International Journal of Sports, Health and Physical Education
Online ISSN: 2664-7567; Print ISSN: 2664-7559
Received: 06-04-2019; Accepted: 06-05-2019; Published: 14-06-2019
www.physicaleducationjournal.in
Volume 1; Issue 2; 2019; Page No. 17-24

The rules for proper nutrition in sports

Roberto Verna[1], Daniela Maria Capuano[2]
[1] Fondazione In Unam Sapientiam, University of Rome, Viale Regina Elena, Roma, Italy
[2] World Association of Societies of Pathology and Laboratory Medicine, IL, United States

DOI: https://doi.org/10.33545/26647559.2019.v1.i2a.11

Abstract
The present review aims to make a comprehensive view on the nutritional needs and habits of athletes in different sports.
With this review we would like to take into consideration and comment on the various trends in sports nutrition, making a summary of the various situations that arise for those who do sports, even competitive. First the basic principles for proper nutrition will be listed, then some aspects of pre-race nutrition and which foods to prefer for the speedy recovery of energy. The need for some athletes to maintain their weight, both for better performance and for the needs of the type of sport practiced, when athletes are divided into categories based on weight, will also be taken into consideration Finally, the metabolic pathways important for athletic performance will be examined in detail, evaluating the properties and validity of the individual nutrients and some supplements, for their best efficiency.

Keywords: proper nutrition, Sports, various, individual

Introduction
Many people ask themselves the question: to do sports, what should I eat? The answer is not simple, but it must take into account a large list of factors. In order to define the correct nutrition of those who want to engage in a sports activity, first of all one must know their physical characteristics, the type of sports activity they intend to carry out and whether they have already practiced this or other sports activities: in a nutshell their metabolic status and training.
Even more so, for those who play a sport at a competitive level (both amateur and professional), a preventive visit is essential to define the correct dietary pattern to follow before and after sporting activity and also in the interval periods.
It is, however, possible to give some general indications, valid for knowing how to follow proper nutrition in many situations, provided that there are no pathologies requiring special conditions.

The Principles
All the energy we need, both for living and for exercise, comes from the food we eat and the liquids we drink. The foods we consume consist of simple nutrients: carbohydrates, fats, proteins, which are made available to the body through the digestion process.
Each category is important for health and we must consume foods so that all three categories are represented. The relationship in which we must consume these categories of nutrients must not be casual and must be defined according to the activity that takes place, in particular for sports. The use of carbohydrates or fats by the body as the main source of energy depends on the intensity and duration of the exercise. The main energy source of athletes are carbohydrates; regardless of the type of sport that takes place, they provide the energy that feeds the muscles in contraction. Fats also provide energy for exercise, indeed, they provide the highest concentration of energy of all nutrients and represent the main source of energy for endurance sports, but are less accessible for quick and intense exercise [1].
Athletes need proteins mainly to rebuild and repair muscle losses that occur during exercise and to optimize the storage of carbohydrates in the form of glycogen; however, it is necessary to check what amount of protein the athlete actually needs for power and duration exercises, because carbohydrates also serve this purpose. Furthermore, high protein diets have not proven particularly useful for athletes. But do power sports athletes really need special diets to build muscle and, if so, how to increase it? Power sports athletes need only a moderately greater amount of protein than other athletes, mainly to repair and rebuild their muscles, but the increased need is often overestimated. Carbohydrates are certainly the main source of energy for athletes, even for those who need strength and power, because they provide the energy that feeds muscle contraction.
Not only food, but also drinks are important in sport. The longer and more intense the exercise, the greater the need to drink the right type of liquids [2].
Many athletes have a habit of exceeding their protein intake because they think they are building more muscle mass. This is true up to a certain point, but it is certain that high protein diets cause dehydration even in the most trained athletes as in the case of endurance sports, whose specific training allowed a greater ability to adapt to dehydration compared to normal people.

It is also important to know how to eat for the competition, that is, what to eat before and after the competition, to facilitate recovery. In fact, while the pre-competition meal must ensure adequate availability of energy available for optimal performance, the post-exercise meal is essential for recovery and to allow training to continue for the next competitions.

Pre-competition nutrition

Nutritional care is essential for the athlete, in particular the so-called "competition regimen", which starts the evening before the athletic effort closing at the end of the same.

Obviously, in relation to the type of sport practiced, specific needs and requirements arise, so a marathon runner will certainly feed in a different way from a jumper.

A rational diet must in any case avoid the loss of shape and minimize the fatigue reactions that follow the effort [3].

During the competition, the athlete will use the calories accumulated with the balanced diet of the previous days; therefore, the pre-competition diet aims to maintain the energy level obtained previously.

The sportsman must have a sufficient supply of glycogen in the muscles and liver, especially if he is preparing to participate in a competition relating to a sport of endurance. In this sense, the most suitable foods for the eve will be those rich in starches (rice, bread, pasta, potatoes); particular attention must be paid to hydrating the body.

The last meal before the competition must consist of easily digestible foods, must have a modest volume and must be consumed at least 3-4 hours before.

If the competition is in the morning, it will be necessary to have breakfast at least 2 hours before and the diet of the previous evening will have particular importance.

If the race is in the afternoon, breakfast must be particularly abundant and light lunch must be eaten at least 3 hours in advance.

If the competition is in the evening, lunch will be of particular importance, while awaiting food ration may be scheduled before the competition.

Waiting rations have specific relevance in long-lasting sports and in cases where the starting time is not well defined or may be susceptible to delay (tennis matches to follow) or in interval competitions.

The waiting ration serves to balance, avoid and compensate for sudden changes in blood sugar and to hydrate the body. In fact, especially in emotional athletes, anxiety about waiting is able to lower blood sugar more than muscle work itself; in addition, delays of more than half an hour, especially with high temperatures, can change blood sugar and hydration.

The most used waiting ration consists in drinking in the interval between the last meal and the start of the competition, every hour, a glass of water with concentrated fruit juice, without adding sugar, or water and fructose; the last must be taken at least half an hour before.

Interval refueling: typical of team sports (e.g. soccer). We must try to replenish the body with the substances consumed during the first part of the race, taking into account that for assimilation we only have a few minutes [4].

It will therefore be appropriate to introduce liquids and salts, to combat sweat losses and fatigue acidosis, and easily and quickly assimilated sugars, to eventually restore the right blood sugar (fructose or, possibly, maltodextrin).

Just before a competition, it is very important not to ingest sucrose (common sugar), since, by causing a surge in blood sugar, it stimulates the intervention of insulin which leads to a subsequent hypoglycaemia, risking to compromise the race.

Therefore, also avoid all the drinks that contain it: canned drinks, added juices, etc.

Summing up:

- take complex carbohydrates (rusks with jam are fine) up to two hours before physical activity;
- avoid in the thirty minutes preceding the effort to ingest sugars, especially those with a high glycemic index;
- In medium and especially long-term disciplines, take 150-200 cc every 20 minutes. Of liquids with dissolved maltodextrins, at a concentration not exceeding 7-8%.

In muscle fibers, during a demanding or prolonged work, following the reduction of the glycogen content, the small available stocks of two amino acids, alanine and glutamine, are first consumed, then, when these substances are also finished, disassemble the constituent proteins of the muscle, that's why, under strict medical supervision, the intake of branched chain amino acids can be recommended, which can be transformed, through a series of reactions, into glucose, the substance which, before it was exhausted, it derived precisely from glycogen, avoiding the problem of muscle reconstruction after the activity.

Food for prompt recovery

After a race, a match or a hard training, the athlete feels fatigued, has accumulated a significant amount of metabolites that cause an acidic situation. In addition to replenishing, post-intensive nutrition must help detoxification and reconstruction processes. In fact, the body may experience loss of water, salts, accumulation of acid substances, emptying of sugar reserves, tissue usury. Therefore the different intake of liquids, minerals, vitamins, sugars, proteins, fats will serve to bring the body back to normal conditions. Each intense effort is followed by a state of acidosis, therefore it will be useful, immediately after this effort, to take an alkaline drink, enriched with salts to remineralize the body and glucose to help the mechanism of glycogen synthesis. Subsequently, to start filling the glycogen deposits, 200-250 grams of maltodextrin will be ingested in plenty of liquid. The meal will be consumed at least two hours after the effort, since before the body is still too fatigued for digestion, and must be alkalinized, to overcome acidosis and more easily eliminate accumulated toxins [5].

List of alkalizing foods (in descending order of alkalizing power)

figs, dried apricots, spinach, dates, beets, carrots, celery, lettuce, pineapple juice, potatoes, apricots, whole pineapple, strawberries, tomato juice, cherries, bananas, oranges, tomatoes, cauliflower, peaches, grapefruit, lemon juice, Mushrooms, apple, pear, grapes, milk, onions, fresh peas.

The regulation of body weight in athletes

Compared to the sedentary individual, considering that the athlete has different dietary needs especially in quantitative terms, in the daily energy calculation, in addition to quality, it is necessary to consider the additional caloric expenditure that sports activity requires.

During the day (24 hours), the energy needs (calories consumed) of the athlete is calculated taking into account a) the activity normally carried out, such as washing, getting dressed, walking, driving, reading, watching television, afternoon rest and night, etc; b) the type of training carried out, therefore the extent and duration of physical exertion; c) the thermogenesis induced by the food consumed, also called the specific dynamic action of the food, which represents the calorie consumption necessary for the digestion and assimilation of food and corresponds to about 10% of the calories ingested. In particular, proteins require 10-35% of the total, while glycides 5-10% and fats 2-5%. Basal metabolism, which represents the energy expenditure deriving from the development of the body's vital processes (respiration, activity of the cardiovascular system, digestion, excretion, maintenance of body temperature at around 37 °, growth and repair of cellular tissues, must also be considered etc). The basal metabolic rate varies according to age, gender, race, climate, type of activity carried out. The cold enhances the basic calorie consumption as the body sustains an additional effort to keep the body temperature constant; anxiety states can increase it by up to 50%. After the age of 30, the metabolism undergoes a constant decrease that reaches up to 30% with the passing of 70 years. This fact constitutes one of the causes of weight gain for those who, over the years, keep certain eating habits unaltered. During sleep it drops by about 7%. A simple and approximate calculation of the basal metabolism can be made in 24 hours considering that the body, in a state of rest, consumes about 1 calorie per kg of body weight (0.9 for women) every hour. Here are some examples of the calories needed per kg of body weight and for each hour in the various activities: sleeping 0.93; walking fast 4.28; drive the car 1.90; calm dance 4.3; calcium 11.7; gymnastics 5.9; recreational swimming 9.1; competitive swimming 25; single tennis 5.2; double tennis 4.1. As can be seen, there are large differences in energy consumption (caloric) between the various activities, in relation to the efforts made. Of particular interest is the difference between recreational and competitive swimming, which requires more than double the energy [6, 7].

The difficulty encountered by an athlete in decreasing body weight is essentially linked to the parallel loss of physical efficiency, especially in disciplines with strong muscular effort. In fact, in addition to fats, mineral salts and muscle proteins are lost. In theory, to lose 100 grams of subcutaneous fat (made up of 90% fat and 10% water) you need to consume about 800-900 calories. In a nutritional protocol for weight loss, in the first days essentially liquids are lost (the lower carbohydrate intake leads to the elimination of water as there is a cellular ratio of 2.8: 1 of balance between glycids and body water). Subcutaneous fat is then affected, but the defensive mechanism called "savings" is also established, which involves significantly lower calorie consumption (up to 20%) to support the basal metabolic rate, lower calorie consumption for the same work done and greater assimilation of ingested food. A weight loss that maintains the optimal organic and muscular efficiency almost unchanged should not go beyond a consumption of subcutaneous fat exceeding 2-2.5 kg every 15 days. More precisely, 1% of the real weight per week. It is essential that all food ingredients are always present in a balanced way, as fats convey fat-soluble vitamins, glycides buffer the state of ketosis resulting from the consumption of subcutaneous fat, proteins are essential for their plastic action. If symptoms of nervousness, insomnia, easy physical and mental fatigue arise, it means that the nutritional protocol for weight loss is not correctly applied. One of the most common means used to decrease body weight is the endurance run which, in order to be effective, must last longer than 20-30 minutes since only after this limit does the mobilization of fats begin following the initial use of the glycides. A very simple calculation to calculate the calorie expenditure in the race is to consider that a trained athlete spends about 0.9 Calories per kg of body weight per km traveled, regardless of the run pace used. A good nutritional program for weight loss must take into account the calories ingested and those consumed in 24 hours (according to the parameters reported at the beginning) and, of course, also the quality of the foods ingested. An easy way to proceed is to weigh the athlete daily and check the weight fluctuations within about 10-15 days, adjusting accordingly. It should also be clear in mind that the nutritional protocols for weight loss involve a substantial consumption of subcutaneous fat, with the circulation of ketone bodies (acids derived from acetoacetic acid) which increase the acidity of the blood (which is added to that provided by training).

A serious mistake that is often made by athletes is in fact to neglect the presence of glycids in the diet. Glycids are the primary energy suppliers and, in the specific case of weight loss, they reduce the tendency of blood towards acidity by limiting the production of ketone bodies.

Finally, it must be remembered that weight loss does not necessarily mean fat loss. In fact, some gimmicks normally used to lose weight, in addition to ineffectiveness, can cause damage to health. Diuretics and the sauna only temporarily lose water and mineral salts such as sodium, potassium and chlorine. This can lead to cellular dysfunction, nervousness, muscle cramps and loss of physical efficiency. Diuretics are also part of the list of substances banned for doping. Massages can only help in recovering from muscle fatigue but do not in the least affect the subcutaneous fat reserves (the only one who consumes calories and can lose weight is the masseur!). The synthetic suits do not evaporate the sweat and therefore only give the impression of greater sweating. If put in contact with the skin they can cause skin irritation and alteration in the transpiration between the skin and the environment (body thermoregulation) [8].

Some athletes may need to gain body weight and in particular muscle mass, especially in disciplines structured in weight categories. This "active" weight increase can be obtained with an appropriate diet combined with training strategies to promote protein synthesis. The nutritional protocol must be based on the ingestion of highly energetic and easily digestible glycids (rice and pasta, potatoes, biscuits, jams, sweetened cooked fruit, etc), proteins (milk and fish or easily digestible meats such as cod, salmon, tuna, veal, chicken, turkey), few fats (preferably raw extra virgin olive oil). The supply of vitamins E, B12 and proteins rich in branched chain amino acids promotes protein synthesis. Appetite can be increased by taking a spoonful of glucose diluted in fruit juice half an hour before meals. A high-protein nutritional protocol must take into account the correct intake of glycides and water, vitamin B1 and potassium necessary to facilitate the disposal of nitrogen waste, since excess protein can even create difficulties in the replacement and reconstitution of new cellular structures. In particular, the products derived from the breakdown of proteins can highlight various problems such as the increase in the load of toxic waste (which are combined with those deriving from physical activity), fatigue of the kidneys and liver, blood acidosis, digestive disorders, excitement nervous and glandular, hypercholesterolaemia.

The metabolic pathways for athletic performance

We have herein briefly described the nutritional needs of sports. However, the time has come to deepen some concepts of pathophysiology in order to better understand the reasons for the choices to be made, in relation to the needs of the metabolism.

Foods are split into simple nutrients (carbohydrates, fats, proteins) through the digestion process and, with subsequent absorption by the intestine, these nutrients are made available to the metabolic pathways.

We have seen how muscle contraction, and therefore sports performance, essentially depend on the intake of carbohydrates. However, they are not used immediately as soon as they are absorbed, to give the body the ability to maintain muscle functions over time: in fact, if they were used immediately, we would have to eat continuously so as not to run out of "fuel". To avoid this situation, the energy produced by the combustion of glucose is stored in a compound called ATP (adenosine triphosphate) which is used for muscle contraction through the release of the phosphate group; previously, to avoid being dependent on a continuous introduction of glucose, it is stored in the form of glycogen which, in turn, is mobilized and broken down into glucose again for the production of ATP as needed. Carbohydrates therefore have two successive levels of storage: one, long-lasting glycogen and the other, short-lived ATP [9, 10].

Energy metabolism

The body does not have an ATP reserve, and what little is deposited is used in seconds; it is therefore necessary to continue generating ATP even during the exercise. In general, the two main ways of converting nutrients into energy (ATP) are: aerobic metabolism (which takes place in the presence of oxygen) and anaerobic metabolism (in the absence of oxygen). These two metabolic pathways can be further divided. Most of the time there is a combination of the energy systems that supply the fuel necessary for operation; it is the intensity and duration of the exercise that determines which system is used and when.

The ATP-CP (Creatine phosphate) pathway

This route, also called the phosphate system, provides about 10 seconds of energy and is used for explosive exercises, such as the sprint of 100 meters. This metabolic pathway does not require oxygen to generate ATP. It first uses the ATP present in the muscle (generally for a period of 2-3 seconds) then uses creatine-phosphate (CP) to re-synthetize ATP until the CP ends (about 6-8 seconds). When both ATP and CP are exhausted, the body shifts to aerobic metabolism or anaerobic metabolism (glycolysis) to continue generating ATP and provide energy for exercise.

Anaerobic metabolism - Glycolysis

The anaerobic metabolic pathway, or glycolysis, generates ATP exclusively from carbohydrates, with the formation of lactic acid. Anaerobic glycolysis generates energy from the partial demolition of glucose, which takes place without the intervention of oxygen. Anaerobic metabolism produces energy for short and intense bursts of activity; this lasts only a few minutes before the lactic acid produced reaches the level known as the lactate threshold, when muscle pain, burning and fatigue make it difficult to maintain its intensity.

Aerobic metabolism

Aerobic metabolism provides most of the energy necessary for long-term activity, using oxygen to convert nutrients into ATP. This system is a little slower than the anaerobic one because the circulatory system must transport oxygen to the muscles before they generate ATP; it is mainly used in lower intensity but long lasting exercises.

During exercise, the athlete moves through all the metabolic pathways described. At the beginning, ATP is produced by the anaerobic route; as the respiratory and heart rate increases, oxygen becomes more available, so that aerobic metabolism can begin and continue until the lactate threshold is reached. If this level is exceeded, the body cannot release oxygen quickly enough to generate ATP and aerobic metabolism comes into play. Since this mechanism is short-lived and the level of lactic acid rises, an intense workload can no longer be sustained and the athlete must decrease the intensity of the exercise to remove the lactic acid produced [11, 15].

The nutrients are converted into ATP based on the intensity and duration of the activity, with carbohydrates providing the main source of energy for both short and long-term exercises and fats for less intense exercise. Fats are an important source of energy for endurance events but are not suitable for high intensity exercises such as jerks or repetitions. If you exercise at low intensity (or in any case below 50% of the maximum cardiac capacity) there are still enough fats deposited to continue the exercise for hours or days.

As the exercise intensity increases, the carbohydrate metabolism stops. It is more efficient than that of fats but has a limited energy reserve. Glycogen is able to provide energy for about two hours of both moderate and high intensity exercise; after that, the depletion of glycogen stores occurs and if that energy source is not replaced, the athletes find themselves "crashing into the wall". An athlete can continue the exercise, both moderate and intense, simply by replenishing the carbohydrate reserves during the exercise; this is the reason why it is of fundamental importance to eat easily digestible carbohydrates during a moderate exercise lasting a few hours. If you do not take an adequate amount of carbohydrates, you will be forced to reduce the intensity of the exercise and return to the fat metabolism to provide energy for the exercise.

With increasing exercise intensity, the efficiency of carbohydrate metabolism dramatically collapses and anaerobic metabolism takes shape; this occurs because the body cannot introduce and distribute oxygen quickly enough to use the metabolism of fats or carbohydrates indifferently. In fact, carbohydrates can produce about 20 times more energy (in the form of ATP) per gram if they are metabolized in the presence of an adequate amount of oxygen, than they produce in an oxygen-free, anaerobic environment, as occurs during efforts intense (shots). With appropriate exercise, these energy systems adapt and become more efficient, allowing greater duration of the exercise at greater intensity.

Are branched aminoacids really useful?

Amino acids are the molecules that make up proteins, essential for muscle structure. The different foods contain proteins, and therefore amino acids, in varying proportions; applying a balanced nutritional protocol ensures that the athlete takes the correct amount of protein and with it all the amino acids he needs. However, we have seen that, compared to the sedentary, the athlete has a need not only increased, but also diversified. In particular, it needs branched chain amino acids. Three amino acids (leucine, isoleucine, valine), which due to their structure are called branched chain, have a particular importance in protein synthesis because they are involved in the process by which energy is obtained from proteins [16, 18].

Making a summary of the results of numerous researches, it can be said that if the activity is not continuous and sufficiently prolonged over time (at least 50 minutes) there is no need for supplementation with branched amino acids to recover the effort. For example, if we examine the physiological needs of running, integration is justified only if it continues for distances greater than 20 km. Considering that 10g of branched amino acids are contained in 250g of chicken meat, it is clearly understood that proper nutrition provides enough for all those "runners" who eat properly (with a sufficient intake of protein) and are not marathon runners. It should also be emphasized that, if they can be important in the recovery phase, amino acids (branched or not) have no particular use in improving performance. Unfortunately, many athletes abuse branched chain amino acids, believing that they can be useful to them, and in the Belief that "they don't hurt". In reality this is not the case since high doses can significantly increase the blood urea nitrogen resulting in renal overload. The practice of using amino acids and protein supplementation to push the body's anabolic abilities to the maximum derives from the practices of body builders who are convinced that, since muscle has a high protein concentration, more proteins introduce more muscles we will have. We have already touched on this topic, but some concepts are worth investigating. This belief is limited by three factors:

a. Anabolism (i.e. the construction of muscle tissue) is created following a stimulus, be it a maximum effort or the presence of substances that favor it and that use the proteins taken (testosterone, insulin, growth hormone). Leaving aside this second possibility, because the intake of hormones is harmful to health and prohibited by doping; the anabolic stimulus determined by the maximum effort concerns only athletes who practice power sports and not others, especially because in many sports a body builder enhancement would be completely contraindicated.
b. Even for body builders, protein intake does not allow you to go beyond a certain level of muscle mass, because anabolism has a well-defined limit. The nitrogen balance expresses the difference between that taken in the form of proteins and used for anabolic functions and that eliminated with the demolition of proteins. It is clear that, for growth, the balance must be positive and that is the nitrogen taken in the form of proteins must be incorporated in the tissues, in this case in the muscle tissue, to a greater extent than is eliminated in the urine, the feces and sweat as a result of catabolism reactions - or the demolition of proteins. A negative balance indicates, however, a loss of tissue. Once the maximum is reached, an additional protein supplement is not necessary or even useful, as shown by a research carried out in 1988, in which three groups were examined, sedentary, body builder and cross-country athletes, showing that for the body builders the correct integration to maintain balance had to be 1.2g per kg of weight, while for cross-country athletes 1.6g. These results, which may surprise non-experts, may explain how in many body builders it is not the protein intake to increase the lean mass as the intake of anabolic substances (natural or not) that stimulate an abnormal protein synthesis. The reason why a body builder in normal conditions (without anabolic agents) has a protein requirement lower than a high level runner is explained by remembering that protein catabolism only comes into play when the effort is sufficiently intense. If the athletic gesture is limited in time (the workouts of many body builders do not go beyond the effective half hour of active effort, due to the large recoveries between one exercise and another) it can also be intense, but the amount of catabolized protein remains low and therefore reintegration is not necessary.

c. The intake of amino acids (arginine, lysine, ornithine, glutamine, tyrosine and others) does not increase growth hormone levels, nor aerobic power, nor performance in maximal activities. Nor do testosterone or cortisol concentrations vary. It is true that studies exist that assert that amino acids such as arginine, lysine, glutamine, glycine and ornithine increase growth hormone levels; however, these studies were all carried out not on samples of the normal population or of athletes, but on small groups of hospitalized subjects, that is, on the sick and / or elderly. The positive results were related to the administration of an amino acid and in general the level of HGH increased by a factor of three to ten.

Regardless of the fact that some amino acids are antagonists (such as the pair arginine and lysine), if these results were true, administering 5g of arginine, 2g of lysine, 5g of ornithine, 2g of glutamine and 6g of glycine, the level of HGH should increase over 100 times. Obviously this is not the case and the explanation is that certain clinical results are achieved in conditions of extreme deficiency (for example by operating on sedentary and elderly patients). The organism always maintains control levels: until these levels are reached, integration works, then it is canceled (for example simply by ignoring the message that comes from the substance).

Be careful, therefore, to follow the indications of those who do not have the right skills, because very often they follow indications that are not valid for everyone but only for sick people.

Nutrition for the recovery

Athletes know the importance of nutrition before exercise; but, once physical exercise is over, what you eat and when it is equally important, especially in situations of close races that occur in some sports. While the meal before exercise ensures adequate glycogen deposits to be used for the best performance, nutrition after exercise is essential for recovery and to increase the ability to return to training and therefore to be able to best express one's potential in the following competitions. We already mentioned this need, but now is the time to go into detail. What should we eat after exercise to restore muscle glycogen?

The nutritional priority, after exercise, is the recovery of lost fluids. In general, the best way to evaluate how much to drink (water or other specific drinks) is to weigh yourself before and after exercise and compensate for the loss of liquids by taking about 500ml for every 500gr lost.

It is also important to consume carbohydrates (fruit or juice) within 15 minutes after exercise to help restore glycogen. Scientific research has shown that the introduction of 100-200 grams of carbohydrates within two hours after a resistance exercise is essential for the reconstruction of adequate glycogen stores, which allow the resumption of training. If the two hour period is exceeded, the glycogen that is regenerated in the muscle is reduced by 50%; in fact, the consumption of carbohydrates stimulates the production of insulin, which, in turn, helps the production of muscle glycogen. In any case, it is useless to take higher quantities of carbohydrates, because their effect on the glycogen storage reaches a plateau.

Combining a moderate amount of protein with carbohydrates in the two hours following exercise can double the insulin response, resulting in a greater amount of glycogen deposited. The optimal ratio of carbohydrates to proteins for this effect is 4: 1 (four grams of carbohydrates per gram of protein). It has been proven that athletes who feed on carbohydrates and proteins have 100% more reserve glycogen than those who only eat carbohydrates. Insulin is also higher in those who consume a liquid mixture of carbohydrates and proteins. Be careful, however, because consuming more protein than necessary has a negative impact because it slows down rehydration and glycogen recovery. Consuming the correct amount of protein after exercise also has other functions: it provides the amino acids necessary to rebuild the muscle tissue that is consumed during exercise and the amino acids themselves can stimulate the immune system making it more resistant to colds and infections in general.

The best choice to restore energy reserves after a long resistance exercise is therefore a mixture of carbohydrates: proteins in a 4: 1 ratio. Solid foods work as well as drinks, but a drink can be easier to take and digest by respecting the correct ratio and the two-hour window.

It is not only necessary to take the right amount of calories, but also the right source of them; in fact, calories can derive from the demolition of carbohydrates (4.1 / g), proteins (4.1 / g), lipids (9.0 / g).

Carbohydrates

The correct source of energy to give energy to training are carbohydrates. Deposited in the muscle in the form of glycogen, they constitute the fuel used for short, intense explosions of force. The stronger and longer you work, the more glycogen your muscles need. Once the glycogen stores run out, the energy level drops and there will not be enough fuel for muscle contraction. For this reason, athletes who train to build muscle mass must have an adequate intake of carbohydrates. Experts recommend at least 5-600 grams of carbohydrates per day to keep glycogen stores at the right level. A simple formula indicates the quantity of carbohydrates needed: 6.5gr carbohydrates x weight in kg = grams of carbohydrates per day. For a 70Kg person the quantity is about 500 grams (equivalent to about 2000 calories); for a person of 100Kg, 720 grams of carbohydrates or 2900 calories.

Proteins

Protein is the basic material for building muscle tissue and those who train must take more than those who do not exercise. In any case, many athletes overestimate their protein needs. The recommendations are 1.2 - 1.6 grams per kg of body weight, which means 90-115 grams for an athlete of 70 kg and 128-164 grams for those of 100 kg.

The Fats after reaching the necessary amount of carbohydrates and proteins, there is room for fats. They are an essential nourishment but a minimum quantity is needed to stay healthy. In particular, less than 30% of the daily calories must come from unsaturated fats (those of vegetable origin).

The water In addition to the 8 glasses of water per day necessary for anyone, it is necessary to replace the fluids lost during exercise. To be sure you are hydrated, you should drink 2 glasses of liquid 2 hours before exercising before exercising. During exercise, drink 100-2000ml every 15-20 minutes, depending on the intensity of the exercise. After the exercise, replace the losses, as previously mentioned.

Sports drinks and energy supplements Energy bars and sports drinks can help if the exercise lasts more than an hour. Carbohydrate supplements can be helpful in reaching the right amount of carbohydrates on a busy day if you don't have the time for an adequate meal. Eating a drink that replaces a meal after a muscle-building exercise is convenient but you can do the same with a tuna sandwich, a banana, a piece of tart or other fast-absorbing food. Many supplements believed to be able to build muscle do not. Some, such as creatine, liquid and electrolyte replenishers, carbohydrate supplements and liquid meal replacements can only provide help. Creatine, combined with a good nutritional protocol and a strengthening program, is able to generate more power in exercise and help accelerate muscle growth. There are many creatine-based supplements available, but meat is the best natural source. The typical dose for creatine loading is 5 grams of creatine monohydrate four times a day for 5 days. Thereafter, a maintenance dose of 2 grams per day should be taken. Taking more than the recommended dosage does not benefit; in fact, taking into account that creatine and other available supplements are not always pure, it can also be harmful (19-23.

In conclusion, any kind of physical activity is fundamental for the wellness and is also important for saving money of public health, given that the activity really fits the person. Professional sports should be approached after a deep medical evaluation of the metabolism and of nutrition needs, who could prepare a precise program on how to train and what to eat according to the type of activity to do. It is also fundamental to monitor the activity using laboratory tests able to assess the condition of the sportsman (24, 25).

References

1. Boon H, Jonkers RA, Koopman R, Blaak EE, Saris WH, Wagenmakers AJ, *et al*. Substrate source use in older, trained males after decades of endurance training. Med Sci Sports Exerc. 2007; 39(12):2160-70.
2. Serra-Majem L, Raposo A, Aranceta-Bartrina J, Varela-Moreiras G, Logue C, Laviada H, *et al*. Ibero-American Consensus on Low- and No-Calorie Sweeteners: Safety, Nutritional Aspects and Benefits in Food and Beverages. Nutrients. 2018; 10(7):E818. doi: 10.3390/nu10070818. Review.
3. Burke LM, Castell LM, Casa DJ, Close GL, Costa RJS, Desbrow B, *et al*. International Association of Athletics Federations Consensus Statement 2019: Nutrition for Athletics. Int J Sport Nutr Exerc Metab. 2019; 29(2):73-84. Doi: 10.1123/ijsnem.2019-0065. Epub 2019 Apr 5.
4. Oliveira CC, *et al* Nutrition and Supplementation in Soccer. Sports (Basel), 2017.
5. Evans GH, *et al*. Optimizing the restoration and maintenance of fluid balance after exercise-induced dehydration. J Appl Physiol, 1985.
6. Hector AJ, *et al*. Protein Recommendations for Weight Loss in Elite Athletes: A Focus on Body Composition and Performance. Int J Sport Nutr Exerc Metab, 2018.
7. Reale R, *et al*. The Effect of Water Loading on Acute Weight Loss Following Fluid Restriction in Combat Sports Athletes. Int J Sport Nutr Exerc Metab, 2018.
8. Thomas DT, Erdman KA, Burke LM. Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. J Acad Nutr Diet. 2016; 116(3):501-528. Doi: 10.1016/j.jand.2015.12.006. Erratum in: J Acad Nutr Diet. 2017; 117(1):146. Sport Nutrigenomics: Personalized Nutrition for Athletic Performance. Guest NS *et al*. Front Nutr, 2019.
9. Marosi K, *et al*. Metabolic and molecular framework for the enhancement of endurance by intermittent food deprivation. FASEB J, 2018.
10. Wu G *et al*. Amino acids: metabolism, functions, and nutrition. Amino Acids, 2009.
11. Elliott-Sale KJ, *et al*. Endocrine Effects of Relative Energy Deficiency in Sport. Int J Sport Nutr Exerc Metab, 2018.
12. Logue D, *et al*. Low Energy Availability in Athletes: A Review of Prevalence, Dietary Patterns, Physiological Health, and Sports Performance. Sports Med, 2018.
13. Burke LM, *et al*. Relative Energy Deficiency in Sport in Male Athletes: A Commentary on Its Presentation among Selected Groups of Male Athletes. Int J Sport Nutr Exerc Metab, 2018.
14. Harty PS, *et al*. Multi-ingredient pre-workout supplements, safety implications, and performance outcomes: a brief review. J Int Soc Sports Nutr, 2018.
15. Wickham KA, *et al*. Administration of Caffeine in Alternate Forms. Sports Med, 2018.
16. Shimomura Y, Murakami T, Nakai N, Nagasaki M, Harris RA. Exercise promotes BCAA catabolism: effects of BCAA supplementation on skeletal muscle during exercise. J Nutr. 2004; 134(6 Suppl):1583S-1587S. Doi: 10.1093/jn/134.6.1583S. Review.
17. Mikulski T, Dabrowski J, Hilgier W, Ziemba A, Krzeminski K. Effects of supplementation with branched chain amino acids and ornithine aspartate on plasma ammonia and central fatigue during exercise in healthy men. Folia Neuropathol. 2015; 53(4):377-86.
18. Ra SG, Miyazaki T, Ishikura K, Nagayama H, Komine S, Nakata Y, *et al*. Combined effect of branched-chain amino acids and taurine supplementation on delayed onset muscle soreness and muscle damage in high-intensity eccentric exercise. J Int Soc Sports Nutr. 2013; 10(1):51. Doi: 10.1186/1550-2783-10-51.
19. Vitale K, Getzin A. Nutrition and Supplement Update for the Endurance Athlete: Review and

Recommendations. Nutrients. 2019; 11(6):E1289. doi: 10.3390/nu11061289. Review.

20. Kerksick CM, Wilborn CD, Roberts MD, Smith-Ryan A, Kleiner SM, Jäger R, *et al*. ISSN exercise & sports nutrition review update: research & recommendations. J Int Soc Sports Nutr. 2018; 15(1):38. Doi: 10.1186/s12970-018-0242-y. Review.
21. Burke LM, Mujika I. Nutrition for recovery in aquatic sports. Int J Sport Nutr Exerc Metab. 2014; 24(4):425-36. Doi: 10.1123/ijsnem.2014-0022. Epub 2014 Jun 5. Review.
22. Lee EC, Fragala MS, Kavouras SA, Queen RM, Pryor JL, Casa DJ, *et al*. J Strength Biomarkers in Sports and Exercise: Tracking Health, Performance, and Recovery in Athletes. Cond Res. 2017; 31(10):2920-2937. Doi: 10.1519/JSC.0000000000002122. Review.
23. Stenner E, Giovannella L, Raffaelli G, Delbello G, Ruscio M, Verna R, *et al*. Laboratory Investigation of the 900-km Lapland Extreme Challenge. Ann Lab Med. 2020; 40(1):92-94. Doi: 10.3343/alm.2020.40.1.92.
24. Verna R. How lifestyle can improve health expenses. Journal Nutrition Health and Food Sci. 2018; 5(4):1-6 DOI: 10.15226