

## **ADEQUATE DIET OF ESSENTIAL NUTRIENTS FOR HEALTHY PEOPLE**

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## Summary

An adequate and balanced diet contributes to achieve or maintain a good state of health. Generally, a balanced diet contains adequate proportions of carbohydrates, fats, and proteins, along with the recommended daily allowances of all essential minerals, vitamins, and health-promoting substances. While carbohydrates and fat mainly provide energy, protein is a structural component of all body cells. The essential nutrients such as a variety of amino acids, fatty acids, vitamins, and minerals have to be provided within the diet. Vitamins and minerals are involved in a large number of metabolic processes.

Nonessential food components such as dietary fibers and phytochemicals are also important for maintenance of health, and possibly also for reducing the risk of chronic disease. Each food group is a characteristic source of certain nutrients: Cereals and legumes mainly provide carbohydrates and protein, vegetables and fruits provide minerals and vitamins, nuts and seeds supply oil and micronutrients, and animal-derived foods are rich in protein.

People in industrialized countries are confronted with a high range of diet-related diseases such as obesity, diabetes, hypertension, certain cancers and coronary heart disease. To achieve an adequate diet and to avoid overnutrition, people have to reduce the consumption of foods high in fat, salt, and energy and low in essential nutrients and therefore increase the intake of foods rich in complex carbohydrates and dietary fiber. In developing countries where traditional diets are frequently adequate, poverty is the main underlying cause of widespread undernutrition and high mortality. Their nutritional problems have to be solved with substantial efforts and changes in the political, economic, and agricultural processes and priorities at national and international levels.

## 1. Introduction

Adequate and balanced diet is one of the most important contributing factors to achieving or maintaining a good state of health (see *Nutrition and Human Life Stages*). The human body is an adaptable organism, and a wide range of dietary patterns and food intakes can lead to good health and nutritional well-being. The individual lifestyles

and cultural and social background determine which diet is adequate. However, the sufficient supply of all essential nutrients and health-promoting substances is the basis of a healthy diet.

Each nutrient has a particular function in the body that is described briefly in this essay. Nutrients are concentrated in foods of animal and plant origin. Each food group is a characteristic source of certain nutrients. Since people consume food rather than nutrients, the benefits of the different food groups to a healthy diet are outlined, too. Diets of the general adult healthy population are focal points of this contribution. The energy and nutrient requirements of people suffering from certain diseases or of those during particular times in the life cycle such as pregnancy, lactation, infancy, or childhood differ considerably. Those population groups need diets adapted to their situation which are discussed in other articles in this volume.

## **2. Definition of Terms**

### **2.1 Healthy People**

Good health does not imply merely the absence of disease or infirmity, but presumes a state of physical, mental, and social well-being. Several indicators, such as a good nature, liveliness, alertness, good appetite, normal body temperature and pulse rate, average height-for-age and weight-for height can show us how to recognize healthy people. A range of social, economic, and environmental factors determines the health status of an individual (see *Human Nutrition* and *Nutrition and Human Life Stages*).

### **2.2 Essential Nutrients**

Essential nutrients are defined as chemical substances found in food that cannot be synthesized at all or only in insufficient amounts by the body, and that are necessary for life, growth, and tissue repair (see *Nutritional Deficiency and Imbalances*). They belong to different groups of macronutrients and micronutrients. Water is the most important nutrient for survival. Of the 20 amino acids found in protein, 8 have to be provided preformed in the diet of adults and are thus identified as being indispensable or essential. The fatty acids linoleic and linolenic acids are the second group of essential macronutrients. Furthermore, the human body depends on the dietary intake of 13 vitamins and a variety of inorganic minerals such as calcium, magnesium, iron, iodine, and zinc.

There are additional groups of food components such as dietary fibers and phytochemicals, which are not yet considered to be essential but which are important for maintenance of health, and possibly also for reducing the risk of chronic disease.

### **2.3 Adequate Diet**

A healthy diet means different things to different people. In children's nutrition, an adequate diet aims to promote healthy growth and development. In adult nutrition, it focuses on attaining or maintaining optimal health and preventing chronic degenerative diseases of complex causation (see *Nutrition and Human Life Stages*). Generally, proper

food provides adequate energy, builds new tissue, repairs worn-out tissue, and keeps the body working well.

Although the needs of people are rather similar worldwide, the individual lifestyle determines which diet is adequate. In societies where physical labor is still common, the variety of foods of plant and animal origin that covers the energy need, as indicated by body weight, will almost inevitably constitute an adequate diet. This is particularly true if the food is not excessively processed. In highly industrialized societies where foods are usually highly processed, a nutrient-dense diet with limited energy content is considered adequate.

Generally, a balanced diet contains adequate proportions of carbohydrates, fats, and proteins, along with the recommended daily allowances of all essential vitamins, minerals, and health-promoting substances. It is recommended that complex carbohydrates of at least 50% of the diet make up the major part of energy intake; 25% to 30% of energy should be derived from fat, and 10% to 15% from protein. Energy needs and nutrient requirements, however, vary widely. They are a function of sex, age, body weight, and activity level and health status.

Principally, plant food forms the basis of adequate diets. Carbohydrate-rich foods such as cereals should be supplemented with foods particularly rich in vitamins A and C, minerals, and protein such as vegetables, fruits, and legumes. Foods of animal origin, particularly meat and fish are not essential for an adequate diet, but they are a useful complement to most diets. Societies that have adopted vegetarian diets do not show evidence of malnutrition when the supply of total food is adequate. They rather have a lower risk of nutrition-related diseases such as obesity, diabetes, hypertension, certain cancers and coronary heart disease.

In addition, a sufficient fluid intake is important to an adequate diet. Breastmilk is the most adequate diet for children up to six months of age. A major problem in all societies is the consumption of a monotonous diet. A prolonged consumption of an inadequate diet is likely to lead to malnutrition, overnutrition or undernutrition, and degenerative diseases (see *Malnutrition: Hunger and Satiety, Obesity and Anorexia*).

### **3. Achieving Adequate Nutrition**

#### **3.1 Industrialized Countries**

The principal components of a country's diet tend to relate to a nation's state of affluence. The decrease in the consumption of starchy foods and the increase in animal fat intake are the most striking dietary features, as societies become affluent. Simple sugars also form on average a much higher proportion of the total dietary carbohydrates in industrialized countries than in low-income countries.

Currently, the average energy intake of adults in industrialized countries exceeds by 3000 kilocalories (kcal) the recommended intake, about 30%. The total carbohydrate intake in most affluent countries averages only 40% to 44% of energy intake, half of which comes from starch, the other half from sugars. Fat intake accounts for 35% to

40% of energy intake.

It has been recognized that excessive intake of energy, certain fats, cholesterol, alcohol, and salt, decreased consumption of fruits, vegetables, and fibers, coupled with sedentary lifestyles contribute importantly to increased incidence of overnutrition among populations in developed countries. A prevalence of overweight of up to 50% and more of the adult population is common in most of the industrialized countries (see *Malnutrition: Hunger and Satiety, Obesity and Anorexia*). Overnutrition is associated with a high prevalence of obesity and chronic diseases such as coronary heart disease, hypertension, certain cancers and diabetes, and with premature mortality. Dental caries and alcoholism are further public health problems.

To avoid overnutrition and to lessen the risk for certain diseases it is recommended to reduce the intake of fat by 10% of energy intake from the current level and keep the intake of saturated fatty acids below 10% of total energy intake. The consumption of foods high in fat and low in essential nutrients such as meat products, fat cheeses, and junk food should therefore be reduced. An increased consumption of important staple foods such as cereals, legumes, vegetables, fruits, and nuts will help to expand the intake of complex carbohydrates by 10% of total energy, as recommended, including an increased intake of dietary fiber. It is also advisable to reduce the salt intake, and alcohol should be consumed only moderately. Important areas to achieve a better nutritional situation of the population in industrialized countries are public health measures such as nutrition education, nutrition counseling, and nutrition research.

### **3.2 Developing Countries**

In low-income countries the major nutritional problem is that large sections of the population cannot afford or cannot grow enough food to meet all their requirements for essential nutrients. Poverty and its associated conditions are recognized as the overriding causes of undernutrition. The four most important forms of malnutrition in developing countries are protein-energy malnutrition (PEM), followed by iron-deficiency anemia, then vitamin A and iodine deficiencies. It is estimated that 1.1 billion people in developing countries live in absolute poverty, and that 20% of the total population in developing countries suffer from chronic dietary energy deficiency.

Low energy intake is closely related to reduced consumption of protein, vitamins, and minerals. Dietary composition plays an important role in nutritional status. Generally, adult nutrient needs are met by most traditional developing country's diets when they are consumed in sufficient quantity to meet normal energy needs. Traditional diets mainly embrace one or two staple crops, tubers, vegetables, pulses and fruits, and are prepared with a minimum of processing. Protein and energy needs can be met easily by combining cereal-based diets with small amounts of other protein foods such as pulses or peanuts.

An increase in the consumption of green leaves and other vegetables could play a major part in reducing vitamin A deficiency in developing countries, and could contribute to lessening the prevalence of iron deficiency anemia. Yet, in rural areas where access to markets is limited, diets often lack variety and are low in fruits and vegetables. The consumption of iodized salt is the best measure to reduce the prevalence and severity of

iodine deficiency disorders.

For the adult population, protein-energy undernutrition is normally a problem only among families that are so poor that they have to abandon their traditional diet and start to depend heavily on cheap, low-protein foods. However, it is often a problem for at-risk family members such as children, pregnant or lactating women if either the diet is inadequate or the person is weakened by diseases, which are the two immediate causes of malnutrition.

Underlying causes of malnutrition are present at different levels of the society. To improve the nutritional situation in developing countries, measures taken must consider the causes of malnutrition at all levels (see *Economic Development, Food, and Nutrition*). These measures embrace national and regional policies and activities to improve food production and marketing and income generation so that families are able to purchase food (see *Socioeconomic Policies and Food Security*). Further policies should focus on improvement of the health situation, especially of mothers and children, development of nutrition knowledge, care, hygiene, and access to drinking water. Superior objectives should be an increase in education level and status of women in the society (see *Women and Food Security, Roles, Constraints, and Missed Opportunities*).

### 3.3 Worldwide

Generally speaking, the world has ample food. The growth of global food production has so far been equal to population growth (see *World Demography and Food Supply*). However, many of the world's people do not live where much of the world's food is produced. Industrial countries produce half of the world's grain, but they have less than one-fourth of the world's population. Thus, many poor countries and hundreds of million of poor people do not share in this abundance. They suffer from a lack of food and nutrition security caused mainly by a lack of purchasing power. Many countries have a critical food supply because of chronic food shortages due to unfavorable growing or harvesting conditions or political turbulence. Only a few countries are self-sufficient in food supply. The rest rely on the world market for food imports (see *Food Control and International Trade*).

Even though on all continents—except Africa south of the Sahara—the nutritional situation of the population has improved during the last decades, there are still dozens of countries classified as food-deficit, low-income countries. Worldwide, almost one third of all children less than five years of age suffers from underweight and even more suffer from growth retardation. Up to two billion people suffer from iron deficiency or anemia, a significant proportion of which live in industrialized countries. Iodine deficiency is another worldwide problem. Especially in Africa south of the Sahara, in Southeast Asia, and in the least developed countries, the nutritional situation is still problematic (see *Ethnographic Aspects of Human Nutrition*).

In addition to strategies at the national level to improve the nutritional situation of a country's population, there are a number of possibilities for joint international action. Some of the current regulations and rules of commercial trade put many poor countries at disadvantage. Effective international markets with fair trade relations and policies

would stabilize or even increase food availability for many countries. The global food support system includes the networks of commercial trade and food aid. As part of this, early warning systems play a vital role in mobilizing world food reserves and distributing assistance to countries facing famine or other food emergencies (see *Food Control and International Food Trade*).

Food aid, mainly provided by international organizations, can help bridge the gap in situations of food unavailability and famine. Program food aid supports mostly vulnerable groups such as children by providing supplementary food. Agricultural research contributes to increasing food supply and expanding food production; however, it does not solve the worldwide problem of unequal distribution of food (see *Socioeconomic Policies and Food Supply*).

## **4. Food Groups**

### **4.1 Cereals and Legumes**

#### **4.1.1 Cereals**

Cereals constitute the basis of most diets, particularly in the developing world. They include rice, wheat, maize (corn), sorghum, millet, barley, oats, and quinoa. Wheat, rice, and maize are currently the predominant cereals in terms of farmland devoted to them and their consumption. About half of the food protein available on the globe is derived from cereals, with consumption greatest in developing countries.

The nutritional values of cereal grains are fairly similar, with some variations (Table 1). They are an important source of energy, providing on average 350 kcal or 1400 kilojoule (kJ) per 100 grams of whole cereal. They supply starch and dietary fiber that make up 70% to 77% of the grain. Protein accounts for 6% to 15%; the limiting amino acid is lysine, with maize additionally low in tryptophan. All cereals are low in fat; oats have the highest fat content; most of the fat consists of polyunsaturated fatty acids.

Whole grains are a good source of B-vitamins (except B<sub>12</sub>), their germ is rich in vitamin E, and they contain significant amounts of minerals, especially potassium, phosphorus, and magnesium, plus certain amounts of calcium, iron, and zinc. However, the contribution of cereals to mineral intake may be less than anticipated because phytate in the outer bran layers binds certain amounts of minerals and inhibits their absorption. Bioavailability of minerals is better from refined products, but because the mineral content is much less, overall whole grains will provide more minerals. During fermentation, as in bread making, the enzyme phytase breaks down phytate.

Cereal grains are subjected to many different processes during their preparation for human consumption. All of the processes have in common that they are designed to remove the fibrous layers of the grain or to produce a highly refined white product. These processes reduce the nutritional value of the grain. Highly milled cereals such as white maize flour, polished rice, and white wheat flour have lost most of the B-vitamins and some of the protein and minerals (Table 1). The predominant consumption of highly milled cereals might lead to malnutrition if other foods in the diet do not make

up for the deficiency.

Nutrient	Nutrients per 100 g						
	Wheat, Whole grain	Wheat flour, white	Brown rice	Rice, polished	Maize	Millet	Oats
Water (g)	13.2	13.9	13.1	12.9	12.5	12.1	13.0
Protein (g)	11.7	9.8	7.2	6.8	8.5	9.8	11.7
Fat (g)	2.0	1.0	2.2	0.6	3.8	3.9	7.1
Carbohydrate, available (g)	60.9	70.9	74.1	77.7	64.6	68.8	59.8
Dietary fiber (g)	10.3	4.0	2.2	1.4	9.2	3.8	5.6
Thiamine (mg)	0.5	0.06	0.4	0.06	0.4	0.4	0.5
Niacin (mg)	5.0	0.7	5.2	1.3	1.5	1.8	2.4
Calcium (mg)	38.4	15.0	23.0	6.0	15.0	22.0	79.6
Iron (mg)	3.3	1.5	2.6	0.6	1.0	9.0	5.8

Table 1. Nutrient content of selected cereals

#### 4.1.2 Legumes

Legumes (pulses) which include dried peas, beans, lentils, and peanuts, are important from a nutritional point of view. Besides being widely available, they most satisfactorily meet the dietary guidelines for healthy eating: They are high in complex carbohydrate and dietary fiber, mostly low in fat, supply adequate protein while being a good source of vitamins and minerals. In many diets, particularly in developing countries, legumes are a staple food alongside cereals.

Dried legumes contain between 22% to 28% protein (6% to 9% when cooked), with soybeans being exceptionally high in protein (35%). The latter is also rich in fat (20%), while the average fat content of legumes accounts for only 2% of energy content. The limiting amino acids of legumes are methionine and cysteine but, being rich in lysine, legume proteins are well complemented by cereal proteins. Soybean protein, which is an important component of diets in China and some other Asian countries, is of a higher biological value than that from other plant sources. Research suggests that the amount of essential amino acids in soy protein products is sufficient to meet protein requirements for normal human growth and development. Legumes are rich in complex carbohydrates, both starch and dietary fiber. They provide vitamins and minerals including thiamine, niacin, iron, zinc, calcium, and magnesium.

The legumes as a group contain a range of antinutrients and toxic constituents (such as trypsin-inhibitors or hemagglutinins) that inhibit their nutritional quality. Cooking and processing inactivates most of these substances and is also required to make legumes digestible. Germination and fermentation improve the nutritional quality of beans resulting in increases in vitamin C, B-vitamins, and vitamin E contents of beans. The abdominal discomfort and flatulence caused by some legumes is perhaps the factor limiting consumption.

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### **Bibliography**

Elmadfa I. And Leitzmann C. (2004). *Human Nutrition*, Fourth Edition, 660 pp. Stuttgart, Germany: Ulmer Verlag. [This is a scientific text on many aspects of human nutrition, written in German.]

Garrow J.S. and James W.P.T. (1993). *Human Nutrition and Dietetics*, Ninth Edition, 847 pp. New York, US: Churchill Livingstone. [This describes the major foods and nutrients and their functions in healthy humans, and the nutritional management of clinical disease states.]

Latham C.M. (1997). *Human nutrition in the Developing World*. Rome, Italy: FAO Food and Nutrition Series No. 29. [This covers the most important nutritional problems of developing countries and suggests appropriate programs and policies to address them.]

Mann J. and Truswell A.S. (2007). *Essentials of Human Nutrition*. Third Edition. 599 pp. Oxford, UK: Oxford University Press. [This is an introductory scientific text for the whole field of human nutrition.]

### **Biographical Sketch**

**C. Leitzmann**, of Giessen, Germany, graduated from Capital University, (B.S. chemistry) Columbus, Ohio, 1962; has an M.S. (microbiology) and a Ph.D. (biochemistry) from the University of Minnesota, Minneapolis, MN, US. He was a research assistant at the University of California, Los Angeles, in molecular biology with Paul Boyer (Nobel prize 1997), and Visiting Professor, Department of Biochemistry and Nutrition Mahidol University, Bangkok, Thailand, from 1969 to 1971, and Chief of Laboratories, Anemia and Malnutrition Research Center, Chiang Mai University, Thailand, 1971 to 1974. Since 1974 he has been a Research Associate, Professor of Nutrition, and Chairman at the Institute of Nutrition University of Giessen, Germany. He is the author or co-author of 28 books, 60 book chapters, and 300 scientific papers.