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## Principles of Nutrition in Sports Training and Health Training

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## Principles of Nutrition in Sports Training and Health Training

### Abstract

Proper nutrition is a decisive factor of growth and development of a young organism. It has also a major impact on athletic performance. The aim of this paper is to discuss the basic principles of nutrition in sports training and health training.

The size, composition and times of meals may have a huge impact on sports performance. Good dietary practices allow athletes to train hard, regenerate quickly, adapt better, while reducing the risk of illness and injury.

Athletes should use appropriate nutritional strategies before and after their performances, so as to achieve the best results. They should pay special attention to the amounts of carbohydrates, proteins, fats, vitamins, minerals in their food:, as well as the amount of consumed fluids.

**Keywords:** training, sports, nutrition.

### Sports training and health training

Sports training is a long-term, specially organized pedagogical process, in which athletes learn the techniques and tactics of their discipline and perfect them, developing physical fitness, as well as volitional qualities and personality, and acquire knowledge of their discipline. The aim of a training is to optimize body functions and develop specific adaptation to physical effort in order to obtain maximum results and achievements in a sports discipline [25].

Adaptation is the ability to adapt to various environmental conditions. One can mention genotypic adaptation (appearance of anatomical and physiological changes in the gene pool, which are handed down from generation to generation) or phenotypic adaptation (physiological responses to direct environmental stimuli) [21], [25].

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Health training is a conscious and systematical physical activity taken up to maintain health and prevent many diseases. What distinguishes health trainings from spontaneous (and often irrational) physical activity, is respect for fundamental principles which determine efficacy and safety of trainings [15].

Proper nutrition plays an important role in both sports training and health training [15], [16], [25].

The aim of this paper is to present and assess principles of nutrition in sports training and health training.

## **Principles of good nutrition**

Rational nutrition (diet) – is food intake in line with nutritional recommendations, which takes into account genetic, social and cultural predispositions. Rational nutrition, which can be also labeled ‘optimum’, ‘proper’ or ‘healthy’ diet, meets biological, psychological and social needs; allows to achieve full, genetically programmed physical and mental development; maintain body's resistance to diseases and fitness until old age [26].

It should be highlighted that proper nutrition is a decisive factor of growth and development of a young organism. It also greatly impacts athletic performance. Young athletes deprived of adequate energy substances or proper hydration may experience reduced strength, speed, endurance, concentration, and increased fatigue. Risk of injury also increases. Nutrition is not given as much importance as is given to sports results. Proper nutrition of athletes helps them practice their sports discipline. To achieve this, young athletes should know what to eat, why to eat it, when and in what quantity [2], [4], [6], [19].

Based on the position (confirmed by numerous scientific studies) [1], [3], [17], [22] of the International Olympic Committee, the American Dietetic Association, Dietitians of Canada and the American College of Sports Medicine – the Polish Society of Sports Medicine presents sports doctors, trainers, nutritionists and athletes with recommended dietary rules.

Suitable composition and times of meals before, during and after workout in a form of an individual nutritional strategy ensures optimum storage of energy resources in the body, its hydration and consequently less challenging workout sessions, quicker recovery time after strenuous workout or competition, and reduced risk of illness or injury. Athlete's diet consists of varied and properly composed meals, containing the right amount of essential nutrients (carbohydrates, proteins and fats), vitamins and micro elements contained in natural foods. The calorific value of these meals must be adapted to the sport discipline and should cover the daily requirement of an athlete, taking into account their twenty-four hour energy expenditure [2], [9], [23].

People who practice sports should obtain 60% of energy (calories) from carbohydrates, 25% from fats and 15% from protein. The total energy requirement depends on age, sex, weight and physical activity. The main rule in every type of nutrition is energy balance. There are sports which require very high energy expenditure (e.g. long-distance cross-country skiing), which exceed 7,000 kcal. The volume of food with such energy value would be an excessive burden on an athlete's body. It could contribute to respiratory problems, reducing the overall efficiency of the body. Therefore, appropriate supplements and nutritional formulations are recommended [23].

### Demand for main nutrients in athlete's diet

Carbohydrates are the primary source of energy for athletes. The RDA or carbohydrates depend on the training time, type of workout, body weight, and individual characteristics of an athlete. The share of carbohydrates in the diet should be four times larger than proteins. The main carbohydrate in athlete's diet should be starch (e.g. potatoes, rice, pasta, etc.), which increases glycogen synthesis more effectively than simple sugars. The share of sucrose and glucose in the carbohydrate intake should not exceed 15%. Greater consumption of sucrose may lead to obesity, insulin-dependent diabetes and dental caries [5], [6].

A better and more accurate determinant of demand is the amount of carbohydrates given in grams per 1 kg of body weight. The recommended amount of carbohydrates depends not only on sports discipline, but also on the frequency of workouts. This relationship is shown in the table 1.

**Table 1.** Recommended amount of carbohydrates, depending on the frequency of sports workout

No.	Level of activity	Amount of carbohydrate in g per kg of body weight
1	3–5 hours per week	4–5
2	5–7 hours per week	5–6
3	1–2 hours a day	6–7
3	2–4 hours a day	7–8
5	> 4 hours a day	8–9

Source: [6].

Speaking of carbohydrates, one should mention the glycemic index (GI), which ranks foods according to how quickly after ingestion the blood levels of sugar – glucose – increases. Foods containing carbohydrates vary greatly in terms of absorption and its rate. Diet should include slowly digested complex carbohydrates with a low glycemic index (eg. whole grain bread), while before competition it should be replaced by products with a high glycemic index [4], [19].

Fats (similarly to carbohydrates) are the main source of energy and provide the body with essential unsaturated fatty acids (EFAs). They also serve as carriers of fat-soluble vitamins (A, D, E, K). Fats are an essential part of each individual's diet, but athletes should pay particular attention to the quantity and quality of consumed fats. Improper consumption of fats may lead to health problems, decreased effectiveness of training and increased level of body fat, which consequently results in diseases of internal organs, such as atherosclerosis [6], [19].

Ideally, fats should cover approximately 15% of daily energy needs. The minimum amount for an adult with a moderate lifestyle is 10%. Unfortunately, a large part of population consumes a lot more fats than necessary, which leads to health consequences. Physically active individuals should consume fat from: virgin olive oil, flaxseed oil, pumpkin seed oil, hazelnut oil, sesame oil and poppy seeds oil. Cold-pressed, unrefined oils are recommended; fish oils are also popular [6].

Proteins – regular, intense physical activity increases muscle mass, which requires elevated protein consumption. Protein is the last energy substrate (after carbohydrates and fats), which may be used to fuel working muscles. Protein is needed for the renewal of tissues, protein of which gets degraded during workout. Nutrition of athletes and individuals who want to improve their sports results and body shape requires adequate protein intake [12], [13], [14].

Depending on the source of publication, a recommended dosage for maintaining good health is 0.8–1.0 g/kg, while for competitive sports athletes it is 1.1–2.2 g of protein per kilogram of body weight per day. It is believed that individuals with average physical activity should consume 1.1–1.5 g protein/kg of body weight per day [10], [12], [20], [23].

**Table 2.** Recommended protein intake depending on sports discipline

No.	Type of workout	Amount of protein in g/kg
1	Average training	Approx. 1.1–1.5
2	Endurance sports	Approx. 1.1–1.8
3	Strength sports	Approx. 1.1–1.8
4	Athletes who limit calorie intake	Approx. 1.8–2.0
5	Maximum amount of protein which body can use	2–2.2

Source: [6].

Detailed recommendations for nutrients and calorific value, depending on the sports discipline are presented in table 3 [6], [24].

Supplementation with vitamins should go hand in hand with the use of minerals and enzymes, as these three groups of components work in close cooperation. Deficiencies in certain minerals and enzymes hinder absorption of vitamins, and vice versa. Carefully selected enzymes improve digestion. These for-

mulations increase absorption and use of macro and micro elements. Athletes should consume larger amounts of potassium, sodium, magnesium, calcium, iron, zinc, copper, chromium and selenium. Increased physical workout also increases demand for B vitamins, as well as antioxidant vitamins, i.e. C, E and beta-carotene. It results from the need to neutralize excessive amounts of free radicals and lipid peroxides [27].

**Table 3.** Recommendations for nutrients and calorific value, depending on the sports discipline

No.	Discipline	Proteins (g)	Fats (g)	Carbohydrates (g)	Energy value of the diet (kcal)
1	Boxing, judo, wrestling	2.4–2.5	2.3–2.3	9.0–10.0	65.0–71.0
2	Sprints and long jumps	2.4–2.5	2.3–2.3	9.5–10.0	65.6–70.7
3	Hour-run and marathon	2.4–2.5	2.1–2.3	11.0–13.0	73.0–83.0
4	Skiing: downhill and slalom	2.1–2.2	2.0–2.1	9.6–10.6	65.0–70.0
5	Swimming	2.2–2.4	2.2–2.4	8.8–9.6	63.0–69.6
6	Rowing and canoeing	2.2–2.4	2.1–2.2	10.0–11.2	67.7–74.2
7	Basketball and volleyball	2.2–2.4	2.1–2.3	9.0–10.0	63.7–70.3
8	Football and handball	2.3–2.4	2.2–2.3	9.0–10.0	65.0–70.3
9	Tennis	2.2–2.4	2.1–2.3	9.0–10.0	63.7–70.3
10	Horse-riding	2.1–2.3	2.1–2.3	8.4–9.2	60.9–66.0

Source: [6].

## Athlete's nutrition in endurance training

The main element of endurance training is long-term workout of uniform intensity. Endurance – i.e. the ability to withstand such effort – depends on the accumulated energy reserves in the form of glycogen and free fatty acids, which serve as main sources of energy. To achieve success in endurance disciplines, a high carbohydrate diet is required [5].

Energy needs of endurance athletes include: body weight, energy expenditure during workout, frequency of competitions, and non-sport activity.

In some endurance disciplines, energy demand may reach even 10,000 kcal per day. Such demand may result in problems with consumption of the amount of food necessary to cover it.

The recommended regimen of caloric intake by nutrients:

- Carbohydrates: 6–8 grams / kg of body weight / day
- Protein: 1.2–1.8 grams / kg of body weight / day
- Fats: 1 gram / kg of body weight / day [19].

When planning the menu, one should consider the appropriate amount of servings of complex and simple carbohydrates, and adequate supply of proteins

and fats in main meals. Ideally, meals should be eaten at short intervals, e.g. every 2 hours. Special attention must be paid to the replenishment of carbohydrates during workout and immediately after its completion [4], [7].

In endurance sports, energy that enables long-term effort is of key importance. The basis of the pyramid of a well-balanced diet for endurance athletes are carbohydrates (6 to 10 servings a day); they should come from rice, grains, pasta, whole-grain bread, cereals, fruits and natural juices. They are a source of carbohydrates, B vitamins, fiber and other necessary components, and do not contain a lot of fat. Daily delivery of carbohydrates with a low glycemic index makes it possible to maintain glycogen reserves at the right level [16], [19].

Athlete's diet should also include at least 5 servings of vegetables and/or fruit a day; the more of these portions, the better. These products are a source of vitamins A and C, fiber, antioxidants and other phytochemicals. Vegetables and fruits serve for natural multivitamin dragees. Consuming carbohydrates (e.g. bananas) and drinking carbohydrate drinks during workout delays depletion of glycogen in muscles and prevents hypoglycemia, thus extending workout length [8], [18].

Proteins also play an extremely important role in the diet of endurance athletes. They enable regeneration of proteins in muscles and other tissues; they also help generate oxygen-carrying hemoglobin; they are the building blocks for antibodies which strengthen the immune system to fight infections; and they are necessary for the synthesis of hormones and enzymes responsible for all processes in our bodies. They should constitute 20% of the daily energy intake [23].

Products which are the main source of protein provide many other important components. Lean meat, leguminous vegetables and eggs are also a source of zinc, iron, and calcium, which are necessary for bones, muscles and nerves. A daily menu should include 2–3 servings of meat or fish and at least 2 servings of dairy products. Protein intake should be increased during periods of intense workout [2], [4].

Fats are a source of energy and fat-soluble vitamins, such as A, D, E and K. They contain fatty acids which are very important to the nervous system, skin and hair. Adequate intake of fatty acid stimulates synthesis of enzymes in the muscles, which are necessary to metabolize fat during workout. They should constitute at least 20% of the daily energy intake. This value should increase with the intensity of workouts.

The length of effort is inversely proportional to its intensity, hence long-term workout needs fats as the major energy source [8].

## **Strength training and strength/speed training**

A typical diet used in strength sports, where maximum muscle growth and maintaining low fat is priority, tends to include substantially increased protein

intake. According to US standards, protein needs of an adult with sedentary lifestyle is about 0.8 g/kg of body weight. Strength sports athletes believe that a significant increase in protein intake (up to 2.8 g/kg) results in higher increase in muscle mass, compared with lower intake (about 1.4 g/kg), which has been shown in some studies. These results have not been confirmed, therefore the recommend daily intake is 1.2–1.7 g/kg of body weight [6].

Diet in strength/speed sports, such as martial arts and team sports, should have protein content increased only by about 15%, compared to the basic standards. Amino acids are not stored, and excessive consumption would cause an unnecessary strain on the system (liver, kidneys). Good sources of protein are foods rich in animal protein: meat, fish, dairy products and protein supplements. Apart from protein, other necessary nutrients play a significant role. The diet should be well-balanced and contain all the necessary ingredients in sufficient quantities, including vitamins and minerals (macro- and microelements). These components play a role of building blocks and biocatalysts of metabolic reactions in the body [19].

Energy needs of athletes are significantly increased. The more intense workout, the greater the demand. Carbohydrates and fats are the primary source of energy. Consuming carbohydrates increases muscle glycogen reserves, which enables long-term workout. Insufficient intake of carbohydrates leads to a decrease in glycogen reserves in muscles, reduction of glucose concentration in the blood, and exhaustion. It is important to consume carbohydrates before workout, but also after it – to replenish muscle glycogen. An essential component of the diet are fats containing unsaturated fatty acids. Good sources of these acids are sea fish, which are also a source of phosphorus and glutamic acid and take part in the renewal process [21]. During increased physical activity one should also consume larger quantities of minerals: macro elements (sodium, potassium, magnesium, calcium) and micro elements (zinc, copper, iron, chromium, calcium and selenium). During workout, the need for B vitamins and antioxidant vitamins (vitamins C and E) increases [23].

As for supplements, strength/speed sports athletes may use branched-chain amino acids (BCAA: e.g. 2–3 g taken on an empty stomach 45 minutes before training and 2–3 g after training) and creatine (e.g. 3–4 grams immediately after training and 1 g with each meal). Caffeine, taurine and carbohydrate supplements are not advisable [27].

## **The importance of proper hydration during workout**

Human body is composed mainly of water. On average, water represents 70% of male and 60% of female body. These differences result from a larger share of body fat in women. Water content in the body decreases with age.

Without food, a person is able to survive up to 50 days, with no water – only a few. Water is essential to sustain life; therefore maintaining proper hydration level is an important factor for the proper functioning of the body: both physical and mental. Hydration consists in 25% of intracellular fluids and in 75% of extracellular fluids. The minimum daily demand for water is determined at 1 ml per 1 kcal of food. However, the amount of consumed water depends on several individual factors, such as age, temperature of the environment, humidity, type and frequency of workout [19].

It should be borne in mind that every day we lose water from the body, and not only with the urine (approx. 1,500 ml), but also through the skin and with breath – up to 700 ml per day, with faeces – approx. 100ml, and further 200ml with sweating (under normal conditions). Higher temperature and more exercise increase these figures and the demand for fluids. It is recommended to drink enough to ensure compensation for the loss of water. Metabolic processes of the body produce about 250 ml of water, while solid foods contain approx. 55% of water. The remaining amount should be supplemented by drinking. Demand for fluids amongst athletes and individuals who train regularly is set at 1.5–2 ml per 1kcal of food. The rate of loss of water from the athlete body depends on: sex, body weight, height, age, fitness level, duration and intensity of workout, climatic conditions (temperature and humidity), and even emotional state. Extracellular fluids are always lost first. As mentioned earlier, athletes lose most of water by perspiration [9].

## **Loss of water versus decreased performance**

With one liter of sweat, the body loses 600 kcal of heat energy. In order to prevent excessive sweating during workouts or competitions, it is recommended to, if possible, provide the body with fluids, add salt to dishes, replenish water losses along with other food components (i.e. combining fluid intake with solid food). Excessive loss of water during workout reduces physical performance, and thus – the effectiveness of training. Research indicates that loss of water equal to 5% of the body weight reduces athlete's performance even up to 30%. Loss of water equal to 8–10% of body weight threatens physiological functions of the body, reduces physical and mental fitness, and is even life-threatening [2]

## **Hydration versus workout**

The American College of Medicine recommends taking 400–600ml of fluid 2 hours before competition, and 150–350ml every 15–20 minutes during workout. Temperature of fluids should be between 15–22°C. Drinks that are too

cold may lead to respiratory infections. After workout, one should consume 150% of fluids lost during training. It is recommended to drink 450–675 ml of fluids for every half a kilogram of body weight lost during workout or competition [22].

## Conclusions

Proper diet is a very important part of a healthy lifestyle. Dietary guidelines help maintain health and fitness of individuals practicing sports. Proper nutrition helps improve effectiveness of workout and the level of intensity [2].

In trainings for every sports discipline, there are periods of working on endurance, speed and strength. Hence, different sports receive different nutrition guidelines:

- 1) endurance trainings should be accompanied by more carbohydrates (especially complex); after a long workout, one should choose diet designed to rebuild the consumed glycogen reserves;
- 2) an athlete should consume a meal 2 hours before competition; it should be easy to digest, low in volume, with 60–70% of energy coming from carbohydrates;
- 3) after physical workout, a meal should be easily digestible and contain easily absorbable products;
- 4) speed trainings require food with high content of digestible phosphorus (e.g. dairy products, lean meat, sea fish, etc.) and should be enriched with nutritious proteins and minerals;
- 5) strength trainings require proper supply of balanced proteins [6].

Athlete's diet should take into account individual habits and preferences. Unexpected dietary changes may reduce sports performance. Meals should be eaten at fixed times (preferably 5–6 times per day), they should be small in volume and contain easily digestible and high-energy products [6], [19].

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## Zasady żywienia w treningu sportowym i zdrowotnym

### Streszczenie

Prawidłowe odżywianie jest decydującym czynnikiem wpływającym na wzrastanie oraz rozwój młodego organizmu, wywiera także zasadniczy wpływ na osiągnięte wyniki sportowe. Celem niniejszej pracy jest omówienie podstawowych zasad żywieniowych w treningu sportowym i zdrowotnym.

Wielkość, skład i godziny przyjmowania posiłków mogą mieć ogromny wpływ na wyniki w sporcie. Dobre praktyki żywieniowe pozwalają zawodnikom ciężko trenować, szybko regenerować siły i lepiej adaptować się przy zmniejszonym ryzyku choroby i kontuzji.

Sportowcy powinni stosować odpowiednie strategie żywieniowe przed i po występach, tak aby osiągać jak najlepsze wyniki. Zawodnicy powinni szczególnie zwrócić uwagę na ilość spożywanych w posiłkach: węglowodanów, białek, tłuszczu, witamin i składników mineralnych oraz ilość wypijanych płynów.

**Słowa kluczowe:** trening, sport, odżywianie.