Hello PINES Members and Conference Attendees!

After a very successful first PINES conference held May 26th, 2009 in Seattle, WA in conjunction with the American College of Sports Medicine Annual Meeting, I am pleased to provide the following conference proceedings on behalf of all of our speakers and experts addressing Hot Topics in Sport Nutrition.

Our conference was divided into two parts. It began with a session in the format of a debate to address the current scientific controversy about the effect of protein in sports drinks on performance. The two debaters were Dr. Jeff Zachweija taking the side of no protein in sports drinks and Dr. Michael Saunders defending the addition of protein to sports drinks. This session was to deliver to the audience an unbiased view through an evidence-based approach pursued by the two presenters.

The second session was organized as discussion forum centered on “The 10 Most Frequently Asked Questions in Sport Nutrition”. This session included responses from international experts to a series of frequently asked questions. Each respondent was allowed a maximum of three slides and three minutes to make their point before comments and questions were invited from the audience. After each presentation, the audience was able to ask questions intended to stimulate a lively and interactive discussion. Unique about this discussion forum was that the presenters were not on stage behind a podium but presented from the grounds of the audience, which stimulated a lively interaction among participants.

From our attendees’ feedback, PINES should repeat this format and its conference in the future (for updates please check http://www.sportsoracle.com/pines/pines-home). The following proceedings summarize the debate and frequently asked questions in sport nutrition in abstract form. Note that some of the responses are addressed to athletes, whereas others speak directly to the professional in nutrition for exercise and sport.

Best Regards,

Nanna Meyer
PINES President

Preface

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Presenting the opponent’s view:
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Gatorade Sport Science Institute
Chicago IL, USA

I am of the opinion that protein is not a necessary component of sports drinks. In defending this position it is important to first define what a sports drink is. Second, provide evidence for effectiveness of the contemporary formulation and lastly expose the flawed thinking that has led to the proposal that a protein containing sports drink is more efficacious. Upon inception, a sports drink was designed to be consumed during exercise to offset dehydration and carbohydrate depletion. A sports drink is typically composed of water, flavor, electrolytes (primarily sodium, potassium & chloride) and carbohydrate. Water, flavor and electrolytes contribute to offsetting dehydration while carbohydrate ingestion replaces or in some cases spares the use of endogenous carbohydrate sources. Independently or combined, these effects maintain or enhance performance during prolonged exercise.

There are numerous mechanistic studies in the literature that describe how offsetting dehydration through ingestion of water and electrolytes reduces thermo and cardiovascular stress and thereby maintains prolonged physical performance. Likewise the mechanisms by which carbohydrate intake maintains or improves performance are well documented. There is no reason to expect protein consumption during exercise would improve hydration status or spare carbohydrate utilization. Accordingly, our research has shown that a protein-containing sports drink is no more effective at improving cycling time trial performance (vs. placebo) than the contemporary formulation. Others have reported that consuming a protein-containing sports drink during prolonged cycling exercise improves time to exhaustion (TTE). While the significance as well as the relevance of this TTE effect has been debated, the overall effectiveness of the contemporary formulation is more robust since it has consistently improved both TTE and time-trial like performance. Further, hypotheses of reduced central fatigue and maintenance of Krebs Cycle anapleurosis when consuming protein during exercise are easily disproved. In short there is no known mechanism to explain the performance enhancement that some have reported for a protein containing sports drink which leads me to believe this observation has occurred by chance. I am not completely opposed to protein and I firmly believe that it is important for promoting muscle adaptation to exercise. However, protein can and should be consumed outside of the training and/or competitive occasion to effectively obtain this benefit.

It is important to maintain the meaning and integrity of a sports drink. However, admittedly by virtue of the generality of its name a broad interpretation of benefits and formulation can be applied. A name change may be in order to better reflect benefits the contemporary formulation delivers.

Presenting the proponent’s view:
Michael Saunders, PhD
James Madison University
Harrisonburg VA, USA

A large body of evidence supports the use of carbohydrate-electrolyte (CHO) beverages to improve performance during long-duration activities. More recently, the influence of carbohydrate-protein (CHO+Pro) co-ingestion on endurance has been investigated in at least eight published studies. Four have reported enhanced performance with CHO+Pro, while four have reported no differences versus CHO beverages.

The varied outcomes of these studies may be related to variations in methodological approaches, such as differences in the carbohydrate content of beverages and the type of endurance tasks utilized. For example, in studies reporting large ergogenic effects (13-36%) for CHO+Pro versus CHO, beverages were matched for carbohydrate calories during time-to-exhaustion tasks, at moderate rates (37-47 g h⁻¹) of carbohydrate intake. Thus, these findings suggest that protein may be beneficial when added to CHO beverages of typical composition (6-8% by volume), consumed at rates similar to those utilized by athletes outside of laboratory settings.

It is less clear whether protein can improve time-trial performance beyond the peak levels attainable with high rates of carbohydrate intake. Three studies have compared CHO and CHO+Pro beverages during long duration time-trials, with beverages matched at carbohydrate intake rates 60 g h⁻¹. Two of
these studies observed no differences between treatments, while we recently reported faster late-exercise performance times with CHO+Pro. Although high rates of carbohydrate intake are necessary to isolate the potential benefits of protein per se, these rates of ingestion may increase the likelihood of gastrointestinal upset, which could negatively affect performance in some subjects. Thus, it may be relevant that the rate of total substrate intake was lower in the study reporting improved performance (75 gCHO+Pro·hr⁻¹) than in those reporting no effects (80-91 gCHO+Pro·hr⁻¹). Further investigation is required to determine the specific conditions where protein may be beneficial for performance, and the potential mechanisms which may explain these effects.

Adding protein to sports beverages may also promote recovery from heavy endurance exercise. Various studies have reported that CHO+Pro ingestion can improve protein synthesis and balance, attenuate markers of sarcolemmal disruption (such as plasma CK levels), reduce post-exercise muscle soreness, and potentially improve performance in subsequent exercise. Though many of these studies have investigated CHO+Pro ingestion during the post-exercise period, researchers reported that attenuated plasma CK and improved post-exercise muscle function resulted when CHO+Pro consumption was confined to the exercise session alone.

The potential effects of protein ingestion on endurance performance remain controversial. However, half of studies investigating this topic have reported improvements in endurance/performance with CHO+Pro and there is minimal evidence suggesting negative effects with protein. Thus, endurance athletes should consider using protein in their sports drinks due to the potential to improve endurance, and to promote post-exercise recovery.

**Debate References:**


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**2 Top frequently asked in sport nutrition**

**Moderators: Ron J. Maughan, PhD and Louise Burke, PhD, Dip D**

**QUESTION 1:** How is it different working with Olympic athletes from working with recreational athletes?

**Karen Daigle, MS, RD, LDN, CSSD**


**Currently employed with US Army**

**Southern Pines NC, USA**

Any professional working with Olympic athletes (OA) must understand the differing motivations between this population and recreational athletes (RA). For most RA, health and leisure are the driving motivation; sport is a means to achieve or maintain health and fitness. Since sport itself is not the priority, RA fit exercise into the higher priorities in their lives. For OA however, sport is their job. The majority of OA identities are tied to their chosen sport. Sport IS their life, therefore the other factors in their lives must fit into their sport (e.g. school, relationships, etc.). OA do not view themselves in terms of the average population, therefore counseling in those terms will not be effective (i.e. general food guide pyramid, National guidelines for physical activity). Health is secondary to performance and is often ignored or delayed in order to continue training and competing.
With an athlete’s specific sport encompassing everything in his/her life, it is extremely important to understand not just the rules, environment and equipment of the sport but also the culture, lingo and superstitions. Each sport has its own set of favored supplements and protocols as well as food phobias and affinities. Without a solid knowledge and understanding of these factors, effective counseling is nearly impossible. OA make a living on taking their bodies to extremes which makes any procedure, routine or product claiming to assist in this endeavor quite appealing. Supplement use is a benefit to risk ratio proposition for any population. In a population whose income can be determined by being 100% better than the competition, the potential benefits very well may outweigh the risk to an OA, whereas it wouldn’t for a RA. Therefore, it is imperative to arm the athlete with a comprehensive summary of benefits and risks so that he/she can make an informed decision. This means that the nutrition professional working with OA must be well versed in biochemistry, energy systems and comprehensive literature reviews. Being able to convert this knowledge into practical application for the Olympic athlete is a hallmark of effectively working with this population.

Recreational athletes like to win and will often aim for a personal record (PR). For the Olympic athlete, a PR may be a good indicator of progress, but his/her success is measured against other athletes. Most RA will choose a competition based on convenience of location, potential for leisure time at that location and/or favorable difficulty. The Olympic athlete must attend competitions that will gain points, ranking or income or has the potential to give them a desired experience or to compete against a particular competitor. This results in frequent and/or international travel which poses a challenge to nutritional consistency for the OA.

In summary, nutrition professionals working with OA must frame all messaging in terms of performance as opposed to health. They must understand the unique challenges of the specific sport as well as frequent and international travel.

**QUESTION 2: I want to gain muscle while losing fat at the same time and still have energy to exercise. What should I do?**

**Melinda M. Manore, PhD, RD, CSSD**
Oregon State University
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Planning a weight loss program for a competitive or recreational athlete requires that a number of factors be examined before determining how severely to reduce energy intake. Athletes are typically leaner and have a lower body fat compared to non-athletes, so if energy restriction is too severe, while energy expenditure is high, lean tissue will be rapidly lost. This approach to weight loss will also cause fatigue and increase risk of injury. An approach that allows the maintenance or gain of lean tissue, while losing body fat, takes a longer period of time than just rapid weight loss, where body composition is not a concern. Consider the following factors before beginning a ‘fat-loss’ program:

- What is the current body size and composition and how much fat needs to be lost? Losing more body fat will take a longer period of time. What are the weight loss goals? Are these goals realistic in the time allotted?
- What is the age, gender and health of the individual? Care must be taken with young athletes who are still growing that energy restriction does not limit growth or development. Older adults often find it hard to lose weight compared to young adults.
- What is the current energy expenditure? If an individual is already training hard and working out 1-2 times/d, it is difficult to increase energy expenditure even higher to increase weight loss. For this individual, energy restriction may be the primary approach used. Conversely, if an athlete’s training program is not demanding a high amount of energy, then adding aerobic training to their current workout will increase energy expenditure. Strength training should be part of a weight loss program to help assure maximal lean tissue is preserved or even gained.
- What is the eating environment? Is the individual living in an environment that is supportive of good eating behaviors to support weight loss? If not, what can be changed and how can the individual be supported in their weight loss efforts?

Remember that macronutrient composition of the diet is as important as energy intake. First, consider the level of protein needed. As energy is restricted, protein needs may increase above what is typically required by the athlete to maintain lean body mass since protein will be used for energy. Thus, consuming ~1.2-1.8 g protein kg⁻¹ body weight (BW) d⁻¹ may be required; however, many athletes already consume this level of protein. Second, strive to match carbohydrate intake with exercise energy expenditures needs. Performance should not be compromised by increasing protein higher than required at the detriment of carbohydrate. For example, a long-distance runner will have a higher need for carbohydrate than a strength athlete, so match the composition of the diet to the athlete’s sport and food preferences. Determine which side of the energy balance equation it will be easiest for the athlete to change so that negative energy balance is achieved. Third, provide adequate fat to meet the essential fatty acid needs and to assure the diet is palatable.
QUESTION 3: What should I do to promote recovery after a hard workout?

Luc J.C. van Loon, PhD
Maastricht University Medical Centre
Maastricht, The Netherlands

Appropriate nutritional support is warranted following resistance as well as endurance type exercise activities to maintain performance capacity and/or to facilitate the post-exercise skeletal muscle adaptive response. Endurance performance capacity is generally limited by endogenous carbohydrate availability. As such, post-exercise muscle glycogen repletion forms the most important factor determining the time needed to recover from exhaustive endurance type exercise. When muscle glycogen stores need to be repleted well within 24 hours, for example during multiday competition or during periods of intensified training, ample amounts of carbohydrate should be ingested during acute post-exercise recovery.

Maximal muscle glycogen repletion rates have been observed with carbohydrate ingestion rates between 1.0-1.2 g · kg⁻¹ · BW · h⁻¹. Carbohydrate consumption should be initiated immediately after cessation of exercise and continued by providing ample carbohydrate every 15-20 min. Co-ingestion of 0.2-0.4 g · kg⁻¹ · BW · h⁻¹ of a protein, protein hydrolysate and/or amino acid mixture can stimulate plasma insulin release and accelerate post-exercise muscle glycogen repletion under conditions where carbohydrate ingestion is less than optimal (between 0.4-0.8 g · kg⁻¹ · BW · h⁻¹). The latter implies that more of the ingested carbohydrates are being routed to the muscle.

Furthermore, protein and/or amino acid ingestion following either resistance and/or endurance type exercise activities can be applied as an effective nutritional strategy to inhibit post-exercise protein breakdown, stimulate muscle protein synthesis and, as such, augment net muscle protein accretion. The latter has been suggested to lead to a more effective skeletal muscle adaptive response to each successive exercise bout. Ingestion of 20-25 g protein or an equivalent amount of 10-12 g essential amino acids is sufficient to allow maximal post-exercise muscle protein synthesis rates during acute post-exercise recovery. Carbohydrate co-ingestion following resistance type exercise does not seem to further stimulate muscle protein synthesis and/or improve whole body protein balance when ample protein is ingested. As resistance type exercise is also associated with a substantial reduction in muscle glycogen content, it would be preferred to co-ingest sufficient carbohydrate when also trying to accelerate muscle glycogen repletion.

In conclusion, both carbohydrate and protein should be ingested following strenuous exercise to support post-exercise recovery. The relative amount and type of carbohydrate and protein that should be ingested to optimize post-exercise recovery depends on the specific metabolic demands imposed upon by intense exercise training and competition by the specific athlete.

QUESTION 4: How can I tell my athletes how much they should be drinking and what the best drink is?

Susan M Shirreffs, PhD
Loughborough University
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Before addressing this question clarification is needed as to why the athletes are considering drinking. Given that water is the only component of a drink that is not easily obtained from solid food, I will assume for the purposes of this answer that the drinking is for hydration reasons.

There is evidence that hypohydration can negatively influence exercise performance in some circumstances and at present the data are most conclusive for endurance exercise. The general conclusions that may be drawn, for sweating-induced dehydration are that:

- Reductions in body mass of 2-7% significantly reduce endurance exercise performance, particularly in environments that are warmer than 30°C.
- Reductions in body mass of 1-2% appear to have no influence on endurance exercise performance when the exercise duration is less than 90 min and the environment is temperate (20-21°C).
- Reductions in body mass of 3-4% appear to consistently attenuate strength (by ~2%), power (by ~3%) and high-intensity endurance performance (by ~10%) suggesting that alterations in total body water do affect some aspect of muscle force generation.
- Reductions in body mass of 2-3% appear to have no significant effect on sprint running performance (i.e., when body mass is “carried”).
There may be reasons for an athlete to drink before, during and/or after exercise. This may be to ensure euhydration prior to exercise, to replace all or some of the sweat losses incurred during exercise or to restore hydration status to euhydration after exercise induced-dehydration.

Acute changes in hydration status due to sweat loss, for example over a period of exercise, are most easily assessed by measuring body mass (ideally nude) before and after the activity. Unless the exercise is of long duration it is not necessary to correct the body mass changes to account for other losses taking place and the assumption that a 1kg mass loss is equivalent to a litre sweat loss can be used. It is clear that the individual sweating response to exercise is highly variable and is influenced by the environmental conditions, the clothing worn, the exercise intensity and the individual’s physiology. The difference in sweat losses between individuals doing the same exercise in the same environmental conditions necessitates that drink volume recommendations are individualised for the athlete.

Along with water, significant amounts of sodium can also be lost in sweat. In some cases this can amount to a number of grams of salt being lost in a relatively short time period. Unless these losses are very high, their replacement can wait until after exercise. If facilities are not available to collect and analyse uncontaminated sweat to assess the quantity of salt or sodium lost, then coaches and athletes themselves can assess this by careful observation of skin and dark coloured clothing: significant quantities of white salt crystals may be apparent when sweat evaporation has occurred.

**QUESTION 5:** What supplements can I recommend, if any, to endurance athletes to counter illness risk and training-induced downturns in immunity?

**David C. Nieman, DrPH**
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Multiple components of the immune systems in athletes exhibit transient dysfunction after prolonged, heavy exertion. During this “open window” of impaired immunity, pathogens may gain a foothold, increasing risk of upper respiratory tract infections (URTI) and other types of infectious diseases.

Nutritional supplements have been studied as countermeasures to exercise-induced immune changes and infection risk. Carbohydrate beverage supplementation (~60 grams sugar per hour) during prolonged and intensive exercise has a strong effect in lowering plasma levels of cortisol, epinephrine, and inflammatory immune responses including blood neutrophil and monocyte counts, and cytokines. Antioxidant and glutamine supplements do not counter exercise-induced immune dysfunction, and vitamin E may actually compound the oxidative stress and inflammation experienced by the endurance athlete.

In vitro/cell culture and animal research indicate that advanced supplements such as β-glucan, curcumin, quercetin, isoquercetin, EGCG (antioxidant in green tea), and other plant polyphenols warrant human investigations to determine if they are effective countermeasures to exercise-induced immune dysfunction and risk of URTI. The immune system is so diverse that a cocktail of these advanced supplements within a carbohydrate beverage will probably perform better than any one alone. The primary immune target should be the nonspecific, innate arm of the immune system to enhance immunosurveillance against a wide variety of pathogens. Initial results have been disappointing for β-glucan but highly supportive for quercetin.

The physiologic effects of dietary flavonols such as quercetin are of great current interest due to their antioxidative, anti-inflammatory, anti-pathogenic, cardioprotective, and anticarcinogenic activities. The richest food sources of quercetin are onions, apples, blueberries, curly kale, hot peppers, tea, and broccoli. Total flavonol intake (with quercetin representing about 75%) varies from 13 - 64 mg · d⁻¹ depending on the study sample and the population studied. Human subjects can absorb significant amounts of quercetin from food or supplements, and elimination is quite slow, with a reported half-life ranging from 11-28 hours. Animal studies indicate that 7-days quercetin feeding augments muscle and brain mitochondrial biogenesis, endurance performance, and survival from influenza virus inoculation.
One gram of quercetin per day for three weeks increased plasma quercetin levels 9.2-fold and lowered URTI incidence in cyclists during the two week period after three days of intensified exercise. A cocktail supplement of quercetin, EGCG, and omega-3 fatty acids strongly countered post-exercise inflammation and oxidative stress.

Results from these studies indicate that immunonutrition supplements have the potential to lessen the magnitude of exercise-induced perturbations in immune function and reduce URTI risk. Additional research will broaden our understanding of the effects of these advanced supplements and others in providing immune benefits to athletes and warfighters during physiologic stress. The ultimate goal is to produce a sports drink containing carbohydrate and a cocktail of advanced supplements that will lower infection risk, exert significant and measurable influences on innate immune function, and attenuate exercise-induced oxidative stress and inflammation.

**QUESTION 6:** The supplement companies say that new legislation and voluntary controls mean that the problem with contamination that was around a few years ago has now gone away. Should I believe them?

*Samantha Stear, PhD  RPHNutr*

*English Institute of Sport*

*London, United Kingdom*

Supplements come in many forms and guises and their use in sport is widespread. Surveys show that most athletes use some form of dietary supplementation from generic sports drinks and multivitamin tablets through to the tailored ergogenic aids. Consequently, one of the factors that elite athletes need to consider in negotiating the complex world of supplements and sports foods is whether the consumption of these products could lead to an inadvertent case of doping.

Following the wave of Nandrolone findings in the late 90’s, several studies have sought to explore the extent of contamination. In 2000-01, the International Olympic Committee (IOC) funded an extensive research project using the then IOC Accredited Laboratory in Cologne to independently analyse 634 non-hormonal nutrition supplements purchased across 13 countries. This pivotal research confirmed the contamination issue with 15% (94 products) being found to contain undeclared WADA banned steroids. Altogether, 289 samples (21% positives) were from companies that were known to sell steroids/prohormones, but perhaps a more worrying 345 samples (9.6% positives) came from companies which did not sell steroid/prohormones. Results of the IOC Cologne Study continue to be confirmed, illustrating that the issue of contamination is still around. In 2007 HFL Sport Science in the UK analysed 58 supplements purchased through standard retail outlets in the USA and found that 25% were contaminated with prohibited steroids and 11% were contaminated with prohibited stimulants. In 2008, HFL followed this up with the analysis of 152 products purchased from standard retail outlets in the UK and found that over 10% were contaminated with steroids and/or stimulants.

The assumption has generally been that the presence of WADA prohibited substances is the result of inadvertent contamination of raw materials and/or cross-contamination within the manufacturing or packaging process rather than deliberate adulteration of the products in an attempt to increase the supplement’s effectiveness. Consequently, the amounts of steroids detected have been extremely variable, even within a single batch, but have generally been extremely small. However, very low levels of contamination (measured in parts per billion) can cause positive drug tests in an elite athlete which is at a level much lower than acceptable impurity levels (typically around 0.01%) in good manufacturing practice regulations. It is important to note that although this minimal amount of contamination could produce dire consequences for an athlete competing under the WADA code, this amount, in most cases, is unlikely to cause detrimental health issues for the general consumer.

The inadequate regulation of dietary supplements means there is no way for consumers to know what many supplements actually contain or how pure the product and its ingredients are. Manufacturers with good quality controls and banned substance testing are better able to control the risk. The inception of the WADA Code and the implications of strict liability means that an athlete is held responsible for whatever is in their body irrespective of how it got there. Therefore, athletes who compete under the WADA code should be extremely cautious about using supplements and always work with a qualified professional on risk minimisation of supplement use.
QUESTION 7: Should I train on a high fat diet to increase fat-burning capacity or to increase training adaptations?

John A. Hawley, Ph.D.
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The results from a number of studies show that 1–3 days of consumption of a high-fat, low-carbohydrate (CHO) diet is associated with a lowering of resting muscle (and presumably liver) glycogen stores and a reduction in training capacity and exercise performance. Longer periods of adherence to a high-fat diet, however, substantially enhance the capacity for fat oxidation during submaximal exercise, with evidence that the major shifts in the pattern of substrate metabolism (from CHO- to fat-based fuels) can be achieved within 5–6 days. This scenario presents a practical opportunity for enhancement of endurance and/or ultra-endurance performance via dietary manipulation. However, to date, studies in well-trained individuals show that fat-adaptation strategies alone do not enhance the performance of prolonged exercise. It is perplexing that in the face of marked changes in metabolism that favour fat oxidation and the consequent sparing of muscle glycogen, fat-adaptation/CHO restoration strategies do not provide clear benefits to the performance of prolonged exercise. Indeed, performance differences are minimal in the case of endurance events, especially when they are undertaken with optimal CHO availability.

However, because elevated rates of fat oxidation resulting from high-fat diets are maintained even in the face of acute strategies to promote CHO availability, there is an opportunity to simultaneously enhance the potential for fat and CHO utilization during exercise (i.e., dietary periodization). Future studies in this area should focus on examining the possibility that there are “responders” and “non-responders” to dietary fat-adaptation strategies: determining the underlying mechanisms for this observation and identifying simple markers for this response, although this is more difficult but could provide some athletes with a “performance edge.”

QUESTION 8: What is the best advice on the timing, composition and size of the pre-competition meal?

Asker Jeukendrup, PhD
University of Birmingham
Edgbaston, Birmingham
United Kingdom

Even textbooks are sometimes confusing when it comes to pre-exercise meals. Some books will tell you to avoid carbohydrate in the hour before exercise and some will tell you that you need it to improve performance. The reason for these different views stems from a couple of early studies. In these studies in the 70s, it was observed that eating carbohydrate in the hour before exercise resulted in high blood glucose and insulin concentrations at the start of exercise. Then, as exercise started there was a rapid drop of the blood glucose concentrations because of a combined effect of hyperinsulinemia and exercise on glucose uptake. Blood glucose concentrations dropped so much that hypoglycemia occurred. Hypoglycemia is associated with symptoms of weakness, nausea and dizziness and is thought to have a negative impact on performance. In fact one of the early studies reported that performance was reduced when carbohydrate was ingested before exercise compared with placebo (water) ingestion.

Since then, numerous studies have been performed. Some of these studies investigated carbohydrates that do not result in a large insulin response (low glycemic index carbohydrates) such as fructose. These studies (over a hundred from different research groups all over the world) showed either no effect of carbohydrate feeding on performance or a positive effect. All these different studies used different types of carbohydrates, different modes and intensities of exercise, different subjects (some trained, some untrained) etc. This made it very difficult to compare the results and very difficult to identify exactly what caused the different effects. However, more recently we performed a series of studies in which we examined the effects of pre-exercise carbohydrate feedings very systematically. All studies had a similar design and we only changed one variable at a time. The overall conclusion of these studies was that there was no effect on performance even though in some cases hypoglycemia did develop. There was no relation at all between the blood glucose concentrations and performance. Hypoglycemia was more prevalent when smaller amounts of carbohydrate were ingested (25g) compared with larger amounts (75g or 200g) 45 min before. Hypoglycemia is less prevalent when it is ingested just (15 min) before exercise compared with 45 and 75 min before. Low glycemic index carbohydrates do not cause hypoglycemia. An interesting finding was that some individuals developed hypoglycemia in all conditions whereas other did not develop hypoglycemia regardless of the condition, confirming anecdotal evidence that some individuals are more likely to develop hypoglycemia than others. Somewhat surprisingly this was not linked to insulin sensitivity of the individual.
In practical terms this means that there is no reason not to consume carbohydrate before exercise as there do not seem to be any detrimental effects on performance. Individuals prone to developing reactive hypoglycemia can find solutions to avoid it. These solutions could include choosing low glycemic index carbohydrates, ingesting carbohydrate just before exercise or during a warm up or avoiding carbohydrate in the 90 min before.

**Question 9: What is the optimum dose of caffeine to enhance performance?**

Lawrence L. Spriet, PhD  
University of Guelph  
Guelph, Ontario  
Canada

The optimum dose for enhancing athletic performance is 200 mg of caffeine or ~3 mg · kg⁻¹ BW. This amount of caffeine, taken ~45-90 min before exercise, has been shown to rapidly enter the bloodstream and increase exercise performance in events lasting from ~4-60 min. Caffeine has a half life of ~3-6 hours and a projected effect time of 2-4 hours. The mechanism for the performance improvements appears to be mainly central, in other words by having a positive effect on the brain. Performance is improved in many situations where the ability to provide energy by the muscles is not compromised, and 200 mg caffeine doses do not appear to have major effects on skeletal muscle contraction or metabolism. However, it should be noted that the research examining the effects of caffeine on exercise performance of events lasting 4 min or less is equivocal, including power events.

Recent research also indicates that low doses of caffeine are effective at improving athletic performance late in prolonged exercise. The brain appears to be sensitized to and require less caffeine when the person is fatigued by previous intense and/or prolonged exercise. For example, cyclists were able to complete a set amount of work in a time trial setting faster following ingestion of ~200 mg caffeine vs. no caffeine or 100 mg of caffeine, when the test was preceded by ~2 hours of cycling at ~70 VO₂max.

In studies examining the effects of caffeine on cognitive function during both resting and exercise situations, doses of ~100 - 200 mg caffeine again appears to be in the optimal range. Caffeine ingestion has also been shown to reduce pain perception, sensation of force, and rating of perceived exertion during many exercise situations. It is also important to note that there are very few, if any, negative side effects when consuming a 200 mg dose of caffeine (e.g. anxiety, dizziness, nausea, tremor). This amount of caffeine can also be added to a sports drink, either before or during exercise, with no adverse effects on hydration.

In summary, a low dose of caffeine (200 mg, ~3 mg · kg⁻¹ BW) taken before or during exercise is ergogenic for performance tests lasting beyond ~4 min and is not associated with negative anxiety or hydration-related side effects.

**Question 10: Can I make a Career in Sports Nutrition? If yes, how should I go about it?**

Nanna L. Meyer, PhD, RD, CSSD  
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Sport nutrition as a profession offers many career opportunities. However, professionals today must exercise creativity and move forward with courage to create positions where they see fit. The following list is only a vague attempt to illustrate where professionals in nutrition for exercise and sport are needed:

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<th>Elite sports</th>
<th>Sports Medicine</th>
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<td>Professional sports</td>
<td>Community</td>
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<td>Recreational sports</td>
<td>Corporate</td>
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<td>Fitness and Wellness</td>
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<td>Culinary arts</td>
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In summary, a low dose of caffeine (200 mg, ~3 mg · kg⁻¹ BW) taken before or during exercise is ergogenic for performance tests lasting beyond ~4 min and is not associated with negative anxiety or hydration-related side effects.
Before you get started on this career path, check out your community and identify job demand versus supply. What are the neighboring countries doing in the field of sport nutrition? It is also important to observe your country's rules and regulations regarding professional credentialing requirements. In the US, the Board Certification as a Specialist in Sports Dietetics (CSSD) credential from the Commission on Dietetic Registration is currently recognized as the highest professional credential. When choosing an academic program, check out what you have around you and what is available online. To complement online education, you may want to look for volunteer opportunities in your country or abroad to gain practical experience. To locate educational programs, a good website is www.scandpg.org (Sports, Cardiovascular and Wellness Nutrition dietetic practice group through the American Dietetic Association). In order to gain knowledge and build the skill necessary to grow from generalist to specialist in sport nutrition you should consider following these steps:

1. Enroll in a University program in Exercise and Sport Science or Nutrition/Dietetics or both (eventually you will have to coordinate both degrees).
2. Get a post-graduate degree in the field you are still missing or a combined sport nutrition graduate degree. You can also add a post-graduate credential such as the IOC Sport Nutrition Diploma or combine it with your graduate degree.
3. In your graduate work, assist in or conduct at least one research study. If research is not your thing you should still get involved to learn how to translate scientific knowledge into the real world. At the graduate level, it is also essential that you volunteer/intern in a variety of settings, which sometimes can lead to a fellowship or even a job.
4. Once you have your graduate degree completed, become a professional member of your country’s organization and get involved! If you have interest in international work or simply want to keep up-to-date with what is going on around the world or to receive mentorship you may also want to join an international network such as PINES (Professionals in Nutrition for Exercise and Sport; www.sportsoracle.com/pines) and the Nutrition Interest Group of the American College of Sports Medicine (ACSMNutrition@yahooogroups.com).
5. And finally, apply for jobs or create your own job and gain years of experience!

Selected References

References Question 2:

References Question 4:

References Question 6:

References Question 9: