# Introduction

Malnutrition refers to deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients. Malnutrition covers 2 broad groups of conditions. One is 'undernutrition'—which includes stunting (low height for age), wasting (low weight for height), underweight (low weight for age) and micronutrient deficiencies or insufficiencies (a lack of important vitamins and minerals). The other is overweight, obesity and diet-related noncommunicable diseases (such as heart disease, stroke, diabetes and cancer).

WHO defines malnutrition as follows: Malnutrition refers to a number of diseases, each with a specific cause related to one or more nutrients (e.g. protein, iodine or iron) and each characterized by cellular imbalance between the supply of nutrients and energy on the one hand, and the body's demand for them to ensure growth, maintenance, and specific functions, on the other.

# Consequences of malnutrition

Malnutrition affects people in every country. Around 1.9 billion adults worldwide are overweight, while 462 million are underweight. An estimated 41 million children under the age of 5 years are overweight or obese, while some 159 million are stunted and 50 million are wasted. Adding to this burden are the 528 million or 29% of women of reproductive age around the world affected by anaemia, for which approximately half would be amenable to iron supplementation.

Many families cannot afford or access enough nutritious foods like fresh fruit and vegetables, legumes, meat and milk, while foods and drinks high in fat, sugar and salt are cheaper and more readily available, leading to a rapid rise in the number of children and adults who are overweight and obese, in poor as well as rich countries. It is quite common to find undernutrition and overweight within the same community, household or even individual – it is possible to be both overweight and micronutrient deficient.

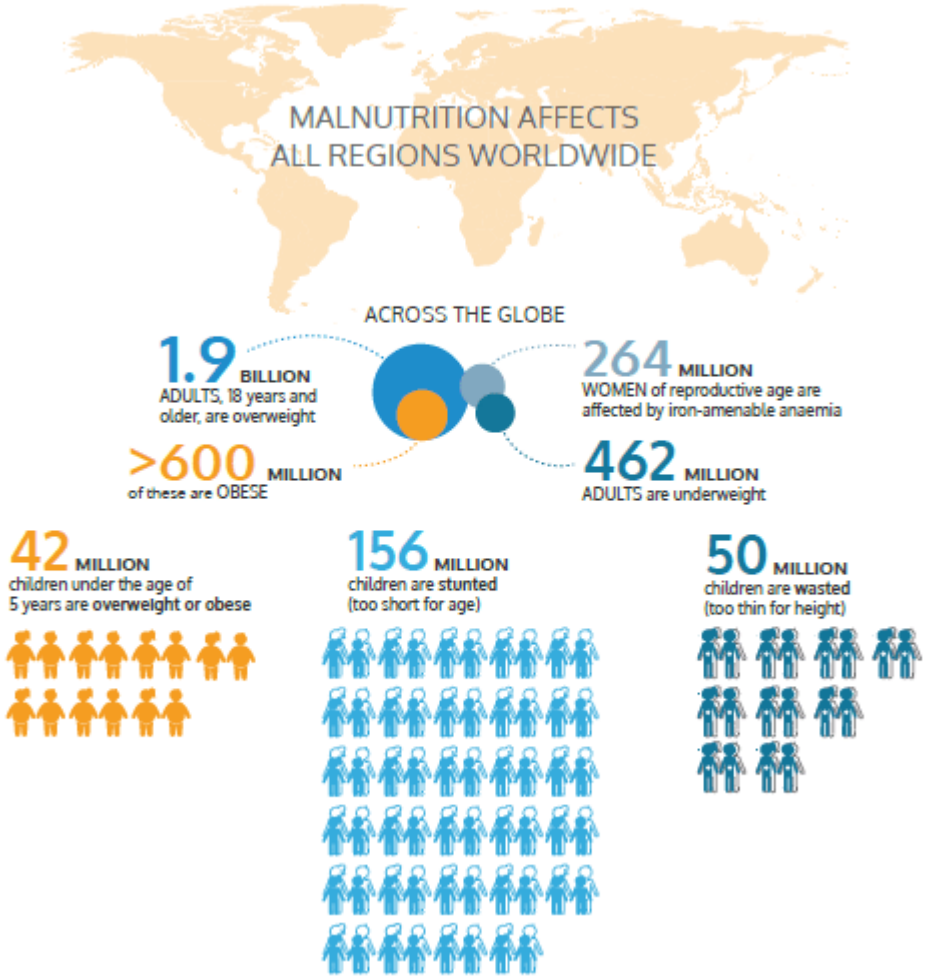


Image: WHO

## Protein-energy malnutrition

Undernutrition is sometimes used as a synonym of protein–energy malnutrition (PEM). While other include both micronutrient deficiencies and protein energy malnutrition in its definition.https://en.wikipedia.org/wiki/Malnutrition – cite_note-Jones2011-12 The term “severe malnutrition” or “severe undernutrition” is often used to refer specifically to PEM. PEM is often associated with micronutrient deficiency. Two forms of PEM are kwashiorkor and marasmus, and they commonly coexist.

**Kwashiorkor**

Kwashiorkor is mainly caused by inadequate protein intake. The main symptoms are oedema, wasting, liver enlargement, hypoalbuminemia, steatosis, and possibly depigmentation of skin and hair. Kwashiorkor is further identified by swelling of the belly, which is deceiving of actual nutritional status. The term means 'displaced child' and is derived from a Ghana language of West Africa, means "the sickness the older one gets when the next baby is born," as this is when the older child is deprived of breast feeding and weaned to a diet composed largely of carbohydrates.

**Marasmus**

Marasmus ('to waste away') is caused by an inadequate intake of protein and energy. The main symptoms are severe wasting, leaving little or no oedema, minimal subcutaneous fat, severe muscle wasting, and non-normal serum albumin levels. Marasmus can result from a sustained diet of inadequate energy and protein, and the metabolism adapts to prolong survival.https://en.wikipedia.org/wiki/Malnutrition – cite_note-Clinical_Nutrition_in_Practice_(2011)-26 It is traditionally seen in famine, significant food restriction, or more severe cases of anorexia. Conditions are characterized by extreme wasting of the muscles and a gaunt expression.

**Undernutrition, hunger**

Undernutrition encompasses stunted growth (stunting), wasting, and deficiencies of essential vitamins and minerals (collectively referred to as micronutrients). The term hunger, which describes a feeling of discomfort from not eating, has been used to describe undernutrition, especially in reference to food insecurity.

# Micronutrients

Micronutrients are essential elements required by organisms in small quantities throughout life to orchestrate a range of physiological functions to maintain health. Micronutrient requirements differ between organisms; for example, humans and other animals require numerous vitamins and dietary minerals, whereas plants require specific minerals. For human nutrition, micronutrient requirements are in amounts generally less than 100

milligrams per day, whereas macronutrients (carbohydrate, protein and fat) are required in gram quantities daily.

The minerals for humans and other animals include 13 elements that originate from Earth's soil and are not synthesized by living organisms, such as calcium and iron. Plants are the primary origin of nutrients for humans and animals and some micronutrients may be available in low levels and deficiencies can occur when dietary intake is insufficient, as occurs in **malnutrition**.

| Trace minerals | Vitamins | Essential fatty acids | Essential amino acids |
|---|---|---|---|
| Boron | Vitamin B complex<br>• Vitamin B1 (thiamine)<br>• Vitamin B2 (riboflavin)<br>• Vitamin B3 (niacin)<br>• Vitamin B5 (panthothenic acid)<br>• Vitamin B6 group (pyridoxine, pyridoxal-5-phosphate, pyridoxamine)<br>• Vitamin B7 (biotin)<br>• Vitamin B8 (ergadenylic acid)<br>• Vitamin B9 (folic acid)<br>• Vitamin B12 (cyanocobalamin)<br>• Choline | Alpha-linolenic acid | Histidine |
| Cobalt | Vitamin A (retinol, retinal, retinoic acid and provitamin A carotenoids (mainly beta carotene)) | Linolenic acid | Isoleucine |
| Chlorine | Vitamin C (ascorbic acid) | | Leucine |
| Chromium | Vitamin D (ergocalciferol, cholecalciferol) | | Lysine |
| Copper | Vitamin E (tocopherol) | | Methionine |
| Iodine | Vitamin K (phylloquinone, menaquinone complices) | | Phenylalanine |

| | | | |
|---|---|---|---|
| Iron | Carotenoids (alpha carotene, beta carotene, cryptoxanthin, lutein, lycopene, zeaxanthin) | | Threonine |
| Lithium | | | Tryptophan |
| Manganese | | | Valine |
| Molybdenum | | | |
| Selenium | | | |
| Sodium | | | |
| Zinc | | | |

Table: Essential Micronutrients

There are 4 essential nutrients: essential mineral (nutrient)s, vitamins, essential fatty acids, and essential amino acids. An alternative method of classifying nutrients as either type I or type II. This classification is based on the way in which the body responds to a nutrient deficiency. A type I response is characterised by specific physical signs of deficiency as a result of a reduced tissue concentration of the nutrient. For example, if the diet is deficient in a type I nutrient such as iron, there is an initial consumption of body stores followed by clinical signs characteristic of iron deficiency. The concentration of iron in the tissues is markedly reduced, but there is no effect on growth or body weight. In contrast, a type II response is characterised by reduced growth rate or weight loss in the absence of specific deficiency signs. For example, if the diet is deficient in a type II nutrient like zinc, growth stops, followed by weight loss. Protein and energy (derived from carbohydrates and fat) are classified as type II nutrients.

| Type I nutrients | Type II nutrients |
|---|---|
| Iodine | Sodium |
| Iron | Potassium |

| | |
|---|---|
| Folic acid | Zinc |
| Calcium | Magnesium |
| Selenium | Nitrogen |
| Copper | Sulphur |
| Manganese | Phosphorous |
| All vitamins | Water |
| | Essential amino acids |
| | Energy (carbohydrates, fats) |

Table: Type I and type II nutrients

The type I and II classification is important because it emphasises that poor growth is not caused solely by protein-energy malnutrition but can result from other nutrient deficiencies which may not be recognised and so appropriately treated. Furthermore, it demonstrates the importance of a wide range of nutrients in causing poor growth or weight loss, and therefore the need for a nutritionally balanced diet.

In much of the developed world, such micronutrient deficiencies are rare; this is due to (1) an adequate supply of food and (2) the addition of vitamins and minerals to common foods (fortification).

Micronutrient deficiencies are widespread in developing countries and affect approximately 2 billion people worldwide which is equivalent to more than one-third of the total world population. The most common deficiencies are due to lack of iron (anaemia), vitamin A (xerophthalmia) and iodine (goitre and cretinism). Outbreaks of deficiency disorders, which are rarely seen in normal circumstances, have also occurred in emergencies among populations entirely dependent on food aid. These include deficiencies of vitamin C (scurvy), niacin (pellagra) and thiamine (beri beri). The general ration provided in emergencies by agencies like WFP and ICRC are frequently lacking in some essential micronutrients, which means that populations always require other foods (or in some cases micronutrient

supplements) to complement the rations. Donor agencies can assist populations to maximise their intake of micronutrient-rich foods by adopting a number of different strategies which, in preferred order, include: promoting the production of vegetables and fruit; providing fresh food items in the ration; adding a food to the ration which is rich in a particular vitamin or mineral; providing fortified foods; and supporting the distribution of nutrient supplements.

## Vitamins

Vitamins have a special place in the history of medicine. At the end of the 19th century, it was thought that infectious diseases could explain most of the illnesses of mankind. It took a while to show that nutritional deficiencies were responsible for certain ailments, instead of a particular infection. The study of thiamine deficiency earned its author the Nobel Prize (Eijkman 1929). The research connected with vitamin C was likewise awarded this prestigious prize (Haworth and Szent-Gyorgyi, 1937).

A vitamin is an organic molecule (or related set of molecules) which is an essential micronutrient — that is, a substance which an organism needs in small quantities for the proper functioning of its metabolism but cannot synthesize, either at all or in sufficient quantities and therefore must obtain through its diet. Vitamins can fulfil different biochemical functions. Some function as regulators of cell and tissue growth and differentiation (e.g. vitamin A), other serve as cofactors/coenzymes (B complex). Vitamin D and vitamin E/C serve as hormone-like regulators of mineral metabolism and antioxidants.

The name vitamin refers to “vital amine” (amine of life), even though not all vitamins (in particular vitamin A) have an amine components. As the word was already ubiquitous by the time it was shown that not all vitamins are amines, the final “e” was dropped to deemphasize the “amine” reference.

Humans must consume vitamins periodically but with differing schedules, to avoid deficiency. Body stores for different vitamins vary widely; vitamins A, D, and $B_{12}$ are stored in significant amounts, mainly in the liver, and an adult’s diet may be deficient in vitamins A and D for many months and $B_{12}$ in some cases for years, before developing a deficiency condition. However vitamin $B_3$ (niacin and niacinamide) is not stored in significant amounts, so stores

may last only a couple of weeks. For vitamin C, the first symptoms of scurvy in experimental studies of complete vitamin C deprivation in humans have varied widely, from a month to more than six months, depending on previous dietary history that determined body stores.

A primary vitamin deficiency occurs when an organism does not get enough of the vitamin in its food. A secondary deficiency may be due to an underlying disorder that prevents or limits the absorption or use of the vitamin, due to a “lifestyle factor”, such as smoking, excessive alcohol consumption, or the use of medications that interfere with the absorption or use of the vitamin. People who eat a varied diet are unlikely to develop a severe primary vitamin deficiency. In contrast, restrictive diets have the potential to cause prolonged vitamin deficits, which may result in often painful and potentially deadly diseases.

Well-known human vitamin deficiencies involve vitamin A deficiency, thiamine (beriberi), niacin (pellagra), vitamin C (scurvy), and vitamin D (rickets). These specific deficiencies will be discussed as well as iodine deficiency disorder. The description of other micronutrient deficiencies is beyond the scope of these lecture notes.