

## Guidelines of the Brazilian Society of Sports Medicine

# Dietary changes, fluid replacement, food supplements and drugs: demonstration of ergogenic action and potential health risks

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### INTRODUCTION

In Brazil, the indiscriminate use of different drugs, for both ergogenic and aesthetic purposes, has attracted attention and caused concern. Such use is being increasingly spread in environments where physical exercises are practiced, especially gym academies and sports associations.

Most of the times, it comes from an illegal trade, with no control from sanitary surveillance departments, carried out in the physical exercise practice facilities, and with direct or indirect involvement of the professional in charge of the physical exercise sessions. Typically, under these circumstances, there is no prescription from a specialist physician and/or guidance from a sports science-trained dietitian, who are the qualified professionals to act in such context. What should be considered only for specific circumstances, and always under control of qualified professionals, tends to be used by individuals, with no indication whatsoever. The financial interest prevails on the well-being and health of the population. And even when there is the involvement of physicians and dietitians, many a time the recommendation for use of products is made empirically, with no specific knowledge nor scientific grounds to support it.

This is due, in part, because of the lack of knowledge that a balanced, quality meal, except for special circumstances, meets the nutritional needs of a physical exercise practitioner, even a competition athlete, making unnecessary the use of food supplements.

When one deals with the use of some drugs and hormones of proven ergogenic effect, but that poses health hazards and are considered doping substances, he faces not

only an anti-ethical, but even a criminal situation. If it is proven the prescription was deliberate, professional who did it can be legally punished by a court of law.

Another aspect that justifies this consensus document is the existence of cases in which there are flaws in meals and fluid replacement schemes that restrain sports performance and place the health of physical exercise practitioners at risk, even of death. Such is the case of dehydration, often seen in long-course athletic contests.

This consensus document had the input of eminent professionals and researchers of sports medicine and other sports sciences in Brazil, and its main purpose is to add to an education process, by conveying information that may be used as guidelines for professionals who work in the field of sports and act on physical exercises program for the overall population. This information is intended to reach the main stakeholders, who are the physical exercise practitioners, whether they are competitive athletes or anonymous members of gym academies or other places where sports are practiced, to preserve their health by making them less vulnerable to nefarious actions from unqualified and/or ill-will individuals. Ultimately, its purpose is to demystify improper attitudes that, in spite of lack of scientific grounds and with potential health risk, are quite common in the physical exercise practice environment. It aims to disseminate the use of proven healthy practices, to allow for the best sports performance.

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For the stands taken by this document, the adopted criteria were suggested by the Evidence-Based Cardiology Committee of the Brazilian Cardiology Society and Brazilian Medical Association (tables 1 e 2). The stands were classified according to the status of recommendation and the level of scientific evidence. To determine the status of the recommendation, in addition to the degree of scientific evidence, the recommendation's applicability, cost-benefit and cost-effectiveness ratios, among other aspects, were taken into consideration.

## I. DIETARY CHANGES

Scientific studies have proved that performance and health of athletes may benefit from dietary changes. There are few controversies on this issue, due to documentation that demonstrates beneficial effects to health, favorable changes of body composition and enhanced athletic performance from dietary management. Studies have been according in reaching the conclusion that, in general, dietary management alone is enough to reach the above mentioned outcomes. Food supplement should therefore be left for special cases only, and its use should derive from prescription of qualified professionals, dietitians and specialist physicians.

The food and nutritional supplies industry has developed modified food, aiming performance improvement. Typically, they use only nutrients whose sources are in the food

TABLE 1  
Degree of evidence

**Degree 1:** evidence based in a number of randomized, controlled, broad, concord, statistically appropriate trials, preferably with conclusive systematic reviews.

**Degree 2:** evidence based in few randomized, controlled, average-size trials or meta-analyses of many of such small or average-size trials.

**Degree 3:** evidence based in few high-quality randomized, controlled trials.

**Degree 4:** evidence based in more than one high-quality cohort trials.

**Degree 5:** evidence based in more than one quality case-control study.

**Degree 6:** evidence based in more than one high-quality series of cases, including records.

**Degree 7:** evidence based just in inferences from results collected for other purposes (to test other hypothesis); rational suppositions, animal-model experiments or experiments based on mechanistic pathophysiology models and/or mechanisms of action; old procedure based on common practice; opinions with no reference to prior studies.

Source: Evidence-Based Cardiology Committee of the Brazilian Cardiology Society and Brazilian Medical Association.

from an ordinary meal. One can state that the athlete who wishes to optimize his/her performance, before any nutritional manipulation should follow a diet that is appropriate to his/her endured effort in terms of quantity and variety, taking into consideration what has been established as a healthy food.

The guidelines in this section target healthy athletes, adults and adolescents at the end stage of sexual maturation. **They do not focus individuals who practice physical exercises with no further concern about performance, for whom a balanced diet according to the recommendations given to the overall population is enough to maintain health and enable a good physical performance. (Recommendation status A and evidence degree 2).**

### Nutritional assessment

Nutritional assessment is an important factor for diet design and compliance. A careful dietary anamnesis allows the definition of strategies for the introduction of eventual dietary changes that may be needed. Athletes should not be deprived of their favorite food, or start a diet with rules and impositions divorced from their reality. Prescriptions should be flexible, so they can become a regular eating habit. Nutritional needs can be calculated through appropriate protocols, being determined by specific tables. One should consider the modality of sports being practiced, the training stage, the calendar of competitions and the purposes of the technical team concerning performance, data

TABLE 2  
Recommendation status

**A = Always use.** This is a conclusive recommendation, unani- mously adopted; conclusively useful and safe procedure; proven effectiveness and safety. It almost always requires evidence level 1 or 2 for such recommendation status to be adopted.

**B = Use is generally advised.** The recommendation is considered acceptable, but with remarks; acceptable and safe procedure; high potential for usefulness, but no conclusive proof, with a less solid degree of evidence.

**C = Use is upon personal decision.** Undefined recommenda- tion; procedure about which there is no evidence for or against its effectiveness and safety.

**D = Use is generally not advised.** Procedure not recom- mended, even though it might be used in some exceptional instances, but it is a very poor option; minimal evidences of effectiveness and safety, but with some potential use in selected cases.

**E = Never use.** Use is unanimously not recommended.

Source: Evidence-Based Cardiology Committee of the Brazilian Cardiology Society and Brazilian Medical Association.

related to basal metabolism, energetic requirements for training, needs for body composition changes, and the presence of clinical factors such as chewing, digestion and absorption conditions. Energetic requirements are calculated by the sum of basal energetic need (protocol of free choice), mean energetic expenditure in training, and extra or reduced intake to control body composition.

To determine the needs of macronutrients (carbohydrate, proteins and lipids), one should take into consideration the caloric needs and the necessary digestion time for muscle utilization. Macronutrients are essential for muscular recovery, maintenance of immunologic system, balance of the endocrine system, and maintenance and/or enhancement of performance.

Overall, micronutrients (vitamins, minerals and oligo-elements) present in balanced and diversified diets, with enough caloric intake to meet energetic demand, are enough for the needs of a sportsperson. The use of food supplement is recommended in some special cases. One is the use of folic acid by pregnant women, the use of calcium in case of osteopenia and osteoporosis, and iron for anemia. Micronutrients play an important role in energy production, hemoglobine synthesis, bone health maintenance, immunologic function, and protection of body tissues from oxidative damages. They are necessary to build and maintain muscular tissues after the exercises. The training can increase or change the needs of vitamins and minerals. The stress from the exercises may result in a biochemical muscular adjustment that increase nutritional needs, with higher use and/or loss of micronutrients. Dietary adjustment, in terms of macronutrients, to higher caloric need derived from sports activities, provides, at the same time, adjustment in the intake of micronutrients. **Thus, it is suggested that nutritional recommendations for the overall population be used, calculated for the intake of 1,000 Kcalories. Therefore, the increment in the supply of micronutrients is proportional to the caloric increase of the diet, and nutritional balance is kept at appropriate levels. (Recommendation status A and evidence degree 2).**

#### **Recommendations:**

##### **a) Total food caloric rate**

A number of studies have shown low caloric intake and nutritional unbalance in professional and/or amateur athletes. In spite of the proven effectiveness of carbohydrates to recover muscular glucogen, elite athletes still resist in taking this nutrient. An adequate meal in terms of carbohydrate supply helps maintaining body weight and composition, maximizing results from training and contributing to health maintenance. A negative caloric balance, from a lower intake of micronutrients, may cause loss of muscu-

lar mass, hormonal dysfunction, osteopenia, and higher incidence of chronic fatigue, musculoskeletal lesions, and infectious disease, which are some of the main features of overtraining.

When one wishes to change body composition by reducing the mass of fat, one typically suggests reducing caloric intake by selecting low-energetic density, low-fat foods. However, in athletes, a 10% to 20% reduction in total caloric intake leads to changes in body composition by reducing body fat, and not inducing to hunger or fatigue, as diets of very low-calorie intake and low fat. A dramatic reduction in fat from diet may not ensure reduction in body fat, and cause significant muscular losses due to lack of important nutrients for post-exercise recovery, such as liposoluble vitamins and proteins.

**In accordance with population nutritional recommendations (RDI – National Research Council – 98), one should intake, in Kilocalories (Kcal), from 1.5 to 1.7 times the produced energy, or from 37 to 41 Kcal/weight (Kg)/day. This variation is influenced by genetics, gender, age, body weight, body composition, physical fitness, and training stage. One should take into consideration the frequency, intensity and duration of physical exercise sessions. Depending on the purpose, the caloric rate can present broader variations, with diets ranging from 30 to 50 Kcal/ weight (Kg)/day. (Recommendation status A and evidence degree 2).**

##### **b) Carbohydrates**

Ergogenic effect of carbohydrate intake during exercises has been consistently demonstrated in a number of experiments, many of which carried out at stages lasting for hours. It has been shown that prolonged exercises significantly decreases the level of muscular glycogen, and one should be constantly concerned on replacing it. Nevertheless, a low carbohydrate intake by athletes has been observed.

The energy used during training and competitions depends on the intensity and duration of exercises, gender of athletes and initial nutritional status. The higher the intensity of exercises, the higher the role of carbohydrates as energy suppliers. The role of fat can be important for the time the exercise lasts, becoming even more significant while the activity lasts and remains an open aerobic activity. However, the proportion of energy from fat tends to decrease when the intensity of the exercise is enhanced, requiring a higher role from carbohydrates. With the exercise lasting longer, the role of protein is enhanced, which helps serum glucose levels to be maintained, mainly through liver gluconeogenesis.

Selection of food to be source of carbohydrates and the preparation of the meal immediately before the sports event

should be according to individual gastrointestinal features of each athlete. The recommendation to fraction diet in three to five meals a day should take into consideration the necessary digestion time for the pre-training or pre-competition meal. The size of the meal and its components as to amounts of proteins and fibers may require over three hours for gastric emptying. If it is impossible for one to wait for over three hours for digestion, gastric discomfort may be prevented by intake of food poor in fibers and rich in carbohydrates. It is suggested food of light or liquid consistency, with an adequate amount of carbohydrates. Thus, the last meal before training should have enough fluid to keep hydration, poor in fat and fibers to facilitate gastric emptying, rich in carbohydrates to keep serum glucose levels and maximize glucogen supplies, with moderate amounts of proteins, and should be part of the athletes nutritional habit.

**It is estimated that carbohydrate intake corresponding to 60% to 70% of the daily calorie intake meets the demands of a sports training session. To optimize muscular recovery it is necessary carbohydrate intake of 5 to 8g/weight (kg)/day. In long-duration activities and/or intense training, there is the need of up to 10g/weight (kg)/day for proper muscular glucogen recovery and/or increase of muscular mass (Recommendation status A and evidence degree 2).**

The amount of used glucogen depends on the duration of the exercise. For long contests, athletes should intake approximately 0.7 to 0.8 g/weight (kg) or between 30 and 60 g of carbohydrate at each hour of exercise, to prevent hypoglycemia, glucogen depletion and fatigue. Often the carbohydrates are part of beverages especially developed for athletes. After an exhaustive exercise, it is recommended intake of simple carbohydrate, in the amount ranging from 0.7 to 1.5 g/weight (kg) within a four-hour period, which is enough for a full muscular glucogen re-synthesis. (Recommendation status A and evidence degree 2).

#### *c) Proteins*

For sedentary individuals, it is recommended a daily intake (RDI) of proteins between 0.8 and 1.2 g/weight (kg)/day. Individuals who practice physical exercises require a higher amount, as proteins contribute to energy supply in endurance exercises, and are necessary in post-exercise muscular protein synthesis. For endurance athletes, proteins play an ancillary role in supplying energy to the activity, and one estimates its daily need to be between 1.2 and 1.6 g/weight (kg). For power athletes, protein has an important role in supplying "raw material" for tissue synthesis, being its daily need be-

tween 1.4 and 1.8 g/weight (kg). (Recommendation status A and evidence degree 2).

#### *d) Lipids*

**An adult requires about 1 g of fat per kg of body weight daily, which is about 25% to 30% of the total amount of calories (TAC). Essential fatty acids intake should be of 8 to 10 g/day. For athletes, it goes the same nutritional recommendations for the population in general as to the proportion of essential fatty acids, which is 10% for the saturated, polyunsaturated and mono-unsaturated. (Recommendation status A and evidence degree 2).**

Athletes should be oriented not to have a poor-fat diet for a long time. When hypolipidic diet is necessary, there should be quotas as to total calorie intake, being of less than 8% for saturated, more than 8% for mono-unsaturated, and from 7 to 10% for polyunsaturated. It has been reported that, in general, athletes intake more than 30% of TAC in form of lipids, with deficit in the intake of carbohydrates, which are consumed in less than advisable proportions.

Some studies have suggested a positive effect of diets somewhat rich in fat for athletic performance. Average- and long-chain lipid supplements have been suggested for intake a few hours before or during exercise. Thus, muscular glucogen would be spared. However, in face of evidence available today, in this document we recommend it should never be used. (Recommendation status E and evidence degree 7).

#### *e) Vitamins*

There is disagreement as to greater needs by athletes. For athletes, it has been suggested the intake of C vitamin between 500 and 1,500 mg/day, which would allow better immunologic response and important antioxidant action. It has also been suggested the use of vitamin E by athletes undergoing intense training, to enhance antioxidant action. Scientific evidence allows physicians and nutritionists to prescribe C and E vitamins, even with a low-degree evidence (Recommendation status C and evidence degree 7).

#### *f) Minerals*

Zinc plays a role in the cell respiratory process, and its shortage in athletes may cause anorexia, significant weight loss, fatigue, lower performance in endurance competitions, and risk of osteoporosis, which explains why it has been given as a supplement. However, due to lack of quality scientific evidence on its systematic use as a nutritional supplement, this document recommends

**it should not be used other than in regular meals. (Recommendation status E and evidence degree 7).**

**Female athletes under low calorie diet may lack minerals, particularly those involved in bone formation and maintenance, such as calcium. Any diet should include, at least, 1,000 mg/day of calcium. The low level of iron seen in about 15% of the world population is cause of fatigue and anemia. Iron deficiency affects performance and the immunologic system. Special attention should be paid to the intake of high bioavailability food with iron, being recommended for the female population the amount of 15 mg/day, and 10 mg/day for males. For pregnant women, RDI is of 30 mg. These needs may be achieved by manipulating diet, not being supplementation necessary. For dietary manipulation, in the specified cases, this document confers a high recommendation status. (Recommendation status A and evidence degree 2).**

## II. FLUID REPLACEMENT

The stress of the exercise is accentuated by dehydration, which increases body temperature, impairs physiological responses and physical performance, and causes health hazards. These effects may take place even if dehydration is light or moderate, with up to 2% of loss, and worsens as it increases. With 1 to 2% dehydration, body temperature starts raising in up to 0.4°C for each subsequent dehydration proportion. At about 3% there is a significant performance weakening; between 4 to 6%, thermal fatigue may occur; from 6% on, there is the risk of thermal shock, coma and death.

As sweat is hypotonic in relation to blood, dehydration from exercise may lead to an increase in serum osmolarity. Both hypovolemia and hyperosmolarity increase internal temperature and reduce heat dissipation from evaporation and convection. Serum hyperosmolarity may increase internal temperature, affecting the hypothalamus and/or sweat glands, delaying the starting of sweat and peripheral vasodilation during exercise.

Dehydration affects aerobic performance, decreases cardiac output due to reduction in the volume of blood, and increases heart rate. These changes are more accentuated in warm and humid climates, as higher skin vasodilatation transfers a good portion of blood flow to peripheral, rather than musculoskeletal vessels, leading to significant reduction of blood pressure, venous return, and cardiac output. Fluid replacement in a volume equal to loss of water through sweat may prevent a decrease in ventricular output, and is beneficial for thermal regulation as it enhances peripheral blood flow, facilitating internal heat to be transferred to the periphery.

It is important for dehydration signs and symptoms to be recognized. Mild to moderate dehydration is evidenced by fatigue, loss of appetite and thirst, red skin, heat intolerance, dizziness, oliguria and enhanced urinary concentration. Severe dehydration causes difficulties to swallow, loss of balance, dry and withered skin, sunken eyes and blurred vision, dysuria, numbness, delusions, and muscle spasms. It has been shown that fluid intake, regardless of the presence of carbohydrate, enhances performance during one hour of high-intensity aerobic exercise. As exercise-related dehydration may occur not only from intense sweating, but also from insufficient intake and/or deficient absorption of fluids, it is important to recognize the elements that influence hydration quality.

### Water

Water can be a good rehydration option, as it is readily available, inexpensive and allows a somewhat swift gastric emptying. However, for prolonged activities, that last for more than one hour, or for highly intense activities, such as football (soccer), basketball and tennis, it has the disadvantage of not containing sodium or carbohydrates, and because it is tasteless, it favors involuntary dehydration and makes hydroelectrolyte balance process difficult. Voluntary dehydration is seen when one compares hydration with water versus hydration with flavored beverages.

### Sodium

As we lose sodium through sweat, in some circumstances it should be taken during exercise. Sodium concentration in the sweat varies from one individual to another, in accordance to a number of factors such as age, the degree of fitness and being used to a warm climate. Mean sodium concentration in the sweat for an adult is around 40 mEq/L. Assuming that a person of 70 kg runs for three hours and loses two liters of sweat per hour, total loss of sodium is 240 mEq, i.e., 10% of the total extracellular space  $\text{Na}^+$ . Such loss would be irrelevant, were it not for the risk of hyponatremia, a concentration of serum sodium less than 130 mEq·L<sup>-1</sup>, due to a fluid replacement with sodium-free or low-sodium fluids, particularly in lengthy events. Reduction of serum osmolarity produces an osmotic gradient between blood and brain, causing apathy, nausea, vomiting, altered perception, seizures, which are some of the neurological signs of hyponatremia. Including sodium in rehydrating beverages allows higher intestinal absorption of water and carbohydrates during and after exercise. This happens because glucose transportation at the enterocyte mucosa is coupled with sodium transportation, leading to a higher absorption of water.

In lengthy exercises, which take longer than one hour, it is recommended the drinking of fluids with 0.5 to 0.7 g/l (20 to 30 mEq·l<sup>-1</sup>) of sodium, which corresponds to a similar or even lower concentration as in the sweat of an adult. (Recommendation status A and evidence degree 2).

### Carbohydrate

The intake of carbohydrates during a lengthy exercise enhances performance and may delay fatigue in those sports that involve intermittent, high-intensity exercises. Carbohydrate intake prevents glucose levels to fall after two hours of exercise. The necessary carbohydrate replacement to maintain serum glucose levels and delay fatigue is of 30 to 60 g/hour, with concentration ranging from 4 to 8 g/deciliter. It is to be stressed that there are publications showing that a beverage with 8% carbohydrate is not absorbed nor allow a swift gastric emptying as water or beverages with 6% carbohydrate. It is preferred that a mixture of glucose, fructose and saccharose be used. The single use of fructose may cause gastrointestinal disorder. (Recommendation status A and evidence degree 2).

### Other elements that affect effectiveness of a sports beverage

Gastric emptying is facilitated by intake of low-calories fluids, and intestinal absorption is optimized with isosmotic fluids between 200 and 260 mosmol/kg. Intake of hypertonic fluids could cause body water to be secreted to the intestinal lumen. A number of other factors related to the taste of the fluid affect spontaneous intake, such as temperature, sweetness, intensity of flavor and acidity, in addition to sensation of thirst and personal preferences.

### Recommendations concerning fluid replacement

One should intake fluids before, during and after practicing exercise. To ensure a good hydration at the beginning of the exercise, it is recommended the drinking of about 250 to 500 ml of water two hours before the exercise. During the exercise, fluid intake should begin within the first 15 minutes, and kept on at every 15 to 20 minutes. The volume to be taken ranges according to sweat rates, from 500 to 2,000 ml/hour. If the activity lasts for more than one hour, or if it is intense, of intermittent type, even lasting less than one hour, one should replace carbohydrate in the amount of 30 to 60 g·h<sup>-1</sup> and Na<sup>+</sup> in the amount of 0.5 to 0.7 g·l<sup>-1</sup>. The temperature of the beverage should range from 15 to 22°C, and flavored according to individual preference. The beverage should be easy to reach, in bottles that make drink-

ing easy, interrupting the exercise as little as possible. After the exercise, one should keep on drinking fluids to make up for additional losses of water through urine and sweat. One should take the opportunity to ingest carbohydrates, about 50 g of glucose on average within the first two hours after the exercise, for re-synthesis of muscular glucogen to take place, along with a swift storage of muscular and hepatic glucogen. (Recommendation status A and evidence degree 2).

Even if a good hydration during lengthy exercises under heat favors thermoregulatory response and performance, one cannot ensure that, in extreme thermal stress it is enough to prevent fatigue or thermal shock. Specific recommendations have been made by the American Academy of Pediatrics Sports Medicine and Fitness Committee (see Table below). The degree of thermal stress follows the Wet Bulb and Globe Temperature (WBGT) index, which combines measurements for air temperature (Tdb), humidity (Twb), and solar radiation (Tg), under the equation  $WBGT = 0.7 Twb + 0.2 Tg + 0.1 Tdb$ .

Indicated restriction of physical activities relating to thermal stress	
WBGT (°C)	Activities restriction
< 24	Any activity is allowed. In lengthy activities, observe for initial signs of hyperthermia and dehydration.
24-25.9	One should make more prolonged intervals under the shade, and fluid intake every 15 minutes.
26-29	Those who are not used to heat or present any other risk factor should interrupt their activities. For all the others, activities should be limited.
> 29	Any athletic activity should be canceled.

American Academy of Pediatrics, 2000.

## III. FOOD SUPPLEMENTS

### Proteins

The benefits of a proper intake of proteins for those who practice regular physical activity are well documented in the international literature. For the proper amount of protein intake to be established, before anything else it is necessary to establish, in addition to individual features (gender, age, anthropometric profile, health status, etc.), basic parameters on the physical activity practiced, such as intensity, duration and frequency. **It is recommended for sedentary individuals the intake of 0.8 g of protein per kg/day. For active individuals, 1.2 to 1.4 g/kg/day meet their needs. Athletes and individuals aiming muscular**

**hypertrophy have their needs met with the maximum intake of 1.8 g/kg/day. These needs may be fulfilled by a balanced meal, unless there is a special situation. (Recommendation status A and evidence degree 2).**

Studies recommend that the use of protein supplements, such as milk serum protein or egg-white albumin, should be in accordance with total intake of protein. Additional intake of such protein supplements over the daily needs (1.8 g/kg/day) does not determine gain in muscular mass nor promotes performance enhancement.

The intake of proteins after physical exercise for hypertrophy favors the increase of muscular mass when combined with intake of carbohydrates, reducing protein degradation. Such intake should be in accordance with total intake of proteins and calories. The increase of muscular is consequence of training, like protein demand, but the reverse is not true.

### **Amino acids**

The intake of amino acids as a food supplement has been suggested as a strategy to meet specific metabolic requirements for the practice of exercises. According to some studies, the intake of essential amino acids after intense training, associated to carbohydrate solutions, allows for a better recovery from the effort, followed by augment of muscular mass. Only essential amino acids have their use supported by the literature as beneficial. The effects of supplementation with branch-chained amino acids (BCAA) in sports performance are discordant, and most studies show it provides no benefits in performance. There is a lack of scientific studies with consistent information on the ergogenic advantages of such supplementation and on occurrence of side effects.

### **Special considerations**

**Branch-chained amino acids – leucine, isoleucine and valine – being potent modulators of tryptophane reuptake by the central nervous system, would foster tolerance to prolonged physical strain. However, these data, which have been reported by some studies, are difficult to be duplicated, and the use of these amino acids for ergogenic purposes is not justified. Another aspect to be considered in branch-chained amino acids is their use to enhance the immune system after intense physical activity, but for this, more significant scientific evidence is also lacking. (Recommendation status E and evidence degree 7).**

**Glutamine is an amino acid that acts as nutrient for fast dividing cells, such as intestinal and immune system cells. Its high use by intestinal cells does not make it available to other body areas when it is orally admin-**

**istered. Thus its use to favor immune response after intense physical activity is not justified. (Recommendation status E and evidence degree 7).**

**Ornithine and arginine are amino acids that, taken intravenously, promote higher secretion of growth hormone, but are ineffective if orally administered. (Recommendation status E and evidence degree 7).**

### **Creatine**

Lately, in the sports area, the use of creatine supplement is being related to potential ergogenic effects that would reflect in increased resistance to strain in short-duration, high intensity activities, and muscular mass augmentation. The use of creatine as an ergogenic resource in prolonged lengthy physical activities has no support in scientific literature.

Even though with controversial results, a number of studies have suggested that creatine would have ergogenic effects for those individuals whose intake of creatine from food is little, such as vegetarians and elders, and only for these specific cases its use is recommended, upon assessment of a specialized professional, either physician or dietitian, though yet with a low recommendation status.

**It is permitted the usage, always as an exception, only for competitive athletes participating in high-intensity and short lasting events, i.e., activities involving predominantly phosphagens. Therefore, even in these cases, creatine should not be widely used, but accepted in rare occasions (Recommendation status D and evidence degree 4). For the other athletes, the recommendation is not to use creatine (Recommendation status E).**

### **$\beta$ -hydroxy- $\beta$ -methylbutirate**

The use of  $\beta$ -hydroxy- $\beta$ -methylbutirate (HMB) is being considered a potential agent to enhance strength and lean body mass. Its action would be anti-catabolic, but it lacks scientific studies that prove, without a doubt, the effectiveness of this supplement for such ergogenic action other than in some specific cases, such as elders who take part in physical exercise programs. **For the overall population, even for competition athletes, its use is not recommended; on the contrary, recommendation is for it not to be used. (Recommendation status D and evidence degree 7).**

## **IV. LICIT AND ILLICIT DRUGS**

Illicit drugs are those whose use breaks ethical and disciplinary codes, according to the World Anti-doping Agency and the International Olympic Committee (IOC), and may lead to punishments to athletes, coaches, physicians and officials. A list of forbidden drugs and methods, approved on September 1<sup>st</sup>, 2001, is in the Appendix A of the Olympic Movement Anti-doping Code.

## **I. Classes of forbidden drugs:**

- A. Stimulants;
  - B. Narcotics;
  - C. Anabolic agents:
    - 1. Androgen anabolic steroids;
    - 2. Beta-2 agonists;
  - D. Diuretics;
  - E. Peptide, mimetic hormones and analogues:
    - 1. Chorionic gonadotrophic hormone (hCG) (only for male athletes);
    - 2. Pituitary and synthetic gonadotropins (LH) (only for male athletes);
    - 3. Corticotrophines (ACTH, tetracosactide);
    - 4. Growth hormone (hGH);
    - 5. Insulin-type growth factor-1 (IGF-1)
- Precursors and analogues to these hormones are also forbidden:
- 6. Erythropoietin (EPO);
  - 7. Insulin (except for insulin-dependent athletes)

The presence of an abnormal concentration of an endogenous hormone (listed above, in class E) or its diagnostic markers in an athlete's urine is a transgression, unless due to a condition peculiar to the individual.

## **II. Forbidden methods:**

- 1. Blood doping: it is the intravenous infusion of blood, red cells and/or similar blood products. It may be preceded by withdrawing blood from an athlete, who goes on training with blood deficiency;
- 2. Dispensation of artificial oxygen transporters or plasma expanders;
- 3. Pharmacological, chemical or physical manipulation of urine.

## **III. Classes of drugs forbidden in some circumstances:**

- 1. Alcohol;
- 2. Cannabinoids;
- 3. Local anesthetics;
- 4. Glucocorticoids;
- 5. Beta-blockers.

It is to be mentioned that some drugs may be licit at some circumstances and illicit at others. Such is the case of stimulants, analgesic narcotics and corticosteroids, which may be used in some medical situations during training period, but cannot be used before a competition. The use of some illicit drugs may lead to legal prosecution, for infringement of the Penal Code. The Brazilian Olympics Committee regularly publishes a bulletin listing the brand name of licit drugs according to symptoms, and illicit pharmacological classes of drugs, in accordance with IOC regulations.

Some results are positive when drugs are present in the urine over a specified level, such as caffeine, catine, ephedrine, methylephedrine, phenylpropenilamine (phenilpropanolamine), morphine and pseudoephedrine. To these, one adds nandrolone precursory substances. There is also a ceiling concentration for THC, to protect passive smoking. Salbutamol is considered to be stimulant over a specific concentration, and anabolic agent over another, ten-fold higher. And last, testosterone/epitestosterone ratio will be considered doping if higher than 6.

Androgen anabolic steroids, peptide hormones and diuretics cannot be used unless specific authorization from a relevant medical official for a particular sport or competition. In case of proven medical indication, the specialized physician can prescribe any drug, even if theoretically illicit, and a relevant medical officer should expressly authorize it. Even though the most important reasons for a sports physician not to prescribe doping drugs are of ethical and moral nature, it is also important to understand the medical problems related to the use of such drugs. Athletes are entitled to know the relative risks of an eventual inadequate choice of drug, and discussing this issue is also a task of a team's physician. The activity of the specialized sports physician is regulated by ethics codes of the World Medical Association, International Federation of Sports Medicine and the IOC.

## **Problems related to the use of food supplements**

Due to an increase in the number of positive cases for nandrolone on high performance sports from 1997 on, the Sports Council of the United Kingdom appointed a committee of experts to analyze the reasons for this problem, and concluded that there is no endogenous production of this hormone in humans, at least not in amounts above the established by the IOC for its accredited labs to consider the amount positive for doping.

The presence of steroids in food supplements and vegetable preparations, such as vitamins, creatines, and amino acids has been detected, but it was not stated in their labels. IOC Medical Committee, due to flaws in legislation of many countries on quality control for manufacturing, decided to warn on the risks of such products to be used. A study financed by IOC (available in its web page) shows that of 634 supplements analyzed by the Cologne Anti-doping Laboratory from 215 suppliers of 13 countries, 94 of those (14.8%) contained hormone precursors not stated in their labels and that could be positive for doping. Among those, 24.5% had testosterone precursors, and 24.5% nandrolone precursors. For this reason, echoing IOC recommendations, we advise Sports Medicine professionals to take extreme caution when prescribing such substances.



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**ERGOGENIC BENEFITS AND POTENTIAL HEALTH HAZARDS**

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Drugs	Benefits for sports	Potential risks and other remarks
<b>Central nervous system stimulants</b>	Performance improvement due to increase in aggressiveness and strength, better flow of thought, less drowsiness and fatigue. They help reducing fat tissue.	Increase of blood pressure, heart rate, propensity to cardiac arrhythmia, coronary artery spasm and myocardial ischemia in susceptible individuals. May cause sleep disorders. May also cause tremors, agitation, lack of motor coordination. In humid settings, there is risk of death due to heart failure. May cause psychological dependency.
<b>Narcotics</b>	Control of pain, cough, dyspnea, headaches and analgesia.	Dangerous inhibition of pain in injured athletes. Risk of physical addiction and withdrawal syndrome. Indicated for deep analgesia.
<b>Androgen anabolic steroids</b>	Increase if protein synthesis, augmenting muscular mass, strength and power. Retention of nitrogen, sodium, potassium, chloride and water is increased.	Indicated for primary male hypogonadism, refractory anemia, angioneurotic hereditary edema, and muscular dystrophias (AIDS and rheumatic diseases). Toxic effects are hydrosaline retention forming edema; high blood pressure, increase of LDL cholesterol, decrease of HDL cholesterol, thyroid dysfunction, mood and sleep disorders. With steroids with 17 alpha position modified, there can be changes in hepatic function, jaundice and hepatic adenocarcinoma. All androgenic steroids increase aggressiveness. There is no circumstance under which androgenic anabolic steroids should be given to healthy individuals.
<b>Adrenergic agonist beta-2</b>	Increase of lean body mass and decrease of body fat.	Anxiety, tremors, headaches, high blood pressure and cardiac arrhythmias. They may cause hyperglycemia, hypokalemia, increase in lactate and free fatty acids.
<b>Diuretics</b>	Cause rapid weight loss. Decrease concentration of solutes in the urine (mask agent).	Among other indications, they are used to control high blood pressure. They are forbidden because they are masking agents for doping drugs, as they decrease solute concentration in the urine; they promote a swift weight loss, thus allowing an athlete to compete in a weight category lower than his, thus establishing an artificial and illicit advantage.
<b>Growth hormone (hGH)</b>	Increase of muscular volume and power.	Increase nitrogen retention and assimilation of amino acids at the tissue, increasing lean weight. Indicated for growth disorders, upon careful medical assessment.
<b>Erythropoietin (EPO) (8)</b>	Increase in red blood cells, and consequently aerobic capacity.	Indicated to treat anemia, particularly in patients with chronic renal disease, where synthesis of this hormone is reduced. Being taken as an injection, it may cause local pain and dissemination of infectious diseases. An excessive increase of the hematocrit decreases speed of capillary perfusion, which decreases tissue oxygenation and compromises performance. Blood transfusion with the purpose or raising hematocrit may cause severe allergic reactions, acute hemolysis, hemodynamic overload, metabolic unbalance, and transmission of infectious diseases.
<b>Beta-blockers</b>	Decrease of anxiety and tremor, decrease of heart rate and blood pressure.	They favor performance in sports that require little muscular effort and high concentration and balance, such as shooting, modern pentathlon, bow and arrow, ornamental diving, sailing, horsebackriding. In shooting, particularly with a pistol, a lesser heart rate means a longer diastole time between each beat, allowing more accuracy in aiming.
<b>Cannabinoids</b>	Feeling of relaxation, decrease of anxiety.	Compromise vision, physical and psychological performance. Decrease memory, learning capacity and serum testosterone. Social drug. In a synthetic form it is used as an antiemetic.

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