ATHLETIC PERFORMANCE AND NUTRITION

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An expert looks at how diet may enhance performance. This is a superb modern overview that is worth the attention of every coach and athlete. From Rapport, *Vol. 3, No. 1, January 1988, published by the Canadian National Institute of Nutrition.*

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Athletes, be they aspiring Olympic champions or weekend tennis buffs, are eager for information on how to improve their performance. Nutrition is of interest to many of these individuals who want answers to two questions: 1) Does exercise change nutrient requirements? and 2) Will manipulation of the diet enhance performance? This article will briefly address these questions, focusing on endurance exercise in adults.

EXERCISE AND NUTRIENT REQUIREMENTS

In response to the first question, the answer is a clear "yes" for two dietary components: energy and water. Although much remains to be established regarding the effects of exercise on energy balance, it is accurate to say that energy needs increase in proportion to exercise intensity and duration, as well as in proportion to body weight with no change in food intake; or by a combination thereof.

The need for water is increased during exercise because of elevated ventilatory and sweat losses. Fluid losses during exercise are substantial, and can exceed 2 L/hr. in hot environments. These losses, which can be determined by obtaining nude weights, pre- and post-exercise, should be replaced during the activity session itself to prevent performance decrements and/or potentially serious heat injury. Current guidelines recommend consumption of 120-180 ml of water every 10-15 minutes during exercise.

As water loss in sweat predominates over electrolytes loss, addition of electrolytes to water is not necessary for "short-term" endurance events such as the marathon. However, use of a dilute electrolyte solution may be desirable in ultraendurance events like the "Ironman" triathlon, as hyponatremia has been reported in individuals who consumed over 20 L of plain water during a 100-mile run.

The protein requirement of active individuals has been debated for many decades, and past beliefs about protein's importance led to a heavy emphasis on meat in athletes' diets. Current estimates of protein's contribution to the energy cost of exercise range from 5 to 15%, thus raising the possibility of increased protein requirements in active individuals. In addition to a possible need for more total protein, some research suggests that the requirements for certain essential amino acids may also be elevated (especially leucine, degraded extensively in muscle).

Debate about the protein needs of athletes may be academic. For instance, consider the dedicated individual who exercises for 2 hr./day, expending 600 kcal/hr. If protein contributed 10% of the energy cost of activity, 30g would be catabolized during exercise. Assuming that no compensation occurred during the rest of the day (likely an invalid assumption), addition of this amount to the Recommended Nutrient Intake would produce levels very close to the average Canadian's protein intake: 71 and 87 g/day for women and men, respectively. At present, a liberal protein allowance for athletes is considered to be 1.0-1.5 g/kg.

The iron requirement of athletes is another controversial topic. Several studies suggest that athletes' iron status may be inferior to that of controls, while others suggest the contrary. A number of mechanisms have been proposed whereby exercise could increase iron requirements (e.g., GI blood loss, sweat loss, decreased absorption, mechanical trauma leading to increased hemolysis, etc.). Further research is needed to establish whether or not endurance exercise increases the iron requirement.

"EATING TO WIN"

To address the second question of whether one can "eat to win," the effects on performance of carbohydrate, vitamin/mineral supplements and caffeine have been examined.

Widespread interest in the *effect of carbohydrate (CHO) on endurance performance* originated in the late 1960s when Scandinavian physiologists showed that "carbohydrate-loading" prolonged endurance. The rationale for this procedure is related to the use of muscle glycogen as a fuel source for exercise, and to the observation that in endurance activity, exhaustion (i.e., inability to maintain a given exercise intensity) tends to occur when muscle glycogen stores reach low levels.

As originally described, CHO loading involved an exhaustive exercise bout one week before competition, followed by two to three days of continued training while consuming a low CHO diet. The athlete would then taper his/her training and eat a very high CHO diet for several days. This caused muscle glycogen levels to rebound to higher-than-normal levels, prolonging endurance performance. A modified version of CHO loading, which avoids the exhaustive exercise and the low CHO diet, has been shown to be as effective as the traditional scheme.

More recently, interest in CHO has focused on its importance in the usual diet of endurance athletes who train intensely on a daily basis. Costill, et al., showed that glycogen stores of athletes consuming a "typical North American" diet (40% of energy as CHO) failed to recover between daily endurance exercise sessions. After three days, glycogen stores were almost depleted: presumably, this would be associated with "staleness" and an inability to train effectively. When the subjects followed a 70% CHO diet, glycogen levels recovered to control levels before the next day's exercise session. Thus, a high CHO diet is recommended for endurance athletes in heavy training.

How high obviously depends on the intensity and duration of the training—in the study cited, subjects ran at 6 min./mile for 2 hr./day. Many recreational athletes have neither the ability nor the inclination to train at this level, and thus the proportion of energy needed as CHO would be lower. Current recommendations for general health (e.g. 50-55% of energy as CHO) are likely appropriate for many active people.

Although most athletes (and many non-athletes) use vitamin/mineral supplements, there is no convincing evidence that they enhance performance in healthy subjects consuming sensible diets. Barnett and Conlee, in a well-controlled, double-blind study, evaluated the effect of a "megapack" vitamin/mineral supplement on performance. After four weeks, there were no differences between supplemental and placebo groups in any of the parameters studied (e.g., endurance time, pre- and post-exercise glycogen level, blood glucose, free fatty acids lactate, etc.).

Iron supplements obviously enhance performance in anemic individuals, and elevated hemoglobin levels achieved through "blood-doping" (removal of blood from an individual, allowing time for restoration of normal hemoglobin levels and reinfusion of the stored blood) are ergogenic. What has not been established, however, is whether supplemental iron benefits performance in those with normal iron status or those who have low iron stores, but are not anemic. Nevertheless, because of the relatively high prevalence of anemia, particularly among menstruating women, monitoring athletes' iron status and administering supplements as required are recommended. Unwarranted supplementation should be avoided because of potential interactions with other minerals.

Caffeine has received much attention as a possible ergogenic aid, although use of large amounts has been banned in international competitions. In theory, when taken prior to exercise, it acts to enhance release and use of free fatty acids, thereby conserving glycogen and prolonging endurance. These effects have been demonstrated in some laboratory studies, using caffeine doses of about 5 mg/kg body weight or about two cups of strong coffee. Some studies also report that caffeine reduces self-perceived exertion.

Whether it is actually beneficial in competitive situations is less clear: it mimics the actions of catecholamines, which are present at more-than-adequate levels in most people prior to competition. Furthermore, a recent study suggested that caffeine was not effective in CHO-loaded subjects. Because some people react adversely to caffeine, it should be tried during training sessions.

In the past, some athletes consumed a *sweet beverage or snack* just before exercise for "quick energy." At present, some reputable sports nutritionists believe that this practice is harmful, as high insulin levels resulting from the CHO are said to impair fat metabolism and to eventually result in hypoglycemia. Examination of the data does not support either position: consumption of CHO 30-60 minutes prior to exercise of 1.5 hours or less duration neither enhances nor harms performance. During exercise, blood glucose may reach lower nadirs following a glucose load than following a placebo or fructose. Symptomatic hypoglycemia, however, is reported very rarely, and performance does not appear to suffer.

During endurance exercise, there is a clear need to replace fluid. Will addition of CHO to water enhance performance, or will gastric emptying and fluid absorption be inhibited, thus harming performance? For several years, the "golden rule" has been to consume fluids with 2.5% or less sugar (w/v) during endurance events, as greater concentrations were said to inhibit gastric emptying. A 2.5% solution would provide someone drinking 150 ml/10 mm. with 22g CHO/hr., considerably less than the 40-45 g/hr. found to prolong endurance. Provision of higher concentrations of CHO as glucose polymers (e.g., 7% solution) appears to provide sufficient CHO without compromising hydration.

Ongoing research in sports nutrition will no doubt allow the questions posed at the start of this article to be answered more completely. However, at this point some general recommendations can be made: endurance athletes' diets should be high in CHO (how high depends on exercise intensity and duration) and adequate in protein; supplemental vitamins and minerals are not routinely required, nor do they appear to enhance performance; fluids should be replaced during exercise; and CHO loading and/or provision of CHO during endurance events of at least two hours may prolong performance.

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