SPORTS NUTRITION

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Abstract:

Following an adequate nutrition pattern determines winning the gold medal or failing in the attempt. Nutrition plays an essential role on sports performance. Nutrition plays an essential role on sports performance. That is why it is commonly referred to as "invisible training." However, regarding food and performance, it is not only referred to professional athletes. Nowadays, a large number of amateur athletes perform daily physical activity both recreationally and semiprofessionally. That population also seeks to achieve an improvement in their personal brands, which can be reached following proper nutritional guidelines. In athlete population, nutrient requirements are incremented compared with non-athlete population. Therefore, it is essential to carry out a nutritional approach adapted to the athlete and training sessions. In addition, other advantages of adequate food intake in sports are related to changes in body composition, reduction of injuries, and prolongation of professional career length. The objective of this chapter is to determine the nutritional requirements of athlete population that allow to achieve their sporting goals. Nutritional strategies will be addressed in terms of macronutrients consumption, hydration, and timing depending on type and intensity of exercise.
Keywords: *intake, nutrients, hydration, nutrition, sports performance*

Introduction:

It is necessary to know the physiology of the exercise in order to know the different metabolic pathways that coexist during sports practice. In this way, you can predict the changes that occur in the organism during physical effort, in order to achieve some dietary recommendations. Nutrition is strongly linked to health, especially when sports are concerned, due to the increase in energy and nutrient demands. The nutritional practices of athletes are multifactorial and depend on the habits, culture, or nutritional knowledge of the athlete. So the work of a sports nutritionist is to advise the athlete and his environment to make the necessary changes in his intake and thereby improve sports performance (SP). Nutrition is determinant in achieving an adequate SP, which is defined by three variables: training, rest, and feeding. However, the main objective of sports nutrition must be preserving the health of the athlete, which can be achieved with an adequate intake adapted to the type of training performed. Optimal nutrition provides the energy necessary to perform physical exercise while reducing injury rate, a factor that together makes the SP increase by itself. Two of the aspects that can limit the SP are the state of hydration and the energy contribution. Hypo hydration states produce alterations in homeostasis, decreased blood volume, increased heart rate, lower rate of sweating, increased organism temperature, and greater perception of effort which translates into SP deterioration. Likewise, a low energy consumption accentuates fatigue, immunosuppression, and predisposition for injuries, which can interfere in the development of SP. Nowadays, an exponential increase in the population that performs physical activity has been reported. In the USA, the total number of runners endorsed in marathon events is 541,000 in 2013, which represents 27% more participants than observed in 2008 in the same trend observed in many countries. For example, in Spain the number of participants increased from 28,000 (2008) to 57,931 (2013), which represented an increase of 101%. These increases far from ceasing have continued growing in the last 5 years. Specifically, marathons of Sevilla and Valencia have reached 14,500 and 20,000 runners in 2018, which contrast with the previous participation observed in 2013 (5963 and 9653 participants, respectively). Unfortunately, sports nutrition is often referenced to sports supplements or "magical" strange diets. In fact 40–70% of athletes use sports supplements without even analyzing if their use is really necessary.

Body composition:

The season of the athlete will be divided into different phases throughout the competitive period. Competitive season can be divided in preseason, competitive period, transition period, and in the worst case injury period. Due to different intensities, timing, and types of training, the BC is normally different in the competitive season. Therefore, it is vital to know the BC of the athletes in order to determine the adequacy of the current season stage. The body composition (BC) of the athletes is related to the SP, as it can be modified throughout the season. There is no single BC for each group of athletes; however, it can serve as a guide for athletes and coaches. Apart from a higher body mass index (BMI), there are several methods for the evaluation of BC. Dual-energy X-ray absorptiometry (DEXA) is considered the gold standard for the assessment of body fat, mainly due to its high reproducibility and accuracy. However, DEXA has high economic cost, is not portable, and also emits a small radiation, so its use is not very common. Among the most used methods are bioelectrical impedance analysis (BIA) and anthropometry. Impedance is defined as the opposition shown by biological materials to the passage of an electric flow. Tissues with high impedance offer greater resistance (adipose tissue, bone, air in the lungs) and contain less amount of water. The greater the amount of water, the better this electrical flow, will pass through. Therefore, the hydration sate of the individual is the determinant for the BC measurement by BIA. In addition, in order to standardize previous conditions and dismiss errors, certain protocols must be followed prior to the measurement of BC by BIA. That fact makes BIA a rather imprecise method.

Metabolic Pathways and Exercise:

The energy systems are integrated by a set of metabolic pathways that come into operation during exercise, depending on the intensity and duration. In summary, they can be divided into non-oxidative pathways (phosphogenic and glycolytic pathways) and aerobic pathways (nutrient oxidation) . Prior to establishing requirements regarding quantity and timing of macronutrients, a brief approach about different metabolic pathways that provides energy during exercise is necessary. Both pathways aim to generate ATP that will be consumed during the exercise. The non-oxidative pathways occur in the cellular cytosol, do not require oxygen, and are activated during short-time periods (seconds). Phosphagen route uses ATP and phosphocreatine, lasting between 1 and 10 s, and is a route that does not need oxygen and does not generate lactate. Glycolytic pathways metabolize glucose, muscle, and liver glycogen through glycolysis and occur in high-intensity exercises up to 3 min. These glycolytic pathways generate lactate and hydrogen bonds, generating an acidity in the muscle cell—this acidity being one of its limitations. The aerobic pathway occurs inside the mitochondria, so it requires the presence of oxygen to metabolize fuels. It is typical of resistance exercises with medium-low intensity and long duration. It includes the oxidation of CHOs, fats, and to a lesser extent protein. This route generates much more ATP than the anaerobic path but more slowly, speed being the limitation of this path.

Energy needs:

However, it can be complicated due to multiple changes in periodization of training and competitions. The energy demands of athletes differ widely depending on the type of sport, duration, intensity, competitive level, and individual variability of each athlete. The key to success for any athlete will be to adapt energy intake to energy expenditure, which allows the correct functioning of the organism while improving BC. The more demanding the competitive levels of the athlete are, the greatest increase in the intensity of both training and competition occurs, which will result in a significant reduction energy reserves that must be replaced by an adequate diet.

Macronutrients:

For this purpose, the recommendations will be provided by grams of nutrient/kg of BW. Main energy substrates used for physical exercise are carbohydrates (CHO) and lipids, while proteins as energy substrate are reserved for extreme conditions. In order to establish recommendations for macronutrients, it is preferable taking into account the body weight (BW) of the athlete, instead of giving the typical percentages based on the total caloric intake of the diet. The use of energy substrate varies depending on the intensity and duration of the exercise, level of training of the athlete, and the state of pre-workout CHO stores. The use of CHO as energy substrate is produced mainly during high intensity and short-duration exercises. Meanwhile, less intense and long-term exercises use fats' main energy substrate. However, the use of CHO will also have a great impact on exercises of less intensity and longer duration such as resistance test, showing that depletion of CHO together with dehydration is a major limitation of the SP.

Carbohydrate:

This is a mistake, due to the importance of CHO as energy substrate for the brain and central nervous system. Moreover, they can also be used at different intensities both by anaerobic and aerobic pathways. CHO are an energy fuel that provides 4 kcal/g of dry weight. Currently, there are a large number of myths related to nutrition, which causes great confusion in general population. One of the most widespread errors is the demonization suffered by the CHO, which has generated some carbophobia in society, including the athlete population. They are stores in liver and muscle in the form of glycogen. Although, these deposits are limited to around 400-500 g, providing 1600- 2000 kcal, they can be depleted if the diet does not contain enough CHO. Glycogen stores in the organism are divided into 350–400 g in the muscle, 75–100 g in the liver, and around 5 g in the plasma. In addition to size differences, the liver is really a store of glycogen, responsible for maintaining blood glucose. Meanwhile, the muscle can be considered a "false" store since it only uses glucose for its own needs. In other words, the liver can contribute to the replacement of muscle glycogen in the event of depletion, something that does not happen in reverse, which can lead to hypoglycemia and considerably affect SP due to fatigue.

In general, the CHO recommendations based on the intensity and duration of physical activity can be summarized as follows:

• 3–5 g/kg/d of low-intensity training such as recovery days or tactical skills
• 5–7 g/kg/d for moderate intensity training of 1 h duration
• 6–10 g/kg/d for moderate–high intensity exercises between 1 and 3 h
• 8–12 g/kg/d for workouts of more than 4–5 h of moderate-high intensity

The rate of glucose oxidation is estimated at 60 g/h. Therefore, the CHO composition must be formed by a combination of CHOs that use different transporters and increase the oxidation rate, such as maltodextrin or sucrose, among others. Consuming 90 g CHOs/h can cause gastrointestinal problems in sports such as continuous running. These gastrointestinal problems may be due to the redistribution of blood flow to the muscles during exercise. Therefore, strategies for bowel training have been proposed to increase the rate of gastric emptying as well as reduce possible discomfort. When it is proposed to reach recommendations, it seems beneficial to alternate different types of drinks, gels, or bars, so that the taste is not monotonous.

Proteins:

The proteins are composed of amino acid (AA) chains. There are 20 types of AA, divide into nonessential AAs (can be synthetized by the organism) and essential AAs (must be contributed by the diet) . Within the essential AAs, there are three types of AAs called branched (leucine, valine, and isoleucine). Among them, leucine stands out as a stimulator of the mammalian target of rapamycin (mTOR) pathway, which is related to protein synthesis and hypertrophy. Although proteins can contribute between 5 and 10% to the total energy used during physical activity, they are not considered as energy source. Proteins constitute the base of muscle tissue and of the immune system and are the major component of muscle enzymes and play a large role in SP. Regarding sedentary population, the estimated consumption rate is 0.8 g/ kg BW/day. In the athlete population, these requirements are increased to repair muscle damage caused by exercise, enhance metabolic adaptations to training, and avoid possible muscle catabolism. The focus of protein consumption is on estimating an adequate protein intake for each given moment.

Lipids:

Along with the CHO, lipids are major energy substrates during exercise. The difference is that fats are not as profitable per unit of time as CHO and high fat consumption is not associated with improvements in SP . Lipid consumption is important for both energy intake and essential nutrients such as fat-soluble vitamins A, D, E, and K. Both quantity and quality of fats are determinant in the diet. The quality is often referred by its content on inflammatory fatty acids. The recommendation regarding fat consumption in athletes is similar to that of the general population. It is advisable not to make restrictive consumption of fat, as it can lead to deficit of nutrients such as fat-soluble vitamins and omega-3 fatty acids. Fatty acid requirements, according to the American College of Sports Medicine (ACSM), are 20–35% of the total kcal of the diet, where 7–10% should correspond to saturated fatty acids, 10% to polyunsaturated fatty acids, and 10–15% to monounsaturated fatty acids.

Hydration:

During exercise, increments of energy requirements are associated to larger production of metabolic heat [34]. Human organism dissipates that extra heat mainly by the mechanism of evaporation, which ultimately induces dehydration. One of the greatest limitations of SP is dehydration. It is estimated that each kg of BW lost during exercise corresponds to 1 L of sweat . The sensitivity to dehydration is personal, but generally no losses greater than 2% of the BW are recommended in order not to compromise the SP. In fact, 1% of BW lost leads to SP decrease by 10%. Some authors have raised the possibility of training dehydration, but there is some controversy about it. The consumption of water is the only method to prevent dehydration and will be essential before, during, and after exercise. However, a large number of athletes usually begin the exercise in a state of hypohydration. Therefore, it is necessary to instruct the athlete to acquire correct hydration habits according to the type of sports, so that the SP is affected as little as possible.

Regarding the drink to be used for sports, it is advisable to use replacement drinks instead of water, due to the CHO and sodium content. Both salts and CHO improve intestinal transport, which facilitates the arrival of fluid in the blood. Prepositional beverages should present an isotonic composition, with the following characteristics:

- 80–35 kcal
- At least 75% of the kcal should be high glycemic index CHO
- No more than 90 g CHO/liter

• 460–1150 mg sodium/liter
• Osmolality 200–330 mOsm/kg of water

As commented before, it is advisable to use drink with different CHOs as glucose, sucrose, and maltodextrinas, in order to facilitate the absorption of liquid due to the use of different intestinal transporters. Moreover, the fructose content should not be very high, due to quantities between 20 and 30% can cause intestinal problems. The hydration guidelines indicated for performing physical exercise are:

• Ingest between 400 and 600 ml of water along the 4 h before the start of the exercise.
• Just at the beginning of the activity, ingest 200–400 ml of water with CHO (5–8%).
• During the exercise, ingest 100–200 ml of water every 15–20 min.
• After physical activity consume 150% of the BW lost in the 6 h after.
• In low-intensity training and short-duration, the intake of water alone is sufficient
• The ideal temperature of drinks oscillates between 15 and 21°C
• The taste should be pleasant to the palate of the athlete.

Diabetes in sports:

First, the effect of exercise between insulin-dependent (type 1) and insulindependent (type 2) diabetes should be differentiated. In type 2, you do the exercise to improve insulin resistance, while in type 1, you should adjust and modify the amount of insulin administered, along with the CHO intake. Physical exercise is one of the most difficult activities to adapt to diabetes, due to the increase in the frequency of hypoglycemia. People with diabetes who perform physical activity on a regular basis have less need for insulin, but this does not ensure adequate glycemic control. The blood glucose value is of multifactorial origin, and one should take into account the CHO intake and type of sports performed as well as adjust the dose of insulin used. In order to avoid hypoglycemia, during the exercise the dose of insulin will be reduced but in no case will be completely eliminated, because the lack of insulin prevents the entry of a sufficient amount of glucose into the cells for obtaining energy. A greater use of fats as fuel can generate an accumulation of ketone bodies and cause ketoacidosis. In the presence of glucose values (>250 mg/dL), ketone levels should be checked, and if elevated (>0.5 mmol/l), postpone the activity.

Supplements:

An ergonomic aid is a product that contains a nutrient or a group of nutrients that improve the SP without taking into account the harmful effects in athletes, while a supplement is a nutritional aid to complete the diet associated with the practice of physical exercise. When an athlete seeks to improve in the SP, his ability to tolerate intense workouts and hard competitions is crucial to avoid falling into injury or chronic fatigue. To achieve this purpose, an adequate supply of nutrients is essential. However, many times this does not happen, and the use of dietary supplements is resorted to. These supplements must be prescribed individually according to the needs of each person (sex, age, fitness, intensity and duration of the exercise, season, etc.), in order to maintain both the state of health and the improvement of the SP. Dietary supplements must offer maximum possible safety and have a degree of scientific evidence to support their effect.

According to the Australian Institute of Sport, supplements are classified into four groups, based on effectiveness and safety:

Group A: based on the evidence. Recommended for athletes. ○ Useful and timely source of energy or nutrients in the diet of athlete ○ Scientifically proven their evidence for the improvement of the SP, when they are used with a protocol and specific situation In this group we can find:

• Food for athletes (gels, bars, electrolytes, isotonic drinks, maltodextrins, whey protein)
• Medical supplements (vitamin D, probiotics, iron/calcium supplements)

• Substances to improve SP (creatine monohydrate, caffeine, beta-alanine, bicarbonate, beet juice)

• Group B: more research deserved and advised under research or monitoring protocol.

○ Some benefit in non-athlete population or have data that suggest possible benefit of SP.

○ Of particular interest to athletes and coaches. In this group we can find (quercetin, HMB, glutamine, BCCA, CLA, carnitine).

• Group C: few tests of beneficial effect are not provided to athletes.

○ Not proven improvement RD despite its widespread use.

○ Very little or no benefit, and sometimes they even affect the RD in a negative way. In this group supplements of group, A and B may be included when used without an individualized protocol and without a basis in scientific evidence.

• Group D: should not be used by athletes.

○ Are prohibited or have risk of contamination with doping or positive substance by drug In this group we can find glycerol, ephedrine, sibutramine, and tribulus terrestris

Conclusions:

The basis of sports nutrition is a varied diet and individually tailored to the requirements and appetency of each athlete. The athlete should be instructed about the importance of diet, called "invisible training," which is not only important on competition day. Prior to establishing nutritional guidelines, it is necessary to know and adapt the BC of the athlete in the different periods of the season and make revisions through the sum of six skinfolds. It is necessary to know some physiology to know the different metabolic pathways that interact during the exercise. In this way depending on the type of sports performed, duration and intensity adapt dietary intake at expense. Macronutrient requirements will be established based on g/kg/BW. With respect to CHOs, recommendations vary between 3 and 12 g/kg/BW to avoid compromising the SP, and protein consumption can vary between 1.2 and 2.0 g/kg/BW, with the total daily intake being more important than the number of intakes. Regarding to fatty acids, quality will prevail, improving the inflammatory profile with an increase in the consumption of omega-3 compared to omega-6.

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