

Energy Supplements and Foods in Sports: When to Use What

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Today, athletes have a wide variety of food choices to satisfy their nutritional needs for top performance. However, there is also much confusion in deciding what foods to eat depending on the activity to be performed. This review serves to dispel the confusion by clearly laying out the recommended macronutrient profile of a meal or snack related to the type of activity as well as suggestions for pre-, during, and postcompetition meals and snacks. (Am J Med Sports. 2003;5:30-33,38)

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Manuscript received September 15, 2000;
accepted October 24, 2000*

The last 40 years have fostered a major revolution in the field of sports nutrition. Not so long ago, athletes were actually discouraged from eating or drinking before, during, or after a workout. But from the moment the scientists at the University of Florida in the 1960s realized that drinking a diluted sugar and electrolyte drink during the football games enabled their team, the Gators, to outplay their opponents, Gatorade became a household name and the sports drink industry was born.

It took another 20 years for the world to witness the birth of the energy bar. Out of a need for convenience, marathoner Brian Maxwell found he needed a high-carbohydrate, compact food he could carry on long training runs, and the Powerbar was created. Since that time, energy bars have evolved in a variety of shapes, sizes, textures, tastes, and nutrient compositions and have graduated from supplying energy for serious athletes to a food alternative/meal replacement for busy, health-conscious individuals.

The question that faces many athletes, consumers, and health professionals working with these populations, however, is not which energy product to use, but instead, which food will satisfy their immediate and long-term nutritional needs.

Overall Nutritional Needs of an Athlete

Nutritional and caloric needs of an athlete will vary according to the athlete's body size, weight, and composition, as well as gender, sport, and training program. Although there are individual variations, the basic diet for athletes should be composed of approximately 60%–70% calories from carbohydrates, 10%–15% calories from protein, 15%–30% calories from fat, vitamins, and minerals, and plenty of fluids.¹ In addition, caloric intake of male athletes should average over 50 kcal/kg/day and that of female athletes 45–50 kcal/kg/day.¹ Depending on the weight of the athlete and the sport, calorie needs may exceed 3000 kcal/day. Because of this increased energy need, athletes often have trouble maintaining their weight; it is for these cases that convenient, energy-

dense foods can be used to supplement the diet. Variations in the dietary requirements and macronutrient profiles of athletes will also differ immediately before, during, or after competition.

As compared to their sedentary counterparts, protein needs may be higher for athletes.¹ Endurance exercise results in protein breakdown, whereas strength exercise results in accretion of protein for increased protein synthesis.^{2,3} The following recommendations for increased protein intake for athletes are based on these exercise-induced changes in protein metabolism. It is recommended that endurance athletes consume 1.2–1.4 grams of protein/kg body weight. A higher amount—1.6–1.7 grams of protein/kg of body weight—is recommended for strength athletes.^{4,5} However, the data to support increased dietary protein needs are equivocal.

Athletes also require adequate fat. Fat consumed during exercise is not readily available as fuel; however research shows that a well trained athlete has an enhanced capacity to oxidize endogenous fatty acids during exercise, and intramuscular triglycerides are an important source of energy for skeletal muscle contraction during endurance exercise.⁶ Recent studies have shown that on high-fat diets (42%–55% calories from fat) with adequate carbohydrate intake, compared to low-fat diets (10%–15%), trained athletes (both men and women) had an increase in endurance.^{7,8} Hence, fat can play an important role in athletic performance. It is important for an athlete to consume a well-balanced diet that includes fat.

Overall, carbohydrate is the preferred fuel for most competitive sports (both aerobic and anaerobic).

Research has shown that an inadequate supply of carbohydrates in the body often leads to poor performance.^{9–21} A high-carbohydrate diet helps to build up the body's supply of glycogen, a form of carbohydrate stored in the muscles and liver, which is efficiently metabolized by the body into energy during exercise. During aerobic exercise, as the intensity increases, the muscle glycogen breakdown increases linearly.²² Furthermore, time to fatigue is directly related to the depletion of muscle glycogen.²² On the other hand, during anaerobic exercise, the benefit from complete glycogen stores seems to stem from the ability to produce lactate via glycogenolysis. Impaired performance has been linked to impaired lactate production.²² It is these metabolic responses that underlie the performance benefits of consuming a variety of carbohydrate-containing foods. Therefore, it is recommended that athletes enter into competition with full glycogen stores, by consuming a high-carbohydrate diet. The type and duration of the exercise, in addition to increased energy needs, will determine whether the athlete needs to supplement the sports diet with additional carbohydrate, protein, and fat sources, such as candy bars, energy bars, or drinks (Table I).

Nutrition During and After Competition

An athlete's macronutrient needs vary, depending on the type of event or activity. For example, marathon runners may benefit from a precompetition meal in which the carbohydrate supply is delivered slowly to

Table I. Energy and Nutrient Composition of Sports, Energy, Breakfast, and Candy Bars

PRODUCT	ENERGY (KCAL)	CHO	FAT	PROTEIN	FIBER
Powerbar	225	75%	8%	18%	3 g
Cliff Bar (peanut butter)	250	72%	14%	16%	4 g
Tiger Milk Bar	130	74%	17%	12%	1 g
Kellog Nutri-Grain Bar	140	77%	19%	6%	1 g
Nature Valley Granola Bar	180	64%	30%	11%	2 g
Milky Way Bar	270	61%	33%	3%	1 g
Snickers Bar	280	50%	45%	6%	1 g
Slim-Fast Meal on the Go	220	65%	20%	15%	2 g
Bagel (4 1/2 inch)	275	77%	0.05%	15%	2 g
Apple (medium)*	81	100%	N/A	1%	4 g
Banana (medium)*	108	100%	4.7%		3 g

CHO=carbohydrate; N/A=not applicable; *carbohydrate calculated by difference
Data derived from the US Department of Agriculture, Agricultural Research Service. USDA Nutrient Database for Standard Reference. Release 13, 1999. Nutrient Data Laboratory home page:
<http://www.nal.usda.gov/fnic/foodcomp>

prolong the use of muscle glycogen, whereas a soccer player may benefit from a beverage that is readily available for high-intensity play. All athletes should experiment with foods or beverages prior to competition to ensure that they do not cause gastric distress during the event. Other considerations are foods that are appropriate for immediately following the competition or in between events, such as for a soccer player between tournament games. The appropriateness of this food depends on the amount of time between events and the individual's gastric tolerance.

There are a variety of foods that can help meet the variation in the nutrient and caloric needs of an athlete. However, manufacturers have recognized the opportunity to create foods that conveniently satisfy these needs, such as sports beverages and bars. Today, energy bars and beverages come in a wide variety of sizes, calorie levels, and nutrient composition. However, athletes should be made aware that there are several other readily available food items that satisfy the same needs (Table I). Research has yet to show a food or supplement that provides nutrition above and beyond what can be found in the current food supply.²³

Carbohydrates, unlike fats and proteins, are immediately available for use. Foods, such as bananas, apples, or bagels, are appropriate during competition or immediately prior to competition because of their high carbohydrate content. However, carbohydrate-containing foods with the other macronutrients, i.e., protein and fat, would be more appropriate 2–4 hours prior to competition or between events when the wait is over 1 hour. In this case, either the energy bar, candy bar, bagel, or granola bar would be appropriate. These foods will not be immediately digested, so fuel availability will be prolonged and hunger delayed.

Immediately after competition, endurance and strength athletes should eat a high-carbohydrate, high-protein, and moderate- to high-fat meal to replace muscle glycogen, build/repair muscle, and correct energy deficits. Tremblay et al.²⁴ showed that 48 hours after an endurance exercise, those given free-living

access to a high-fat (>30%) diet, compared to those who had access to a low-fat diet, achieved energy balance and were able to compensate for the energy cost during and after exercise. In addition, protein synthesis rebounds 48 hours after exercise. Rennie and Tipton²⁵ showed that positive protein balance is achieved only if amino acids are available postexercise. According to the macronutrient profiles of the foods listed in Table I, energy bars, candy bars with nuts, and granola bars would be convenient and immediate foods to satisfy these increased needs. It is also critical to replenish glycogen stores in the hours immediately after competition. The rate of muscle glycogen synthesis is linear during the first 6 hours after a glycogen-depleting event. The type of carbohydrate chosen may also affect glycogen repletion.²²

The foods listed in Table I provide examples of easy, convenient foods that can be used during competition and training. However, a balanced, varied diet is the key to meeting an athlete's overall dietary needs. Besides the macronutrient profile of a food, the glycemic index of a food is believed to affect the availability of carbohydrates.^{26–29}

Glycemic Index

Applying the glycemic index (GI) to sports nutrition to enhance performance is largely viewed by the athletic community as controversial. Additionally, the scientific community has not confirmed the validity of this index.

The GI is an attempt to classify foods according to their blood glucose responses. It is defined as the total area under the blood glucose response curve during the 2-hour period after the food is eaten, compared with the standard response to an equivalent amount of glucose or white bread.³⁰ Although not generally viewed as a clinically useful tool, individuals can use blood glucose monitoring to determine individual postprandial differences associated with various foods. Typically, foods are grouped according to high, moderate, and low GI (Table II). For endurance sports,

Table II. Glycemic Index (GI) of Commonly Consumed Foods, Candy Bars, and Energy Bars

HIGH GI (>85)	MODERATE GI (60–85)	Low GI (<60)
Glucose	Bagel	Brown rice
Honey	Crackers	Most dairy foods
Carrots	Sweet potatoes	Most fruit
Most breakfast cereals	High-fiber breakfast cereals	Most pastas
Sports drinks	Power bars	Snickers
Corn chips	Milky Way	Most dried beans

Data derived from Miller Brand J. International tables of glycemic index. *Am J Clin Nutr.* 1995;62(S):871S–893S.

low-GI foods are often recommended before exercise to promote sustained carbohydrate availability. In this case, fruit, pasta, and candy bars would be appropriate. Moderate- to high-GI foods are recommended during exercise to promote carbohydrate oxidation and following exercise to promote glycogen repletion.³¹ Thus, energy bars, sports drinks, and honey would be considered more appropriate for interval feedings during prolonged events.

Utilizing the GI index for sports performance has limitations. Burke and associates³² suggest that it may be a useful tool in helping the athlete fine-tune the sports diet, but caution athletes not to overlook the other important aspects of food choices, such as nutritional content, palatability, cost, portability, gastric discomfort, and ease of preparation.

How to Choose Foods

The question remains, whether one is working with an athlete or a nonathlete, can the person obtain the carbohydrates and fluids his or her body needs without using these performance foods? Would such foods as bananas, bagels, and granola bars work just as well? The truth of the matter: yes. Basically, performance foods, such as energy bars, are convenience foods. They come in portion-controlled individual packages designed for eating on the run. This is why they appeal to busy consumers as well. The basic disadvantage for many athletes is the price, and for busy individuals it may be price and the high calorie load. For some individuals, the high-calorie and high-fat concentration of certain energy bars may interfere with their weight management objectives.

Other considerations include the rate of gastric emptying. It is important to have an athlete test the energy bar prior to competition, since many can cause gastrointestinal distress if adequate fluids are not consumed. Also, many manufacturers are beginning to fortify their bars with possible "ergogenic" substances, such as ephedrine, ma haung, and caffeine. Careful label reading is important, since research in this area is still preliminary and often these substances are banned by sports organizations.

Bottom Line

Athletes have several options available to get the extra calories and macronutrients they need before, during, and after exercise, provided they are eating a well balanced diet. It is also important to note that once symptoms of hypoglycemia appear, no energy supplement will help. Preemptive consumption is the key to any supplement usage. ■

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