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ABSTRACT

Malnutrition is the most important underlying determinant of global disease and death. Maternal undernutrition and too early introduction of complementary foods with low energy-nutrient density lead to low birth weight, impaired growth and intellectual development, and high mortality due to infectious diseases. More than 5 of the 10 million annual child deaths are due to underlying undernutrition. With rural-urban migration, and access to refined sugar and fat, overnutrition and chronic diseases are becoming an increasing problem, also among the poor.

Malnutrition – under- or overnutrition – is probably the most important global determinant of morbidity and mortality.

Over several million years, man has become adapted to a hunter-gatherer diet, characterized by considerable diversity with respect to plant and animal foods. This so-called paleolithic diet has a large energy-nutrient density, and not least a high content of fibres, vitamins, minerals and other bioactive compounds. The last 10,000 years, we have changed our diet (nutrition transition) from a paleolithic diet, to an agricultural diet, to a diet with a high content of refined sugar and fat. Rural populations in low and middle-income countries still subsist on cereals (e.g., maize), tubers (cassava) or legumes (beans), with only a small amount of fruit and vegetables, and animal foods. Such a diet contains inadequate amounts of energy, and vitamins and minerals, such as vitamin A, iron and zinc. With rural-urban migration, even the poor get access to refined sugar and fat. These communities suffer from the double burden – both in terms of nutritional problems (under- and overnutrition) and disease burden (infectious and chronic diseases).

MICRONUTRIENTS

Deficiencies of vitamin A, iron, zinc and other micronutrients are widespread, and are due to a low content and bioavailability in the typical cereal/tuber/legume-based diet, without good animal sources of these nutrients. Anti-nutrients bind iron and zinc, and impair the absorption. Bioconversion of provitamin A carotenoids from yellow-orange fruits and especially green leafy vegetables has proved to be less efficient than expected, and to be impaired by lack of zinc. Micronutrient deficiencies impair a range of important functions, including reproduction, growth, intellectual development, and immunity. Deficiencies of vitamin A, iron and zinc are among the ten most important underlying causes of death [1].

Fortunately, simple public health interventions are available to increase the micronutrient intake among populations, whereas it is difficult to increase the intake of energy and protein. For example, the population can be advised to increase the intake of good sources of micronutrients (diversification), sugar, salt or flour can be fortified (fortification), the content of micronutrients in eg maize can be increased or the content of anti-nutrients can be reduced (modification). Furthermore, supplements can be administered to high-risk groups in contact with the health system (supplementation), e.g. iron-folic acid to pregnant women. Finally, prevention and treatment of infections are important, since infections lead to loss of micronutrients.

NUTRITION AND REPRODUCTION

Nutritional status during pregnancy and lactation is not only of importance to women, but also to the health of their offspring. Maternal undernutrition impairs foetal growth. Children are born with low weight and small stores of nutrients such as vitamin A, which are not filled up during lactation, since the breast milk will also have a low content if maternal stores are low. During the first months of life, the infant will be exposed - despite the WHO recommendation of exclusive breast feeding - to an inadequate and contaminated diet. This will lead to a vicious circle of undernutrition and infections. Impaired growth within the first years of life is a determinant of morbidity and mortality, poor intellectual development, and of chronic diseases in adulthood. Pregnant women in low-income countries are offered iron-folic acid supplements, despite poor evidence of efficacy and safety. As pregnant women often are deficient with respect to a whole range of micronutrients, it has been proposed to replace the iron-folic acid supplement with a multi-micronutrient supplement containing one recommended dietary allowance of 15 micronutrients, and to reduce the dose of iron from 60 to 30 mg. Results of randomised trials in Africa and Asia have shown that such a daily multi-micronutrient supplement increases birth weight by up to 100 g, but that this is not accompanied by a reduction in mortality [2].

NUTRITION AND INFECTIONS

Poverty leads to inadequate diet and infections. Too early introduction of complementary foods, and cessation of breastfeeding within the first year of life increases the risk of diarrhoea and respiratory tract infections. This leads to undernutrition, including deficiencies of vitamin A, zinc and other nutrients, which impair the immune system and further increase the risk of diarrhoea and respiratory tract infections. The majority of the 10 million annual deaths among children below five years of age are due to infections, but undernutrition explains more than half of these deaths. Children die from infections, but due to undernutrition. Vitamin A was previously known as the "anti-infective vitamin", but the value of vitamin A interventions only became established after renewed interest and research in the 1980's. Large randomised trials among children without clinical signs of deficiency demonstrated that vitamin A supplements two or three times a year will reduce mortality by 23-30% [3]. Among children with measles, vitamin A supplements will reduce mortality by 70% [3]. WHO therefore recommends regular administration of vitamin A capsules to children below five years of age and to children admitted with measles.

Women often have vitamin A deficiency during pregnancy, and night blindness - a sign of vitamin A deficiency - is regarded as a sign of pregnancy in some places. Vitamin A supplements can be given to women before, during and after pregnancy, to cover the needs of the mother as well as her offspring. A randomized trial in Nepal found that a small weekly vitamin A supplement - given as preformed vitamin A or the provitamin A carotenoid β-carotene - to fertile women reduced maternal mortality by 50% [4]. A mega-dose of vitamin A can also be given to the mother the first weeks after delivery, when there is no risk of malformations, to ensure a high content of vitamin A in the breast milk and hence an adequate intake by the infant in the first year of life. The effect on vitamin A status has, however, been disappointing. And one trial, but not other trials, found that vitamin A supplementation of pregnant and lactat-
Malnutrition is the most important determinant of global morbidity and mortality.

Maternal undernutrition is a cause of low birth weight.

Early introduction to inadequate complementary feeding leads to infections and impaired growth.

The typical cereal-based diet, with only little fruit, vegetable and meat, is inadequate with respect to energy, vitamin A, zinc and iron.

Lack of vitamin A and zinc increases the risk of infections and death.

Half of the ten million yearly deaths among children below five years is due to undernutrition.

Simple nutritional interventions could prevent 30% of the ten million annual death among children.

Increased micronutrient intake among HIV and TB patients reduces mortality.

The poor in low- and middle-income populations are now also at risk of overweight and chronic diseases.

**Nutrition and Chronic Disease**

The global number of individuals with overweight and obesity, and chronic diseases such as coronary-heart diseases, cancer and diabetes are increasing dramatically. It is estimated that 35 million died from chronic diseases in 2005, and of these death 80% were in low- and middle-income countries. Some populations that 100 years ago were hunter-gatherers now have 80% obese and more than 50% with impaired glucose tolerance and diabetes, eg the Pima-indians were hunter-gatherers now have 80% obese and more than 50% with impaired glucose tolerance and diabetes, eg the Pima-indians from the USA. The global number of type 2 diabetics will increase from 170 million in 2000 to 366 million in 2030. Most of the additional 200 million new cases will occur in low- and middle-income countries, and the majority will be young or middle-aged. The increase will be due to an increasing intake of refined sugar and fat, and less physical activity, following rural-urban migration. But low- and middle-income populations are possibly more susceptible than people in

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**Key Points**

- Malnutrition is the most important determinant of global morbidity and mortality.
- Maternal undernutrition is a cause of low birth weight.
- Early introduction to inadequate complementary feeding leads to infections and impaired growth.
- The typical cereal-based diet, with only little fruit, vegetable and meat, is inadequate with respect to energy, vitamin A, zinc and iron.
- Lack of vitamin A and zinc increases the risk of infections and death.
- Half of the ten million yearly deaths among children below five years is due to undernutrition.
- Simple nutritional interventions could prevent 30% of the ten million annual death among children.
- Increased micronutrient intake among HIV and TB patients reduces mortality.
- The poor in low- and middle-income populations are now also at risk of overweight and chronic diseases.
western countries. This could be due to genetic factors (thrifty genotype hypothesis), or that early undernutrition increases the risk associated with later overnutrition (thrifty phenotype hypothesis). Finally, it cannot be excluded that other factors, such as micronutrient deficiencies or infections could play a role. (Box 1)

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References