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Dietary supplement use by adolescents

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Abstract

Objective: To review the use, benefits and adverse effects of the main dietary supplements consumed by adolescents.

Sources: The literature review was performed using MEDLINE and LILACS databases (1997-2008). We analyzed 377 articles, and 52 of them were selected as references.

Summary of the findings: Consumption of dietary supplements is widely spread among adolescents. This habit has often been detected in pediatric and adolescent medicine clinics. Most of the time, the use of supplements is motivated by the search of the "ideal body." Other reasons for this practice are: attempt to compensate for an inadequate diet, increase immunity, prevent diseases, improve athletic performance and overcome their own athletic limits. The dietary supplements most frequently used and for which there is little evidence of beneficial effects in healthy adolescents are: proteins, amino acids, beta-hydroxy-beta-methylbutyrate, microelements, carnitine, creatine, vitamins, caffeine, and bicarbonate. This dietary supplementation may be beneficial for competitive athletes who do not have a balanced diet after a specific dietary deficiency has been detected.

Conclusion: The unrestrained consumption of dietary supplements should be avoided, since, besides the lack of evidence that such practice will lead to improvement of performance, it exposes adolescents to several adverse effects. Balanced nutrition, with intake of essential energy and nutrients is usually enough to achieve good athletic performance. The use of dietary supplements must be allowed only for selected cases in which specific nutritional deficiencies are identified.

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Introduction

Medical evidence has suggested that dietary supplementation may be beneficial for a small group of people, including competitive athletes, who do not have a balanced diet.[1] In such cases, after nutritional deficiency has been detected, the increase in the intake of such nutrients is recommended, either by means of food or supplements. However, there has been an increasing use of supplements by adolescents engaged in physical or athletic activities.[2] Consumption prevalence varies according to types of sports (it is often used for weight lifting and bodybuilding), cultural aspects, age groups (more common among adolescents) and sex (higher prevalence among men).[3,4] Few studies have mentioned the frequency, type and amount of supplements used, but it seems that the recommended doses are often exceeded.[3]

The media has contributed to stimulate the use of dietary supplements by spreading, for instance, the myth of the ideal body. In 2001, the industry of dietary supplements invested US$ 46 billion in advertisement worldwide as a way to convince potential consumers to buy its products.[1,3] During adolescence, a period when self-assurance is being developed, many adolescents do anything they can to meet that goal.

Unfortunately, most of the time, this consumption does not have the necessary guidance, and it is a result of suggestions from classmates, coaches, magazines,

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websites, and conversations with people who attend gyms.[5,6] Furthermore, these products are sold in drugstores or gyms as over-the-counter products without advice from a nutritionist.[2,6,7] Many appointments are scheduled at pediatric endocrinology, adolescent medicine and nutrition clinics with the purpose of assessing indications and possible adverse effects of this practice.

Based on the issues mentioned above, the objective of the present study was to perform a critical review of the literature about indications, benefits and adverse effects of the main dietary supplements used by adolescents.

Methods

We searched MEDLINE and LILACS databases for studies published from 1997 to 2008. The following keywords, combined in different ways, were used: dietary supplements, adolescents, puberty, athletes, and sports. The literature review included consensuses, editorials, original articles and review articles written in English and Portuguese. Studies were initially selected based on their titles and abstracts. The desired outcomes were use, benefits and adverse effects of consumption of dietary supplements by adolescents. Studies written in languages other than English and Portuguese, studies that did not include an abstract or studies whose title was not related to the objectives of our review were excluded. Of a total number of 377 articles, 52 met the inclusion criteria. The articles selected were read and included in the present review of the literature.

Dietary supplements

Dietary supplements are defined as orally administered substances used with the purpose of resolving a specific nutritional deficiency. They are often sold as ergogenic substances that can improve or increase athletic performance.[8] Proteins and amino acids, creatine, carnitine, vitamins, microelements, caffeine, beta-hydroxy-beta-methylbutyrate and bicarbonate are the most often used dietary supplements.

Table 1 shows the reasons mentioned by adolescents to explain the use of dietary supplements. Table 2 shows the supplements available in Brazil, including the following data: product format, average price and doses suggested by manufacturers. Table 3 shows a comparison between the "beneficial" effects detected by the users and the documented athletic effects of these supplements.

Proteins

Protein preparations are the most often consumed dietary supplements,[4] mainly whey proteins and albumin. Whey proteins are obtained by the extraction of casein from fat-free milk. They have a high nutritional value, high concentration of essential and branched-chain amino acids, high concentration of calcium and bioactive peptides.[17] Their biological effects result from increase in muscle protein synthesis, reduction of body fat due to their high concentrations of calcium, and glutathione, diminishing the action of oxidative agents in the skeletal muscles and increasing plasma insulin concentration, which favors the uptake of amino acids into the muscle cell.[17,18] Whey protein is available in powder form, which should be dissolved in water or milk, in the average dose of 30 g/day in the morning in fasting state or just after physical activity.[17]

Albumin is a supplement containing high concentration of proteins. It is obtained from dehydrated and pasteurized egg whites, being highly digestible and having high biological value. It is usually consumed in the amount of 1 g/day.

Table 1 - Main reasons mentioned by adolescents for using dietary supplements[3,6,8-10]

Muscle mass gain
Better athletic performance
Improved physical performance
Delayed onset of muscle fatigue
Supplementation of inadequate diet
Overcoming the limits of physical capacity obtained only with food intake
Cultural "rule" in some sports
Recommendation by friends, classmates and coaches
Information about the use of supplements by some potential competitors
Availability of supplements in drugstores and specialized stores
Advertisements informing that supplements are safe, "natural", free of adverse effects and that they can increase muscle strength and resistance
Copying the behavior of high performance athletes who are assumed to have used these supplements
Diseases prevention
Immunity improvement

Table 2 - Dietary supplements sold in Brazil: trade names and average prices obtained by a survey carried out on October 18, 2008 at drugstores in the city of Salvador, state of Bahia, Brazil, and at websites[11-16]

Generic name	Examples of commercial products	Format	Price	Dose suggested by advertisers
Whey protein	Bio Whey®, Nutri-Whey Protein®, Only Whey®, Pro Whey®, Pure Whey Nutrition®, Super Whey®, 100%Whey Nutrition®, Ultra Whey Pro®, WheyAdvancedProtein®, Whey Dyn®	500, 900, 1,800, 2,200, 2,300, 2,500 and 3,000 g bottles	500 g = R$ 27.00 2,300 g = R$ 289.00	30 g/day, dissolved in water or milk (do not heat to avoid denaturation) in the morning in fasting state or just after training
Albumin	Albumin, Albumix Plus®, Albumin Protein®, Amino Power Plus®, Hiper Albumina®, Mega Gym Albumina®, Super Alb®	500 and 1,000 g bottles	500 g = R$ 28.00 1,000 g = R$ 58.00	40 g/day
BCCA	Age BCCA®, Amino BCCA Top®, BCCA Body Action®, BCCA Dyn®, BCAA Plus®, Hiper BCAA®, Perfect BCAA®	60-, 120- and 240-pill bottles containing: 717 to 945 mg/pill	60 pills = R$ 39.00 240 pills = R$ 112.00	3-4 g/day (2 pills before and 2 pills after training)
Glutamine	Glutadyn®, Glutalean®, Glutamax®, L-Glutamine®, Perfect L-Glutamine®	100, 200, 400, 500 and 600 g bottles	100 g = R$ 59.00 20 5-g sachets = R$ 85.00 10 10-g sachets = R$ 90.00	5 g/day, dissolved in water
Arginine	Aminofluid®, GH Arginine®, Noxplode®	480 mL bottles (2 g/60 mL) and 135 g bottles (3 g/measure)	480 mL bottles (2 g/60mL) = R$ 42.00 135 g bottles (3 g/measure) = R$ 115.00	1 g before and 1 g after training
Caffeine	Termodyn®, Termofire®, Termopro®	120-pill bottles and 480 mL bottles	120-pill bottles = R$ 155.00 480 mL bottles = R$ 65.00	1 pill or 60 mL after training

BCCA = branched-chain amino acids.

Both products are often used because athletes frequently believe that they need a very high amount of protein to increase their muscle mass, mentioning four reasons for such behavior: 1) increased protein need in individuals who do intense physical training[3,19]; 2) risk of negative nitrogen balance with loss of fat-free mass when protein intake is reduced[20]; 3) anabolic effect of amino acid supplementation stimulating muscle protein synthesis[9,21]; and 4) increased growth hormone release.[22]

In spite of that, Nissen & Sharp,[23] in a meta-analysis of dietary supplements, gain of strength and fat-free mass, did not find beneficial effects of protein supplementation, and Rennie & Tipton[21] showed that, with the consumption of a diet containing normal amounts of protein (12-15% of the total energy), even athletes being trained do not need any protein supplementation. Excessive intake of protein may also increase the production of urea, causing abdominal cramps and diarrhea, and increasing the risk of dehydratation.[22,24] In addition, since protein is the main source of endogenous acid production via sulfate excretion, this increased production may have a negative influence on bone mineral density if it is not balanced with an adequate diet (fruits and vegetables).[25]

To date, there is little evidence of the benefits of protein supplementation in adolescents, including those engaged in athletic activities, provided that they have a normal diet.[20,26] According to the Brazilian Society of Sports Medicine, the additional intake of protein supplements surpassing the daily needs of an athlete, which can be fulfilled with a healthy diet, does not provide gain of additional muscle mass or improved performance.[7]

Amino acids

The most popular amino acids used as dietary supplements are: glutamine, branched-chain amino acids (leucine, valine, isoleucine), arginine, lysine, and ornithine. They are usually consumed in combination with carbohydrates soon after the practice of physical activity with the purpose of increasing muscle mass.[7]

Glutamine is the free amino acid with the highest concentration in plasma and muscle tissue; it is used

Table 3 - Dietary supplements: "beneficial" effects mentioned by adolescents and manufactures vs. documented athletic effects[2,3,6,7]

Generic name	"Beneficial" effects mentioned by adolescents to explain their use	Documented athletic effects
Whey protein	- Easily digested and absorbed protein supplement - Improves muscle synthesis - Reduces catabolism	Little evidence of benefits along with an adequate diet
Albumin	- Easily digested and absorbed protein supplement - Improves muscle synthesis - Reduces catabolism	Little evidence of benefits along with an adequate diet
Creatine	- Stimulates ATP synthesis and energy production	It might be beneficial for very intense and short duration exercises
Carnitine	- Stimulates fat metabolism (fat burner)	There are not definite conclusions about its benefits for athletes
BCCA	- Reduces symptoms of fatigue associated with exercises	There is little evidence of its benefits
Glutamine	- Stimulates the immune system - Stimulates muscle growth	Effectiveness has not been documented
Arginine	- Stimulates growth hormone release - Increases anabolism and reduces muscle catabolism	Effectiveness has not been documented
BHMB	- Increases muscle strength - Increases fat-free mass	Effectiveness has not been documented
Bicarbonate	- Delays fatigue - Increases muscle capacity	Effectiveness has not been documented
Caffeine	- Improves neuromuscular function - Increases the length of time one can exercise - Increases fat metabolism	Little evidence of benefits

ATP = adenosine triphosphate; BCCA = branched-chain amino acids; BHMB = beta-hydroxy-beta-methylbutyrate.

in high concentrations by fast-dividing cells in order to provide energy and favor the synthesis of nucleotides.[27] Some studies have demonstrated a reduction in plasma and tissue concentrations during and after intense and long duration exercises due to the increase in the concentration of cortisol, which stimulates muscle glutamine efflux and its hepatic uptake, or because of the increase in the blood concentration of lactate, favoring a larger uptake of glutamine by the kidneys.[28] According to Cruzat et al.,[27] glutamine supplementation may diminish the oxidative stress, reducing the amount of cell lesions caused by exhausting physical exercises and improving immune defenses. Recent data suggest that oral supplementation of glutamine is not necessary even for competitive athletes.[7]

The consumption of arginine and ornithine as dietary supplements is not associated with changes in fat-free mass or muscle function, except for some individuals under stress (i.e., trauma, burns, surgeries), for whom supplementation may reduce the extensive muscle loss.[3,22] With regard to the stimulation of growth hormone release, only venous infusion is able to produce such stimulation – oral intake of these amino acids cannot promote more growth hormone release.[7]

Because it increases the uptake of tryptophan by the central nervous system, branched-chain amino acid supplementation has been suggested with the purpose of reducing protein loss, improving performance and delaying fatigue. However, in human beings, in addition to being controversial, such effect was only found in stressful situations with increased proteolysis.[7,29]

Carnitine

Carnitine (L-3-hydroxy-trimethylamine-butanoate) is quaternary amine found in beef, milk and its derivatives, and it is synthesized from lysine and methionine in the liver, kidney and brain.[3] Except for individuals who have a strict vegetarian diet, carnitine deficiency is rare. Carnitine participates in the uptake and translocation of free fatty acids through the mitochondrial membrane and, inside the mitochondria, it contributes to the oxidation process of fat

and carbohydrates, increases the production of acylcarnitine and increases the production of energy.[3,30,31] It may also increase blood flow to muscles due to its vasodilator and antioxidant effect.[31] Because of these functions, carnitine has been used by athletes who want to achieve better performance and higher muscle resistance to fatigue.[3] Some people use it to lose weight, since it promotes oxidation of fatty acids and, as a result, increases the use of fat reserves.[3] Although muscle carnitine content is reduced by the practice of exercises, the functional result of such change, or its prevention by means of supplementation, cannot be predicted, since carnitine supplementation increases plasma concentration, but does not increase muscle concentration.[30] The usual supplementation dose is 2-6 g/day for a period from 10 days to 10 weeks.[31] There are not reports on kidney lesions in healthy individuals who used carnitine as a dietary supplement, but there is risk of aggravation of renal function in patients with nephropathies.[32] To date, there are no definite conclusions on the beneficial effect of carnitine on the exercise metabolism of athletes without nutritional deficiency.[3]

Creatine

Creatine is produced in the liver, kidney and pancreas from glycine, arginine, and methionine.[2,33] It is also found in beef.[3] The average daily need is 2 g/day, with 1 g being provided by diet and 1 g as a result of endogenous production.[2,3]

Its highest tissue concentration is found in the skeletal muscle, where two thirds of the total amount are found as phosphocreatine, which is responsible for regenerating ATP (adenosine triphosphate) in the cell cytoplasm.[3,33] During a highly intense physical activity, ADP (adenosine diphosphate) is rephosphorylated to ATP, using the phosphocreatine reserves. Creatine supplementation may increase such reserves in 6-8 times, increasing the availability of phosphocreatine for the regeneration of ATP.[3,34,35]

According to Nissen & Sharp,[23] there are three action mechanisms of creatine in sports physiology: increase in muscle strength, as a consequence of increase in the myosin heavy chain expression; anticatabolic action; and increase in cell volume, stimulating protein synthesis. Other effect of creatine would be the antioxidant action.[36] Maughan et al.[3] suggested that the increase in body mass is a result of the retention of water inside the muscles, due to the increase in intracellular osmolality retaining water and higher insulin release, which leads to glycogen synthesis and increase in the water content inside the muscles. According to Calfee & Fadale,[2] creatine supplementation can cause an increase of 20% in muscle phosphocreatine, speeding up its replenishment during recovery. During dephosphorylation of phosphocreatine, hydrogen ions are consumed, which potentially delays fatigue onset.

The usual dose of creatine consumed by athletes is 20 g/day for 4 to 5 days (loading phase), followed by 1-2 g/day (maintenance phase) for 3 months.[2,34,37] In terms of adverse effects, Casey & Greenhaff[33] reported that the usual supplementation doses do not cause alterations in hepatic or renal function. The adverse effects of long-term use are: weight gain, gastrointestinal discomfort and muscle cramps.[2,3]

Although the American College of Sports Medicine does not recommend the use of creatine by individuals under 18 years old, the estimated prevalence of its use by adolescents in the USA ranges from 7-30%.[2,36] Some authors believe that creatine may be beneficial for competitive athletes who practice short and high-intensity sports.[7,23,38]

Vitamins

Highly intense and/or long physical activity may produce free radicals as a result of the increase in the consumption of oxygen by mitochondria. This excess of free radicals might damage muscle membranes.[39] However, the human body has several endogenous defense mechanisms to neutralize free radicals, such as enzymes: superoxide dismutase, glutathione peroxidase and catalase.[3] In addition, regular physical activity increases the effectiveness of such endogenous mechanisms, contributing to avoid oxidative damage even after exhaustive physical activity.[40]

Even though, the use of extra doses of vitamins, mainly vitamins C and E, is a common habit among athletes due to their antioxidant properties.[41] A study conducted in São Paulo involving university students from a private university showed that 30.4% of the interviewees used vitamins.[42]

Studies in this area show controversial results, with some studies revealing good results and others describing toxic effects caused by long-term megadose, such as, for instance, more muscle lesions.[3] Therefore, there is no scientific evidence supporting the use of vitamins C and E supplementation with the purpose of improving physical performance.[7,41,43,44]

Microelements

Many microelements have an important role in the energetic metabolism, acting as anabolic agents. During exhausting physical activity, their turnover rates in the skeletal muscle can be increased up to 20-100 times in comparison with the baseline rates.[39] Since some of these elements are part of metalloenzymes responsible for the release of free radicals generated by exercises, a deficiency of such elements might impair the recovery of tissue lesion.[45] Therefore, although such deficiency might have a slight effect on sedentary people, theoretically it may impair athletes' performance.

Iron is an important nutrient for physically active individuals due to the role it plays in the production of

energy, serving as an oxygen carrier. The mechanisms through which there is increase in iron requirement during exercise are: loss through sweat, feces and urine, intravascular hemolysis and impaired absorption. Adolescents during growth spurt, girls soon after menarche and vegetarian individuals are at a high risk of developing iron deficiency; however iron supplementation should only be recommended after its actual need is detected.[46]

Although calcium is essential for bone composition, Molgaard et al.[47] reported that its supplementation does not contribute to improve bone mineral density in individuals that have a normal diet. The inverse association between relative risk of obesity and calcium intake may be reached only through calcium consumption in the diet.[48]

Magnesium acts as a co-factor and activator of several enzymes of the energetic metabolism. It participates in calcium metabolism, helps to maintain the electric gradient in the membranes of muscle and nervous cells, in addition to being involved in the hormonal, immune-cardiovascular and neuromuscular functions.[49] Its deficiency (loss through sweat) has been reported as a cause of muscle cramps induced by exercise.[39] Consumption of more than 500 mg/day often results in gastrointestinal disorders, in addition to inducing loss of phosphate.

Zinc participates in many enzymatic reactions as a co-factor, acting in the process of tissue repair. Exercises can stimulate its loss through urine. Most individuals who practice physical activities eat diets that provide enough amount of zinc, except for those who practice sports that require weight control.[49] Its supplementation in a dose higher than 50 g/day may inhibit copper absorption, in addition to reducing the level of HDL-cholesterol.

Copper plays a role in the modulation of the activity of some enzymes, besides acting in the synthesis of hemoglobin, catecholamine and some peptide hormones.[39] Its deficiency is rare. Studies on copper supplementation in athletes showed that there is no need of increasing its intake.[45]

Iodine is essential for the synthesis of thyroid hormones. Although hypothyroidism is common in areas where there is low availability of iodine, salt supplementation with iodine is a rule in these areas. There is no evidence suggesting that individuals who practice physical activity should consume iodine supplementation.[39]

Although there is no evidence of the increase of its requirement or a beneficial effect produce by supplementation on the athletic performance, many of these elements are used as supplements by athletes.[45,46]

Caffeine

Caffeine (1,3,7-trimethylxanthine) is an omnipresent substance daily consumed in several different manners by a large portion of the population.[50] It is present in coffee, tea, guarana, cola-type soft drink, chocolate, sweets, pain killers, and in a great number of dietary supplements.[10]

Theoretically, caffeine can improve athletes' performance by means of the mobilization of free fatty acids from fat tissue, increasing the supply of fat to muscles, saving glycogen, improving the neuromuscular function, and extending the duration of exercises.[10,51] It also improves heart and skeletal muscle contractility, in addition to stimulating the central nervous system, which brings benefits to activities that require concentration.[34] It is also assumed that caffeine might help with weight loss, fatigue prevention and production of energy. According to Spriet & Gibala,[52] another effect would be that of crossing the blood-brain barrier and antagonizing the effects of adenosine, resulting in higher concentrations of stimulatory neurotransmitters, improving the wakening state and high mood.

Positive effects provided by the use of caffeine can be obtained with a dose between 3-6 mg/kg.[34,35] The most relevant adverse effects are: insomnia, shivers, headache, gastrointestinal irritation, hemorrhage and diuresis stimulation,[3,34,35] restlessness, shivers and mental distraction,[50] hyperesthesia and diuresis,[34] which may delay or even impair performance.

Beta-hydroxy-methylbutyrate

Beta-hydroxy-methylbutyrate is a derivative from leucine. It is supposed to reduce muscle proteolysis and/or contribute to cell integrity.[23,54] Some studies have shown that beta-hydroxy-methylbutyrate may increase fat-free body mass and strength, in addition to acting as an anticatabolic, reducing biochemical indicators of muscle lesion in individuals who undergo strength training.[7,23,55,56] Nissen et al.[29] showed that supplementation with 1.5 to 3 g/day of beta-hydroxy-methylbutyrate may prevent muscle catabolism induced by exercise, resulting in a gain of muscle function associated with resistance training. These findings suggest that it may provide some benefits to athletes engaged in strength training programs, in spite of its relatively high cost. On the other hand, Slaler et al.[55] did not find changes in strength or body composition of young adult athletes involved in resistance training after oral supplementation with beta-hydroxy-methylbutyrate at a dose of 3 g/day during 6 weeks. Clinical evidence is not conclusive regarding the benefit of this supplementation, and its use is not recommended even for competitive athletes.[7,57]

Bicarbonate

Although there are not consistent and conclusive studies, induction of metabolic alkalosis (through the intake of bicarbonate or sodium citrate) before high-intensity physical activity that can cause important muscle acidosis is supposed to increase muscle capacity because it regulates acidity

and increases the rate of hydrogen ion efflux of muscles, delaying fatigue and improving muscle performance.[3,57] Other mechanisms suggested include: decrease in muscle phosphocreatine and use of muscle glycogen. Combined, such mechanisms contribute to the production of anaerobic energy.[57] The metabolic effects of induced alkalosis are secondary to an increase in the plasma pH, which leads to a delay in the onset of intracellular acidification during exercise. Van Montfoort et al.,[57] in a randomized double-blind study involving 15 runners, concluded that bicarbonate is more beneficial to improve performance than placebo or other buffer agents.

The oral dose of bicarbonate or sodium citrate usually consumed to induce alkalosis is 300 mg/kg.[58] Adverse effects such as vomiting, diarrhea and abdominal pain may limit the desired increase in performance.[3] The use of bicarbonate before physical activity seems to be beneficial in exercises that potentially induce significant muscle acidosis either due to their high intensity or long duration.[3]

Knowledge gaps and suggestions for further studies

The interpretation of data on the use of dietary supplements by adolescents is hindered by several variables that confound the analysis of such studies. With regard to the subjects of such studies, it is important to mention sex, pubertal stage and type of physical activity and its characteristics (for instance, sedentary individuals vs. athletes; amateur athletes vs. professional athletes). In terms of the supplement used, there is a wide variety of products, doses and replacement duration. Regarding the study designs, in addition to the variables mentioned above, it is worth to mention methodological problems such as those related to sample size, randomization, power and differences in the evaluation of the outcome and effectiveness – whether according to clinical (anthropometric), laboratory (biochemical doses, assessment of enzymatic activity), respiratory capacity criteria – safety control and adverse effects. The need to replace a certain supplement is not always evaluated before beginning its replacement, and, when such need is actually detected, it is not always fulfilled by means of dietary counseling before the indication of supplement use. There is also replacement of multiple supplements, which makes it difficult to analyze their individual effects. Some subjects of studies, depending on the type of physical activity they practice, may have very restrictive diets, which could be changed only by means of appropriate dietary counseling. Other subjects, also due to the characteristic of their physical activity, need a higher replacement of certain nutrients, for instance, proteins. In such cases, the difficulty is to define the amount needed to fulfill the increased demands. In addition, physical activity induces several physiologic and metabolic responses that vary according to the duration and type of activity.

Conclusion

The consumption of dietary supplements is widely spread, mainly among athletes and adolescents who exercise at gyms. The main reasons for such consumption are: to compensate inadequate diet, improve immunity and prevent diseases, and improve physical and competitive performance. The source of information most often used is the recommendation made by friends and coaches. The most popular supplements are: proteins and amino acids, creatine, carnitine, vitamins, caffeine, beta-hydroxy-methylbutyrate, microelements, and bicarbonate. To date, the available data, mostly provided by studies conduct with adults, were not able to demonstrate the benefits of the use of such supplements, except for situations in which there is deficiency, once diet can provide a healthy person with all the necessary nutrients in adequate amounts. Nutritional supplementation is recommended only in specific situations. There is need of further scientific research involving adolescents with the purpose of assessing the beneficial effects and safety of its long-term use. Nutritional education of adolescent athletes is highly important. Finally, regulations on this topic could assist the activity of health professionals and improve the education of the general population about the safe and effective use of these products.

References

1. Scofield DE, Unruh S. Dietary supplement use among adolescent athletes in central Nebraska and their sources of information. J Strength Cond Res. 2006;20:452-5.
2. Calfee R, Fadale P. Popular ergogenic drugs and supplements in young athletes. Pediatrics. 2006;117:e577-89.
3. Maughan RJ, King DS, Lea T. Dietary supplements. J Sports Sci. 2004;22:95-113.
4. Pereira RF, Lajolo FM, Hirschbruch MD. Consumo de suplementos por alunos de academias de ginástica em São Paulo. Rev Nutr. 2003;16:265-72.
5. Burns RD, Schiller MR, Merrick MA, Wolf KN. Intercollegiate student athlete use of nutritional supplements and the role of athletic trainers and dietitians in nutrition counseling. J Am Diet Assoc. 2004;104:246-9.
6. Petróczi A, Naughton DP, Mazanov J, Holloway A, Bingham J. Limited agreement exists between rationale and practice in athletes' supplement use for maintenance of health: a retrospective study. Nutr J. 2007;6:34.
7. Carvalho T, editor. Guidelines of the Brazilian Society of Sports Medicine: dietary changes, fluid replacement, food supplements and drugs: demonstration of ergogenic action and potential health risks. Rev Bras Med Esporte. 2003;9:57-68.
8. Halack A, Fabrini S, Peluzio MC. Avaliação do consumo de suplementos nutricionais em academias da zona sul de Belo Horizonte, MG, Brasil. Rev Bras Nut Esportiva. 2007;1:55-60.
9. Rosenbloom CA, Loucks AB, Ekblom B. Special populations: the female player and the youth player. J Sport Sci. 2006;24:783-93.
10. Altimari LR, Moraes AC, Tirapegui J, Moreau RLM. Cafeína e performance em exercícios anaeróbicos. Rev Bras Cienc Farm. 2006;42:17-27.
11. Corpoperfeito.com.br [website]. www.corpoperfeito.com.br Access: 20/11/2008.
12. Xtreme Nutrition [website]. www.xtremenutrition.com.br Access: 20/11/2008.

13. Copacabana Runners [website]. www.copacabanarunners.net/suplementos.html Access: 20/11/2008.
14. Suplementos online [website]. www.suplementosonline.com.br Access: 20/11/2008.
15. Fisiculturismo.com.br [website]. www.fisiculturismo.com.br Access: 20/11/2008.
16. Mega Muscle Produtos Naturais [website]. www.megamuscle.com.br Access: 20/11/2008.
17. Haraguchi FK, de Abreu WC, de Paula H. Proteínas do soro do leite: composição, propriedades nutricionais, aplicações no esporte e benefícios para a saúde humana. Rev Nutr. 2006;19:479-88.
18. Calbet JA, MacLean DA. Plasma glucagon and insulin responses depend on the rate of appearance of amino acids after ingestion of different protein solutions in humans. J Nutr. 2002;132:2174-82.
19. Petrie HJ, Stover EA, Horswill CA. Nutritional concerns for the child and adolescent competitor. Nutrition. 2004;20:620-31.
20. Millward DJ, Bowtell JL, Pacy P, Rennie MJ. Physical activity, protein metabolism and protein requirements. Proc Nutr Soc. 1994;53:223-40.
21. Rennie MJ, Tipton KD. Protein and amino acid metabolism during and after exercise and the effects of nutrition. Annu Rev Nutr. 2000;20:457-83.
22. Chromiak JA, Antonio J. Use of amino acids as growth hormone-releasing agents by athletes. Nutrition. 2002;18:657-61.
23. Nissen SL, Sharp RL. Effect of dietary supplements on lean mass and strength gains with resistance exercise: a meta-analysis. J Appl Physiol. 2003;94:651-9.
24. Cotunga N, Vickery CE, McBee S. Sports nutrition for young athletes. J Sch Nurs. 2005;21:323-8.
25. Millward DJ. Protein and amino acid requirements of athletes. J Sports Sci. 2004;22:143-4.
26. Pitkänen HT, Oja SS, Rusko H, Nummela A, Komi PV, Saransaari P, et al. Leucine supplementation does not enhance acute strength or running performance but affects serum amino acid concentration. Amino Acids. 2003;25:85-94.
27. Cruzat VF, Rogero MM, Borges MC, Tirapegui J. Aspectos atuais sobre estresse oxidativo, exercícios físicos e suplementação. Rev Bras Med Esporte. 2007;13:336-42.
28. Rogero MM, Mendes RR, Tirapegui J. Aspectos neuroendócrinos e nutricionais em atletas com overtraining. Arq Bras Endocrinol Metab. 2005;49:359-68.
29. Nissen S, Sharp R, Ray M, Rathmacher JA, Rice D, Fuller JC Jr, et al. Effect of leucine metabolite beta-hydroxy-beta-methylbutyrate on muscle metabolism during resistance-exercise training. J Appl Physiol. 1996;81:2095-104.
30. Brass EP. Supplemental carnitine and exercise. Am J Clin Nutr. 2000;72:618S-23S.
31. Coelho CF, Mota JF, Bragança E, Burini RC. Aplicações clínicas da suplementação de L-carnitina. Rev Nutr. 2005;18:651-9.
32. Armentano MJ, Brenner AK, Hedman TL, Solomon ZT, Chavez J, Kemper GB, et al. The effect and safety of short-term creatine supplementation on performance of push-ups. Mil Med. 2007;172:312-7.
33. Casey A, Greenhaff PL. Does creatine supplementation play a role in skeletal muscle metabolism and performance? Am J Clin Nutr. 2000;27:607S-17S.
34. Ahrendt DM. Ergogenic aids: counseling the athlete. Am Fam Physician. 2001;63:913-22.
35. Preen D, Dawson B, Goodman C, Lawrence S, Beilby J, Ching S. Effect of creatine loading on long-term sprint exercise performance and metabolism. Med Sci Sports Exerc. 2001;33:814-21.
36. Souza Júnior TP, Pereira B. Creatina: auxilio ergogênico com potencial antioxidante? Rev Nutr. 2008;21:349-53.
37. DesJardins M. Supplement use in the adolescent athlete. Curr Sports Med Rep. 2002;1:369:73.
38. Ostojic SJ. Creatine supplementation in young soccer players. Int J Sport Nutr Exerc Metab.2004;14:95-103.
39. Maughan RJ. Role of micronutrients in sport and physical activity. Br Med Bull. 1999;55:683-90.
40. Margaritis I, Tessier F, Richard MJ, Marconnet P. No evidence of oxidative stress after a triathlon race in highly trained competitors. Int J Sports Med. 1997;18:186-90.
41. Kanter M. Free radicals and exercise: effects of nutritional antioxidant supplementation. Exerc Sport Sci Rev.1995;23:375-97.
42. dos Santos KM, Barros Filho AA. Consumo de produtos vitamínicos entre universitários de São Paulo, SP. Rev Saude Publica.2002;36:250-3.
43. Clarkson PM, Thompson HS. Antioxidants: what role do they play in physical activity and health? Am J Clin Nutr. 2000;72:637S-46S.
44. Weight LM, Myburgh KH, Noakes TD. Vitamin and mineral supplementation: effect on the running performance of trained athletes. Am J Clin Nutr.1988;47:192-5.
45. Lukaski HC, Hoverson BS, Gallagher SK, Bolonchuk WW. Physical training and copper, iron, and zinc status of swimmer. Am J Clin Nutr. 1990;51:1093-9.
46. Akabas SR, Dolins JR. Micronutrient requirements of physically active women: what can we learn from iron? Am J Clin Nutr. 2005;8:1264S-51S.
47. Molgaard C, Thomsen BL, Michaelsen KF. Effect of habitual dietary calcium intake on calcium supplementation in 12-14-y-old girls. Am J Clin Nutr. 2004;80:1422-7.
48. Lorenzen JK, Molgaard C, Michaelsen KF, Astrup A. Calcium supplementation for 1 y does not reduce body weight or fat mass in young girls. Am J Clin Nutr. 2006;83:18-23.
49. Lukaski HC. Magnesium, zinc, and chromium nutriture and physical activity. Am J Clin Nutr. 2000;72:585S-93S.
50. Pipe A, Ayotte C. Nutritional supplements and doping. Clin J Sport Med. 2002;12:245-9.
51. Magkos F, Kavouras AS. Caffeine and ephedrine physiological, metabolic and performance-enhancing effects. Sports Med. 2004;34:871-89.
52. Spriet LL, Gibala MJ. Nutritional strategies to influence adaptations to training. J Sport Sci. 2004;22:127-41.
53. Graham TE, Helge JW, MacLean DA, Kiens B, Richter EA. Caffeine ingestion does not alter carbohydrate or fat metabolism in human skeletal muscle during exercise. J Physiol. 2000;529 Pt 3:837-47.
54. Alvares TS, Meirelles CM. Efeitos da suplementação de b-hidroxi-b-metilbutirato sobre a força e hipertofia. Rev Nutr. 2008;21:49-61.
55. Slater G, Jenkins D, Logan P, Lee H, Vukovich M, Rathmacher J, et al. β-Hydroxy-β-Methylbutyrate (HMB) supplementation does not affect changes in strength or body composition during resistance training in trained men. Int J Sport Nutr Exerc Metab. 2001;11:384-96.
56. Ransone J, Neighbors K, Lefavi R, Chromiak J. The effect of beta-hydroxy beta-methylbutyrate on muscular strength and body composition in collegiate football players. J Strength Cond Res. 2003;17:34-9.
57. Van Montfoort MC, Van Dieren L, Hopkins WG, Shearman JP. Effects of ingestion of bicarbonate, citrate, lactate, and chloride on sprint running. Med Sci Sports Exerc. 2004;36:1239-43.
58. Raymer GH, Marsh GD, Kowalchuk JM, Thompson RT. Metabolic effects of induced alkalosis during progressive forearm exercise to fatigue. J Appl Physiol.2004;96:2050-6.

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