



International nutrition and health

Friis, Henrik

Published in:
Danish Medical Bulletin

Publication date:
2007

Document version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
Friis, H. (2007). International nutrition and health. *Danish Medical Bulletin*, 54(1), 55-57.

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– secondary publication

Henrik Friis, MD, PhD, Professor

Department of Human Nutrition, Faculty of Life Sciences, University of Copenhagen, Rolighedsvej 30, 1958 Frederiksberg, Denmark.

Correspondence: Professor Henrik Friis, Department of Human Nutrition, Faculty of Life Sciences, University of Copenhagen, Rolighedsvej 30, 1958 Frederiksberg, Denmark.

E-mail: hfr@life.ku.dk

Dan Med Bull 2007;54:55-7

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 (eg 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 forti-

fied (*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 megadose 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-

ing HIV-infected women increased the risk of mother-to-child HIV transmission [5]. It is important to understand these unexpected effects, which might be due to interaction between β -carotene and a high-dose iron supplement [6], to avoid a setback in the combat against vitamin A deficiency.

Iron deficiency is also widespread, and may increase the risk of infections. Paradoxically, iron supplementation may also increase the risk of tuberculosis, malaria and other infections. It is particularly parental or large oral iron supplements that have been considered harmful, especially when given to undernourished individuals. Smaller doses of iron to healthy children have been considered beneficial, even though it may increase the intensity of malaria parasitaemia. Recent data have led to a re-assessment of the advantages and disadvantages of iron supplementation: randomized trials of the effect of daily supplements containing iron (12.5 mg) and folic acid to young children were conducted in parallel in Nepal and at Zanzibar. The study at Zanzibar was stopped due to increased morbidity and mortality among children in the intervention group [7], apparently due to malaria. The data suggested that the supplement was harmful only among those with iron in their stores, but was beneficial among those with iron deficiency.

Zinc is of importance to the cell-mediated immune system, and it is known from experimental animal studies that a zinc-deficient diet leads to disappearance of the thymus (dietetic thymectomy) and increased risk of infections. Randomised trials have documented, that zinc supplementation of children reduces the risk of diarrhoea and respiratory tract infections, and reduces the severity and duration when given therapeutically.

Of the ten million deaths among children below five years of age each year (Figure 1), only 42 countries account for more than 90%. If 20 simple, feasible and cheap interventions with documented effects could reach all children, then more than 60% of the deaths could be avoided [8]. These interventions include nutrition interventions, such as: improved breast feeding, improved complementary feeding, as well as preventive and therapeutic vitamin A and zinc supplementation. Together, these nutritional interventions could prevent 30% of these deaths [8]. Promotion of breast feeding is impaired by the risk of mother-to-child HIV transmission. However, data suggest that HIV in the milk rarely infects the infant through exclusive breast feeding, but mainly

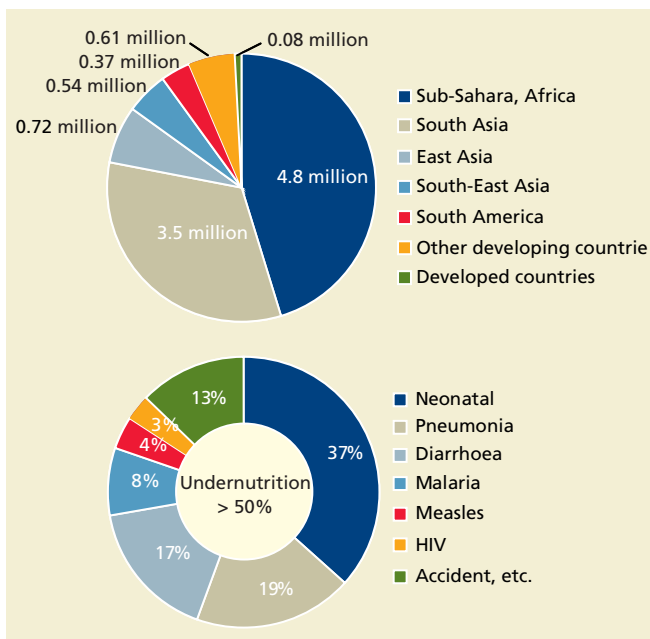


Figure 1. Distribution of 10 mio yearly deaths among children below five years of age by region (number) and cause of death (%). More than half of the deaths is due to underlying undernutrition. (Source: The Millennium Development Goals Report 2005, United Nations. New York.)

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.

through mixed feeding, where foreign proteins or bacteria cause mucosal lesions which can be a port of entry for the virus. Women with HIV infection are therefore recommended to use exclusive breast feeding and fast cessation when safe alternatives become available.

Micronutrient interventions are also of importance among adults with HIV and tuberculosis (TB). Even early HIV infection increases the requirements for energy and nutrients, which are rarely met by a cereal-based diet. Furthermore, advancing HIV infection reduces household food production and income. After a period with a negative energy and nutrient balance, the working capacity declines. Micronutrient deficiencies lead to a loss of lean body mass, increased viral replication and loss of CD4 cells. A randomized trial among HIV-infected women in Tanzania showed that at daily supplement containing vitamins B, C and E reduced viral load and risk of progression of HIV to AIDS or AIDS-related death [9]. Despite the fact that undernutrition is a cause of TB, and that TB patients often have a weight deficit of 5-10 kg, nutritional support is not an integrated part of the case-management. A randomized trial among TB-patients in Tanzania found that a daily micronutrient supplement considerably increased weight gain during TB treatment [10]. Furthermore, among those with HIV co-infection, mortality was reduced by 70%.

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 in 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

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)

This article is based on a study first published in Ugeskr Læger 2006; 168:3020-23.

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