Fit and Healthy from 1 to 100 with Nutrition and Exercise

Current Medical Knowledge on Health

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For Lilly and Lucy
Good knowledge is the power of people, their ignorance the power of diseases.

The Broad Growth as a Result of Malformations Already in Childhood—A Preface

Diverse nutrition, plenty of exercise, no smoking and great restraint in consuming alcoholic beverages are the key factors for a healthy lifestyle. The education about this must begin as early as possible, because what children learn, they take into adulthood. Unfortunately, the necessary learning process is often omitted, so malformations are already programmed in childhood.

Evaluations of the Global Burden of Disease Study with data from 195 countries show that already in 2015 604 million adults and 108 million children were **obese** (The GBD 2015 Obesity Collaborators, 2017). Of the children, according to WHO (2016), 41 million were not even 5 years old. In the USA, the proportion of obese children has tripled since the 1960s (Fryar et al. 2014). Today, 18% of all children are alarmingly obese. In the European Union, around 19% of all children and adolescents suffer from overweight or obesity (Garrido-Miguel et al. 2019). In Germany alone, according to the Robert Koch Institute (2018), 15% of those under 18 are overweight and 6% obese. Every year, several hundred of these obese adolescents already suffer from type 2 diabetes. Large international studies regularly confirm that the overweight adolescents in the middle of their lives will develop chronic coronary syndrome and cancer much more often than their normal-weight peers.

The overweight teenagers in Germany spend an average of 23 h lying, sitting or standing. Four out of five 15-year-olds are no longer able to balance two or more steps backwards, nine out of ten can no longer stand on one leg for a minute. However, the desire and ability to move physically starts in early childhood and actually lasts a long time. However, according to a WHO report from 2019, there are already small restrictions on movement competence in children up to the age of 6 in industrialized countries. These problems then intensify at the age of 10 and become clearly visible in 15-year-olds. In many countries, these children are today 15% less fit than their parents were 30 years ago (Tomkinson 2013, 2017). Therefore, movement training is becoming increasingly important and it is best to start in preschool. Small children should be physically active for three hours a day, for older children and adolescents, at least one hour of sport per day is

recommended. In addition to intensity, the variety of movement exercises also plays an important role.

Athletic students have a sharper sense of time and space and therefore move more safely in traffic. They have a stronger sense of self-confidence and often have better grades than the couch potatoes in their group. That's why they start their careers more successfully (Kantomaa et al. 2013, 2016; Booth et al. 2014). Because they also exercise as adults for the most part, they permanently increase their quality of life, see everything in their environment more optimistically and can benefit from the many positive health effects of their physical activity for a long time (Rozanski et al. 2019). This also applies to later stress situations. In them, people usually fall back mindlessly into old habits. It is good if, for example, sports are part of these, but also a healthy diet (Neal et al. 2013).

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Part I
Nutrition

Introduction

1

According to results of the Global Burden of Disease Study, 2.1 billion people worldwide are overweight. This problem has thus increased by 28% among adults and by 47% among children since 1980 (Ng et al. 2014). According to data from 19.2 million people from 200 countries, obesity in particular has increased enormously worldwide since 1975, from 6% to 15% among women and from 3% to 11% among men (NCD Risk Factor Collaboration 2016). According to data from over 112 million adults, residents of rural areas are more affected by this development than city dwellers (NCD Risk Factor Collaboration 2019). The report of the German Nutrition Society (2019) shows that 43% of women and 62% of men in Germany were overweight in their middle age in 2017, with a corresponding significant increase in these values at the end of their working lives.

Overeating often makes people sick, but most unhealthy diets are also very problematic. According to data from 195 countries over a period of 27 years, this is the cause of about 11 million deaths each year (Forouhi and Unwin 2019; The Global Burden of Disease Study 2019).

Because physical activity and conscious nutrition have a positive effect on well-being and health, it is important to promote self-initiative and self-responsibility for a reasonable way of life. For example, simply by eating lots of vegetables and fruit, eating less meat and drinking less alcohol, exercising for at least 2.5 h a week, avoiding obesity and giving up smoking, the risk of serious diseases such as diabetes, cancer, heart attack and stroke is more than halved (Ford et al. 2009; Rasmussen-Torvik et al. 2013; Khera et al. 2016). These measures are particularly effective in combination and show significant life expectancy (Li et al. 2018, 2020). The Nurses Health Study (Chap. 3) presented as a central result from studies on 83,882 women a reduction in the rate of hypertension by 80%, if the women were not overweight, were physically active for 30 min every day and ate healthy (Forman et al. 2009). These results are confirmed by the EPIC study (Andriolo et al. 2019).

It is therefore helpful for all people to gain as much knowledge as possible about this topic. If, for example, precise knowledge shapes thoughts, the risk that unbalanced nutrition and lack of movement shape the body decreases. The more comprehensive their knowledge becomes, the easier it is for people to change their lifestyle and the greater the likelihood that this will be associated with lasting success. It is particularly important to set an early focus on a health-promoting lifestyle for children, because they can still be easily and unbiasedly imprinted with the basics and no established habits exist yet.

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Promoting health should be a top priority for any government and of course always part of the school curriculum.

The voluntary advertising ban on food industry, which is supposed to protect children under 12 years of age from too much sweets, too much fat and too much salt, unfortunately does not work. Legislative regulations would be necessary here. A small help for everyday use is, for example, the food labeling with the Nutri-Score developed in France. With this, the health values of the respective food are very clearly labeled with 5 different colors and an emphasized letter from A to E on the front of the respective packaging.

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2 "Those Who Know Nothing Must Believe Everything"

The knowledge of basic principles of nutrition is always of high value. In order to be able to benefit from it in the long run, the habits associated with deep emotions here must also be considered. Because eating is more than just food intake, it is memory, ritual, entertainment, often reward—and sometimes torture. But if it succeeds in steering the acquired knowledge into the channels of reason, this usually also has the desired sustainable effects on health.

The physical and mental damage caused by overweight and obesity is enormous. Alone, about one third of the approximately 510,000 new cancer cases predicted by the Robert Koch Institute for 2020 in Germany will be attributed to poor nutrition. Healthy people are happier, but for individuals, sound knowledge of health issues also has a strong economic value. On the one hand, the knowledge protects against expensive, but often useless, offers of pseudo-medicine. On the other hand, the constant progress in all medical areas will continue to increase the cost of the health care system. In 2020, a total of around 425 billion € were spent on the German health care system, of which 260 billion € (61%) were for statutory health insurance and 35 billion € (8.2%) for private health insurance. The federal budget was 362 billion € in comparison. The treatment of nutrition-related diseases alone causes annual costs of around 150 billion €. And because the rapidly increasing medical knowledge can no longer be paid for solely from rigid health insurance contributions, **prevention** is always a sensible financial investment in the future for everyone.

In addition, the age structure in our society is constantly changing. More and more people are reaching the age of the elderly. According to the Federal Statistical Office, in 2030 every third inhabitant in the Federal Republic of Germany will be over 60 years old. The WHO also defines the **health-adjusted life expectancy (HALE)** here for the increasing life expectancy, that is, the time a person is likely to live healthy. However, HALE has so far increased much more slowly than life expectancy. The financing of our health care system is therefore also playing an increasingly important role under the aspect of **healthy aging**. Good prevention programs for a reasonable way of life are therefore very important. The general acceptance for this is available. Because a long time ago, in a time when our well-being is constantly increasing, the attitude towards health has gained a new quality. It is regularly confirmed as the highest good in surveys.

Marie von Ebner-Eschenbach (1830–1916).

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3 Important Long-Term Studies

Even the biggest alleged nonsense is often justified by the fact that there is a study on this. But alone for the area **nutrition** several thousand articles appear worldwide in medical specialist literature every year, so that's a number of "studies" every day. The reference to such a study is therefore not very informative at first, especially if it is apparently an industry-driven study. However, the results of respected working groups of renowned universities or institutes published in specialist journals with high impact factors (appendix) are always of importance. Here, in particular, the large, international intervention and observation studies with periods of many years and tens of thousands of volunteers should be mentioned (Table 3.1). Even their results cannot have the force of natural laws, but they improve our knowledge of the many details of the physiological relationships between nutrition, exercise and health steadily and reliably. They are the basis for the following chapters.

Table 3.1 Examples of important prospective long-term studies

	Running since	Number of subjects
Black Women's Health Study	1995	**59,000**
California Teachers Study	1995	133,**500**
Cancer Prevention Study I	1960 (bis 1972)	1 Million
Cancer Prevention Study II	1982	1.2 Millionen
Cancer Prevention Study III	2010	304,000
EPIC study	1992	**520,000**
Framingham Heart Study	1948	4000
Health Professionals Follow-up Study	1986	51,500
Interheart Study	1997	30,000
NIH-AARP Diet and Health Study	1995	**566,000**
Nurses Health Study I	1976	122,000
Nurses Health Study II	1989	116,500
Nurses Health Study III	2010	100,000
Procam Studie	1978	50,000
Whitehall-II Study	1985	10,300
Women's Health Initiative	1991	**120,000**

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High-quality scientific work includes, among others, the Framingham Heart Study. When on April 12, 1945 Franklin D. Roosevelt unexpectedly suffered a stroke, this was the trigger for the world's longest-running, current cardiovascular study, for which the town of Framingham with its then 28,000 inhabitants near Boston was selected. Its residents are seen as a perfect cross-section of the American population. This study is now in its 3rd generation with usually only about 4000 subjects.

4 The Human Organism—A Huge Chemical Factory

The today's civilization diseases often have their origin already in the changed life world of the young people. Loss of the street childhood by the increased car traffic, disappearance of other free spaces of movement and the enormous attraction of the electronic media are important causes for this. Nutrient deficiencies by misjudging the importance of an optimized mixed diet and the pronounced preference for fast food further deteriorate the health status of the people (Fig. 4.1).

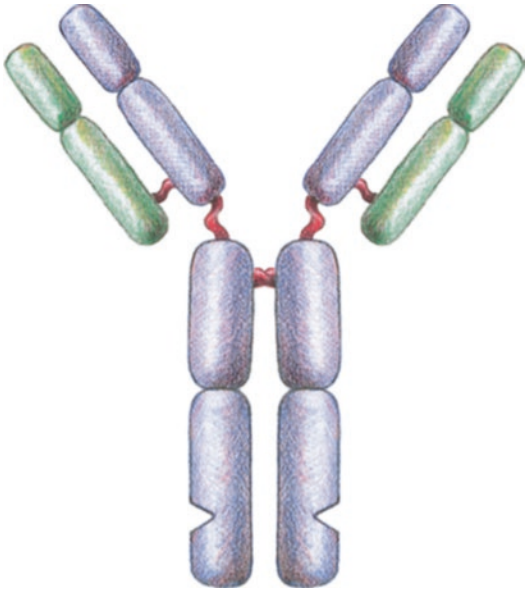

Fig. 4.1 Schematic representation of an antibody molecule

Our organism is a huge complex and complicated chemical factory which has to be cleverly conducted. It consists of about 10^{27} atoms. Only 99.4% of them are distributed on the 4 most frequent body building blocks water, protein, fat and carbohydrates. In detail these are 63% hydrogen atoms, 25.5% oxygen atoms, 9.5% carbon atoms and 1.4% nitrogen atoms. The mean atomic weight of them is 7.0 in this example. With a person weighing 75 kg these 4 building blocks already contribute with 95.4% to the weight. The other elements for our body composition make up only 0.6% of the total number of atoms. These are calcium, phosphorus, potassium, sulphur, sodium, chlorine, magnesium and then also in traces bromine, chromium, cobalt, iron, fluorine, iodine, copper, manganese, molybdenum, nickel, selenium, silicon, zinc and tin.

The **genome** acts as the supreme regulator for all functions. With 3.2 billion letters (base pairs), it is very large and controls the approximately 30 billion cells of adults (Sender et al. 2016). Several million cells are formed per second to replace old or destroyed cells. Skin cells renew themselves within a few weeks, muscle cells can perform their functions for up to 15 years, and bone cells often become 30 years old. The currently known human genome catalog contains approximately 19,500 protein-coding genes (Abascal et al. 2018). Almost 1500 of them influence our aging process, but they only account for about 25% of

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our life expectancy. Environmental conditions and lifestyle are much more decisive for a healthy old age.

Proteins are the function carriers in body cells. Their distribution is analogous to the genome and is referred to as the **proteome**. So far, 90% of our proteome has been deciphered (Kim et al. 2014; Wilhelm et al. 2014; Wiemann et al. 2016). These proteins include, among others, numerous structural proteins with long half-lives, the many hormones and enzymes, or the numerous messenger substances of the immune system. An example of this are the plasma cells, which, upon detection of an antigen, form 2000 specific antibodies per second for 7 to 10 days. Thousands of similar complex reactions are taking place constantly, for which the right replacement materials must be supplied in the right amount with the food.

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Our Food—The Energy Carriers

5

The desirable, daily intake of energy carriers is respectively for

- Complex carbohydrates (= 4.1 kcal/g): about 55–60% (Chap. 41)
- Fats (= 9.3 kcal/g): about 30%
  - 1/3 saturated fatty acids,
  - 1/3 simple unsaturated fatty acids, e.g. oleic acid,
  - 1/3 polyunsaturated fatty acids (Chap. 15),
- Proteins (= 4.1 kcal/g): about 10%

Children, adolescents, older people and adults recovering from serious illness need about 15% protein (Chap. 86).

The ratio of amino acids in the proteins taken up should correspond as far as possible to the composition of the body's own proteins, i.e. the biological value of the proteins should be high. This applies to most animal proteins, especially milk, eggs, fish and meat. However, some plant proteins contain individual amino acids only in relatively small amounts.

Biological value of some proteins (in percent):

- Whole egg (reference value) 100
- Fish 90
- Milk 88
- Soybeans 85
- Rice 83
- Beef 80
- Rye flour 79
- Potatoes 76
- Beans 72
- Corn 72
- Oats 60
- Wheat flour 57

Essential, non-synthesizable amino acids are: isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. Arginine and histidine are considered semi-essential amino acids. They may not be produced in sufficient quantities during growth or during severe illness.

The primary goal of every food intake is first and foremost the energy supply of cells and tissues, whereby fats, carbohydrates and proteins can replace each other to a large extent. An excess of energy from food is stored in the body fat. Only 3% of the calories consumed are necessary for this storage process with fat. Carbohydrates, on the other hand, have to be converted into fat first, which uses up at least 25% of the calories supplied. So the storage of energy in the form of carbohydrates is limited to about 70–100 g in the liver and 300–400 g in the muscles. For well-trained athletes, this can also be 400–600 g due to the larger muscle mass. Proteins are indeed important building blocks for all organs, bones and muscles, but

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as energy suppliers they are rather insignificant under normal conditions. Only in times of food shortages do they play a role in this respect, because some amino acids can be converted into glucose.

According to the basic laws of physics, all 3 calorie suppliers, consumed in excess, are responsible for the growth of the population. However, because fat has more than twice the energy content of carbohydrates or proteins, limiting the intake of fat is particularly effective for maintaining or achieving the desired weight.

The internationally valid energy unit "kilojoule" has not been established in the medical field to date. Therefore, the energy values are mostly given in kilocalories (1 kcal = 4.1868 kJ, 1 kJ = 0.239 kcal, 1 kJ = 1000 W seconds) in the text.

Energy Production

6

In the mitochondria of cells, energy production begins with a cyclic process, the **citric acid cycle**, for which the building block pyruvate from the breakdown of carbohydrates is necessary. If pyruvate becomes scarce because, for example, the limited carbohydrate stores are depleted by strenuous physical activity, fats (and proteins) can only be metabolized to a very limited extent (Chap. 7).

The combustion of fats takes place in the flame of carbohydrates.

In the citric acid cycle, 10% of the adenosine triphosphate molecules (ATP) necessary for the work processes in the cells are already won, the other 90% are then formed by oxidative phosphorylation in the citric acid cycle closely coupled with the respiratory chain. The efficiency with which the chemical energy of the nutrients can be converted into workable ATP in these processes is only about 40%. The larger share of this energy flows into heat generation (Chaps. 9 and 80) (Fig. 6.1).

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