High-Quality Carbohydrates and Physical Performance

Expert Panel Report

Mitch Kanter, PhD

While all experts agreed that protein needs for performance are likely greater than believed in past generations, particularly for strength training athletes, and that dietary fat could sustain an active person through lower-intensity training bouts, current research still points to carbohydrate as an indispensable energy source for high-intensity performance. Nutr Today. 2017;00(0):00–00

Numerous studies conducted over the past 40 to 50 years have consistently pointed to carbohydrate as the primary macronutrient for sustaining and improving physical performance. In recent years, however, with the advent of techniques that better allow scientists to measure the metabolism of key nutrients such as proteins/amino acids, and studies on alternative feeding regimens such as ketogenic diets and periodized nutrition, our knowledge of sports nutrition principles has expanded at the same time that a consensus on what constitutes the most appropriate diet for an active person has been clouded. The Alliance for Potato Research and Education (APRE) convened a panel of experts to discuss the latest science on the macronutrient needs for physical activity.

Athletes and other physically active people are always searching for an edge– a new technique, a training regimen, or an article of clothing that might help them shave minutes or seconds off their personal best time, lead to strength gains necessary to compete at a higher level, or hasten recovery after a difficult training bout. Among the most often-cited and frequently misunderstood ergogenic aids that athletes use to enhance performance is their diet. Over the past few decades, athletes and the people who train them have become more aware than ever of the link between physical performance and nutrition. Now, most trained athletes can recite their macronutrient and micronutrient intakes almost as adeptly as they discuss their training techniques, with eating regimens such as the *ketogenic diet*, *periodized nutrition* (*or nutritional training*), and *training low* a regular part of locker room discussion.

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But how much has our understanding of the dietary needs for physical performance truly evolved over the past quarter century? Is the age-old admonition for physically active people to "eat their carbs and drink their fluids" obsolete, or do the same rules that applied to athletes of yesteryear still hold true today? Many sports nutrition researchers have lamented that basic feeding principles are often forgotten in the quest to find the next "big thing"—the diet regimen that trumps all other regimens and leads to enhanced performance. Because the general misunderstanding about limiting carbohydrate intake for health reasons in the physically inactive population has become more prevalent, some have lost sight of the fact that athletes have an unequivocal need to consume high-carbohydrate foods to enhance muscle glycogen storage and deliver carbohydrate to muscle during strenuous exercise.[1–3]

In an environment filled with athletes willing to experiment with their nutrient intake to enhance performance and health advocates admonishing people to include

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fewer carbohydrate foods in their diets, a desire to more fully understand the tenets of high-performance eating prompted APRE, the nonprofit research overseer for one of the leading natural carbohydrate sources, to seek answers from experts. APRE convened a panel of sports nutrition researchers and practitioners to discuss recent science on nutritional needs for optimal physical performance and provide their collective perspectives on how dietary recommendations for athletes have changed over the years.

The panel consisted of Dr Lawrence Spriet from the University of Guelph, one of the more prolific basic and applied researchers on the role of diet in exercise performance over the past quarter century; Dr Janet Rankin from Virginia Tech, a leader in the application of sports nutrition research and principles; Dr Katherine Beals, an endurance athlete and certified specialist in sports dietetics (CSSD) from the University of Utah who has advised the potato industry in recent years on the role of potatoes in physical performance; and Dr Bob Murray, former Gatorade Sports Science Institute director and a respected researcher and lecturer in the sports nutrition arena for over 30 years.

The panel met for one day and reviewed the latest nutrition research regarding the dietary needs of serious athletes, trained-but-not-elite performers, and weekend warriors alike. They discussed issues such as the potential impact of high-quality, nutrient-dense carbohydrates versus low-quality, calorie-dense simple sugars on performance and the evolving role of protein in an athlete's diet. The wisdom of low-carbohydrate eating regimens for athletes was broached, as was the balance between natural, whole food sources and nutritional supplements on physical performance. The overall conclusion of the day's discussion was that, although athletes in general are more aware of their diets than ever and that expertise in the form of sports registered dietitians and other sports nutrition professionals is more available to athletes than ever before, many physically active people (particularly those who restrict energy intake or eliminate certain food groups from their diets) still fall short in meeting their nutrition requirements and may benefit from macronutrient and micronutrient supplementation. The panel acknowledged that different types of athletes, from the competitive long-distance cyclist to the hockey player who performs at a high intensity for repeated short periods of time to the recreational 10-K runner, have distinct and often unique nutritional needs for performance and recovery.[2,4] However, a few constants exist, particularly the need for carbohydrates, protein, and fluids in varying combinations (depending on the sport and the intensity of the training regimen), ideally from natural, whole-food sources, to fuel the training, recovery, and adaptation requirements of the physically active individual.

FOR HIGH-INTENSITY PERFORMANCE, CARBOHYDRATES ARE STILL KING

Despite reams of new data that have been generated over the years and an ever-evolving understanding about how athletes metabolize foodstuffs, the panelists generally agreed that the primary tenets of sport nutrition have not changed much over the past 25 years. Although they acknowledged that recent research suggests an athlete's need for protein and some fats may be a little higher than believed by previous generations,[5] one factor that remains as true today as it did decades ago is the athlete's indispensable need for carbohydrate as a key component of the diet. Although dietary protein and fat can provide necessary energy to perform physical activity, carbohydrate is the substrate most efficiently metabolized by the body and the only macronutrient that can be broken down rapidly enough to provide energy during periods of high-intensity exercise when fast-twitch muscle fibers are primarily relied upon.[1,3,4,6]

Furthermore, the experts pointed to data indicating that many athletes fail to consume enough carbohydrate to fully replenish muscle glycogen stores,[7] a factor that can lead to performance decrements, particularly when strenuous exercise is performed on a regular basis.[8] As an example, one of the panelists cited the daily carbohydrate needs of the serious competitor, someone who may train for four hours a day or more, as potentially exceeding 12 g/kg body weight, which translates to a whopping 3,800 carbohydrate calories for a 175-lb athlete.[4] According to experts, without consuming a diet rich in carbohydrate sources such as potatoes, rice, and pasta (5–7 g/kg per day for a moderate exerciser, up to 8–12 g/kg per day for a very heavy exerciser), the athlete stands little chance of satisfying such high carbohydrate demands.

SLOWLY ABSORBED VERSUS RAPIDLY ABSORBED CARBOHYDRATES

Panelists pointed out that, before and during exercise, the rapidity with which a carbohydrate source enters the bloodstream could impact exercise intensity and duration. High-carbohydrate foods and beverages that tend to be rapidly absorbed are best for providing the muscles with the energy that they need during exercise to maintain performance. Over the years, some sports nutritionists have theorized that lower glycemic index (GI) carbohydrates, those that appear in the bloodstream more slowly after ingestion and promote a blunted rise in the blood glucose response, may be preferable before exercise because they tend to "meter" the appearance of glucose in the blood. However, this construct is not supported by robust data; the experts pointed to recent research indicating no difference between pre-event consumption of a low GI meal (lentils, GI = 26) or a moderate GI meal

(mashed potatoes, bread, egg whites) on the ability to maintain or improve high-intensity running performance[9] (as a side note, the utility of GI as a predictor of foods appropriate for exercise performance and recovery, or general health for that matter, has been questioned by many sports nutritionists in light of recent data citing poor intrasubject and intersubject variability of the measure).[10] In the hours immediately post-exercise, research indicates that nutritious, carbohydrate-rich foods that can be quickly digested, absorbed, and transported in the blood can most readily alter the hormonal milieu to speed glycogen resynthesis, a key factor when performing strenuous exercise on consecutive days or, sometimes, during the same day.[3] When rapid glycogen resynthesis is required, the experts indicated that consuming approximately 0.5 to 0.6 g/kg of rapidly absorbed carbohydrate (approximately 150 kcal for a 160-lb athlete; roughly the equivalent of one medium potato, one cup of pasta or white rice) every 30 minutes for two to four hours (or until the next full meal) can sustain a high rate of glycogen synthesis.[4] For long-term glycogen recovery (e.g., 24 hours or more), panelists pointed to a recent review by Burke et al[11] that suggested, among other things, that long-term resynthesis is not affected so much by carbohydrate type but more so by the total amount of carbohydrate ingested.

LOW-CARBOHYDRATE DIETS AMONG ATHLETES: TREND OR FAD?

With ample available data supporting the need for carbohydrate in the athlete's diet, the experts expressed concern about the increasing popularity of low-carbohydrate diets among active individuals.[12] Diet and exercise regimens such as the "training-low" concept (a type of periodized nutrition, as well as a strategic meal/exercise approach designed to promote training adaptations), which has existed for more than a decade, represent examples of low-carbohydrate eating for performance that the panel viewed as potentially more faddish than practical. The training-low concept generally requires an athlete to conduct heavy exercise training bouts after skipping a meal or meals to reduce carbohydrate availability and train the muscles to more readily use fat as substrate, thereby conserving limited glycogen stores and promoting greater responses in the molecular signals that lead to adaptation.[4,13,14] Proponents of the "train-low" concept emphasize that athletes must compete with high glycogen stores, and many recognize that "train-low" may impair the ability to use carbohydrate during competition, increase the risk of illness, reduce training intensity, and increase protein oxidation during exercise.[13,14] The experts agreed that more quality research is needed to clarify the utility of "train-low" regimens for optimal health, performance, and recovery from heavy exercise. Furthermore, all the experts indicated that "train-low" regimens will inevitably reduce training intensity and potentially compromise performance improvements.

Based on available data, panelists also questioned the value of low-carbohydrate, ketone-promoting diets as a means of improving performance. Although previous research has suggested that physically active people can adapt to the use of ketone bodies as fuel when subsisting on a low to moderate carbohydrate diet and may become more adept at burning fat and conserving carbohydrate at low exercise intensities,[15] the experts viewed the long-term use of such eating regimens as potentially harmful to the performance of the athlete. Some of the experts cited impaired cognitive performance and mood, perceptions of fatigue,[16] and an inability to focus on the task at hand as rationale for avoiding low-carbohydrate diet regimens. Others mentioned data suggesting a greater susceptibility to skeletal muscle damage while training or competing with low-carbohydrate stores.[17] One panelist cited a recent study of world-class race walkers who consumed a low-carbohydrate, high-fat diet for three weeks and experienced a loss of exercise economy, resulting in a decrement in performance gains.[12] The researchers also cited data indicating that, as athletes become dehydrated during exercise, their reliance on carbohydrate for energy actually increases, suggesting an additional benefit of adequate carbohydrate stores.[18,19] All the panelists were adamant that low-carbohydrate stores make it difficult to sustain the intensity levels at which most competitive and serious recreational athletes train and compete.

The Skinny on Protein

The experts acknowledged that our understanding of dietary protein for physical activity has evolved considerably over the past decade and that science consistently demonstrates that protein is needed in greater-than-recommended daily allowance (0.8 g/kg per day) levels to enhance performance, recovery, and skeletal muscle accretion.[5] There was much discussion on the recent advent of techniques that have allowed researchers to identify and assess the effects of individual amino acids on muscle protein synthesis as having a great impact on our understanding of the protein needs of athletes. For example, leucine, an amino acid particularly high in whey and eggs, was cited as a key nutrient in skeletal muscle-signaling reactions that promote muscle growth, a fact that was largely unknown to exercise scientists not long ago.[20]

Nevertheless, despite the acknowledgement that athletes and resistance-trained athletes, in particular, can benefit by increasing protein intake, the experts agreed that some athletes are already consuming enough protein, roughly 1.2 to 2 g/kg per day.[2] Furthermore, the recent

emphasis on protein for physical performance may have clouded issues regarding the athlete's diet and, in some instances, inadvertently promoted less-than-optimal dietary practices. Athletes who overconsume protein at levels far above those recommended in the literature may cut carbohydrate intake drastically and (depending on protein sources) may consume more fat than they need. These practices can lead to suboptimal skeletal muscle glycogen levels, which, as pointed out earlier, can limit the amount of high-intensity exercise an athlete can engage in before he/she fatigues or affect how well he/she can perform during subsequent exercise bouts.

Some discussion centered on the purported satiety-promoting potential of various proteins,[21,22] a factor that may not be beneficial for serious competitors for whom food is fuel. For athletes with very high caloric needs, overconsumption of highly satiating foods could possibly lead to underconsumption of calories, resulting in possible weight loss or impaired performance. For the casually active individual, the notion of satiety leading to a decrease in calorie consumption may be appealing; for the seriously active individual, it may well be counterproductive.

Why Potatoes?

At the conclusion of the meeting, the experts discussed the merits of a balanced diet and the avoidance of focusing on one or two food groups as keys to enhancing physical performance and health. Although none of the experts argued with the convenience and portability afforded by many of the bars and gels on the market and their practicality during competition, they all believed that diets high in natural, whole foods are the best choice for athletes. Citing potatoes as an example of a high-carbohydrate food with other nutritional benefits, panelists discussed its high levels of potassium, various B vitamins, and vitamin C. Some mentioned the fiber content in a potato and indicated that the protein quality of a potato is very high, carrying a biological value between 90 and 100, greater than most other nonanimal, and some animal, protein sources.[23] Lastly, one panelist cited various phytonutrients and antioxidants that have been identified in potatoes[24–26] and indicated that there may be other yet-to-be-discovered phytonutrients in potatoes and in other fruit, vegetable, and grain sources, for that matter, further driving the point that whole, natural foods should comprise the bulk of the athlete's diet.

Future Research Directions

Although studies dating back more than 50 years have demonstrated the benefits of carbohydrate intake for improving physical performance, the experts closed the session by discussing future research needs regarding the impact of high-quality carbohydrate sources on performance and recovery from strenuous exercise, as well as on general health (e.g., the interaction of chronic high-quality carbohydrate diets and exercise on indices of diabetes, cardiovascular disease, obesity, etc).

The panelists cited the following as possible research questions worth considering:

- Impact of potato (which may contain as much as 7 g of protein) versus a lower-protein carbohydrate source on recovery from strenuous exercise in elite athletes, particularly on the time course of glycogen replenishment between heavy exercise bouts
- Impact of rapidly absorbed carbohydrates such as potatoes post-exercise on performance of a subsequent exercise bout after a modest recovery period
- Impact of potatoes as a good source of carbohydrate and antioxidants such as vitamin C on exercise-induced skeletal muscle damage and repair
- Impact of potato carbohydrate consumption on performance parameters in various athletic populations across various age ranges
- Comparison of the muscle protein synthetic capacity of potato protein versus other protein sources used prevalently post-exercise, such as soy or dairy protein
- Chronic consumption of high nutrient-dense carbohydrate sources such as potatoes versus low-nutrient dense sources such as sugar on physical performance parameters, as well as on hyperlipidemias, inflammation, and other disease-related biomarkers in physically active people
- Impact of potatoes and other high-potassium food sources on blood pressure in mildly hypertensive athletes

IN CONCLUSION

Although our understanding of the nutritional needs of athletes has increased dramatically in recent years and the research tools used to measure the ways we assimilate and metabolize foodstuffs have become more sophisticated, the primary tenets of sports nutrition have not changed much over the past 25 years. Although it is generally acknowledged that an athlete's need for protein may be a bit higher than previously believed and that issues regarding the timing and make-up of meals before, during, and after exercise can affect performance and recovery, one factor that remains as true today as it did decades ago is the athlete's indispensable need for carbohydrate as a key component of the diet.[1–4] Although protein and dietary fat can provide necessary energy to perform physical activity, carbohydrate is the only macronutrient that can be broken down rapidly enough to provide energy during periods of high-intensity exercise. Although additional research aimed at fine-tuning the dietary needs of the physically active individual still needs to be conducted, all the experts who participated in the panel discussion endorsed the concept of consuming a majority of daily calories in the form of high-quality, high-carbohydrate whole food sources, such as potatoes, as a means of improving physical performance and recovery from exercise.

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After spending a day discussing the nutritional needs of the physically active person with a group of sports nutrition experts, one is left with the feeling that the more things change, the more they truly remain the same. The advice doled out by the experts in 2017 would not likely have been much different had they gotten together in 1987. To enhance physical performance, high-quality, nutrient-dense carbohydrate sources are still critical.

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