

Diseases resulting from nutrient deficiencies

Nutrient deficiencies are a form of **malnutrition**, whereby an individual has a lack of nutrients necessary for the body to function normally. This may be a **lack of macronutrients** (sugars, fats, proteins) or a lack of some more specific nutrients (vitamins, trace elements, essential fatty acids, etc...).

Lack of macronutrients

Marasmus

Simple starvation (marasmus) is mainly caused by a lack of energy (energy malnutrition). It occurs due to the **long-term insufficient intake** of all nutrients and manifests as a typical gradual symmetric weight loss. This leads to a general **weakening** of the organism: **cachexia**. There is a breakdown of fat and glycogen stores and ultimately also a **breakdown of active muscle mass** and body proteins. It affects individuals with anorexia nervosa, elderly people, and otherwise healthy people who have reduced energy intake.

 For more information see *Marasmus*.

Kwashiorkor

Much more severe **stress** starvation causes poor intake and rapid **protein breakdown** (protein malnutrition). Muscle mass is rapidly broken down, fat reserves are preserved, so the affected people do not show signs of malnutrition at first sight. Lack of protein (so-called hypoproteinemia) causes edema. It is protein-energy malnutrition with a predominant lack of protein (unlike marasmus, in which a lack of overall energy intake predominates). Kwashiorkor is a severe form of malnutrition that occurs in young children in developing countries, characterized by, among other things, edema.

However, the authors of a number of studies published since 1968 reject the **hypothesis** of protein deficiency as the etiology of kwashiorkor because:

- The same diet with insufficient macro and micronutrients led to the development of marasmus in some children in the same area, while in others kwashiorkor developed.
- Children recovered on a diet with less protein than expected to lead to kwashiorkor, with edema disappearing, but low serum albumin levels (thought to be the cause of the edema) persisting.
- Kwashiorkor has also been described in exclusively breastfed infants receiving high quality protein from their mothers who did not show any signs of malnutrition.^[1]

Several other hypotheses were then postulated on the **etiology** of kwashiorkor (excess free radicals, aflatoxin, changes in the intestinal microflora, in which malnutrition produces metabolites that damage cell cell membranes, lack of vanadium, a combination of some of these factors), but none of them have been confirmed: its **etiology is still unclear**. According to the current pathophysiological concept, cell membranes are damaged throughout the body, leading to leakage of potassium and water from cells of all types and dysfunction of all organ systems. Loss of the ability of glycosaminoglycans to bind water is thought to be a potential mechanism for the development of edema.^[2]

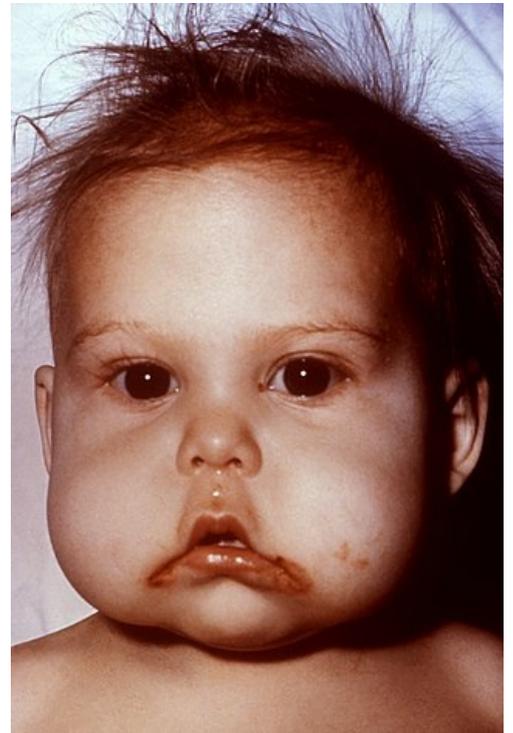
 For more information see *Kwashiorkor*.

Protein-energy malnutrition

According to the FAO, 925 million people worldwide suffer from protein-energy malnutrition (PEM), most in Asia Pacific, most often in sub-Saharan Africa (30%).^[3] It affects a quarter of children under 5 in the world and is associated with 30% of deaths in children under five in developing countries.^[4] Malnutrition is a relatively rare cause of death in children. At the beginning of the malnutrition spiral is an inadequate diet and frequent episodes of common infectious diseases. During the course of the disease, the child's nutritional status deteriorates, which contributes to the increased risk of another episode of the infection, which is more severe and during which the nutritional status deteriorates further. The situation recurs when a malnourished child has a fatal infectious episode.

In more developed countries, malnutrition occurs mainly in the seriously ill, the elderly, and people experiencing anorexia nervosa.

Vitamin deficiencies (hypovitaminoses, avitaminoses)



Fat-soluble vitamins

Vitamin A deficiency

Vitamin A is especially important for sharp eyesight at night. Vitamin A administration in deficiency can significantly improve vision in a few hours. Vitamin A deficiency is a significant problem, especially in developing countries. The major risk groups are **young children**, and **pregnant and lactating women**. Manifestations of deficiency include xerophthalmia (dry eyes), age spots, susceptibility to respiratory infections, acne, eczema, loss of appetite, fatigue, and loss of smell. Diseases that occur with a prolonged deficiency of this vitamin are night blindness and conjunctivitis.

Vitamin D deficiency

If it occurs during childhood (especially in young children) and infancy, it manifests itself as **rickets**. This occurs due insufficient intake of vitamin D (e.g., it is low in breastmilk, low sun exposure), which is necessary for these periods of rapid growth.

Rickets occurs on all continents, but global prevalence is unknown. It occurs mostly in high altitudes (e.g., in Mongolia, 70% of children are affected. This figure is 66% in Tibet.) and in areas where social or religious customs prevent exposure to the sun (the Middle East, some countries in Africa, India): this is more common in the Muslim community when compared to the Hindu community. In temperate zones, there is a higher risk of rickets in dark-skinned populations (African Americans, Asian community in Europe, Australia).

In recent years, **subclinical vitamin D deficiency** - low levels of 25OHD - has attracted attention, especially in relation to possible other roles of vitamin D in the human body. Subclinical vitamin D deficiency is described in a significant percentage of the population in both North America and Europe, but the American Institute of Medicine points to the lack of a general consensus on adequate plasma 25OHD levels and thus the possibility of overestimating the prevalence of the deficiency in the population.^[5]

 For more information see *Rickets*.

 For more information see *Vitamin D*.

Water soluble vitamins

Vitamin B1 deficiency

Manifestations of this deficiency include inability to concentrate, fatigue, loss of appetite, heart rhythm disorders, constipation, difficulty breathing, depression, and sleep disorders

Vitamin B2 deficiency

Manifestations of this deficiency include red, inflamed tongue, small cracks in the corners of the mouth, burning, reddened, tired eyes, chapped lips, oily hair, flaking of the skin on the nose, mouth, forehead and earlobes, hair loss, and limb tremors.

Vitamin B12 deficiency

Manifestations of this deficiency include fatigue, persistent nervousness, depression, tingling in the hands and feet, difficulty walking, and inflammation in the mouth. A common consequence of vitamin B12 deficiency is the development of macrocytic anemia.

 For more information see *Vitamins*.

Lack of mineral (inorganic) substances

Iron deficiency

The most common type of malnutrition **in the world**. The main manifestation is the development of sideropenic anemia. It occurs in both developing and developed countries. In 2002, the WHO identified anemia as one of the most significant contributors to the global disease burden.^[6] The association of severe anemia with increased infant and maternal mortality, and the negative impact of anemia on children's cognitive and physical development and adult productivity have been demonstrated.

According to a WHO assessment in 2008, anemia, measured by hemoglobin level, affects 1.62 billion people, a quarter of the world's population, most often young children (47.4%), and less often men (12.7%), with women representing the greatest percentage of total affected individuals. The highest prevalence of anemia is in Africa (47.5-67.6% of the population), but the majority of affected individuals are in Southeast Asia.^[7]

Anemia has a number of causes that can be combined. On a global scale, **the most common iron deficiency** is due to its insufficient intake, poor absorption of non-heme iron, and increased need for iron (growth, pregnancy). Other causes are blood loss (menstruation, infestation *Ankylostoma duodenale*, *Necator americanus*, *Ascaris lumbricoides*, schistosomiasis, minor bleeding from the GIT). Acute and chronic infections (malaria, cancer, TB and HIV) also reduce hemoglobin levels.

In developing countries, the causes are often compounded by a lack of other micronutrients (vitamin A, folic acid, vitamins B2, B12, copper) and in some areas also hemoglobinopathies (e.g., sickle cell disease).

Risk groups for the development of iron deficiency anemia are mainly low birth weight infants (insufficient iron supply), children from half a year to two years of age, **women of childbearing age**, especially **pregnant women**, and seniors.

Rich sources of iron include meat and offal (heme iron - 20-30% is absorbed), as well as cereals, tuberous and root crops, legumes, nuts, eggs, and leafy vegetables (non-heme iron - less than 5% is absorbed). Breast milk is also an important source of iron - the relative proportion of iron in it is small, but its up to 50% is absorbed. Iron deficiency results in **hypochromic microcytic anemia**, which leads to a reduction in oxygen delivery to the tissues. Its symptoms include increased fatigue, shortness of breath, pale skin and mucous membranes, hair loss, and koilonychia.

 For more information see *Sideropenic anemia*.

Iodine deficiency

Worldwide, iodine deficiency is **the most important preventable cause of brain damage**. People living in areas with severe iodine deficiency may have an IQ up to 13.5 points lower than in areas without iodine deficiency. This mental deficit has a drastic effect on children's ability to learn, women's health, the quality of life of the community, economic productivity, and animal agriculture (even livestock are iodine deficient).



Until the 1990s, **goiter prevalence** was used as the primary indicator of the occurrence of iodine deficiency in the population - it usually occurred in mountainous areas and in areas far from the coast. **Urinary iodine excretion** and other methods, however, have shown in later years that insufficient iodine intake is very extensive and occurs not only in areas where goiter is endemic, but also in industrialized countries.

Since 1991, the World Assembly adopted the goal of eliminating iodine deficiency worldwide. In 1993, the WHO and UNICEF, recommended universal salt iodination (for both humans and livestock) as the main strategy for eliminating iodine deficiency.^[8] The number of countries where iodine deficiency is a problem has decreased, but still **2 billion people in 47 countries suffer from iodine deficiency** in the world: most often in Europe (52% of the population) and in the eastern Mediterranean (47% of the population). The largest number of affected individuals is in Southeast Asia and Europe. The smallest percentage and number of people with insufficient iodine intake is on the American continent.^[9]

In the Czech Republic, salt has been iodized since 1947 and the Czech Republic is one of 19 out of 40 European countries with a sufficient iodine intake and 9 countries where $\geq 90\%$ of households use iodized salt.^[10]

 For more information see *Trace Elements in Human Nutrition*.

Zinc deficiency

The importance of zinc for the nutritional status of humans has only recently been recognized. Significant zinc deficiency is rare, but a **mild deficit is estimated to affect about 20% of the world's population** (9% in the US and Canada, 33% in Southeast Asia). The risk of deficiency is highest in infants and young children, and pregnant and lactating women. Globally, it is estimated that 80% of pregnant women and 100% of people in developing countries have a zinc intake lower than is considered necessary.^[11]

Mild zinc deficiency is associated with decreased immunity, failure to thrive, and growth retardation. Clinical studies in developing countries show that zinc administration reduces the morbidity and mortality of common childhood infectious diseases (gastroenteritis, pneumonia, malaria) and improves the growth of malnourished children. WHO recommends the administration of zinc as part of the treatment of diarrheal diseases.^[12]

 For more information see *Zinc*.

There are generally a number of possibilities in the categorization of pathological conditions, and the choice of one particular method of categorization depends on the purpose for which it is to be used. In the International Classification of Diseases^[13] for epidemiological purposes, diseases caused by a lack or excess of nutrients are classified into different groups:

Diseases of the blood, hematopoietic organs and certain disorders involving the immune system

- *D50-D53 Nutritional anemias*

Endocrine, nutritional and metabolic diseases

- *E00-E07 Disorders of thyroid gland (iodine deficiency disorders)*
- *E40-E46 Malnutrition - malnutrition (kwashiorkor, nutritional marasmus, marasmic kwashiorkor and protein-energy malnutrition)*
- *E50-E64 Other nutritional deficiencies (deficiencies of vitamins, minerals, and trace elements)*
- *E65-E68 Obesity and other hyperalimentation (obesity, vitamin excess)*

Links

Related Articles

- Diseases resulting from nutrient excesses
- Vitamins and their importance in nutrition
- Minerals and their importance in nutrition

Citations

1. GOLDEN, MHN. The development of concepts of malnutrition. *Journal of Nutrition*. 2002, y. 7, no. 132, p. 2117S-2122S, ISSN 1541-6100.
2. MANARY, MJ. , et al. Kwashiorkor: more hypothesis testing is needed to understand the aetiology of oedema. *Malawi Medical Journal*. 2009, vol. 21, no. 3, p. 106-107, ISSN 1019-1941.
3. UNITED NATIONS FOOD AND AGRICULTURE ORGANIZATION (FAO),. *Media fact sheet: September 2010* [online]. FAO, © 2010. [feeling. 2011-08-02]. <http://www.fao.org/fileadmin/user_upload/newsroom/docs/2010_hunger_facts.pdf>.
4. BLACK, RE, et al. Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet*. 2008, vol. 371, no. 9608, s. 243-260, ISSN 0140-6736.
5. ROSS, AC, et al. *Dietary Reference Intakes for Calcium and Vitamin D*. 1. edition. Washington D.C : Institute of Medicine (IOM); National Academy of Sciences, 2011. 1132 pp. ISBN 978-0-309-16394-1.
6. WORLD HEALTH ORGANIZATION,. *The World Health Report 2002 : Reducing risks, promoting healthy life* [online] . 1. edition. Geneva : WHO, 2002. 248 pp. Available from <http://www.who.int/whr/2002/en/whr02_en.pdf>. ISBN 9789241562072.
7. DE BENOIST, B - (EDITORS),, et al. *Worldwide prevalence of anaemia 1993-2005 : WHO global database on anaemia* [online] . 1. edition. Geneva : WHO, 2008. Available from <http://apps.who.int/iris/bitstream/10665/43894/1/9789241596657_eng.pdf>. ISBN 978 92 4 159665 7.
8. WHO,. *Assessment of iodine deficiency disorders and monitoring their elimination: A guide for program managers* [online] . 3rd edition. Geneva: WHO, 2007. 97 pp. Also available from <http://www.who.int/nutrition/publications/micronutrients/iodine_deficiency/9789241595827/en/> . ISBN 978 92 4 159582 7 .
9. BENOIST, B, et al. Iodine deficiency in 2007: Global progress since 2003. *Food and Nutrition Bulletin* [online] . 2008, vol 29, no. 3, pp. 195-2002, also available from <<http://www.who.int/nutrition/publications/micronutrients/FNBvol29N3sep08.pdf>> . ISSN 0379-5721.
10. ANDERSSON, M, et al. *Iodine Deficiency in Europe: A continuing public health problem* [online] . 1st edition. 2007. 70 pp. Also available from <http://www.who.int/nutrition/publications/micronutrients/iodine_deficiency/9789241593960/en/> . ISBN 978 92 4 159396 0 .
11. (EDITOR), Richard D. Semba, et al. *Nutrition and Health in Developing Countries : [object Object]*. 2. edition. Totowa : Humana Press, 2008. 931 pp. ISBN 978-1-934115-24-4.
12. WHO,. *Technical updates of the guidelines on the Integrated Management of Childhood Illness* [online] . 1. edition. Geneva : WHO, 2005. 38 pp. Available from <http://www.who.int/maternal_child_adolescent/documents/9241593482/en/>. ISBN 9241593482.
13. World Health Organization. . *International Classification of Diseases and Related Health Problems 10th revision* [online] . 2nd edition. Geneva: WHO, 2004. Also available from <<https://old.uzis.cz/en/mkn/index.html>> . ISBN 9241546492 .

References

- BENCKO, Vladimír, et al. *Hygiena : Učební texty k seminářům s praktickým cvičením. 2.* edition. Prague : Karolinum, 1998. ISBN 80-7184-551-5.
- HAINER, Vojtěch – KUNEŠOVÁ, Marie, et al. *Obezita : Etiopatogeneze, diagnostika, terapie. 1.* edition. Prague : Galén, 1997. ISBN 80-85824-67-1.