in which there is a deficiency of calories, protein, and other nutrients causes measurably negative effects on tissue and body processes, as well as a clinical consequence of growth inequity (7). Paediatric malnutrition is defined as disparity among nutrient intake and need, an accumulation of calorie, proteins, or micronutrient insufficiency that may negatively impact growth, development, and other important consequences. Malnutrition has two possible aetiologies: disease-related (one or more illnesses or injuries directly lead to nutrient deficiency) or behavioral/environmental variables linked to inadequate nutrient intake and/or delivery (8). Children suffer from primary acute malnutrition, this is particularly common in nations with low and moderate incomes (9). It is a result of the lack of food supply brought on by ecological, social, financial, and political aspects. Among the factors that contribute to malnutrition include poverty and household shortages of food, insufficient prenatal nutrition, low birth weight, poor nursing, intrauterine development restriction, and recurrent viral illnesses, water of inadequate quality, poor cleanliness, etc. Acute malnutrition is a complicated condition that is mostly social in origin as opposed to biological. More and more experts believe that poor water quality, inadequate sanitation, and poor hygiene practises are the root causes of the illness known as "ecological enteropathy" that leads to acute malnutrition in children (10).

II. EPIDEMIOLOGY

Interagency estimates from the World Health Organization (WHO), United Nations International Children's Emergency Fund (UNICEF), and World Bank Group that are based on common anthropometric indices and indicate levels and trends in undernutrition and stunting in children. There were 52 million wasted child in 2016, including 17 million severely wasted children, and an approximate 155 million stunted youngsters that are younger than five (11). Additionally, the Global Burden of Disease Study 2015 revealed that

protein-energy malnutrition was directly responsible for 174,000 kid fatalities under the age of five (12). According to the most recent Lancet Nutrition series, which was published in 2013, 875,000 deaths were attributed to wasting and 516,000 deaths were attributed to severe wasting (3). Malnutrition is connected to metabolic diseases, such as hypoglycemia and refeeding syndrome, as well as infectious conditions, such as pneumonia, measles, and diarrheal illnesses (13).

III. PATHOPHYSIOLOGY

Lack of protein and calories due to malnutrition, a poor diet, and disease can contribute to the muscle and fat tissue loss that characterises wasting. Severe malnutrition, on the other hand, is rarely brought on by a single source; rather, it typically the product of complicated interplay of economic, social, and political variables, the prevalence of inflammatory and ongoing infections (both internally and externally, including in the stomach). Malnutrition can often be caused by gender inequalities, for example, a lack of female empowerment (14).

- 1. Wasting:** Our understanding of the processes and metabolic adjustments connected to wasting is primarily derived from the studies on prolonged hunger and cachexia (wasting brought on by a long-term illness). During brief periods of hunger, free fatty acids and ketone bodies are largely oxidised utilising fat reserves derived from fat tissue. Amino acids can also be extracted from myofibrillar proteins, which can subsequently be turned into glucose. Myofibrillar proteins are substantially divided into sustain critical metabolic functions after several days of hunger. Insulin and glucagon control macronutrient oxidation and synthesis in the near term, whereas additional hormones, including corticosteroids, catecholamines, thyroid hormones, and growth hormone control these processes in the long term (15).
- 2. Marasmus:** The Greek word "marasmus," which meaning to waste or wither, is where the name "marasmus" originates. Marasmus is the most typical symptom of acute malnutrition (9). It happens on account of inadequate consuming calories over the course of several months or years. It is distinguished by the deterioration of body tissues, particularly muscles and subcutaneous fat, and often happens as a result of severe calorie intake restrictions. In response to acute food and energy shortage, hunger is the body's physiologically adapted response. Children under the age of five are most commonly impacted due to their higher calorie requirements and increased susceptibility to diseases (16).
- 3. Kwashiorkor:** Kwa language of Ghana is where the word "kwashiorkor" originates, and it means "the sickness of the weaning" in English. The phrase was originally used in 1933 by Cicely D. Williams. Kwashiorkor is thought to be brought on by normal calorie intake rather than a lack of protein. It was first seen in children who consumed a lot of maize (16); these kids are known as "sugar babies" because their diets are often heavy in carbohydrates but poor in protein. Kwashiorkor is a common practise in underdeveloped nations that mostly affects older, newborns and young toddlers. It mainly occurs in famine-stricken or food-scarce places, especially in nations where the staples of the diet are maize, rice and beans (17). Kwashiorkor is one example of an unnatural reaction to famine. The distinctive characteristic of kwashiorkor is edoema, which marasmus lacks

(18). Edoema, dermatoses, hypopigmented hair, an enlarged belly, and hepatomegaly are clinical features in addition to almost normal weight for age. Hair is typically reddish yellow in colour, dry, sparse, brittle, and depigmented (9).

4. **Alterations in Immune System:** T cell impairment and decreased microbicidal action of neutrophils are symptoms of severe malnutrition (19). The complement cascade's protein levels, antigen priming and presentation, the quantity of dendritic cells, Thymic atrophy, T cell hyporesponsiveness, and decreased T cell proliferation may result from long-term immunological activity and/or the metabolic needs of T cells for glucose, amino acids, and nutritionally mediated regulatory hormones like leptin (2).
5. **Oxidative Stress:** Oxidative stress has also been linked to severe undernourishment, especially kwashiorkor. Indeed, compared to children without malnutrition, Children that are severely undernourished have lower amounts of antioxidants, such as vitamin E and glutathione, and this drop is particularly prominent in kids with kwashiorkor (20). A disparity between the creation of reactive oxygen species and their detoxification by peroxisomes leads to damage to the mitochondria, which in turn reduces ATP generation and limits cellular activity in the liver. The response to a concurrent infection may be impacted by mitochondrial dysfunction, ATP depletion, and certain dietary shortages, which may also hasten the onset of multi-organ failure (21).
6. **Enteropathy:** Although the probable link between enteropathy and stunting is the subject of great investigation, severe malnutrition is also accompanied by intestinal dysfunction. In fact, diarrhoea is typical in malnourished children and is linked to subpar clinical outcomes (22). Secretory and osmotic diarrhoea may be caused by a number of conditions, such as intestinal infections and inflammation, in malnourished people (23). Additionally, nutritional malabsorption and diarrhoea may be caused by inefficient nutrient digestion brought on by reduced hepatobiliary and pancreatic exocrine function (24). Small intestine villous blunting brought on by malnutrition lowers intestinal absorptive capacity, including reduced absorption of monosaccharides and disaccharides, which may lead to osmotic diarrhoea (25).
7. **Renal Function:** There aren't many studies evaluating renal function in very malnourished kids (as measured by glomerular filtration rate). The pre-renal contribution to lower glomerular filtration may have a significant impact given the incidence of diarrhea and dehydration in these children. Children who are malnourished and dehydrated have been found to have low glomerular filtration rates (26).
8. **Brain Function:** Children with kwashiorkor exhibit brain atrophy (27), and are irritable; kids that severely wasting are frequently lethargic, with delayed movements and decreased speech (28). Severe starvation is also associated with significantly changed mental and behaviour processes alterations. However, it is unclear what causes these behavioural alterations at their core. Few studies have concentrated on the enduring development implications of acute malnutrition and growth in early life, despite the well-documented link between these factors and development. After a period of extreme undernourishment, children have been found to have impaired development (29).

IV. ASSESSMENT

A proper nutritional evaluation involves a thorough dietary history, physical examination, and anthropometric measurements (which include length, weight, and circumference of the head in younger children) using acceptable reference standards, such as the WHO standard growth charts, and basic laboratory indicators are performed (30). Furthermore, measurements of the mid-upper-arm circumference (MUAC) and skinfold thickness offer a helpful way to assess body composition (31). Inquiries concerning mealtimes, food consumption, and eating issues should be included in routine history-taking since they give a fast-qualitative evaluation of nutritional intake. For a more quantitative review, a detailed dietary history must be gathered by maintaining a food journal or, less regularly, weighing the items ingested. A professional nutritionist would normally be engaged in this. Dietary reference values measure the range of calorie and nutrient consumption needs in populations, which can be useful in establishing adequacy of intakes(32).

V. MANAGEMENT

A number of practical and widely recognised WHO guidelines and training programmes serve as the foundation for management. In fact, the management principles have evolved so ingrained in clinical practise that conducting randomised controlled trials other than to demonstrate superiority or equivalence to the present standard of treatment may be regarded as unethical. Notably, many management principles were developed in response to crises, and it is still difficult to apply them in low- and middle-income nations where acute malnutrition burdens healthcare systems on a regular basis. Antibiotics are typically used in conjunction with therapeutic diets to treat any underlying infections. Children with simple severe malnutrition can be managed in their communities (33).

To meet projected calorific demands as well as protein, electrolyte, and micronutrient requirements based on treatment stage, therapeutic foods such as ready-to-use therapeutic foods as well as their use initially limit exposure to nutrients such as sodium and iron that might be dangerous to youngsters with metabolic instability or those who have illnesses. The specific nutritional needs of children who suffer from severe malnutrition, as well as the bioavailability of certain therapeutic meals, are not well understood and may vary depending on the environment and the existence of co-morbid conditions in some individuals.

Vitamin C aids immune system defence by supporting several cellular activities of the innate and adaptive immunity. Vitamin C strengthens the skin's epithelial barrier function against infections and promotes its capacity to neutralise free radicals, which may aid in resistance to environmental oxidative stress. The antioxidant vitamin C can increase chemotaxis, phagocytosis, the production of reactive oxygen species, and ultimately the death of bacteria because it concentrates in phagocytic cells like neutrophils(35).

REFERENCES

- [1] Saunders J, Smith T. Malnutrition: causes and consequences. *Clin Med (Lond)*. 2010 Dec;10(6):624-7. doi: 10.7861/clinmedicine.10-6-624. PMID: 21413492; PMCID: PMC4951875.
- [2] Bhutta ZA, Berkley JA, Bandsma RHJ, Kerac M, Trehan I, Briend A. Severe childhood malnutrition. *Nat Rev Dis Primers*. 2017 Sep 21;3:17067. doi: 10.1038/nrdp.2017.67. PMID: 28933421; PMCID: PMC7004825.
- [3] Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, Ezzati M, Grantham-McGregor S, Katz J, Martorell R, Uauy R; Maternal and Child Nutrition Study Group. Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet*. 2013 Aug 3;382(9890):427-451. doi: 10.1016/S0140-6736(13)60937-X. Epub 2013 Jun 6. Erratum in: *Lancet*. 2013. 2013 Aug 3;382(9890):396. PMID: 23746772.
- [4] Nandy S, Miranda JJ. Overlooking undernutrition? Using a composite index of anthropometric failure to assess how underweight misses and misleads the assessment of undernutrition in young children. *Soc Sci Med*. 2008 May;66(9):1963-6. doi: 10.1016/j.socscimed.2008.01.021. Epub 2008 Mar 4. PMID: 18299166; PMCID: PMC2685640.
- [5] McDonald CM, Olofin I, Flaxman S, Fawzi WW, Spiegelman D, Caulfield LE, Black RE, Ezzati M, Danaei G; Nutrition Impact Model Study. The effect of multiple anthropometric deficits on child mortality: meta-analysis of individual data in 10 prospective studies from developing countries. *Am J Clin Nutr*. 2013 Apr;97(4):896-901. doi: 10.3945/ajcn.112.047639. Epub 2013 Feb 20. PMID: 23426036.
- [6] Olsen EM, Petersen J, Skovgaard AM, Weile B, Jørgensen T, Wright CM. Failure to thrive: the prevalence and concurrence of anthropometric criteria in a general infant population. *Arch Dis Child*. 2007 Feb;92(2):109-14. doi: 10.1136/adc.2005.080333. Epub 2006 Mar 10. PMID: 16531456; PMCID: PMC2083342.
- [7] Joosten KF, Hulst JM. Prevalence of malnutrition in pediatric hospital patients. *Curr Opin Pediatr*. 2008 Oct;20(5):590-6. doi: 10.1097/MOP.0b013e32830c6ede. PMID: 18781124.
- [8] Mehta NM, Corkins MR, Lyman B, Malone A, Goday PS, Carney LN, Monczka JL, Plogsted SW, Schwenk WF; American Society for Parenteral and Enteral Nutrition Board of Directors. Defining pediatric malnutrition: a paradigm shift toward etiology-related definitions. *JPEN J Parenter Enteral Nutr*. 2013 Jul;37(4):460-81. doi: 10.1177/0148607113479972. Epub 2013 Mar 25. PMID: 23528324.
- [9] Grover Z, Ee LC. Protein energy malnutrition. *Pediatr Clin North Am*. 2009 Oct;56(5):1055-68. doi: 10.1016/j.pcl.2009.07.001. PMID: 19931063.
- [10] Ahmed T, Michaelsen KF, Frem JC, Tumvine J. Malnutrition: Report of the FISPUGHAN Working Group. *J Pediatr Gastroenterol Nutr*. 2012 Nov;55(5):626-31. doi: 10.1097/MPG.0b013e318272b600. PMID: 22983380.
- [11] UNICEF, and WB WHO. "Joint child malnutrition estimates 2017 edition." *UNICEF/WHO/World Bank Group* (2017).
- [12] Institute for Health Metrics and Evaluation. "Global burden of disease results tool." *GBD Results Tool* (2021).
- [13] Pelletier DL, Frongillo EA Jr, Schroeder DG, Habicht JP. The effects of malnutrition on child mortality in developing countries. *Bull World Health Organ*. 1995;73(4):443-8. PMID: 7554015; PMCID: PMC2486780.
- [14] Sethuraman K, Lansdown R, Sullivan K. Women's empowerment and domestic violence: the role of sociocultural determinants in maternal and child undernutrition in tribal and rural communities in South India. *Food Nutr Bull*. 2006 Jun;27(2):128-43. doi: 10.1177/156482650602700204. PMID: 16786979.
- [15] Cohen S, Nathan JA, Goldberg AL. Muscle wasting in disease: molecular mechanisms and promising therapies. *Nat Rev Drug Discov*. 2015 Jan;14(1):58-74. doi: 10.1038/nrd4467. PMID: 25549588.
- [16] Batool R, Butt MS, Sultan MT, Saeed F, Naz R. Protein-energy malnutrition: a risk factor for various ailments. *Crit Rev Food Sci Nutr*. 2015;55(2):242-53. doi: 10.1080/10408398.2011.651543. PMID: 24915388.
- [17] Edhborg, M., et al. "Fussy child-difficult parenthood? Comparisons between families with a'depressed'mother and non-depressed mother 2 months postpartum." *Journal of Reproductive and Infant Psychology* 18.3 (2000): 225-238.
- [18] Dicko, Mamoudou H., et al. "Sorghum grain as human food in Africa: relevance of content of starch and amylase activities." *African journal of biotechnology* 5.5 (2006): 384-395.
- [19] Takele Y, Adem E, Getahun M, Tajebe F, Kiflie A, Hailu A, Raynes J, Mengesha B, Ayele TA, Shkedy Z, Lemma M, Diro E, Toulza F, Modolell M, Munder M, Müller I, Kropf P. Malnutrition in Healthy

- Individuals Results in Increased Mixed Cytokine Profiles, Altered Neutrophil Subsets and Function. *PLoS One*. 2016 Aug 22;11(8):e0157919. doi: 10.1371/journal.pone.0157919. PMID: 27548305; PMCID: PMC4993519.
- [20] Becker K, Pons-Kühnemann J, Fechner A, Funk M, Gromer S, Gross HJ, Grünert A, Schirmer RH. Effects of antioxidants on glutathione levels and clinical recovery from the malnutrition syndrome kwashiorkor--a pilot study. *Redox Rep*. 2005;10(4):215-26. doi: 10.1179/135100005X70161. PMID: 16259789.
- [21] van Zutphen T, Ciapaite J, Bloks VW, Ackereley C, Gerding A, Jurdzinski A, de Moraes RA, Zhang L, Wolters JC, Bischoff R, Wanders RJ, Houten SM, Bronte-Tinkew D, Shatseva T, Lewis GF, Groen AK, Reijngoud DJ, Bakker BM, Jonker JW, Kim PK, Bandsma RH. Malnutrition-associated liver steatosis and ATP depletion is caused by peroxisomal and mitochondrial dysfunction. *J Hepatol*. 2016 Dec;65(6):1198-1208. doi: 10.1016/j.jhep.2016.05.046. Epub 2016 Jun 14. PMID: 27312946.
- [22] Irena AH, Mwambazi M, Mulenga V. Diarrhea is a major killer of children with severe acute malnutrition admitted to inpatient set-up in Lusaka, Zambia. *Nutr J*. 2011 Oct 11;10:110. doi: 10.1186/1475-2891-10-110. PMID: 21989455; PMCID: PMC3214843.
- [23] Attia S, Versloot CJ, Voskuijl W, van Vliet SJ, Di Giovanni V, Zhang L, Richardson S, Bourdon C, Netea MG, Berkley JA, van Rheenen PF, Bandsma RH. Mortality in children with complicated severe acute malnutrition is related to intestinal and systemic inflammation: an observational cohort study. *Am J Clin Nutr*. 2016 Nov;104(5):1441-1449. doi: 10.3945/ajcn.116.130518. Epub 2016 Sep 21. PMID: 27655441; PMCID: PMC5081715.
- [24] Bartels RH, Meyer SL, Stehmann TA, Bourdon C, Bandsma RH, Voskuijl WP. Both Exocrine Pancreatic Insufficiency and Signs of Pancreatic Inflammation Are Prevalent in Children with Complicated Severe Acute Malnutrition: An Observational Study. *J Pediatr*. 2016 Jul;174:165-70. doi: 10.1016/j.jpeds.2016.04.013. Epub 2016 May 11. PMID: 27178623.
- [25] Kvissberg MA, Dalvi PS, Kerac M, Voskuijl W, Berkley JA, Priebe MG, Bandsma RH. Carbohydrate malabsorption in acutely malnourished children and infants: a systematic review. *Nutr Rev*. 2016 Jan;74(1):48-58. doi: 10.1093/nutrit/nuv058. Epub 2015 Nov 17. PMID: 26578625; PMCID: PMC4684688.
- [26] Kerpel-Fronius, Ödön. *The pathophysiology of infantile malnutrition. Protein-energy malnutrition and failure to thrive*. Akademiai Kiado, 1983.
- [27] Gunston GD, Burkimsher D, Malan H, Sive AA. Reversible cerebral shrinkage in kwashiorkor: an MRI study. *Arch Dis Child*. 1992 Aug;67(8):1030-2. doi: 10.1136/adc.67.8.1030. PMID: 1520007; PMCID: PMC1793595.
- [28] Atalabi OM, Lagunju IA, Tongo OO, Akinyinka OO. Cranial magnetic resonance imaging findings in kwashiorkor. *Int J Neurosci*. 2010 Jan;120(1):23-7. doi: 10.3109/00207450903315727. PMID: 20128668.
- [29] Grantham-McGregor S, Powell C, Walker S, Chang S, Fletcher P. The long-term follow-up of severely malnourished children who participated in an intervention program. *Child Dev*. 1994 Apr;65(2 Spec No):428-39. PMID: 8013232.
- [30] Wright, Charlotte M. "The use and interpretation of growth charts." *Current Paediatrics* 12.4 (2002): 279-282.
- [31] Brook CG. Determination of body composition of children from skinfold measurements. *Arch Dis Child*. 1971 Apr;46(246):182-4. doi: 10.1136/adc.46.246.182. PMID: 5576028; PMCID: PMC1647464.
- [32] British Nutrition Foundation Nutrient Requirements. [(accessed on 12 August 2020)]; Available online: www.nutrition.org.uk/nutritionscience/nutrients/nutrient-requirements
- [33] Gross R, Webb P. Wasting time for wasted children: severe child undernutrition must be resolved in non-emergency settings. *Lancet*. 2006 Apr 8;367(9517):1209-11. doi: 10.1016/S0140-6736(06)68509-7. PMID: 16616563.
- [34] Murray E, Manary M. Home-based therapy for severe acute malnutrition with ready-to-use food. *Paediatr Int Child Health*. 2014 Nov;34(4):266-70. doi: 10.1179/2046905514Y.0000000135. Epub 2014 Jul 28. PMID: 25066618.
- [35] Carr AC, Maggini S. Vitamin C and Immune Function. *Nutrients*. 2017 Nov 3;9(11):1211. doi: 10.3390/nu9111211. PMID: 29099763; PMCID: PMC5707683.