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Carbohydrate-Protein Supplements Can Improve Intermittent Running Performance

Soccer players generally experience increases in fatigue at the end of games, potentially as a result of depletion of muscle glycogen stores. In order to combat this response, carbohydrate (CHO) supplements are commonly given to soccer players in an attempt to spare muscle glycogen utilization and positively influence key performance time periods during the later stages of game play. Interestingly sensations of fatigue appear to mirror muscle glycogen depletion patterns. An additional strategy is to combine protein (PRO) and CHO supplements in an attempt to enhance short-term recovery. Several studies have been completed which demonstrate that combining PRO and CHO in one supplement has the potential to induce even greater performance enhancements in comparison to just PRO or CHO alone. However, most of the studies looking at PRO-CHO have examined time-to-exhaustion, and virtually no research has examined its effect on intermittent activities such as those seen in soccer. Recently, researchers from the United Kingdom attempted to explore the effects of PRO-CHO supplementation on short-term recovery and its effect on a soccer-specific intermittent exercise test when compared to an isocaloric CHO supplement. Three treatment conditions were explored including a placebo (PLC), CHO and PRO-CHO supplements. A total of six soccer players received each supplement condition in a randomized counterbalanced fashion. The CHO and PRO-CHO supplements yielded 272 kcals in 515 mL of liquid. The PLC treatment yielded 4 kcals in 515 mL of liquid. Under each condition, the subjects performed a total of five 15-min cycle bouts. The first three bouts were completed in 45 min at which time a simulated 15-min halftime occurred after which the subjects performed two more 15 min bouts of exercise followed by a run time to failure test at 80% of VO_2. Supplements were given before the first cycle bout and during the simulated halftime in order to simulate when a soccer team may be able to provide supplements during a game scenario. PRO-CHO supplements resulted in a significantly greater time-to-exhaustion when compared to the CHO (PRO-CHO: +6.53 min) and PLC (PRO-CHO: +12.02 min) treatments. Ratings of perceived exertion were also significantly lower in the PRO-CHO treatment when compared to the CHO and PLC treatments. Overall, the results of this study suggest that the combination of PRO and CHO can have a meaningful impact on performance in intermittent sports such as soccer when administered during key points prior to and during game play. This performance gain may be most noted during the later stages of the game play, which traditionally has been noted as a time point when significant fatigue manifests itself.

Alghannam, AF. Carbohydrate-protein ingestion improves subsequent running capacity towards the end of a football-specific intermittent exercise. *Applied Physiology, Nutrition, and Metabolism* 36: 748–757, 2011.

Omega-3 Fatty Acid Supplements Attenuate Inflammation

Performing exercise that contains a significant eccentric component is often marked by acute muscle injury and acute inflammatory responses. In these situations, alterations in specific tissue damage markers such as creatine kinase (CK), lactate dehydrogenase (LDH), and myoglobin (Mb) content are often noted. Additionally, elevations in interleukin 6 (IL6), tumour necrosis factor α (TNFα) as well as prostaglandin E2 (PGE2) have been noted. One proposed method for dealing with these acute responses to eccentric exercise is to use nutritional or pharmacological countermeasures in an attempt to mediate acute muscle damage and inflammatory responses. While very few nutritional interventions have been shown to be successful, pharmacological interventions such as nonsteroidal anti-inflammatory (NSAID) treatments have been shown to address these responses. However, due to the potential negative effects of NSAID treatments, investigations into the effects of polyunsaturated fatty acids (PUFAs) and effects on inflammatory responses have become popular. Several studies have shown positive effects of PUFAs specifically in their ability to reduce PGE2 and other eicosanoids, while cell culture studies suggest a positive effect on IL6 and TNFα. In the clinical literature PUFAs appear to positively affect C-reactive protein, IL6, PGE2, and TNFα responses. However, very little research has been completed examining the effects of PUFAs on exercise-induced muscle damage, such as the response seen in eccentric exercise. In the present study, a total of 45 young healthy untrained subjects were recruited and placed into either a treatment (n=15), placebo (n=15), or a control group (n=15). The placebo group took one supplement capsule per day,

while the treatment group consumed 1.8 g per day of N-3 family PUFAs that contained 324 mg eicosapentaenoic acid (EPA) and 216 mg of docosahexaenoic acid (DHA). Each supplementation regimen was conducted for a total of 30 days before and 48 hr after the exercise program. The exercise program consisted of 40 min of bench stepping at a rate of 15 steps per minute to a 50 cm average height box. There were five blood draws taken during the course of the investigation including prior to supplementation, before the exercise protocol, immediately after the exercise protocol, 24 hr post-exercise protocol, and 48 hr post-exercise protocol. The treatment group demonstrated significantly fewer elevations in TNFα and PGE2 immediately, 24 and 48 hr after the exercise bout. At 24 and 48 hr after the exercise bout the treatment group also demonstrated significantly lower IL6, CK, and Mb concentrations. Based upon these results, the researchers recommended consuming N-3 family PUFAs before, during and after bouts of exercise that contain high amounts of eccentric muscle actions. This recommendation is based upon the data which suggests that N-3 PUFAs have potential anti-inflammatory properties which could reduce exercise-induced muscle damage. While these results are promising, much more research is warranted to look at the long-term training effects of this type of nutritional countermeasure.

Tartibian, B, Maleki, BH, and Abbasi, A. Omega-3 fatty acids supplementation attenuates inflammatory markers after eccentric exercise in untrained men. *Clinical Journal of Sport Medicine* 21: 131–137, 2011.

Can a Dietary Supplement Improve Cognitive Function?

Creatine is probably the most investigated dietary supplement, yielding positive performance responses in high-intensity exercise activities as well as improving strength and muscle mass in individuals who strength train. More recently, an exploration of creatine's effect on cognitive function has become popular. While there is much dispute in the literature about the efficacy of creatine supplementation as a countermeasure for declining cognitive function, some researchers have suggested that this supplement may be useful for those carrying apoEε 4, a genetic risk factor for Alzheimer's disease, as well as part of the treatment paradigm for Huntington's and Parkinson's disease. It is well documented that creatine is synthesized in the body from the amino acids glycine, arginine, and L-methionine. When examining the brain specifically it has been suggested that creatine content is largely synthesized in situ. The consumption of 5 g of creatine monohydrate four times a day has been shown to result in an 8.7% increase in brain creatine levels. Additionally, it is well documented that creatine is mainly found in meat products and that individuals who don't consume meat, have lower muscle creatine levels. Very little research has explored the combined effect of dietary practices and creatine supplementation on cognitive function. In order to explore this phenomenon, researchers from the United Kingdom examined the effect of a vegetarian and omnivore diet on the effects of a creatine supplement's ability to impact cognitive function. One hundred and twenty one young women were recruited and separated into either a vegetarian (n=70) or omnivore (n=51) diet group. The groups were then randomly sub-divided into either a creatine supplemented (n=61) or placebo treatment group (n=60). Subjects who were given creatine consumed 20 g per day for five days. It was determined that creatine supplementation did not influence verbal fluency and vigilance. Vegetarians, however, experienced an enhanced memory when consuming creatine supplements. Regardless of diet, it was also determined that creatine supplements decreased the variability in the subjects' responses to a choice reaction-time task. While these preliminary findings appear promising, it is too early to establish the exact mechanism for creatine's ability to impact basic brain physiology and cognitive function. At this time, much more research is needed in order to fully understand creatine's effects on the brain.

Benton, D, and Donohoe, R. The influence of creatine supplementation on the cognitive functioning of vegetarians and omnivores. *The British Journal of Nutrition* 105: 1100–1105, 2011.

How Many College Students Consume Energy Drinks?

Fluid intake is an essential component of the human diet. In the United States the average caloric intake has increased by about 150 – 300 kcal per day, with 50% of this increase largely coming from an increase in the consumption of sweetened beverages. When examining young individuals, energy drink consumption is increasingly contributing to their overall fluid intake. Research on energy drinks reveals that they have the potential to improve attention, reaction times, and alertness. Additionally, the combination of caffeine and glucose has been shown to reduce deficits in cognitive performance and subjective fatigue during periods of intense cognitive demand. Additionally, this combination of ingredients can prevent sleep, increase heart rate and blood pressure mainly in response to the caffeine contained in these beverages (50 – 505 mg per can). While it appears that energy drink consumption is on the rise more information is needed to understand the frequency of consumption in various populations including college students. A cross-sectional study of college students at Hacettepe University in Ankara, Turkey was examined in this investigation. Four hundred and thirty nine students participated in this investigation. The highest rates of energy drink consumption were found in students who were studying arts and sports as well as those who regularly did not consume breakfast, smoked, drank alcoholic beverages, and participated in sports. Reasons for using energy drinks included increasing energy, staying awake, boosting sports performance, and mixing with alcohol. Over 40% of the current energy drink users reported mixing them with alcoholic beverages. When questioned about the ingredients and potential side effects of energy drink consumption most students were unable to identify

either ingredients or side effects. Additionally, most students were unable to distinguish between sports and energy drinks. Based upon this study, it was concluded that energy drink use by college students is very prevalent, particularly in conjunction with alcoholic beverages. Overall, more research on the health effects of energy drinks and the reasons students use them is warranted.

Attila, S, and Cakir, B. Energy drink consumption in college students and associated factors. *Nutrition* 27: 316–322, 2011.

Increasing Protein Intake During Periods of Intensified Training Can Reduce Symptoms of Psychological Stress and May Reduce Performance Declines

Periods of intentionally increased training volumes are commonplace in the training practices of most athletes. These periods of intentional overreaching challenge the athletes' abilities to recover by creating perturbations in biological function and psychological status. One potential countermeasure to these occurrences has been the consumption of carbohydrates (CHO) in an attempt to increase the athletes' tolerance to intensified training. Recent research suggests the possibility that the consumption of protein after an acute bout of intensified endurance training has the potential to positively affect markers of muscle damage, modulate post-exercise protein balance, and increase rates of glycogen resynthesis. While it appears that the consumption of additional protein exerts a positive acute benefit, very little research has been conducted looking at the effects of increasing protein consumption during periods of intentional overreaching or intensified training in endurance athletes. Recently, researchers from the University of Birmingham in Edgbaston in the United Kingdom examined the effects of increased protein intake on short-term endurance responses to a period of high-intensity training. The study involved eight well-trained endurance cyclists performing two 3-week trials equally divided into normal, intensified, and recovery training. In a randomized counterbalanced design, the cyclists received a high protein (3 g/kg per day) a normal diet (1.5 g/kg per day) each combined with normal carbohydrate intake (6 g/kg per day). Energy balance was maintained throughout each training week. Performance was assessed with a VO_2 max test and a 120 min time trial performed at 50% of Watt max at the end of each week. Results of the study suggest that increased protein intake during intensified training attenuates the reduction in time trial performance when compared to the normal diet. Psychological markers of stress were also reduced with the additional protein consumption. Overall, increasing the amount of protein in the diet during intensified training appears to result in an attenuation of psychological stress and a worthwhile attenuation of the performance decrements that typically occur during intensified training. ■

Witard, OC, Jackman, SR, Kies, AK, Jeukendrup, AE, and Tipton, KD. Effect of increased dietary protein on tolerance to intensified training. *Medicine and Science in Sports and Exercise* 43: 598–607, 2011.

Kyle Brown, CSCS

Water is Nature's Energy Drink: Secrets of the Best Performance Enhancer

Athletes are constantly looking for a competitive edge. Many want a magic pill or energy drink that will increase their energy, improve their stamina, and improve their fat-burning ability. Sadly, such a solution does not exist. The answer does not come in a pill; it actually comes in a liquid and is available to anyone. The answer to the competitive edge so many athletes seek is, simply, water. Water is nature's most important substance for energy and weight management to improve performance.

According to Dave Carpenter, ND, optimal hydration is vital to maximal performance because water performs the following functions (2):

- Stabilization of body temperature
- Removal of lactic acid and waste products from muscle cells, which helps dissolve minerals and other nutrients, making them accessible to the body
- Maintenance of DNA/mRNA structure and function for the generation of new repair proteins
- Support of the three-dimensional infrastructure of enzymes that repair existing proteins
- Reinforcement of protein structure
- Facilitation of the reactions in the cell mitochondria that release energy from the energy currency molecule, known as ATP
- Transportation of compounds made in the central nervous system to the periphery
- Transportation of nutrients and oxygen to cells throughout the body

Water also serves as the major constituent of the synovial fluid in joints; the fluids between the lungs and the chest wall, the abdominal organs, the inner lining of the abdomen, the cushioning material in cartilage and vertebral disks that absorbs the shock of forces generated during vigorous movement, and the connective tissue fluids that lubricate movements of muscle and fascia (2).

In addition, water helps alkalize the body as it detoxifies and removes acid waste. The reason water is nature's best fat burner is that it suppresses one's appetite while it speeds up the metabolism.

Dehydration

The body's primary fuel is a combination of water and minerals. The body can survive days without food but cannot last much more than 100 hr without water (3). Frequently, individuals become dehydrated without realizing it by misinterpreting hunger for thirst after it's already too late. The small amount of water required to quench thirst is generally not enough to hydrate the body. It only takes slight dehydration to reduce energy levels and performance and alter the ability to think clearly.

Most athletes underestimate the amount of water lost during practice and competition. Keep in mind that the body is more than 70% water. Blood is more than 85% water, muscles more than 75% water, and the liver is 96% water (2).

Dehydration is one of the main reasons it can take so long for athletes to recover from intense workouts and competitions. Adequate hydration reduces recovery time and enhances performance. If you're 1% dehydrated it can cause a 5% decrease in cognitive function (2). Fortunately, when you drink a glass or two of water your hydration and energy levels can improve quickly (1). It's helpful to carry a liter-sized water bottle with you throughout the day. Dehydration can lead to headaches. Drink a big glass of water right when you wake up in the morning to help you rehydrate after sleeping.

about the AUTHOR

Kyle Brown is a health and fitness expert whose portfolio includes everything from leading workshops for Fortune 500 companies and publishing nutrition articles in top-ranked fitness journals, to training celebrity clientele—from pro athletes to CEOs to multiplatinum recording artists. Kyle's unique approach to health and fitness emphasizes nutrition and supplementation as the foundation for optimal wellness. After playing water polo for Indiana University, as well as in London, Kyle became involved in bodybuilding and fitness for sport-specific training. Kyle is the creator and Chief Operating Officer for FIT 365—Complete Nutritional Shake (www.fit365.com).

Remember, water you get in a public water fountain can fall short of the quality of water your body needs. Make sure your water is at least filtered of environmental toxins like herbicides and pesticides or mountain spring water, or from another untainted source. Despite being a public fountain, it is a much better choice than not drinking enough water. ■

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Effects of Antioxidants on Sports Performance

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Andrew Vu is currently an exercise physiologist at a local hospital and sole proprietor of Epiphany Fitness (www.epiphanyfit.com). Vu received both his Bachelor of Science and Master of Art degrees in Kinesiology from San Jose State University. He holds multiple fitness training certifications, including the Certified Strength and Conditioning Specialist® (CSCS®), and is a registered emergency medical technician (EMT) in the state of California. Vu's training expertise is on weight loss and health education. He has been a personal trainer for over eight years and has been a practicing exercise physiologist for four years.

Recently, antioxidants have become a popular topic when it comes to nutrition and health. Some athletes feel adding antioxidants to their diet, through food or supplementation, will help increase their performance on the playing field. This belief is based on research findings that have shown antioxidant supplementation may have health benefits. Antioxidants have been found to help protect against harmful naturally produced chemicals in the body, known as free radicals, which can lead to advanced aging, cancer, cardiovascular disease, degenerative disease (arthritis), muscle fatigue, and muscle injuries (2,3).

What are Antioxidants?

To better understand how antioxidants affect the human body, it is important to know the definition of an antioxidant. Many things happen when the body utilizes oxygen for its energy needs, including a process that converts oxygen to energy. During this process, cells in the body inadvertently create harmful byproducts (i.e., free radicals), leading to the body's inability to balance the oxygen and the free radicals which may cause damage to the body; this is known as oxidative stress (2). Antioxidant compounds help protect biological systems against the harmful effects or reactions that create excessive oxidants (3). From a nutritional standpoint, the body receives antioxidants from vitamins A, C, E, and the minerals selenium, copper, zinc, and manganese (2).

Effects on Sports Performance

Although the benefits of antioxidants in sports performance are still debatable, the various antioxidant vitamins and minerals have been shown to benefit endurance but not strength performance (2). Table 1 illustrates the various antioxidant vitamins and minerals and the effects they have on sports performance (2).

Even with some of the performance benefits antioxidants may yield, there still isn't enough research to conclusively state that antioxidants improve sports performance. However, if an athlete is deficient in a certain vitamin or mineral, then correcting that deficiency may improve performance (2). However, athletes should try to meet their vitamin and mineral needs by eating an adequate diet rather than through supplementation (1,3). ■

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Table 1. Antioxidants and Their Effects

Vitamin / Mineral	Effects on Performance
Vitamin A	Has been shown to reduce muscle soreness
Vitamin C	Maintains normal connective tissue and cut the risk of upper respiratory infections
Vitamin E	Appears to prevent destruction of O_2 carrying red blood cells, which could potentially improve aerobic performance
Selenium	Aids in normal growth and metabolism
Copper	Assists in formation of hemoglobin and red blood cells
Zinc	Assists in growth regulation and promotes wound healing (Also has been shown to boost the immunity system)
Manganese	Aids in metabolism

Performance Foods of the Future

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The currently accepted standard for a healthy diet for peak athletic performance includes eating an appropriate amount of carbohydrates, proteins, fats, vitamins, and minerals (4). Adequate fluids are also essential for optimum strength, power, endurance, and overall health. Many athletes consume these important foods by following the recommended dietary plan of the United States, MyPlate, previously referred to as the Food Guide Pyramid (12). The design includes eating fruits, vegetables, grains, meats, and dairy products.

In addition to MyPlate, athletes, coaches, and sports enthusiasts often create their own individual diet based on scientific research, peer recommendations, or personal preferences believing they can further enhance performance. Some athletes severely restrict or eat abundant amounts of carbohydrates, fats, proteins, minerals or vitamins. Consumption of commercial supplements and/or varying the time at which nutrients are consumed is also commonly used in an attempt to enhance strength, power and endurance (4).

The future of peak sports performance and scientific advances in sports nutrition may involve a new source of nutrition—insects. Because the consumption of insects may be a healthier way to improve sports performance, adhere to time-tested nutritional concepts, and sustain overall health and fitness, this practice may become the preferred power diet of the future. For many people in the United States, the thought of eating insects usually elicits a reaction of disgust, fear, avoidance, or curiosity. It should be noted however, that eating insects has existed for over 7,000 years and is very common in many parts of the world (13). Even in Biblical times, crickets and grasshoppers were considered important sources of food energy. Currently, more than 2,000 species of insects are eaten by over 3,000 ethnic groups in Asia, Australia, and Central and South America (13). Not only are insects a common delicacy in many restaurants today, they are also a very good source of food energy. Insects are a rich source of carbohydrates, proteins, fats, vitamins, and trace elements (5). A caterpillar, for example, has more protein per gram, and 10 times the iron content of lean ground beef (6).

In addition to their high nutritional value, ingesting insects may reduce the chance of developing food poisoning, or disease caused by diet. By varying food sources, one will be less inclined to overconsume something that is bad and that can cause harm. In ancient times, the practice of varying food sources was an effective means to ensure that poisonous food did not reach critical levels inside one's stomach (3). Philosophers and physicians from ancient Greece and Rome also supported this concept; they referred to it as moderation (7). This practice, currently supported by today's nutrition experts, is known as variation. For example, healthy diets can include apples, snails, sea cucumbers, ants, and burdock root (2). Extreme diets that do not follow the guidelines of moderation and variety often fall short of providing adequate nutrition.

There are a number of insects that are commonly eaten around the world today that provide great nutritional value. Many of these insects need special preparation to ensure good taste and safe eating. There are many techniques used to boil, fry, and prepare the food. Examples of commonly eaten insects include grasshoppers, silkworm pupae, wasps, longhorn beetle caterpillars, weaver ants, dung beetles, stinkbugs, and termites.

It is reasonable to assume that MyPlate and performance eating plans of the future will add insects to the recommended list of foods. Coaches and sports experts may see the potential for improved performance by expanding their current thinking on what constitutes a safe, effective, and highly successful nutritional eating plan. The food guide proposed in Table 1 may become the power eating plan of the future. Creating a daily diet that includes a variety of food, from each box each day, may be commonplace in the near future.

Table 1: Food Box of the Future

Plants	Animals	Insects
Fruits: Apple, Banana,	Land: Poultry, Beef, Pork	Flyers: Wasps
Vegetables: Carrots, Peas	Water: Seafood, Fish	Walkers: Ants
Grains: Wheat, Barley, Flax		Crawlers: Caterpillars
Nuts: Almond, Hazel		
Beans: Pinto, Black		

If the food box of the future seems strange, odd, or eccentric, there is evidence that might make it more appealing or acceptable. First of all, insects are in many of the foods we currently eat. The Food and Drug Administration (FDA) allows insects to be present in the foods we consume, to a certain extent. For example, 10 insect fragments are allowed per 100 g of chocolate, and 30 insect fragments are allowed per 100 g of peanut butter (10). Secondly, populations in developing countries who suffer from hunger and malnutrition could benefit from non-traditional food sources. People in the United States make up only 10% of the world's population but consume 70% of all the food (1,9). So, insects may be a healthy, nutritious and available alternate food source to supplement current food choices. ■

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The Influence of Nutritional Ergogenic Aids on Soccer Skill Performance

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Mark Russell is currently a Senior Lecturer at Moulton College and is also the Editor of www.scientific-football.com. Russell has a PhD in Exercise Physiology from Swansea University and his research interests focus mainly on the physiology of intermittent exercise and interventions to promote improvements in performance in team-sport athletes. As a result of this research, Russell continues to publish academic journal articles and works with a range of professional sports teams and athletes.

Success in soccer is determined by the number of goals scored. Consequently, the performance of skilled actions, such as dribbling, passing, and shooting, can influence the outcome of a match. In the latter stages of a match, a reduced capacity to perform certain physical components of match play (such as sprinting and high-intensity actions) is a common observation. However, evidence seems to suggest that skilled performances may also be influenced by exercise, as recent research from Swansea University has confirmed previous observations that important aspects of passing and shooting skills are influenced by soccer-specific exercise, particularly in the second half (5).

Although the cause of this reduced level of skilled performance is currently unclear, a number of factors have been proposed, including reductions in fuel availability (i.e., lowered muscle glycogen and blood glucose concentrations), impaired cognitive function (i.e., reductions in reaction times and decision making skills), dehydration (i.e., increased thermal strain due to a fluid loss in excess of 2% body mass) and changes in acid-base balance (i.e., a reduced capacity to buffer hydrogen ions produced by high-intensity exercise). Over the past decade, evidence relating to strategies that aim to minimize the effects of exercise on the performance of skills during soccer-specific exercise has begun to accumulate, and most of these strategies have related to the use of selected nutritional interventions, including carbohydrates, caffeine, buffering agents, and fluid provision.

Carbohydrates

Acute supplementation of carbohydrates is generally used to improve physical performance relating to exercise endurance (e.g., time-to-exhaustion); however, as the brain is the only organ that is primarily dependent on blood glucose concentrations for maintenance of optimal functioning, decisions made in the game and the performance of the skills executed during match play are probably influenced by blood glucose concentrations. Although the issue of whether or not blood glucose concentrations actually decline to levels that may impair performance throughout soccer match play is still under debate, carbohydrate supplementation strategies which aim to elevate blood glucose concentrations throughout exercise are routinely used and advocated in most team sports. Although the primary reason behind this is related to physical performance, evidence suggests that exogenous carbohydrates may offer an acute strategy to prevent reductions in skilled performances throughout simulated or actual soccer match-play.

A study headed by Stephan Bandelow, PhD, at Loughborough University recently identified that serum glucose concentrations appear to be an important determinant of cognitive function before, at halftime, and after soccer match play performed in the heat (2). Specifically, higher glucose concentrations were associated with faster visual discrimination, faster fine motor speed and faster psychomotor speed. Therefore, as cognitive processes are crucial to the skilled actions involved in competitive team sports, and the role that blood glucose plays in the maintenance of the functioning of the brain, it is plausible that carbohydrate supplementation regimens in the form of sports drinks and sports gels could maintain selected soccer skills in the latter stages of a soccer match; however, further research is warranted to identify the specific carbohydrate supplementation strategies that achieve this aim optimally.

Caffeine

Caffeine is a central nervous system stimulant which has consistently been reported to enhance concentration and reaction time during non-sports-related tasks. Consequently, supplementation of caffeine may improve performance for athletes participating in team sports that require the execution of skills, concentration, and cognitive

function. Although previous researchers have attempted to investigate this in soccer players, the precise effects of caffeine on soccer skills are currently unknown and thus, remain undetermined. That said, it is physiologically plausible that caffeine could improve skilled performance either on its own due to its stimulatory effects on the brain, and/or by increasing the oxidation of co-ingested carbohydrates as observed by researchers at the University of Birmingham (7).

Buffering Agents

Supplementation of buffering agents (e.g., sodium bicarbonate and sodium citrate) aim to increase the body's tolerance to the change in acidity that occurs throughout high-intensity exercise and is a relatively common supplementation strategy used by today's athletes. Although the effects of this type of ergogenic aid have consistently been shown to improve physical performance (e.g., sprinting and exercise endurance), researchers at the National Taiwan College of Physical Education recently observed that reductions in skilled performance that occurred following a simulated tennis match were prevented when players ingested the buffering agent, sodium bicarbonate (6). This data suggests that the performance of tennis skills may be improved by ingesting buffering agents. Although this finding remains to be confirmed in soccer players, it is scientifically plausible that the effects are not limited to tennis alone as both soccer and tennis require skilled actions to be performed throughout high-intensity exercise.

Fluid Provision

In athletes that started exercise in a fasted and energy-depleted state and also drank a beverage that did not replace fuel or electrolytes during a continuous 90 min exercise test, Ajmol Ali, PhD, and colleagues observed reduced shooting performances after exercise compared to before exercise (1). Similarly, in a study headed by Stephen McGregor, PhD, soccer dribbling performance was observed to decline by 5% when players were prevented from drinking any fluid during 90 min of exercise (4). Although the application of these findings is limited by the unrealistic nature of the state of the participants before exercise (i.e., you would not be recommended to start exercise without having eaten and while being in a poor state of recovery), and the fluid intake regimens used during exercise (i.e., current recommendations advocate consumption of 150 – 300 mL of a carbohydrate-electrolyte beverage every 15 min during exercise lasting longer than 60 min when weight loss is not desired), the link between dehydration and impaired performance is strengthened by the fact that strength, power and anaerobic endurance are also compromised by dehydration (3). Therefore, consuming fluid in a manner that adheres to the recommended guidelines for athletes may prevent the performance deterioration that appears to result from dehydration.

In summary, despite coaches and athletes allocating a large proportion of training time to improving soccer skills, it is also possible that certain nutritional strategies may have an acute effect on skilled performances throughout the duration of match-play. Although research to identify the effects of carbohydrates, caffeine, buffering agents and fluid provision on the quality of skills performed during exercise is ongoing, athletes are recommended to consider their use when seeking to maintain their skilled performances throughout exercise. ■

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Vitamin D: Much More Than Bone Health

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Dawn Weatherwax is a Registered/ Licensed Dietitian with a specialty in Sports Nutrition and is the Founder of Sports Nutrition 2Go. She is also a Board Certified Specialist in Sports Dietetics. In addition, she is an athletic trainer and has earned the Certified Strength and Conditioning Specialist® (CSCS®) credential. Weatherwax is also the author of The Official Snack Guide for Beleaguered Sports Parents and The Complete Idiot's Guide to Sports Nutrition. Weatherwax is an official speaker for the Gatorade Sports Science Institute. She has also been featured on television shows that include Good Morning America, MSNBC, Geraldo Rivera, and Fox News.

In the past couple of years vitamin D has received a lot of attention regarding how it impacts overall health. However, many fitness professionals still do not realize vitamin D goes well beyond bone health and "female" clients.

What is Vitamin D?

Vitamin D is a secosteroid; it functions as a modulator for as many as 1,000 genes involved in cellular growth, immune function and protein synthesis as well as intestinal calcium absorption and osteoclastic activity (1,3). Vitamin D is related to health and athletic performance through the following processes (1,2,3):

- Calcium homeostasis and bone health
- Immunity
- Inflammatory modulation
- Skeletal muscle function
- Potential to impact health, training and performance of athletes

Not Just a "Female" Issue

One research study found that 72 out of 89 football players in the National Football League (NFL) with an average age of 25, had inadequate levels of vitamin D (6). Vitamin D levels range from 32 – 100 ng/dl on most lab reports. Serum 25(OH) D concentration is the best indicator of vitamin D status and 40 – 70 ng/dl are considered optimal levels (5,6).

Out of these 89 NFL football players, 27 players had deficient levels (<20 ng/dl) and 45 had insufficient vitamin D levels (20 – 31.9 ng/dl). Sixteen of the 27 players suffered a muscle injury with an average vitamin D level of 19.9 ng/dl.

Vitamin D conversion comes mainly from sunlight and happens around midday when the sun is highest overhead. Many people are out in the morning or evening but not as much during the lunch hour. Also, depending on the region in which you live, vitamin D conversion during the winter months may be severely limited (e.g., latitudes above or below 35 – 37 degrees north or south have no conversion). Another contributing factor is the increased usage of sunscreen and the push to wear it at all times.

How Much Sun is Needed

Anywhere from 5 – 30 min per day of sun exposure is suggested (5). The lighter the skin color one has, the less time is needed in the sun to absorb vitamin D; the darker the skin color one has requires a longer exposure time for optimal conversion (5).

Food Sources and Guidelines

The goal is to acquire 200 IU of vitamin D per day from food. Fatty fish (e.g., mackerel, salmon, sardines, and tuna), fortified milk, egg yolks, fortified orange juice and certain brands of margarine, yogurt and cereal are reputable sources of vitamin D (4).

Overall Recommendations

- Does not matter if you are a female or male
- 200 IU of vitamin D per day through food
- Serum 25(OH) D between 40 – 70 ng/dl for optimal levels
- 5 – 30 min of sunlight per day depending on skin color and living location
- Individuals with limited sun exposure require 1,500 – 2,000 IU per day of vitamin D to maintain a sufficient range

It is suggested that coaches start asking their clients/athletes if they know their current vitamin D status due to the percentage of individuals who are not at optimal levels, and its importance to the bone, immune, muscular and inflammatory systems. ■

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Nutritional Considerations for the Adolescent Athlete

Athletic performance during adolescence has received a great deal of attention in recent years as competitive performance has increased in both intensity and popularity. Adolescence (i.e., 13 – 19 years of age) marks the beginning of increased energy demands, hormonal changes, transition into puberty and elevated rates of growth and development. A wide range of physiological variation exists within this age range; therefore, individual recommendations for carbohydrates, protein, fat and fluids should take into account both physical maturation age and activity level (3,7).

Calorie Requirements

Adolescent athletes experience an increased demand for calories to ensure proper growth and physical development as well as those demands required for training. Adolescents who do not consume enough calories to meet those demands may experience a loss of muscle mass, menstrual dysfunction, loss or failure to gain bone density and an increased risk for fatigue, injury or illness (3). Due to the number of factors affecting adolescent energy needs, the Institute of Medicine (IOM) recommends a range of caloric recommendations (as seen in Table 1). Adolescent athletes should consume the higher end of the calorie range seen in Table 1 and those that experience a period of rapid growth, or a "growth spurt," should consume an additional 500 calories per day above their usual intake (2).

Macronutrient Requirements

To determine macronutrient (i.e., carbohydrates, protein and fat) needs for adolescent athletes, the total daily number of calories is broken down below.

Carbohydrates are the main source of energy during exercise and serve to replenish muscle and liver glycogen after bouts of intense physical exercise. Adolescents should aim to consume 55 – 60% of their daily calorie intake as carbohydrates (2). Athletes training in endurance exercise for longer than 90 min are recommended to consume 6 – 10 g of carbohydrates per kg of body weight during training. Additionally, those who train aerobically for longer than 60 min should consume 25 – 30 g of carbohydrates every 30 min during exercise (4). Refueling after a bout of intense exercise is critical to replenishing glycogen stores and keeping energy up. Guidelines recommend a 3:1 ratio of carbohydrates to protein for post-exercise consumption (e.g., crackers and cheese, cereal and milk or fruit and yogurt) (7).

Table 1: Institute of Medicine (IOM) Calorie Recommendations for Adolescent Athletes (3).

	Adolescents: 13 – 19 Years
Boys	3000 – 6000 calories per day
Girls	2200 – 4000 calories per day

Protein provides essential amino acids that support the growth and development of lean body mass and contribute to athletic performance during periods of extended exercise and recovery (4,6). The recommended daily allowance for protein in active adolescents is 2 g/kg of body weight per day (g/kg/day) (4). Activity level and type of training require varied protein needs for adolescent athletes (as seen in Table 2) (4,7). Eating more protein than the daily requirements should be avoided because it can lead to dehydration and loss of calcium, and has not been proven to improve performance (4).

Table 2: Adolescent Athlete Daily Protein Recommendations (3).

Activity Level	Protein (g/kg/day)
Early Resistance and Endurance Training	1.5 – 1.7
Resistance Training	1.2 – 3.4
Maintenance Phase	1.0 – 1.4

Table 3. IOM Fluid Recommendations (4).

Sex	Age	Liters/day
Male	9 – 13 years	2.4 L/day
	14 – 18 years	3.3 L/day
Female	9 – 13 years	2.1 L/day
	14 – 18 years	2.3 L/day

Fats are a secondary fuel source during prolonged exercise and are necessary for normal growth and function. Fat is also an essential component for the female reproductive cycle, vitamin absorption and protection of internal organs (3). There are no additional recommendations for type of fat or intake above those of a normal individual. Daily fat intake should constitute 20 – 25% of total daily calories with an emphasis on consuming a total fat intake of no more than 10% saturated fat, 10% polyunsaturated or 10% monounsaturated fats to compose no more than 30% of total calories from fat (2,5,4,7).

Fluid Requirements

An athlete should drink fluids before, during and after athletic events to prevent dehydration and fatigue, and promote optimal performance during exercise (Table 3). Athletes can experience significant water losses through sweat as individual sweat rates vary based on body size, exercise intensity, temperature and humidity (7).

Body weight changes are the best method to determine fluid replacement needs and even a 1% decrease in body weight from sweating can significantly impact athletic performance (6). To account for water losses during an exercise session, athletes should consume 500 mL of fluid for every 1 lb lost during an exercise session (4). In addition, athletes should aim to drink 400 – 600 mL of fluid 2 – 3 hr before exercise and 150 – 350 mL every 15 – 20 min during exercise (4,7). Water is the best source of hydration for exercise that lasts less than 60 min. Athletes exercising longer than 60 min, or at an elevated temperature or humidity level, may benefit from consuming a sports drink with a 4 – 8% carbohydrate solution (4,7,8).

Bottom Line

Adolescence marks a time of increased growth and development that should be accounted for with individualized additional energy recommendations, especially for adolescent athletes. This age group should be monitored closely to ensure they meet energy and hydration needs for proper growth and development as well as for optimal sports performance and overall health. ■

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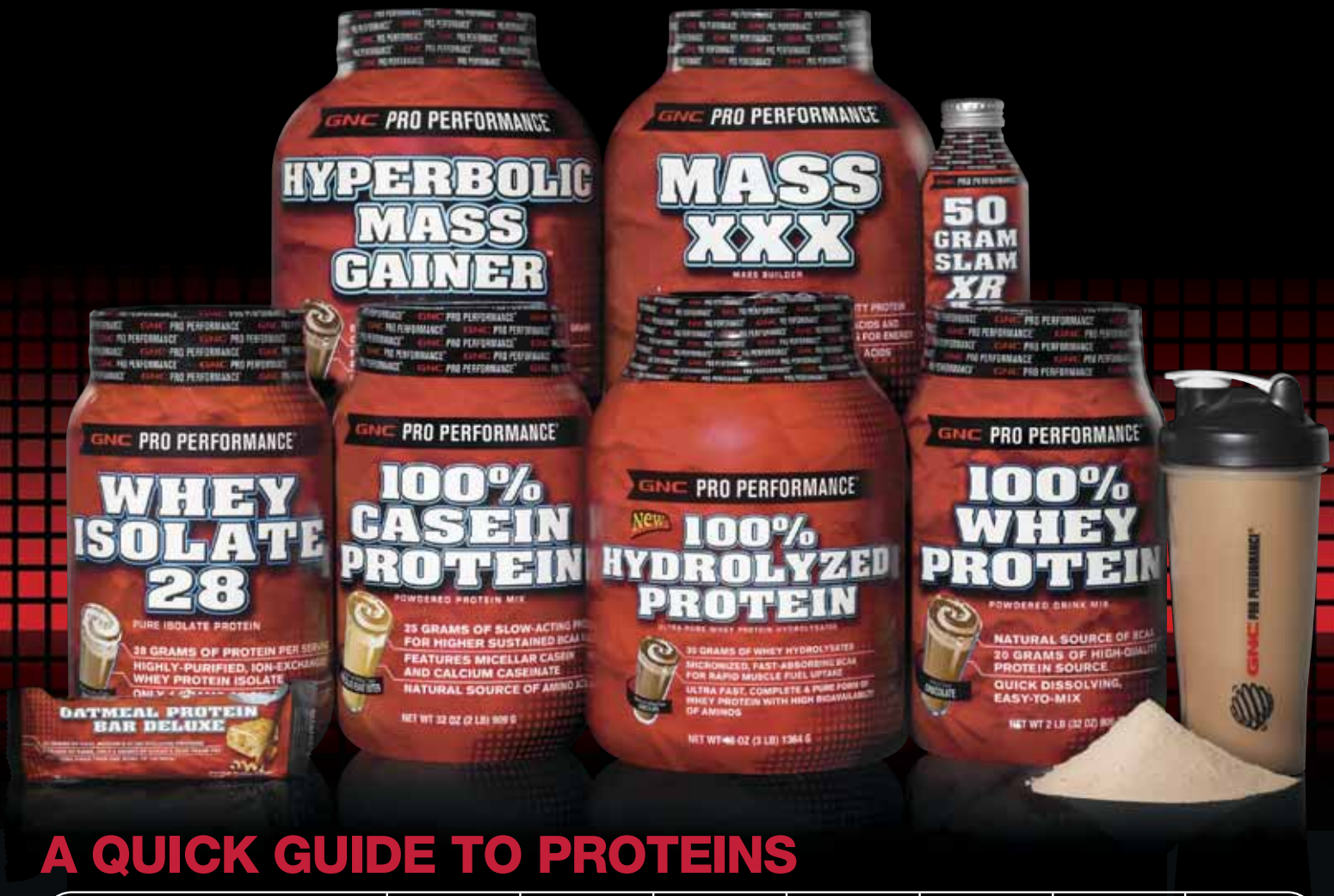

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