

Nutrition and the allergic athlete

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Nutritional management of the allergic athlete centers around providing a diet adequate to meet the increased needs of the athlete at the same time that it is modified by the exclusion of any problematic foods. The athlete has an increased need for water, total energy, carbohydrate, B vitamins, and perhaps protein, the last two of which are usually met when the diet fulfills the energy requirements of the athlete. Requirements for electrolytes are minimally increased, and the need for additional iron is unclear in light of "sports anemia." There is no evidence to support the use of vitamins C and E as ergogenic aids; however, the findings relating vitamin C to bronchospasm and bronchial hyperreactivity are interesting. Caffeine and bee pollen, often believed to increase performance, may be harmful for the allergic athlete. An approach for determining the problematic foods for the allergic athlete and necessary supplementation when they are avoided is given. (J ALLERGY CLIN IMMUNOL 73:728, 1984.)

Nutrition is an important aspect of training in athletic performance from both a physical and a psychologic standpoint. For the athlete who is allergic to foods, nutritional management centers around the identification and avoidance of those foods while maintaining an adequate diet. This article presents a reasonable approach to nutritional management of the allergic athlete based on the current knowledge of the nutritional requirements of athletes.

WATER

The most important nutritional requirement of athletes is water to replace insensible loss from respiration and sweating during strenuous physical activity. Depletion of body water of greater than 2% of body weight will significantly impair thermal and circulatory homeostasis during exercise. Hypohydration can lead to decrements in endurance performance. The importance of fluid replacement during exercise has been well documented,^{1,2} although in some situations of strenuous exercise, such as soldiers marching in the heat, drinking ad lib did not replace all fluid losses.³ It is important that athletes replace water lost during strenuous exercise to maintain their preexercise weight, especially in hot climates. During long-distance running events, water should be replaced during exercise. Guidelines for replacement are given in Table I. In very hot weather when the athlete is sweating excessively, he or she may not be able to replace

all fluid losses and will need further rehydration afterwards.

ENERGY

The next most important nutritional need and one that is frequently overlooked is to meet total energy needs. The energy requirements for athletes depend upon the sex, age, state of maturation, and growth and size of the athlete, in addition to the type of sport and amount of training. Since more energy is needed to initiate a muscle contraction than to maintain it, sports such as running, rowing, and swimming that require repetitive muscle contractions use 10 to 16 kcal/min while gymnastics and golf, which involve more muscle contraction maintenance, use 3 to 6 kcal/min. In addition to the energy expenditure of exercise, an elevated metabolic rate exists for several hours after exercise because of thermogenesis, body cooling, and recovery of O₂ debt,⁴ so energy requirements are increased further.

Athletes in heavy long-distance training programs often cannot meet their energy requirements through eating and thus lose weight as body fat. These athletes must consciously eat more to prevent undue weight loss.

In efforts to maximize performance, many athletes alter normal energy intake to either gain or lose weight. For some young athletes, achievement of unrealistic light weights may jeopardize growth and development.^{5,6} Starvation and dehydration as practiced by wrestlers, lightweight crews, and gymnasts to "make weight" can impair performance.⁷ To avoid this, a weight reduction program should begin early

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in the season so the weight loss can be gradual without a large daily deficit in kilocalories. Maximum weight loss should be 2 pounds per week from an energy deficit of 500 to 700 kcal/day, but no less than a total of 1800 to 2000 kcal/day, combined with an increase in energy output of 300 to 500 kcal/day. Losses greater than this will usually mean loss of lean tissue.

The goal weight should be determined based on measurements of body fatness. For wrestlers, one of the groups of athletes most concerned with body weight, the American Medical Association suggests that body fatness be 7% to 10%,⁸ and the American College of Sports Medicine recommends a body fatness of at least 5%.⁹ Before the competitive season the wrestler's weight should be determined for the appropriate level of body fatness and that level should be reached gradually, also keeping in mind that the adolescent athlete could grow several centimeters during the same period. During the weight reduction program periodic body fat measurements will indicate whether weight loss is from lean or adipose tissue.

Weight gain should be of lean tissue, not body fat, and again measurements of body fat are important. To increase body weight with lean tissue requires increased energy intake combined with exercise and a maximum weekly weight gain of 1 to 2 pounds. Increased energy intake should be through additional carbohydrate and protein in the diet with attention to the prevention of a high fat, high cholesterol, atherogenic diet.

CARBOHYDRATE

Interest in carbohydrate in the athlete's diet came in the late 1960s with the demonstrated importance of muscle glycogen as a fuel during the performance of intense, prolonged aerobic exercise and the discovery that the amount of glycogen stored in muscles could be increased with appropriate training and diet manipulation. A high protein, low carbohydrate diet combined with heavy training to deplete glycogen, followed by a high carbohydrate diet with light training to replete and supercompensate glycogen, could result in an increase in muscle glycogen to at least twice the normal amount, and an individual could perform a standard aerobic work load for about twice as long.¹⁰ Glycogen supercompensation could enable long-distance runners to maintain an optimal pace for longer periods of time.¹¹

Practically, however, the phase of glycogen depletion when the athlete must eat a low carbohydrate (maximum of 100 gm of carbohydrate per day) diet and train heavily for 3 to 4 days makes the athlete so miserable because of light-headedness, irritability, weakness, and nausea that a "modified" glycogen

TABLE I. Replacement of fluid during exercise for optimal effectiveness

Forced drinking to fully replace sweat losses
Hypotonic saline (no more than 1 gm NaCl/L) drink — may increase rate of water absorption
Cold drink
250 to 400 ml every 10 to 15 min
If glucose is desired, no more than 2 to 2.5 gm/100 ml fluid

loading regimen is now recommended. This "depletion-taper" regimen is nearly as effective in raising muscle glycogen levels as the original glycogen loading regimen.¹² The "depletion-taper" regimen involves a long, hard workout on the seventh day before the event or race followed by 4 days of a gradually increasing carbohydrate intake (from 50% to 70% of kilocalories) and decreasing training until the day before the event, which is without exercise. Carbohydrate intake is high (maximum level of carbohydrate is 500 to 600 gm/day).

After a hard workout and glycogen depletion it takes 12 to 24 hr to replete glycogen levels and up to 48 hr to supercompensate glycogen levels. Sixty percent of the total glycogen storage occurs within the first 10 hr after depletion, so carbohydrate intake during this time is important. The high carbohydrate diet should be high in starches for maximal glycogen loading, and better glycogen storage has been achieved with fewer large meals than with isocaloric, more frequent smaller feedings.¹³

Glycogen loading is recommended only for athletes participating in long events of 1 hr or more, but it may be useful for athletes competing in several short events in 1 day, such as during a track meet.¹⁴ However, the glycogen loading regimen should be used only in preparation for special events and not more than four times per year since the safety of the regimen is still questionable. Angina and electrocardiographic abnormalities have been reported in an older runner,¹⁵ and there is some speculation that muscle cell damage occurs from glycogen loading.¹⁶ Complaints of diarrhea during the loading phase and extra weight and muscle tightness caused by water retention that accompany glycogen loading have also been reported.

In general it is recommended that the athlete consume a diet in which at least 50% of the kilocalories are from carbohydrates to allow for maximal repletion of glycogen from daily training, workouts, and competition.

PROTEIN

Three theories have been proposed as to why athletes need more protein than that recommended by the

TABLE II. Liberal estimate of protein requirement for a growing male adolescent athlete weighing 70 kg

28.7 gm	Replacement of obligatory N loss in urine, feces, skin, and other sites assuming largest loss
8.6 gm	30% Allowance for individual variation
4.8 gm	Allowance for growth assuming most rapid growth
7.5 gm	Replacement of N lost in sweat during 4 hr of vigorous exercise
6.3 gm	Allowance for increased muscle mass as during some kinds of training
8.6 gm	Allowance for loss of efficiency of standard protein
19.8 gm	Allowance for use of protein for energy during rigorous exercise*
104.1 gm	Total estimated protein requirement = 1.5 gm/kg†

*Determined according to an energy expenditure during activity of an average of 12 kcal/min and exercising time daily of 240 min and the assumption that 5.5% of the total energy expenditure during exercise is from protein.

†Data from: "Energy and Protein Requirements," Report of Joint FAO/WHO Ad Hoc Expert Committee; World Health Organization Technology System Series, No. 522, Geneva, Switzerland, 1973, and Durnin JVGA: Protein requirements and physical activity. In Parizkova J, Rogozkin VA, editors: Nutrition, physical fitness, and health. Baltimore, 1978, University Park Press.

recommended dietary allowances (RDA) for the person with light activity: (1) increases in muscle mass, myoglobin, hemoglobin, and enzymes during training require greater than normal amounts of protein in the diet^{17, 18}; (2) increased intake of protein is necessary in the early phase of training to meet the increased need for protein to support skeletal muscle increase when erythrocytes and plasma proteins are destroyed, thus producing "sports anemia"¹⁹; and (3) protein is a source of energy for the working muscle during exercise. Several recent studies present evidence of increased nitrogen turnover during exercise and the role of the glucose-alanine cycle and the possible use of the branched chain amino acids (leucine, isoleucine, and valine) for energy.²⁰⁻²²

Evans et al.,^{23, 24} who found that there is a substantial decrease in the rate of protein synthesis during exercise, estimate that protein can provide up to 5.5% of the total caloric cost of exercise. Lemon and Mullin²¹ calculated that 4.4% of the total energy used during exercise after glycogen loading came from protein, whereas 10.4% of the calories used came from protein in the glycogen-depleted individual.

Table II summarizes a very liberal estimate of the protein requirements for the athlete with the greatest protein needs—the rapidly growing male adolescent

athlete in rigorous training and sweating profusely for 4 hr/day. This very liberal estimate is about 104 gm of protein daily or 1.5 gm/kg. This is greater than the RDA of 0.8 gm/kg for the adolescent male but is still easily within the range of intake of most athletes. The athlete described, if meeting his energy intake, would probably be consuming at least 3500 kcal, of which 10% to 15% of the calories would be from protein, considering the usual intake of individuals in this country. This would mean a protein intake of 87 to 131 gm, probably adequate to meet the needs of this athlete. Generally there is not a need to recommend greater than normal amounts of protein in the diets of most athletes, but there is a need to study the minimum requirement for protein for these physically active individuals. The athlete who is restricting energy intake at the same time that he or she is exercising heavily does need to give attention to protein intake, but increasing the energy intake will usually solve the problem.

It has been reported that the metabolism of theophylline, a drug widely used in the treatment of allergic and asthmatic athletes, is affected by the carbohydrate and protein content of the diet.^{25, 26} A high protein (3 gm/kg) diet for 12 days significantly decreased the half-life of theophylline, while a low protein (0.5 gm/kg) diet increased it. This may have implications for asthmatic athletes taking theophylline who follow high protein diets for long periods of time for reasons of performance or weight loss.

MINERALS

Because of their loss through sweat, sodium, chloride, magnesium, and potassium are the minerals of greatest importance to the athlete. However, sweat is hypotonic compared with body fluids, so even with prolonged sweating (as much as a 9-pound body weight loss) the losses of sodium and chloride amount to only 6% to 8% of the body's total sodium chloride content, and the potassium and magnesium losses are less. Sodium and chloride can usually be replaced by eating salty foods and salting foods to satisfy taste. Rarely are salt tablets or excessive salt intake necessary for salt replacement. With heavy training in hot temperatures, dilute salt-containing solutions (no more than 1 gm NaCl/L) may be used as rehydration drinks to correct excessive sweat loss.²⁷ However, sweating always causes more water loss than salt loss so it is far more important to replace water than salt.

In the absence of vomiting or diarrhea, which cause substantial potassium losses, the daily potassium losses of an athlete are offset by a normal dietary intake of potassium (70 to 80 mEq daily), and the same is true for magnesium.^{28, 29} It is also evident that the body is able to adjust and maintain proper body

TABLE III. Spectrum of food intolerance

Allergic reactions—immunologic mechanism
IgE mediated
non-IgE mediated
Reactions to pharmacologic agents in foods
Phenethylamine (e.g., chocolate)
Vasoactive amines (e.g., banana and aged cheese)
Methylxanthines (e.g., coffee, tea, cola, and chocolate)
Licorice (mineralocorticoid-like activity)
Reactions to food additives
Monosodium glutamate (e.g., Chinese food)
Metabisulfite (e.g., restaurant salads and wine)
Tartrazine and other food colors
Other controversial substances (e.g., preservatives)
Reactions to toxins in food
Bacteria (e.g., salmonella)
Fungus (e.g., aflatoxin)
Trace metals (e.g., mercury and lead)
Histamine and histamine-releasing agents from micro-organism contamination
Naturally present toxins (e.g., solanine)
Reactions to foods in association with exercise
Food-dependent exercise-induced anaphylaxis
Reactions to foods caused by psychologic factors such as stress, anxiety, and nervousness
Intolerance of foods because of gastrointestinal disorders
Intolerance of foods because of inborn errors of metabolism

potassium on a wide range of intakes and that during repeated bouts of heavy exercise and dehydration during the heavy training and competitive season, the body adjusts to minimize electrolyte losses.³⁰

Except for the electrolytes, the mineral that has received the most attention in relation to athletic performance is iron because of the role of hemoglobin in carrying oxygen from lungs to tissues and the presence of iron in myoglobin, cytochromes, and enzymes involved in aerobic metabolism. Anemic athletes appear to have less than optimal performance in activities that stress aerobic endurance. However, the effect does not appear to be caused entirely by hemoglobin changes and may be due to reduction in aerobic metabolism and elevated blood lactate levels.³¹

Is true iron deficiency anemia a common problem in the athlete? One study showed that 22% of female athletes and 10% of male athletes were deficient in iron.³² It is true that sweat contains 0.3 to 0.4 mg iron/L and (since athletes may lose as much as 5 to 8 L of sweat per day during heavy training in a hot environment) the amount of iron lost by athletes could be considerably greater than that lost by the nonathlete, thus making them more susceptible to iron deficiency. However, it also has been reported that because of their large energy intakes, most athletes have intakes of iron that meet the RDA.³³

It now appears that heavy training may cause a

TABLE IV. An approach to diagnosis and treatment of the food-intolerant athlete

Diagnosis
Physical examination and clinical history with description of suspected food intolerance
Time between food ingestion and any other accompanying activity and onset of symptoms
Description of most recent reaction
Estimate of quantity of food needed to cause reaction
Food and symptom diary to document usual food intake and frequency of symptoms
Necessary tests to rule out nonallergic causes for food intolerance
Diet eliminating suspected foods for period of time with recording of symptoms
If no improvement, initiation of a more severe elimination diet—omission of additional foods
When improvement seen, reintroduction of suspected foods one at a time to see if symptoms recur
Challenge with suspected food in double-blind fashion with recording of symptoms; avoid challenge if reaction has been anaphylaxis unless done with proper supervision
Immunologic tests to determine if identified food intolerance is a food allergy
Treatment
Elimination of identified problematic foods from the diet
Provision of nutritionally sound diet with supplementation of nutrients if necessary
Rechallenge with suspected foods periodically (unless reaction is anaphylaxis) to determine if intolerance still exists

transient anemia or "sports anemia" that is characterized by significant decreases in RBC count, hemoglobin concentration, and packed cell volume, but the RBC morphology remains normal and it appears that there is no deterioration in performance.³⁴ The cause of "sports anemia" is not known but reasons such as a hemodilution effect of expanded blood volume and increased rate of destruction of RBCs because of intravascular hemolysis have been postulated.

It is important to determine if anemia is "sports anemia" or true iron deficiency anemia. If true iron deficiency anemia exists, iron supplementation along with vitamin C is appropriate. If the athlete has "sports anemia" there is little evidence that additional iron in this noniron-deficient person will lead to increased RBC production.^{35, 36} At present no treatment is believed to be necessary. Furthermore, the data do not support giving routine iron supplementation to athletes to prevent "sports anemia."

Athletes at risk for developing iron deficiency anemia are the rapidly growing male adolescent athlete, the female athlete with heavy menstrual losses (greater than 60 ml of blood during a menstrual period), and

TABLE V. Nutritional considerations when certain foods are avoided by athletes

Food	Nutrient potentially inadequate	Suggested supplementation
Milk	Vitamin D	Vitamin D
Milk and all milk products	Vitamin D, calcium, and riboflavin	Vitamin D, calcium, and riboflavin
Animal flesh and proteins	Iron and zinc	Iron, zinc, and vitamin C to enhance nonheme iron absorption
Wheat	Carbohydrate	Carbohydrate supplement or increased use of other grains
Citrus and many fruits	Vitamin C and folic acid	Vitamin C and folic acid, wheat germ, or increased use of beans

the athlete with a poor diet. However, it should also be remembered that many female competitive athletes become amenorrheic during heavy training and competition, with a consequent conservation of iron.

VITAMINS

There is an increased need for B vitamins because of increased energy metabolism by the athlete, but these requirements are usually met by an adequate diet. There is no doubt that deficiencies of the B vitamins decrease athletic performance, but there is no evidence that supplementation with B vitamins in the replete athlete will increase performance.³⁷ A study of Norwegian cross-country skiers skiing 50 to 60 miles/day and consuming 8000 to 9000 kcal/day showed that they had serum pyridoxine levels below normal. When they were given supplements of vitamin B₆, serum levels increased, but the significance of this for performance is not clear.³⁸

Many athletes use huge amounts of vitamin C in an attempt to prevent fatigue or increase performance. However, studies to date on the efficacy of ascorbic acid supplementation do not support these claims.³⁹ One of the problems with many of the studies, however, is that the vitamin C supplements were used without prior determination of the vitamin C status of the subjects, which is important with a vitamin as labile as vitamin C.

Another aspect of vitamin C that deserves mention in relationship to allergic athletes is its effect on asthma or bronchospasm. However, reports are contradictory, several reporting beneficial effects⁴⁰⁻⁴² and others reporting no effect.^{43, 44} Moshenit et al.⁴⁵ recently studied the effect of ascorbic acid in 14 mild asthmatic nonathletes. One gram of ascorbic acid reduced bronchial hyperreactivity as measured by methacholine challenge in 11 of 14 athletes, and the effect of ascorbic acid was reversed by the administration of indomethacin. Whether this has any implication for the trained athlete is not clear.

Vitamin E is probably the vitamin most widely used as a supplement by athletes. Theoretically, the reason

for the use of vitamin E supplements is that it reduces the amount of oxygen used during exercise. However, studies have shown no beneficial effect of 400 to 1200 IU of vitamin E in swimmers.^{39, 46} It would appear that Vitamin E contributes little to performance in most situations. Whether vitamin E may have a protective clinical effect during exercise in polluted environmental conditions, especially of ozone as suggested by one study,⁴⁷ is not clear.

ERGOGENIC AIDS

Two substances used by athletes because of their "ergogenic" properties deserve mention in reference to allergic athletes.

Caffeine

Caffeine has long been thought to be an ergogenic aid by athletes but the popularity of its use has increased in recent years because of the finding that it can enhance performance in endurance exercise.⁴⁸

However, if caffeine is going to be used to enhance performance by the allergic athlete who is also taking theophylline, it is important to remember that both are methylxanthines with potentially additive effects. Combined with theophylline, the side effects of large doses of caffeine (nervousness, jitteriness, and anxiety) may make its use undesirable in these athletes.

Bee pollen

Another substance thought to have ergogenic properties is bee pollen, although there is no scientific basis for these claims. However, there have been several reported cases of anaphylaxis to ingested bee pollen, so bee pollen should be avoided by the allergic athlete.⁴⁹⁻⁵¹

FOOD INTOLERANCE AND HYPERSENSITIVITY

The spectrum of food intolerance ranges from serious allergic reactions, such as anaphylaxis, to minor gastrointestinal disorders (Table III). It is important for the allergic athlete to determine whether a food

intolerance truly exists and whether it is due to a food allergy involving an immunologic mechanism or to some other factor, such as psychologic stress from competition.

A reasonable approach (Table IV) begins with a detailed description of the symptoms with special noting of the time between food ingestion and the onset of symptoms, the amount of food estimated to produce the reaction, and a description of the reaction. This is followed by a food and symptom diary, necessary tests to rule out nonallergic causes, and an elimination diet with reintroduction of eliminated foods and observation of symptoms. Immunologic tests can be performed to determine if the intolerance is an allergy.

NUTRITIONAL MANAGEMENT

Once problematic foods are identified, treatment involves elimination of those foods with provision of an adequate diet. This may necessitate supplementation (Table V). Subjects should be rechallenged with suspected foods periodically (unless the reaction is a serious one such as anaphylaxis) to determine if intolerance still exists. Proper diagnosis of a food allergy or intolerance will help considerably in the management of the problem.

No matter how much the athlete knows about nutrition and the need for more food and fluids, if he or she does not have the time to eat or if nutritious, wholesome foods are not readily available, as may be the case in low-income homes or disorganized families, the athlete may not receive proper nutrition. If a demanding training schedule does not allow time for meals, the athlete will suffer. For many athletes, the evening meal and after-dinner eating must provide 75% or more of the total energy and nutrient requirements. It is important that coaches, family, and the athlete recognize the importance of taking adequate time to eat an adequate diet.

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