NUTRITION AND ATHLETE HEALTH

The sport of athletics includes a wide range of events whose requirements range from speed to endurance, from a light physique to explosive power, and from multiple events lasting less than a minute to a single race lasting more than 2–3 hours. Despite the extreme contrast in these characteristics, all athletes share some common nutrition goals (see Table 6-1). This chapter will briefly explore these goals.

Table 6-1. The athlete's nutrition goals.

Characteristic	**The athlete's nutrition-related goals**
Everyday eating or training diet	• Achieve and maintain a physique that is suited to the event • Eat to stay healthy and injury-free • Train hard and promote optimal adaptations and recovery from the training programme • Practice competition eating in training to fine tune strategies
Competition eating	• Prepare adequate fuel stores for the event • Eat and drink well on competition day to prepare for an event and to recover between multiple events • During prolonged events (> 1 hour), replace fluid and carbohydrate to enhance performance • Achieve competition strategies when traveling
Sports foods and dietary supplements	• Make use of specialised sports foods to meet nutritional goals when it is impractical to eat everyday foods • Make wise decisions about the use of nutritional ergogenic aids based on cost: benefit analysis

A. The Training Diet

1. Achieving Energy Needs

Energy needs vary according to body size, the energy cost of training (volume, frequency, and intensity of workouts) and requirements for growth or changes in body physique. As a result, energy needs vary not only amongst athletes, but vary between phases of the season and over the athlete's career. It is important for each athlete to achieve a suitable energy intake since this affects hormonal and metabolic function as well as the ability to provide adequate fuel for training, and to consume the range of nutrients and food components that promote good health.

There are often problems at the extremes of energy intake or requirement. Examples include the athlete who over-restricts their energy to reduce body weight and body mass levels, the athlete who is unable to adjust to a new energy requirement while they are injured or in the off-season, and the athlete with very high energy requirements who is unable to consume adequate food in a busy day. A consultation with a sports dietitian can help such athletes to recognise their true energy requirements and adopt appropriate eating patterns and food choices.

A new concept that is being promoted is that of energy availability—that is, the energy that is left for body functions once the energy cost of training is taken into account (see Table 6-2). There is evidence that the body can tolerate a certain level of reduction in energy intake, but energy availability lower than 30 kcal (126 kJ) per kg of lean body mass is associated with impairments of metabolic, hormonal, and reproductive function. This is now identified as being important in the development of menstrual disorders in female athletes.

Table 6-2. Calculation of energy availability.

Definition of energy availability	**Total energy intake—energy cost of training**
Example of low energy availability Athlete = 50 kg distance runner, 10% body fat Training programme = 1000 kcal/day Energy intake = 2250 kcal	Calculations: Body fat = 10% or 5 kg Lean body mass (LBM) = 45 kg Energy availability = 2250 -1000 = 1250 kcal = 1250/45 kg = 28 kcal/kg LBM
Example of adequate energy availability Athlete = 60 kg distance runner, 10% body fat Training program = 1000 kcal/day Energy intake = 3250 kcal	Calculations: Body fat = 10% or 6 kg Lean body mass (LBM) = 54 kg Energy availability = 3250 -1000 = 2250 kcal = 2250/54 kg = 42 kcal/kg LBM

2. Maintaining the Ideal Physique

In many events, the athlete's physique plays an important role in promoting optimal performance. For example, a high level of muscularity is required to achieve explosive power in sprints or strength for throwing events. Furthermore, when the athlete is required to move their own body mass over long distances (distance running and walking) or against gravity (jumps and hilly running courses), a favorable "power to weight" ratio is achieved by being light and lean.

Some athletes automatically arrive at a desirable physique for their event, as a result of genetics and the conditioning effects of training and healthy eating. Other athletes need to manipulate their training and diet to produce an increase in muscle mass and/or a loss of body mass and body fat levels. In many cases, the expectations of such a program are unrealistic or the dietary strategies are unsound.

Loss of body fat/body mass should be gradually achieved by a program of mild energy deficit that still permits the achievement of the athlete's other dietary goals and allows the athlete to be reasonably free of food-related stress. The athlete should not strive for minimal body fat levels per se, but rather a physique that is associated with good performances and health over both the long term and short term. An increase in muscle mass and strength is achieved by an appropriate resistance program with the support of adequate energy intake and strategic timing of food intake around training sessions.

3. Protein Needs

Athletes in events requiring strength and power (e.g. sprinters and throwers) often believe that protein intake is their most important nutritional concern, and that high protein diets and protein supplements are a required part of their preparation. The perceived link between a high protein intake and gain of muscle protein is understandable but is not supported by scientific evidence. By contrast, many athletes in endurance events (e.g. distance runners and walkers) pay little attention to dietary protein despite the importance of protein synthesis in the achievement of their desired training adaptations (e.g. repair of muscle damage and the synthesis of functional body proteins such as enzymes).

Whether heavy training increases protein requirements is still debated. Studies typically show that protein intakes needed to achieve nitrogen balance are not elevated in subjects habituated to an exercise load. However, this may not reflect the situation for athletes who practice progressive overload in their training. Nevertheless when the possible increases in protein requirements have been calculated for athletes in heavy training, they appear to be within the range of 1.2–1.6 g/kg body mass per day for both strength and endurance activities. Dietary surveys show that such intakes are achieved by most athletes, especially those consuming high-energy intakes. Therefore, an exaggerated focus on protein-rich foods or high protein supplements is unnecessary. Athletes who are most at risk of consuming protein intakes below this range are those who restrict total energy intake to lose weight. This is particularly the case for female athletes.

Recent studies suggest that the total *amount* of protein consumed by the athlete is not as important as the *timing* of intake in relation to training. The consumption of protein before and after a resistance workout has been shown to enhance protein synthesis and net protein balance in response to the training stimulus; this enhancement is still evident in the 24-hour picture of protein balance. This strategy should be integrated into the athlete's recovery eating program.

4. Meeting Fuel Requirements for Training

Although various substrates combine to provide the fuel for exercise, the body's carbohydrate stores are limited and are often less than the fuel cost of daily training. The athlete's everyday eating should provide adequate carbohydrate to fuel training and promote adequate recovery of muscle glycogen stores between workouts. Older dietary guidelines promoted a single recommendation for the carbohydrate content of the athlete's diet, expressing this as a percentage of total energy intake (e.g. 55–70% of daily energy).

However, it is now recognised that this terminology fails to recognise the varying fuel needs associated with different types of training, and falsely assumes that these fuel needs are always aligned with total energy requirements. Therefore, new guidelines express carbohydrate needs according to the type and volume of training, and the size of the athlete. It is suggested that daily carbohydrate needs vary from ~5 g/kg body mass for athletes undertaking a light training program or training that is not dependent on muscle glycogen, to intakes of 7–10 g/kg for prolonged and strenuous daily workouts or where optimal synthesis of glycogen is required. Of course, these guidelines are considered “ball park” figures and should be fine-tuned by the athlete according to their total energy budget and feedback from training performances.

5. Vitamins, Minerals, and Anti-oxidants

Food contains a variety of vitamins, minerals, anti-oxidants, and other food components that promote optimal function and health. Generally, we can be confident that a moderate to high energy intake (>2000 kcal or 8.4 MJ per day), chosen from a wide variety of nutrient-rich foods, is able to supply all needs for these micronutrients and food components. Athletes are at risk of inadequate intake of these compounds when they restrict energy intake, dietary variety, or both of these factors. This includes athletes following weight loss diets or other programs that limit food choices, fussy eaters, and athletes who are traveling to areas in which food availability is limited. These athletes should be directed to a sports dietitian for advice to improve the quantity and quality of their food intake. Where the athlete is unable or unwilling to implement such changes, a low-dose broad range multi-vitamin/mineral supplement should be considered.

The micronutrients that are at most likely to be consumed in inadequate amounts are iron and calcium. Iron deficiency occurs in athletes for the same reason that it occurs in the general population; intake of bio-available iron that is less than iron requirements or iron losses. Risk factors for low iron intake include low energy intake, vegetarian eating, and other eating patterns that restrict dietary variety and intake of red meats. While iron requirements are increased during growth and pregnancy, iron losses are increased by problems of gastrointestinal bleeding or malabsorption (e.g. ulcers, Crohn’s disease, or parasitic infections), excessive hemolysis associated with footstrike, and unusual blood loss (frequent blood donations, traumatic bleeding, and abnormal menstrual blood loss). It appears that the prevalence of iron deficiency anemia in athletes is similar to that of the sedentary population. However, there is a higher prevalence of iron deficiency without anemia (hemoglobin within normal ranges, but serum ferritin levels below 20–30 ng/ml) and recent studies show that this condition is associated with a reduced responsiveness to training. It is now recommended that interventions occur at this stage, even if it is only to prevent a further decline into anemia.

Prevention and treatment of reduced iron status should include attention to the factors that are causing iron drain, including dietary modifications to increase the intake of bio-available iron. Such dietary changes may include the frequent intake of small servings of foods containing the heme form of iron (e.g. red meats, shellfish, liver) and increased consumption of good sources of non-heme or plant iron (e.g. fortified breakfast cereals, nuts and legumes, wholegrain cereals, and green leafy vegetables). The athlete should also plan meals to combine the plant sources of iron with factors that promote iron absorption (e.g. Vitamin C and "meat factor"), while reducing interaction with excessive amounts of food factors that reduce the bio-availability of this iron (e.g. phytate in bran or tannin in tea). Vegetarians should pay particular attention to such planning. Iron supplements may be part of the therapy required to achieve good iron status in athletes. However, athletes should be warned about self-prescribing iron supplements on the basis of perceptions of fatigue. Iron deficiency needs to be diagnosed and treated by appropriate experts in sports medicine and sports nutrition.

Some athletes also fail to consume adequate calcium in their diets; this is a factor but not a primary cause in the development of poor bone health and stress fractures. The athlete should receive early intervention in the treatment of such problems (see Female Athlete Triad, below). This may include dietary advice to correct low energy availability, and to increase dietary calcium intake, principally through the consumption of low-fat dairy products or calcium-fortified soy alternatives.

B. Special Issues

1. Eating for Recovery

The training and competition programs of high-level athletes often require several sessions of exercise each day. This has focused the attention on eating strategies that promote recovery after strenuous exercise and enhance the adaptations achieved by the training program. Nutrition-related aspects of recovery include refueling, rehydration, rebuilding and staying healthy. Rehydration requires the replacement of the fluids and electrolytes lost in sweat, and when the fluid deficit remaining after a workout or race is greater than 2% of body mass, it is sensible to implement a rehydration plan rather than relying on thirst or good luck. Strategies to remain as well-hydrated as practical during exercise are discussed in the section on competition eating (below). These strategies should also be used during training sessions, to enable the athlete to train optimally as well as to fine-tune the drinking practices that might occur during prolonged competitive events.

During the hours after exercise, the athlete should be guided to consume a volume of fluids equal to 125–150% of the remaining fluid losses. The replacement of electrolyte losses, particularly sodium, is also needed to maximise the retention of these drinks and the re-equilibration of body fluids. Sodium replacement can be achieved via the intake of electrolyte replacement products (e.g. oral rehydration solutions), foods with high sodium levels (e.g. bread, breakfast cereals, and other processed foods), or the addition of salt to meals.

The speedy resynthesis of muscle glycogen levels is assisted by the intake of carbohydrate-rich foods and drinks, and where there is less than 6–8 hours between workouts, it makes sense to maximise the time for efficient muscle refueling by consuming a carbohydrate supply as soon as practical after the first session of exercise. The inclusion of protein to post-exercise recovery eating is valuable in promoting net protein synthesis after exercise, including gains in muscle mass and strength and the repair of muscle damage. Such recovery eating probably requires the intake of ~10–20 g of high quality protein and 1 g of carbohydrate per kg body mass in the hour following exercise. In the case of resistance training, there is some evidence that the consumption of protein *prior* to the session is particularly effective in promoting the net protein gain following a workout.

To achieve recovery eating goals for key sessions of training or competition, the athlete should organise a suitable supply of snacks that can be taken to their exercise venue, or re-organise their daily timetable so that meals can be eaten in proximity to the session. Examples of food combinations that provide protein and carbohydrate are found in Table 6-3.

Table 6-3. Examples of foods that can be used for rebuilding and refueling goals.

Foods providing 50 g carbohydrate for refueling goals	**Foods providing 50 g carbohydrate and at least 10 g high quality protein for refueling and rebuilding**
• 600–800 ml sports drink	• 1.5–2 cups breakfast cereal with1/2 cup milk
• 450 ml soft drink or orange juice	• 200 g carton fruit-flavored yoghurt + 35 g cereal/granola bar
• 60–70 g packet of jelly beans	• 1 round sandwich with cheese/meat/chicken filling + piece of fruit
• 2 sports gels	• 500 ml flavored low-fat milk
• 3 medium pieces of fruit or 2 bananas	• 300 ml liquid meal supplement
• 2 thick slices of bread with jam or honey	• 2 slices of toast + 1 cup baked beans

2. Staying Healthy and Injury Free

To maximise the length and success of a sporting career, an athlete needs to stay healthy and injury free. Sound nutrition is one of the factors that can assist this goal. Conversely, poor eating practices can increase the risk of succumbing to sickness or injury, or lengthen recovery time. Heavy training is associated with a suppression of the immune system, especially during the hours following a bout of prolonged or strenuous exercise. Although products such as vitamin C, Echinacea, glutamine and bovine colostrum have been proposed as immune protectors, the available research fails to support overall benefits to the athlete’s health. Instead the nutritional factors that are most likely to influence immune health are energy and carbohydrate status.

Inadequate energy intake is known to impair immune function and increase susceptibility to illness and infection. Carbohydrate depletion during exercise is associated with an increase in stress hormones and a suppression of immune parametres. Strategies that enhance carbohydrate availability, such as carbohydrate intake during and after exercise, have been shown to reduce these effects. Studies that track the success of these strategies in reducing the incidence of illness and infection in athletes are required.

Energy restriction and carbohydrate depletion can also be factors in injury. Training while fatigued can increase the risk of both traumatic and overuse injuries. More importantly, there are clear links between restrained eating and poor bone health. New research shows that low energy availability affects rates of bone turnover; this is in addition to its indirect effects on bone via disturbances to reproductive hormones in females. This is discussed in more detail in the section on the Female Athlete Triad. Since athletes are usually concerned about illness and injury, emphasis on the benefits of well-chosen eating practices could provide a new education message in sports nutrition.

3. The Female Athlete Triad

The term Female Athlete Triad was coined over a decade ago to describe the inter-relatedness of eating disorders, amenorrhea, and osteopenia in female athletes. At this time the syndrome involved a clinical diagnosis of these three medical issues and was often described in female distance runners. The aim of drawing attention to this syndrome was to change perceptions about the problem of impaired menstrual status in female athletes.

Originally, the cessation of regular periods was considered a benign condition, and was sometimes prized by female runners as a convenience or reward for heavy training. However, the past decades have seen accumulating evidence of the negative effects of disturbances to reproductive hormones on bone accumulation and bone density. Immediate problems include an increased risk of stress fractures, while the long-term picture includes a premature onset of osteoporosis. (See Chapter 13, Part 1, *Endocrine/Menstrual Factors* for additional details.)

The updated version of the Female Athlete Triad now targets energy availability, menstrual health, or bone density. It considers that each of these issues enjoys a continuum between optimal health and frank disorder, and that the athlete should be alerted to any change in their status of any issue. In other words, athletes must be educated that negative outcomes occur at a much earlier stage than previously considered, and that there are benefits of an earlier diagnosis and treatment of problems. The detection, prevention, and management of the Female Athlete Triad, or individual elements within it, require expertise and, ideally, the teamwork of sports physicians, dietitians, psychologists, and the coach/fitness advisor.

C. Competition Eating

1. Fueling Up for Competition

In the days and hours prior to competition, the athlete should consume foods to prepare adequate fuel stores for their event. The normalised muscle glycogen levels of a trained athlete are considered adequate for the needs of events lasting up to 60–90 minutes. Preparation for such events can be managed by 24 hours of high carbohydrate eating and tapered exercise. Races lasting longer than this—for example, a marathon or 50 km race walking—are associated with the depletion of muscle glycogen which causes fatigue known as “hitting the wall”.

Carbohydrate loading is a technique of maximising or super-compensating glycogen stores in the days leading up to the event. The original technique, described from research undertaken on relatively untrained subjects, required a period of low carbohydrate intake and hard training to deplete muscle glycogen levels (= 3 day depletion) followed by 3 days of high carbohydrate eating and exercise taper to supercompensate glycogen stores. More recent studies have shown that this depletion phase is unnecessary in trained individuals, and glycogen supercompensation can be achieved in as little as 36–48 hours of taper and high-carbohydrate eating (~10 g/kg/d). Optimising muscle glycogen stores will allow the endurance athlete to run or walk longer in their event at their optimal race pace. Carbohydrate consumed in the hours before, and during prolonged events can provide additional fuel for the muscle and central nervous system.

2. Eating On the Day of Competition: Pre-Event and Between Events

The goals of the pre-event meal are to provide a final top-up of fuel and fluid stores, and to leave the athlete feeling confident and prepared to compete at their best. In general, a carbohydrate-rich meal is promoted, and the athlete should experiment with the type, amount, and timing of food intake to find an individualised plan that suits the needs of their events. When high-intensity exercise or competition nerves increase the risk of gastrointestinal upsets during the event, the athlete should try to reduce the fibre intake, fat intake, or volume of their last meal. Some athletes find that a liquid meal (commercial liquid meal supplement or fruit smoothie) is a convenient option.

The competition requirements of sprinters, jumpers and multi-event athletes (heptathletes and decathletes) often include a series of events over a day or days. Food and fluid intake over these days should be organised to refuel and rehydrate according to the needs of the event and the environmental conditions. The athlete should organise a nutrition plan of meals and snacks that suits the timetable of warm-up, competition and recovery.

3. Fluid and Fuel Intake During Events Lasting More Than 1 Hour

In events of greater than one hour duration, there is both an opportunity and need to consume fluid and carbohydrate during exercise to promote optimal performance. The loss of fluid and electrolytes through sweating leads to a reduction in body water. Fluid deficits of as little as 2% of body mass can impair performance, particularly in hot weather, with the impairment increasing in ratio to the size of the fluid deficit. Fluid intake during a race should be undertaken in consideration of the athlete’s likely sweat rates balanced against the practicalities of the time lost in grasping and consuming the supplies at an aid station, and the risk of gastrointestinal problems. Monitoring weight changes before and after training sessions and events can provide an estimate of sweat rates (1 kg loss ~1 liter of sweat), and help to develop a personalised fluid intake plan. (See Appendix 5, *IAAF Policy on Fluid Replacement,* for additional information.)

Ideally, the athlete should try to match fluid intake with sweat losses as well as is practical, or to keep the fluid deficit to less than 2% of body mass. Although this is sometimes difficult for elite athletes running at high speeds in hot-weather races, practicing drinking during training can help to improve the skills and tolerance of fluid intake "on the run". Slower runners are better able to match fluid intake to their sweat losses, and in some cases, need to be warned about the dangers of overdrinking. Runners should not drink excessive amounts of fluid during an event so that they increase their body mass over the race. Overdrinking increases the risk of developing hyponatremia, which is a potentially fatal condition.

In events lasting greater than 60–90 minutes, race intake should also include carbohydrate to provide an additional fuel source. A strong literature shows that the intake of 30–60 g of carbohydrate per hour of a prolonged event can enhance performance by maintaining carbohydrate availability at a time when body carbohydrate stores are becoming depleted. This can be achieved by drinking commercial sports drinks that typically contain 4–8% carbohydrate and 10–20 mmol/l sodium. Such drinks have been manufactured to allow simultaneous replacement of fluid and fuel during exercise, and their pleasant taste has been shown to increase the voluntary intake of fluid compared to plain water. Recent studies have shown that the intake of carbohydrate may enhance performance of high-intensity events lasting about 1h (e.g. a half marathon). This is curious since muscle glycogen are not limiting in this event, at least if the athlete has undertaken a good nutritional preparation for competition. It is thought that benefits might be derived through the central nervous system, whereby carbohydrate supplementation causes enhancements of the perception of effort and pacing strategies. Further research is needed, and athletes in these shorter events should experiment with a race plan including carbohydrate intake from sources such as sports drinks, sports gels or confectionery items.

4. The Travelling Athlete

Most elite athletes are well-seasoned travelers, undertaking trips to training camps or specialised environments (e.g. altitude), and to compete. Athletes must be able to achieve their peak performance at important competitions such as Olympic Games or World Championships in an environment that is often both far away and different to their home-base. Many athletes compete in series like the Golden League or Grand Prix, which require them to travel almost weekly to compete against other athletes in this competition. Frequent travel can pose a number of challenges. These include disruptions to the normal training routine and lifestyle while the athlete is en route, jet lag, changes to food availability including absence of important and familiar foods, and a reliance on hotels, restaurants, and takeaways instead of home cooking. Even in an Athlete's Village there are the temptations of an "all you can eat" dining hall. Depending on the destination, the athlete may be at risk of gastrointestinal illnesses due to exposure to food and water with poor hygiene standards (see Chapter 12, *Infectious Diseases*).

There are many strategies that an athlete can put into place to overcome these challenges. These include preparation techniques such as investigating the likely food issues in the new environment, and organising a supply of important or missing foods to accompany the athlete. Items that are portable and practical for travel include powdered sports drinks and liquid meal supplements, sports bars, cereal/granola bars, breakfast cereal and skim milk powder, dried fruit and nut mixes, and rice cakes/crackers with spreads. Having an "emergency" supply of foods can allow the athlete to supplement inadequate meals, provide additional snacks, and be self-reliant in looking after nutritional needs at key times such as post-training or post-event.

D. Sports Foods and Supplements

Sports foods and supplements represent a multi-billion dollar industry, supported by aggressive marketing from manufacturers and word of mouth between athletes and coaches. Sports scientists believe that well-controlled research should underpin the promotion of any sports nutrition practice and are understandably frustrated that supplement manufacturers often make impressive claims about their products without adequate (or in some cases, any) proof. However, in most countries, legislation regarding supplements or sports foods is either minimal or not enforced, allowing unsupported claims to flourish and products to be manufactured with poor compliance to labeling and composition standards (see also Part 2 of this chapter, *A Rational Approach to Supplements,* for additional details). Athletes are usually unaware of these lapses.

Before making a decision to use a supplement or sports food, athletes and coaches should consider the likely benefits, balanced against the cost of the product and the risk of negative outcomes. Problems include the risk of side-effects or inadvertent intake of a substance that is banned in sport, leading to a "positive" doping outcome. The advice of a sports nutrition expert should be sought to provide such information.

The ever-growing range of sports nutrition products can be divided into two separate groups. Some supplements and sports foods address the special nutritional needs of athletes, and offer a simple or practical way to meet known nutritional goals. This group includes sports drinks, sports bars, liquid meal supplements and micronutrient supplements that are part of a prescribed dietary plan. Many of these products are specially designed to help an athlete meet specific needs for energy and nutrient, including fluid and carbohydrate, in situations where everyday foods are not practical to eat. The use of many of these products has been discussed in previous parts of this chapter. These sports foods and supplements can be shown to improve performance when they allow the athlete to achieve their sports nutrition goals. However, they are more expensive than normal food, and this consideration must be balanced against the convenience they provide.

Conversely, some products claim a direct ergogenic benefit to sports performance. Very few of these products have clear scientific evidence to support these claims, with a few exceptions including caffeine, creatine, and bicarbonate/citrate. Athletes should seek expert advice about such supplements to see if their sport/exercise warrants experimentation with these products to ensure that a correct protocol is tried. It should be noted, however, that supplements and sports foods are neither a short cut to optimal performance nor a replacement for the sound principles that underpin good training.

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A RATIONAL APPROACH TO SUPPLEMENTS

Nutrition scientists in recent years have identified an increasing number of elements that are now deemed essential for a complete diet. In addition to the well-known critical need for vitamins and macro-nutrients (energy fuels), they have noted the importance of the ‘essential’ amino acids, trace minerals, fatty acids, and phyto-chemicals, as well as many other organic compounds. With the increasing use of industrial food production processes, many of these elements have been found to be deficient in various segments of the population, including possibly athletes who are training intensively.

It is well known that the diets of many pre-adolescents and adolescents, including athletes, are often lacking in adequate calcium and iron. In this age group the consumption of “empty calories” (sugars and sweets) is well documented. This is especially true among young women. Further, those women athletes in whom weight control is a concern are often calorie-deficient and suffer from an “energy deficit” that may have long-term effects on skeletal and reproductive health.

A. Athletes and the Supplements Industry

In order to ensure that athletes are obtaining nutrients sufficient for their training needs, they should have a complete dietary analysis and counseling by a qualified sports nutritionist, including a blood analysis for macro- and micro-nutrients.

Instead, athletes and coaches have been convinced by the dietary supplement industry that all athletes’ diets are inadequate, and routinely need supplementation.

The “nutritional supplement” industry has now become a multi-billion dollar enterprise. This industry utilises modern advertising techniques and mass-marketing, which is often based upon pseudo-science, factual distortion, and nutritional half-truths, in order to promote its products.

The U.S. “Dietary Supplements and Health Education Act” of 1994 established the legal framework for the manufacture of supplements. A dietary/food or nutritional supplement is defined as:

1. A product (other than tobacco) that is intended to supplement the diet that bears or contains one or more of the following ingredients:
   a. a vitamin
   b. a mineral
   c. an herb or botanical
   d. an amino acid
   e. a dietary substance for use by man to supplement the diet by increasing the total dietary intake
   f. or a concentrate, metabolite, constituent, extract, or combination of any ingredient described above.
2. Is intended for ingestion in pill, capsule, tablet, or liquid form.

3. Is not represented for use as a conventional food or the sole item of a meal or diet
4. Is labeled as a "dietary supplement"

These products are sold primarily as "ergogenic aids", "natural" or "legal" steroids, "fat burners", energy or immune system "boosters", etc. Many of these contain or are contaminated with androgenic pro-hormones that the body may convert to active anabolic steroids, resulting in a positive doping test.

The dietary supplement industry is unregulated, as these products are classified as "foods." They are not required to demonstrate the efficacy of their claims, so long as they do not purport to treat diseases.

Numerous studies have shown that:

- The quantity of the listed products on the label may vary widely from the amount listed.
- Many products contain ingredients that are not listed.
- "Natural" products are not necessarily safe.
- Side-effects are seldom listed.
- They may interfere with other prescription medications.
- They may create deficiencies of other nutrients.
- Some products that are purported to contain "legal" or "natural" pro-hormones actually contain banned anabolic steroids.

Many studies have shown that a significant number of supposedly "legal" or "safe" supplements may contain anabolic steroid precursors or pro-hormones that will result in a positive doping test. This is especially true if the manufacturer also produces a line of products that contain these banned substances, as cross-contamination may occur during the manufacturing process. In addition, Geyer et al. (2004) have shown that a sizable percentage of supplements are contaminated with androgenic-anabolic steroids, even those manufactured by a company that does not produce a line of anabolic products. The majority of these products are manufactured in the U.S., but labels are not required to list the country of origin.

It has been suggested that athletes use only supplements that 1) have been approved by such agencies as the U.S. Pharmacopeia (USP) or similar, or 2) have been tested and certified by the manufacturer as being free of pro-hormones or other banned substances, and have had no contact with these substances during their production or transport. Such certification ensures the quantity and purity of the product, but does not ensure its being free of banned substances.

However, it is unlikely that this type of certification will occur to any extent, unless laws governing the manufacture of these supplements are altered radically. The number of elite athletes who are subject to doping control is miniscule compared to the total number of consumers. Hence, such testing and approval would not be cost-effective for the manufacturer. Further, even if the manufacturer were to test and certify its products, in the event of a positive doping test such verification would not likely render it immune from a legal liability suit.

B. IAAF Recommendations

In view of the foregoing, the IAAF must still recommend that:

1. Athletes must review their diet carefully, along with a qualified sports nutrition professional, to ensure its adequacy, and to determine whether any supplementation is necessary (see Part 1 of this chapter, *Nutrition and Athlete Health*).
2. In nearly all cases, the athlete's complete nutritional needs can best be met by a well-selected menu of properly-prepared foods. This menu is more likely to provide the essential micro- and macro-nutrients, vitamins, and essential amino acids in a well-balanced, readily absorbable combination than can be obtained by the use of a barrage of expensive, randomly-chosen "supplements." However, many health professionals do now recommend a simple multi-vitamin preparation daily for all adults, and specific supplementation may be required if a true deficiency is detected by reliable testing.
3. Athletes and coaches must realise that the consumption of supplements, even under the best of circumstances, risks the possibility of causing a positive test for a banned substance during doping control. This possibility may vary from manufacturer to manufacturer, and even from batch to batch by the same manufacturer. Hence, we cannot avoid the adage—CAVEAT EMPTOR! (LET THE BUYER BEWARE).

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