

Nutrition for Athletes

A practical guide to eating for health and performance

Prepared by the Nutrition Working Group of the International Olympic Committee

Revised and updated in February 2010



Message from Atul Singh



At the outset let me first welcome all the participants and delegates from across the world to New Delhi and India — a land of rich and diverse culture, more than 5,000 years old. Your participation in the XIX Commonwealth Games is a tribute to your competitive spirit and your commitment to bringing people closer to each other through sports.

Staying committed to a balanced nutritional diet is key to achieving peak-level athletic performance. Aware of this, The Coca-Cola Company and the International Olympic Committee (IOC) have partnered to put together this booklet containing nutrition advice for athletes. It has information that will help athletes to make informed choices to meet their nutritional needs in different situations. It is no substitute for individual advice from a qualified professional

but tries to give practical information that will be of use to athletes.

The Coca-Cola Company has a rich heritage of supporting sports and physical activity. We are proud partners to the Summer and Winter Olympic Games, the Paralympics and FIFA World Cup™ Football, etc. We encourage sports at all levels, from youth development activities to intense competitive sporting events at the international level. We are already supporting several such programs in India. In fact, globally, the Company has now committed itself to have at least one physical activity program in every country in which it operates, by 2015.

On behalf of the entire Coca-Cola system in India, we wish you the very best as you compete and establish friendships with people from other cultures and countries who share your passion for sports, friendship and goodwill.

Atul Singh

President,
Coca-Cola India



Foreword by Dr M Jegathesan



It is indeed a great privilege for me to pen a foreword to this handy booklet on nutrition for athletes. The Commonwealth Games Federation (CGF) and its Medical Commission have always placed great emphasis on the value and importance of sound nutrition for athletes. The CGF also appreciates the efforts of the IOC in producing this booklet. This publication has been circulated widely and has gained acceptance as a simple but effective handbook for athletes. This booklet underscores the strong conviction of the IOC and the CGF

that proper nutrition, applied with the help of appropriate experts, is a viable alternative to the scourge of doping in sports. Athletes need to be aware of the value of good nutrition, and it is our duty as sports physicians and sports nutritionists to provide the necessary support. It is clear that the sports nutritionist will play an ever-increasing role in the care, training and preparation for competition of elite athletes. This booklet will stimulate athletes to want to know more of the impact of nutrition in their daily lives as well as on their thrust to greater sporting heights.

Tan Sri Dr M Jegathesan

Honorary Medical Advisor,
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The Games environment

The 2010 Commonwealth Games are the nineteenth celebration of sporting competition between nations of the Commonwealth and the ninth to be held under that name. The opening ceremony will take place at the Jawaharlal Nehru Stadium, Delhi. Competitions in 17 different sports will be held in New Delhi, India, between 4 October and 13 October 2010, with the Closing Ceremony taking place on 14 October.

A state-of-the-art Games Village for use by athletes, support staff and team officials is being developed along the east bank of the River Yamuna by the Delhi Development Authority, an agency of the Government of Delhi and a Commonwealth Games delivery partner. The site is located off the National Highway 24 adjacent to the Akshardham Temple at the Noida intersection. Construction work on the Games Village started in August 2007 and is on schedule for completion by March 2010. The Village is designed to translate traditional Indian hospitality into standards of comfort and excellence never seen before by participating teams. To be created at a cost of more than US\$230 million (including the Residential Zone), the Games Village is spread over an area of 63.5 hectares (158 acres). It has 14 blocks, 34 towers and 1,168 air-conditioned flats to comfortably accommodate 8,000 athletes and team officials. There will be a number of apartment types ranging from two- to five-bedroom units, each with ensuite facilities. The residential facilities are expected to be the best provided for any Games.

Apart from living accommodations, the Games Village will contain training areas for

Athletics (400 m eight-lane synthetic track and separate area for Throwing events); Swimming (50x25m, kids and leisure pool); Weightlifting; Wrestling; and a Fitness Centre. Temporary structures will house the International Zone, Village Operation and Support Areas. World-class stadia will house competitors in 17 sports: Archery, Aquatics, Athletics, Badminton, Boxing, Cycling, Gymnastics, Hockey, Lawn Bowls, Netball, Rugby 7s, Shooting, Squash, Table Tennis, Tennis, Weightlifting and Wrestling. In addition, 15 events will be contested across 4 Para-Sports, for elite athletes with a disability, on the inclusive Sports Programme: Athletics, Swimming, Powerlifting and Table Tennis.

The weather in India can be challenging, especially for newcomers to the country. The average daily temperature high in New Delhi during the period of the Games is about 33°C and the average daily low is about 20°C. The temperature may, however, be much higher than this — it was over 40°C for several days during this time period in 2007. It is unlikely to fall to less than about 18°C at any time during this period. Full records for humidity are not available, but the humidity is generally high — often in the region of 80%, especially later in the day. Rainfall is generally light. These are challenging conditions for athletes from high latitudes who are used to much cooler and drier climates.

Where athletic competitions are scheduled for hot weather venues, there is a need for all athletes to prepare for the conditions that will be encountered. This is especially true for those athletes who normally live, train and compete in



cool climates. There are three aspects of preparation for these conditions: first, the development of a suitable rehydration regimen, and, second, the development of an acclimatisation strategy. The third issue relates to the pre-event warmup, for warming up may not always be beneficial. For athletes who habitually live and train in cool climates, there are few opportunities to rehearse these preparations, but they are essential if there is to be any chance of success.

It is also important that athletes reassess their idea of what 'hot' actually means. In endurance events, performance already suffers when the temperature reaches 20°C and is likely to be at its best at about 10°C. Few athletes would think that a temperature of 20°C is enough to start thinking about drinks and other issues associated with hot weather running. Over shorter distances, the optimum temperature for competition is likely to be higher, but too much time spent in a warm sun may be harmful even in the sprints.

All athletes should take advantage of opportunities to gain experience of living, training and competing in hot environments before the Games. Each athlete should have a personal strategy that fits within the team's hot weather strategy.



Key messages

Whenever highly talented, motivated and well-trained athletes gather for competition, the margin between victory and defeat is small. Attention to detail can make that vital difference.

Diet affects performance, and the foods that we choose in training and competition will affect how well we train and compete. Athletes need to be aware of their nutritional goals and of how they can select an eating strategy to meet those goals.

Diet may have its biggest impact on training, and a good diet will help support consistent intensive training without the athlete succumbing to illness or injury. Good food choices can also promote adaptations to the training stimulus.

Athletes are all different, and there is no single diet that meets the needs of all athletes at all times. Individual needs also change across the season and athletes must be flexible to accommodate this.

Getting the right amount of energy to stay healthy and to perform well is key. Too much and body fat increases: too little and performance falls and illness results.

Carbohydrate is a key nutrient for energy supply. Athletes must be aware of foods that can help meet their carbohydrate needs and make these a focus of their diet.

Protein foods are important for building and repairing muscles, but a varied diet containing everyday foods will generally supply more than enough protein. Well-chosen vegetarian diets can also meet protein needs.

A varied and wholesome nutrient-rich diet that meets energy needs and is based largely on vegetables, fruits, beans, legumes, grains,

animal meats, oils and carbohydrate should ensure an adequate intake of vitamins and minerals.

Maintaining hydration is important for performance. Fluid intake before, during (where appropriate) and after exercise is especially important in hot climates. Salt replacement is important when sweat losses are high.

Athletes are cautioned against the indiscriminate use of dietary supplements.

This booklet contains information that will help athletes to make informed choices to meet their nutritional needs in different situations. It is no substitute for individual advice from a qualified professional but tries to give practical information that will be of use to the serious athlete.



The benefits of eating well

A well-chosen diet offers many benefits to the elite athlete:

- Fuel to train and perform at the elite level
- Optimal gains from the training program
- Enhanced recovery between workouts and between events
- Achievement and maintenance of an ideal body weight and physique
- Benefits from the many health-promoting components of food without the requirement for supplements
- A reduced risk of injury, overtraining fatigue and illness
- Confidence in being well-prepared to face competition
- Consistency in achieving high-level competition performances
- Enjoyment of food and social eating occasions at home and during travel

Despite these advantages, many athletes do not meet their nutrition goals. Common problems and challenges include:

- Poor knowledge of foods and inadequate cooking skills
- Poor or outdated knowledge of sports nutrition
- Lack of access to dietitians /nutrition professionals or other credible resources
- Inadequate finances
- Busy lifestyle leading inadequate time to obtain or consume appropriate foods
- Poor availability of good food choices

- Frequent travel
- Indiscriminate use of large amounts of supplements and sports foods

The information in this booklet is designed to provide coaches and athletes with an overview of the latest guidelines in sports nutrition. While there is no such thing as a magic diet or food, there are many ways in which eating well can allow athletes at all levels of performance to achieve the specific goals of their training and competition programs. It makes no sense to train hard and ignore the benefits that follow from good food choices.

This booklet is based on the conclusions of the IOC Consensus Conference on Nutrition for Sport, held in Lausanne in June 2003. It was first produced for the 2004 Olympic Games and was revised for the Games of 2006, 2008 and 2010. We gratefully acknowledge the contribution of the conference participants as the expert scientific sources for this booklet. We are also especially grateful to Powerade for their support.

The information in this booklet was extensively revised and updated in February 2010 in preparation for the Commonwealth Games of 2010 to ensure that athletes have access to the latest information.

Energy needs for training and competition

An athlete's daily energy intake (total Calories or kilojoules) provides for immediate energy needs such as that for body functions, activity and growth. In addition, energy intake also influences the body's energy stores. Energy stores (body fat + glycogen in muscle and liver) play a number of important roles related to exercise performance, since they contribute to:

- an athlete's size and physique (e.g., body fat stores and muscle mass)
- function (e.g., muscle mass)
- fuel for exercise (e.g., muscle and liver carbohydrate stores, i.e., glycogen)

Many athletes try to manipulate energy intake to gain an advantage in their sport. In most cases, the goals are to change body weight, reduce body fat, increase muscle mass and optimize fuel storage. Problems can occur when:

- the athlete is unable to identify goals that are suitable for their sport and appropriate to their individual makeup
- the athlete is unable to monitor the separate components of their goals (for example, to distinguish changes in body fat from changes in total body weight, or to see whether total energy intake provides for optimal fuel storage, i.e., muscle and liver glycogen)
- the athlete restricts energy intake to a level that interferes with the body's metabolic and hormonal functions (e.g., loss of the menstrual cycle in female athletes)

Strategies for managing energy intake and energy balance:

Individualized assessment of an athlete's body weight and body composition may be necessary for improved athletic performance. Age, sex, genetics and sport requirements are factors that affect an individual athlete's body composition.

An optimal competitive body weight and relative body fat level should be determined when an athlete is healthy and performing at his or her best.

Each athlete should individually manage their energy stores of body fat, carbohydrate (muscle fuel) and protein (muscle mass) by managing intake and expenditure of these nutrients separately. These issues will be discussed in separate parts of this booklet.

Athletes should eat to a plan that achieves their specific goals rather than relying on appetite (which may be suppressed with intense training) or opportunity (overeating when food is abundant rather than planning ahead) to guide energy intake. Advice from a sports nutrition expert is often required to develop an effective plan.

The athlete should have a number of separate biomarkers to monitor their progress in achieving each of their energy-related goals. Body weight is not a reliable or accurate indicator of energy balance. Monitoring body weight is often a stressful activity for athletes, especially when the information is misinterpreted or the outcome is manipulated. Long-term monitoring of skinfold fat



thicknesses, especially when undertaken by a trained kinanthropometrist, can provide useful information about changes in body fat stores. Measurements of changes in muscle strength and endurance provide a useful biomarker of muscle development.

Special concerns about restricting energy intake

Many athletes reduce their energy intake to assist with the loss of body weight and body fat, but it is harmful to restrict energy intake below levels that interfere with healthy body function.

Athletes requiring advice for weight loss or fat loss should seek guidance from a sports nutrition expert such as a sports dietitian.

To avoid irreversible skeletal damage, athletes with menstrual disorders should be immediately referred to a medical expert for treatment.



Fuel needs for training and recovery

Carbohydrate provides an important but relatively short-lived supply of fuel for exercise that must be refilled each day from carbohydrate foods in the diet. The athlete's everyday eating plan needs to provide enough carbohydrate to fuel their training program and to optimise the recovery of muscle glycogen stores (muscle fuel) that are depleted during workouts. General targets can be provided for carbohydrate needs, based on the athlete's size and the demands of their training program (see Table below). However, actual needs are specific to the individual athlete and need to be fine-tuned with consideration of the athlete's total energy needs, specific training needs and feedback from their training performance. Carbohydrate intake should be scaled down or up according to the fuel needs of training or competition, and some consideration given to arranging when it is consumed around key workouts or competition events over the day to promote good fuel availability for performance and recovery.

Targets for carbohydrate intake

- Immediate recovery after exercise (0-4 hours): about 1 g per kg of the athlete's body weight (BW) per hour, perhaps consumed at frequent intervals in the hours after exercise
- Daily recovery from a moderate duration/low intensity training program: 5-7 g per kg BW per day
- Recovery from moderate-heavy endurance training: 7-12 g per kg BW per day
- Daily recovery from extreme exercise program (more than 4-6 h+ per day): 10-12 g or more per kg BW per day

Strategies for choosing carbohydrate foods and for optimising glycogen recovery

When the period between workouts is less than about 8 hours, carbohydrate intake should start as soon as practical (possible) after the first session to maximise the re-fuelling process. There may be some advantages in meeting carbohydrate targets as a series of frequent snacks during the early recovery phase. Consuming a high carbohydrate snack before stretching or showering may improve the ability to work intensely in the following training session.

During longer recovery periods (24 hours), the pattern and timing of carbohydrate-rich meals and snacks does not appear to be critical, and can be organised according to what is practical and comfortable for each athlete. There is no difference in glycogen synthesis when carbohydrate is consumed in liquid form or as solid foods.

It is valuable to choose nutrient-rich carbohydrates and to add other foods to recovery meals and snacks to provide a good source of protein and other nutrients. These nutrients may assist in other recovery processes, and in the case of protein, may promote additional glycogen recovery when carbohydrate intake is below targets or when frequent snacking is not possible.

Carbohydrate-rich foods with a moderate to high glycaemic index (GI) provide a readily available source of carbohydrate for glycogen synthesis and should be the major fuel choices in recovery meals. (See Table for examples.)



Adequate energy (total calorie intake) intake is also important for optimal glycogen recovery. The restrained eating practices of some athletes, particularly females, make it difficult to meet carbohydrate intake targets and to optimise glycogen storage from this intake. This in turn may result in suboptimal training or poor recovery between workouts.

Special comments

Guidelines for carbohydrate should not be provided in terms of percentage contributions to total dietary energy intake, as such values are inaccurate in assessing the muscle's absolute needs for fuel. Using grams of carbohydrate per kilogram BW provides a more realistic way to target fuel needs.

Athletes should not consume excessive amounts of alcohol during the recovery period since it is likely to interfere with their ability or interest to follow guidelines for post-exercise eating. All athletes should follow sensible drinking practices at all times, but particularly in the period after exercise, as alcohol may impair optimal muscle recovery.

Examples of carbohydrate foods with moderate-high glycaemic index

- Most breakfast cereals
- Most forms of rice
- White and brown breads
- Sports drinks and soft drinks
- Sugar, jam and honey
- Potatoes
- Tropical fruits and juices

Examples of nutrient-rich carbohydrate and protein combinations (contains 50-75g CHO + 15-20 g protein)

- 500-750ml low-fat chocolate milk
- 1-2 sports bars (check labels for carbohydrate and protein content)
- 1 large bowl (2 cups) breakfast cereal with low-fat milk
- 1 large or 2 small cereal bars + 200 g fruit-flavored yoghurt
- 1 cup baked beans on 2 slices of toast or on a baked potato
- 1 bread roll with cheese or peanut butter + large banana
- 2 cups fruit salad with 200 g fruit-flavored yoghurt
- Bagel with thick spread peanut butter + 1-2 cups low-fat milk
- 300 g (large) baked potato + low-fat cottage cheese filling + 1-2 cups low-fat milk
- 2-3 slices veggie pizza (no meat)
- 2 cups breakfast cereal with milk
- 400 g flavoured yoghurt
- 500-750 ml fruit smoothie or liquid meal supplement
- Thick bread sandwich with meat and salad filling
- 2 cups stir-fry with rice or noodles and meat

Protein needs for training and bulking up

Protein has been considered a key nutrient for sporting success by athletes of all eras. Whereas ancient Olympians were reported to eat unusually large amounts of meat, today's athletes are provided with a vast array of protein and amino acid supplements to increase their protein intakes.

Protein plays an important role in the response to exercise. Amino acids from proteins form building blocks for the manufacture of new tissue, including muscle, and the repair of damaged tissue. They are also the building blocks for hormones and enzymes that regulate metabolism, support the immune system and other body functions. Protein provides a small source of fuel for the exercising muscle.

Some sports scientists have suggested that endurance and resistance-training exercise may increase daily protein needs up to a maximum of 1.2-1.6 g per kg body weight (BW), compared to the recommended intake of 0.8 g/kg BW for a sedentary person. However, the evidence for this increase in protein needs is not clear and universal. Part of the confusion is caused by problems involved in scientific techniques used to measure protein requirements.

The debate over protein needs of athletes is largely unnecessary. Dietary surveys show that most athletes already consume diets providing protein intakes above 1.2-1.6 g/kg BW/d, even without the use of protein supplements. Therefore, most athletes do not need to be encouraged or educated to increase their protein intakes. Rather, athletes who consume adequate total energy intake from a variety of nutrient-rich foods should be confident of

meeting their protein needs, including any increases that could arise from high-level training.

Athletes at risk of failing to meet their protein needs are those who severely restrict their energy intake or dietary variety. An adequate energy intake is also important in promoting protein balance, increasing protein retention (as lean tissue) as well as being protein (muscle) sparing.

Some resistance-trained athletes and body builders consume protein intake in excess of 2-3 g/kg BW/d, but there is no evidence that intakes of more than about 1.7 g/kg BW/d are ever necessary to enhance the response to training or increase the gains in muscle mass and strength. While such diets are not necessarily harmful, they are expensive and can fail to meet other nutritional goals, such as replacing important fuel sources (carbohydrates) needed to optimise training and performance.

Enhanced protein balance is a desirable goal of the recovery phase — to overturn the increased rates of protein breakdown that occur during and after exercise, and to promote muscle hypertrophy, repair and adaptation following the exercise stimulus. Recent studies have focussed on the acute response to workouts of both endurance and resistance training. These studies have found that the intake of protein, and perhaps the addition of carbohydrate, enhances protein synthesis during the recovery phase after training. There is some evidence that the response is enhanced when these nutrients are provided soon after exercise. Further work is required to fine-tune guidelines for the optimum amount, type and



timing of intake of these nutrients, and to confirm that these eating strategies lead to better achievement of the goals of training.

In the meantime, it appears sensible to focus on the total balance of the diet and the timing of protein-carbohydrate meals and snacks in relation to training, rather than high protein intakes per se. Frequent intake of smaller amounts of protein is most beneficial due to the fact that protein is not stored in the body in significant amounts; therefore, frequency of ingestion ensures protein needs are consistently being met.

Special sports foods such as sports bars and liquid meal supplements can provide a compact and convenient way to consume carbohydrate and protein when everyday foods are unavailable or are too bulky and impractical to consume. There is little justification for using very expensive protein-only powders or amino acid supplements, which are not superior in quality to foods, and also do not contain valuable nutrients that are found in protein foods.

Protein-rich foods: 10 g of protein is provided by

- 2 small eggs
- 300 ml cow's milk
- 20 g skim milk powder
- 30 g cheese
- 200 g yoghurt
- 35-50 g meat, fish or chicken
- 4 slices bread — 90 g breakfast cereal
- 2 cups cooked pasta or 3 cups rice
- 400 ml soy milk 60 g nuts or seeds
- 120 g tofu or soy meat — 150 g legumes or lentils
- 200 g baked beans — 150 ml fruit smoothie or liquid meal supplement



Vitamins, minerals and antioxidants for training and staying well

Strenuous bouts of prolonged exercise and heavy training, particularly aerobic exercise, stress the body both physically and mentally. Adequate intakes of energy, protein, iron, copper, manganese, magnesium, selenium, sodium, zinc, and Vitamins A, C, E, B6 and B12 are particularly important to health and performance. These nutrients, as well as others, are best obtained from a varied and wholesome nutrient-rich diet based largely on vegetables, fruits, beans, legumes, grains, lean meats, dairy foods and healthy oils. Dietary surveys show that most athletes are well able to meet the recommended intakes for vitamins and minerals by eating everyday foods.

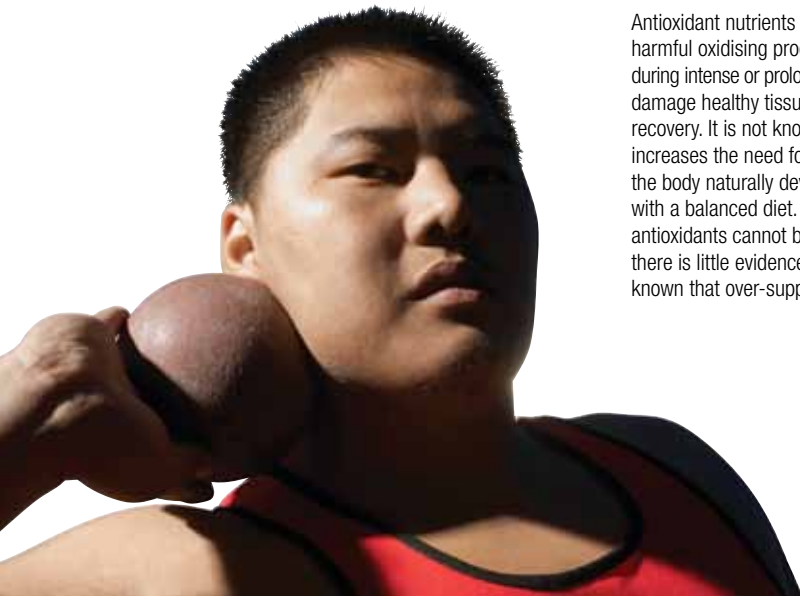
Those at risk of suboptimal intakes of these micronutrients include:

- athletes who restrict their energy intake, especially over long periods, especially to meet weight-loss goals
- athletes who follow eating patterns with restricted food variety and reliance on foods with a poor nutrient-density

The best way to correct this situation is to seek advice from a sports nutrition expert such as a sports dietitian. When food intake cannot be adequately improved — for example, when the athlete is travelling in a country with a limited food supply — or if an individual is found to be suffering from a lack of a particular vitamin or mineral, then short-term supplementation can be warranted. This should be undertaken with the advice of a qualified sports nutrition expert. In general, a broad-range multivitamin/mineral supplement is the best choice to support a restricted food intake, although targeted nutrient supplements may be necessary to correct an established nutrient deficiency (e.g., iron deficiency).

Antioxidant nutrients

Antioxidant nutrients help the body neutralize harmful oxidising products that may accumulate during intense or prolonged training and potentially damage healthy tissues and impair proper recovery. It is not known whether hard training increases the need for dietary antioxidants, as the body naturally develops an effective defence with a balanced diet. Supplementation with antioxidants cannot be recommended because there is little evidence of benefit, while it is known that over-supplementation can diminish





the body's natural defence system and may possibly interrupt the body's own adaptation to training. Antioxidants are safest and most effective when consumed in abundance as plant-derived foods from a wide variety of sources (e.g., fruits, vegetables, nuts, seeds, whole grains, teas and non-medicinal herbs, etc.)

Ideas for promoting dietary variety and nutrient-rich eating

- Be open to trying new foods and new recipes
- Make the most of foods in season
- Explore all the varieties of different foods
- Mix and match foods at meals
- Think carefully before banishing a food or group of foods from your eating plans
- Find substitution foods that have similar nutrients when excluding a food group
- Include fruits and/or vegetables at every meal and snack. The strong and bright colours of many fruits and vegetables are a sign of a high content of various vitamins and other food antioxidants. Aim to fill your plate with a rainbow of highly coloured foods to ensure a good intake of the range of these health-promoting dietary compounds.

Special concerns

Iron. Some athletes may develop iron deficiency and this will impair performance. Unexplained fatigue, especially in vegetarian athletes, should be explored. Routine use of iron supplements is not wise: too much is just as harmful as too little. Self-medication with iron supplements may not address the real causes of an athlete's fatigue or other issues of poor eating and may do more harm than good. See page 25 for iron-rich eating strategies.

Calcium. Calcium is important for healthy bones, especially in adolescents and in female athletes, so it is important to ensure adequate calcium intake. The best sources are dairy produce, including low-fat varieties. Each athlete should aim to include at least 3 servings of these foods in their daily eating plans (e.g., glass of milk, slice of cheese, carton of yoghurt). Additional daily servings are required during growth spurts in childhood and adolescence, and for pregnancy and lactation. Fortified soy foods may provide a useful substitute for athletes who cannot consume dairy foods.

Preparation for competition

Many athletes appreciate the need to rest and eat well during the days prior to competition or a particularly intense day of quality training, but questions arise regarding how much to eat, what type of food and when is the best time. This includes what to eat during the few hours immediately before competition or intense training.

Carbohydrate is the key energy-providing nutrient that must be optimised during the days leading up to and including the day of competition. Attention should also be given to optimising water and salt levels in the body. However, during the 2-4 days prior to a competition, an athlete's need for protein and fat, as well as most other nutrients, typically does not increase above the levels that are recommended for normal moderate-level training, especially as the training load is tapered at this time.

'Carbo-loading'

Athletes who compete intensely for more than about 90 minutes benefit from 'carbohydrate-loading' for a few days. This loading of muscle glycogen to super-compensated levels can be achieved within 1-3 days by eating a large amount of carbohydrate (about 8-10 g CHO per kg of body weight per day; see below) at the same time that training intensity is reduced to no more than easy levels of short duration. It is assumed that a moderate to hard bout of fatiguing exercise is performed in normal training sometime earlier in the week prior to competition.

One-day example of foods providing 630 g of carbohydrate for a carbohydrate-loading diet* (for a person weighing 70 kg with an intake of 9 g CHO/kg BW).

- Early AM: 150 g = 2 cups cereal with milk + 250 ml fruit juice + 1 banana + 2 thick slices toast + thick spread of jam
- Late AM: 50 g = 500 ml soft drink
- Mid-day: 150 g = 1 large bread roll + 1 medium muffin + fruit smoothie
- Snack: 50 g = 200 g flavoured yoghurt + 250 ml fruit juice
- Dinner: 200 g = 3 cups cooked pasta + 2 cups fruit salad + 2 scoops ice cream + 500 ml sports drink
- Snack: 30 g = 50 g chocolate or dried fruit

(*Note that other foods may be eaten at the meal, such as moderate amounts of protein foods, but also keeping fat intake low.)

Carbohydrate in the 6-hour period before competition

Athletes sometimes find a favourite pre-competition meal that not only provides extra energy during the event but also feels right in terms of curbing hunger, quieting their stomach and being convenient as well as practical. In sports that do not cause fatigue or carbohydrate depletion (e.g., gymnastics, sprinting,



ski-jumping, etc., the pre-event meal need not be predominantly carbohydrate. However, in intense competitions lasting longer than about 60 minutes, athletes are advised to either:

- Eat a meal or snacks providing 1-4 g/kg body weight of carbohydrate during the 6-hour period before exercise, or
- Miss the pre-event meal, if preferred, but only when a carbohydrate-loading diet has been followed during the prior 2-3 days and the competition is not late in the day.

The main 'mistake' athletes might make is to eat only a small amount of carbohydrate (less than 1 g CHO/kg body weight) during the 1-6 hour period before exercise and then fail to consume any carbohydrate during exercise. This small carbohydrate meal primes the body to rely more heavily on blood glucose, but it does not provide enough carbohydrate to sustain the athlete.

Five different examples of foods that each provide 140 g CHO in a pre-competition meal* (2 g/kg BW for a 70 kg person) are:

- 2.5 cups breakfast cereal + milk + large banana
- Large bread roll or 3 thick slices bread + thick spread honey
- 2 cups boiled rice + 2 slices bread
- 4 stack pancakes + ½ cup syrup
- 60 g sports bar + 500 ml liquid meal supplement or fruit smoothie

(*Note that other foods may be eaten at the meal.)

Fluid intake prior to competition

Athletes should drink sufficient fluid with meals on the day before competition to ensure adequate hydration on the morning of competition. The athlete should not refrain from drinking water or carbohydrate-containing fluids during the hours leading up to warm-up before competition and it is recommended that athletes have a final drink during the 60- to 90-minute period before the start of the event. This will allow sufficient time for urination of excess fluid, and thus rest-room facilities should be identified. During competitions lasting longer than 1 hour and which cause heavy sweating without sufficient opportunity for fluid intake, athletes often benefit by having an extra drink during the 15-minute period immediately before the start of the event.



Fluid, carbohydrate and salt needs during and after exercise

Athletes generally appreciate the need to drink fluids during exercise and the importance of sometimes using drinks that contain added carbohydrate and salts. The next step in applying this theory for optimal performance and well-being is to learn the practical aspects of: a) how much, b) what type of foods, drinks, products, c) when during exercise, and d) what modifications should be made in hot or cold environments. Just as general training and competition strategies should be tailored for individual athletes in accordance with their unique needs and preferences, so should their drinking and eating choices during exercise. Athletes, coaches and trainers should fine-tune these recommendations to identify their own winning formula.

How much to drink?

Athletes should generally limit dehydration during workouts and competitions by trying to drink at a rate that is close to sweat rate and thus limit loss of body weight (see the box on page 20).

It may not be necessary to drink enough to prevent loss of body weight, but the amount of dehydration should be limited to no more than about a 2% loss of body weight (i.e., 1.0 kg for a 50 kg person, 1.5 kg for a 75 kg person, and 2 kg for a 100 kg person). Greater losses will negatively impact performance.

In warm environments, try to minimize dehydration, as dehydration and exercise intensity interact to increase the risk of heat illness.

Don't drink so much that you actually gain weight during exercise, unless you began exercise already dehydrated.

When it is not possible to drink during heavy-sweating type exercise lasting longer than 30 minutes, practise drinking during the 15 minutes before exercise and find out how much is initially filling but comfortable once exercise begins (e.g., 300-800 ml).

When do you need more than water?

In terms of proven performance benefits, no nutrients match water and/or carbohydrate.

During exercise lasting longer than 1 hour and which elicits fatigue, athletes are advised to ingest 20-60 grams per hour of carbohydrate that is rapidly converted to blood glucose. This generally improves performance — allowing you to maintain your pace, skills and concentration instead of succumbing to fatigue.

The use of commercial sports drinks with a carbohydrate content of about 4-8% (4-8 g/100 ml) allows carbohydrate and fluid needs to be met simultaneously in most events. This carbohydrate can come from sugars (i.e., sucrose, syrups containing no more than 50% fructose, glucose), maltodextrins or other rapidly digestible carbohydrates. It is best for athletes to stick to well-known sports drinks that they are familiar with to avoid gastrointestinal distress or other consequences.

If carbohydrates are ingested immediately before exercise or during rest periods in a long contest (more than 40 minutes), it is sometimes beneficial to continue to ingest 20-60 grams



per hour throughout the contest. This maintains the flow of glucose into the bloodstream.

Sodium should be included in fluids consumed during exercise lasting longer than 1-2 hours or by individuals during any event that stimulates heavy sodium loss (i.e., more than 3-4 g of sodium, see next page for assessment).

Caffeine contained in commonly available beverages and foods can enhance endurance power during the later stages of prolonged exercise. This benefit can be obtained with relatively small doses of caffeine (about 2 mg/kg body weight; e.g., 150 ml of brewed coffee or 750-1,000 ml of a cola beverage) that are commonly consumed by people of various cultures.

Rehydration after exercise

Replacement of water and salts lost in sweat is an essential part of the recovery process. Aim to drink about 1.2-1.5 litres of fluid for each kg of weight loss in training or competition. Drinks should contain sodium (the main salt lost in sweat) if no food is eaten at this time. Sports drinks and pharmacy oral rehydration solutions that contain electrolytes are helpful, but many foods can supply the salt that is needed. A little extra salt may be added to meals when sweat losses are high, but salt tablets should be used with caution.

Recovery after exercise is part of the preparation for the next exercise session, and all athletes, including strength and power athletes, will perform below their best if they are not well hydrated when they begin exercise.

Special strategies

Athletes who have dehydrated to make weight will need special strategies for drinking before and during competitions to optimise performance.

Athletes training and competing while practising fasting during the month of Ramadan must rehearse a hydration strategy that preserves performance and protects health.

Just like shoes, don't try out new plans for fluid and fuel intake during important competition. Do it in practice and find what fits you best.



Practical hydration messages

Severe dehydration impairs performance and increases the risk of heat illness, but drinking too much can also be harmful or uncomfortable. Every athlete is different because they have different sweat losses and different opportunities to drink fluid during their workouts and events. You need a personal hydration plan and YOU have to play a role in developing this.

Remember that humans do not adapt to dehydration, but may learn to complain less about it.

Follow these three simple steps to check on your hydration.

1. Start training well hydrated. If you are passing urine less often than normal, you may be dehydrated. If urine colour becomes darker than what is normal for you, then you may not be drinking enough. Check your urine colour against the chart. The aim should NOT be for your urine to be as pale as possible. Develop a drinking plan for training and competition that is right for you, based on sweat losses (see Table).

2. Monitor your sweat losses and the success of your drinking plan during training sessions in different situations (see Table). How did you feel? How did you perform? What was your weight loss over the session? This should generally not exceed about 1-2% of body mass. If you lost more than this, you probably did not drink enough. Drink more next time. If you lost less, you might have drunk too much. Did it make you feel uncomfortable? Did you take time out to drink that was unnecessary?

3. If you are a 'salty sweater', you may need drinks with more salt and may need more salt in food when sweat losses are high. To check whether you are a salty sweater, wear a black T-shirt in training and look for salt stains (white powder) under the arms and on the chest.

High salt losses are a contributing factor in some cases of muscle cramp. Sports drinks with higher salt (sodium) levels (e.g., 300-500 mg sodium per 500 ml liquid) may help reduce the risk of cramps.

How to estimate sweat losses and sweat rates:

1. Measure body weight both before and after at least 1 hour of exercise under conditions similar to competition or a hard practice.

2. Take these body weight measurements wearing minimal clothing and while barefooted. Towel dry after exercise and obtain body weight as soon as is practical after exercise (e.g., less than 10 min, and before eating, drinking or going to the toilet).

3. Estimate the weight of any fluid or foods you have consumed during the workout (e.g., 500 ml of fluid = 500 g or 0.5 kg).

Sweat loss (litres) = Body weight before exercise (in kg) — body weight after



exercise (kg), + weight of fluids/foods consumed (kg). Example: $74.5 \text{ kg} - 72.8 \text{ kg} + 0.80 \text{ kg}$ (800 ml fluid) = 2.5 kg.

4. To convert to a sweat rate per hour, divide by the exercise time in minutes and multiply by 60.

5. Your weight deficit at the end of the session provides a guide to how well you hydrated during the session and how much you need to rehydrate afterwards. To convert kg to % body weight, divide the weight deficit by starting body weight and multiply by 100: e.g., $1.7 \text{ kg} / 74.5 \times 100 = 2.3\%$.

Note: 2.2 pounds equals 1.0 kg and converts to a volume of 1.0 litre or 1,000 ml or 34 ounces of water.

Drinking so much that you gain weight during competition is never likely to be a good idea. The only time you might need to do this is when you have been dehydrated at the start of the event.

Use this chart (right) to check your urine colour. If the colour is dark, you may need to drink more.





Special needs of the young athlete

Every child and adolescent around the world should have the opportunity to participate in sport and should be encouraged to do so. Sport offers the benefits of aerobic fitness, skill development and a team environment. Girls and boys can start practising and competing at an early age, though the focus should be on fun and on skills development rather than on performance. Nonetheless, most children are naturally competitive and it would be a mistake to suppress this instinct. Those with particular talent may progress to serious training and competition, but others continue for reasons of recreation, fitness or social contact.

Training issues

Depending on the age and calibre of the young athlete, 'training' may range from the weekly school PE lesson to structured sessions at a local club. The goals of training may range from simply having fun through to a progressive program aimed at developing the skills and specific fitness and physique required to progress to serious competition. Talented young athletes may be invited to train with another age group or with a senior squad, often in addition to their involvement with their age-group team.

Competition issues

For the youngest age groups, there should be no special need for any change to diet in the days before competition or on competition day itself. The main aims are to minimise the risk of gastrointestinal upset and to avoid problems of dehydration on hot days. It may be best to avoid solid food for 2-3 hours before

competition — the combination of exercise and nerves can cause some gastric distress.

Children can often be out in the sun for many hours on sports days, and adults should be vigilant to ensure frequent application of sun cream and be aware of any child who seems to be having problems. Ample fluid should be available, and children may need to be reminded to take small amounts of drinks at regular intervals.

Special issues and eating strategies

Parents are often roped in to become the coaches and trainers of age-group teams. They may accept these positions without an appreciation of the nutritional needs of the sport or young people, and without any resources to implement an effective training and diet program. It is important that education resources are made available to these coaches so that they can guide young athletes into good habits.

Athletes should be encouraged to develop good nutritional habits at an early age. Adolescence is a time marked by an increased independence, and this extends to greater freedom of food choice and greater responsibility for food preparation. The promise of sporting success may provide strong motivation to develop good dietary practices. Information and the example of good role models may help a young person to develop sound eating practices in everyday (training) diets as well as the specific preparation for competition.

The physiology of children and adolescents differs from that of adults in several ways. The mechanisms of thermoregulation are less



effective in children, and special attention must be paid to the environment, activity patterns, clothing and hydration to avoid problems of hyperthermia or hypothermia.

The growth spurts during childhood and adolescents require nutritional support in terms of adequate intake of energy, protein and minerals. Active young people may find it difficult to meet their needs for energy and nutrients when the costs of training and growth are added. Young people may not have developed the nutritional knowledge and time-management skills to fit in all the eating occasions required to achieve high-energy, nutrient-rich eating.

The rate of obesity in children is still rising, but active youngsters do need a plentiful supply of energy from foods and energy-containing drinks. Young athletes have been shown to drink more of a flavoured sports drink than water during activity, which is an important consideration especially if exercise is in the heat. Sports drinks should be made available to encourage more fluid intake.

Many young athletes are eager to increase the rate of their growth and muscular development in pursuit of the physique of an adult. While growth and maturation are genetically determined, high-energy eating plans can assist the young athlete to maximise the outcomes of growth and specialised training programs.

Young athletes eating a wide range of foods should not need to use dietary supplements, including the use of energy drinks which contain high amounts of caffeine and are not suitable for young athletes. Athletes and

coaches should be aware that supplements do not provide a short-cut to success.

Ways to encourage good nutrition practices in children

Encourage children to become involved in menu planning for the family meals, and for special needs associated with their training and competition sessions. Encourage positive messages that good eating practices, involving good choices of foods and drinks, are part of the formula for sporting success, and a healthy life.

Children often need snacks to meet their energy needs over the day, and the special needs of recovery from sport. These snacks should involve nutrient-rich choices such as fruit, sandwiches, dried fruit and nuts/seeds mixes, flavoured milk and yoghurt, and cereals with milk. Some planning is needed to have these choices on hand over the day, and before or after sport.



Special needs of the female athlete

General health issues

All female athletes should eat sufficient food to achieve an energy intake that:

- provides sufficient energy for training and competition needs
- meets the energy demands of other daily activities
- allows the athlete to achieve a body size and composition that meets her health and fitness goals

Some athletes do not achieve this and restrict food intake to achieve their desired weight at the expense of both health and performance.

Losing body fat

There is enormous pressure on many women to achieve an unrealistic body weight and body fat level. This can compromise both short-term athletic performance and long-term health, with the real possibility of harm to reproductive health and to bone health. Any athlete with menstrual irregularities should treat these as a possible warning sign and seek professional advice.

If there is a need to reduce body fat, this should be done sensibly. Reducing body fat requires a negative energy balance — energy expenditure should be greater than energy intake — and a negative body fat balance. It is a mistake to reduce energy intake — especially protein and carbohydrate intake — too far. This increases fatigue in training and daily life, reducing energy levels and thus limiting weight

loss. Severe energy restriction reduces the effectiveness and progress in the training program, and in turn compromises competition performance.

Strategies for reducing body fat

- Set realistic targets: this is a medium-term goal rather than something to be achieved by next week.
- Limit portion sizes at meals rather than skipping meals altogether.
- Use well-chosen snacks between meals to maintain fuel levels for training sessions. Save part of a meal for a later snack, rather than eating extra food.
- Maintain carbohydrate intake to maintain fuel levels for exercise.
- Use low-fat strategies in choosing foods and while cooking or preparing meals.
- Limit alcohol intake or cut it out altogether — it is not an essential part of the diet.
- Make meals and snacks more filling by including plenty of salads and vegetables, by taking the higher-fibre option, and by including low glycaemic index forms of carbohydrate-rich foods (e.g., oats, legumes, dense-grainy breads, berries, apples, etc.).



Calcium. Calcium is important for healthy bones. In some countries, many everyday foods are fortified with calcium (e.g., fruit juice). However, the best sources of calcium are dairy foods, with low-fat varieties providing a great way to meet calcium needs within a smaller energy budget.

- Each athlete should aim to include at least 3 servings of dairy foods in their daily eating plans — e.g., 200 ml of low-fat milk, 30 g cheese or a 200 ml carton of low-fat yoghurt.
- Calcium-fortified soy versions of dairy foods are also suitable — e.g., soy milk, soy yoghurt.
- An additional 1-2 daily servings are required during growth spurts in childhood and adolescence, and for pregnancy and when breast feeding.
- Fish eaten with bones (e.g., tinned salmon, sardines) and leafy green vegetables (e.g., broccoli, spinach) provide a useful source of additional dietary calcium.

Iron. Iron deficiency is a cause of fatigue and reduced performance. Females are particularly at risk because of increased iron requirements due to menstrual blood losses matched against a smaller intake of food. Iron-rich eating will help to reduce this risk. Athletes at risk should perhaps be monitored on a routine basis.

Iron-rich eating

- Consume moderate servings of red meats (well-absorbed iron) in 3-5 meals per week.
- Choose iron-fortified cereal products such as breakfast cereals.
- Combine plant and non-meat sources of iron (e.g., legumes, cereals, eggs, green leafy vegetables) with food factors that enhance iron absorption. These include Vitamin C and a factor found in meat/fish/chicken. Examples of clever matching include fruit juice or fruit with breakfast cereal, or chilli con carne (meat and beans).



Supplements and sports foods

Athletes look to nutritional supplements for many benefits, including:

- promoting adaptations to training
- increasing energy supply
- allowing more consistent and intensive training by promoting recovery between training sessions
- maintaining good health and reducing interruptions to training due to chronic fatigue, illness or injury
- enhancing competitive performance

Supplement use is widespread among sportsmen and women, but few of these products are supported by a sound research base and some may even be harmful to the athlete. Athletes should look carefully at the risks and rewards of individual supplements before trying them.

Where there is a demonstrated deficiency of an essential vitamin or mineral, and an increased intake from food is not possible, a supplement may be helpful. The use of supplements, however, does not compensate for poor food choices and an inadequate diet. Many athletes ignore the need for caution in supplement use and take supplements in doses that are not necessary, and may even be harmful.

Protein powders and supplements

Protein supplements, high-protein bars and amino acid preparations are among the biggest-selling sports nutrition products. An adequate

intake of protein is essential for muscle growth and repair, but this can easily be achieved from everyday foods and extra protein is seldom required (see pages 12-13).

Protein-carbohydrate supplements may have a role as part of a post-exercise recovery plan, but whole proteins have advantages over individual amino acids.

Fat reduction and muscle building

A huge array of supplements is on sale with claims that they can reduce body fat levels and build bigger and stronger muscles — claims that appeal to athletes and non-athletes alike.

The reality is that many of the products that are effective in doing this are either on the banned list or are associated with serious health risks (or both).

Compounds in the muscle-building category include chromium, boron, hydroxymethylbutyrate (HMB), colostrum and others. Based on current research, none of these has anything worthwhile to offer the athlete.

Increasing energy supply

Supplements in this category include pyruvate and ribose as well as some more exotic herbal preparations. None of these is likely to improve performance and, in spite of advertising claims, none is supported by good independent evidence. There is now limited evidence that carnitine can affect exercise metabolism in some circumstances, but the evidence for performance effects is not convincing.



Nutrition and the immune system

There is some evidence that athletes who are training hard may be at increased risk of minor illnesses and infections. In themselves, these are generally trivial, but they can interrupt training or cause an athlete to miss important competitions. Hard training may compromise the body's immune system, and high levels of stress hormones reduce its ability to fight these infections.

Many nutrition supplements, including glutamine, zinc, echinacea, colostrum and others, are on sale with claims that they can boost the immune system, but there is no strong evidence that any of these is effective. The best strategies to support a healthy immune system include scheduling appropriate rest periods and matching carbohydrate intake to fuel needs. There is good evidence that carbohydrate intake during prolonged exercise reduces the release of stress hormones.

Supplements for bone and joint health

Hard training puts extra wear and tear on the bones, joints and associated structures, and numerous supplements are claimed to look after these tissues.

Healthy bones need a good supply of calcium and Vitamin D. In most cases, these nutrients can be supplied by the diet. Athletes who suffer from problems related to suboptimal bone density should seek professional advice and supervised treatment from a sports physician.

Glucosamine, chondroitin, methylsulphonylmethane (MSM) and other

products are promoted for joint health. There is some evidence that long-term (2-6 months) glucosamine treatment can provide subjective relief in elderly individuals suffering from osteoarthritis, but evidence is lacking for a benefit such as a 'joint protective' effect from high-intensity training in healthy athletes.

Supplements that might work

Some supplements do offer the prospect of improved performance: these include creatine, caffeine, bicarbonate, β -alanine and perhaps a very few others.

Creatine. Creatine supplements can increase the amount of high-energy creatine phosphate stored in the muscles and may improve performance in single or multiple sprints. It may also lead to a gain in strength and/or muscle mass, which is helpful for some athletes, but the extra weight may be harmful for others. As with all supplements, exceeding the maximum effective dose is not helpful. Creatine is normally found in meat and fish, but the effective doses (10-20 g per day for 4-5 days to load, and then 2-3 g per day for maintenance) are more than is found in normal foods. Creatine supplementation does not appear to be harmful to health.

Caffeine. A small amount of caffeine (1-3 mg/kg) can help performance in prolonged exercise and may also be helpful in exercise of shorter duration. Such moderate doses can be found in everyday amounts of coffee, cola drinks and some sports products (e.g., gels). For example,



100 mg of caffeine is supplied by a small cup of brewed coffee or 750 ml of a cola drink. Larger doses of caffeine do not seem to be more effective and may have negative outcomes such as anxiety, gastrointestinal distress, over-arousal and poor sleep patterns after an event. This is likely to be a problem in multi-day events and in sports involving heats and finals.

Energy drinks. These sugary caffeinated drinks should not be confused with sports drinks, which are designed to rehydrate the body during exercise. In fact, energy drinks are a poor choice to consume when exercising (especially in the heat) due to high sugar content, which can impair fluid absorption. While energy drinks may seem refreshing and hydrating, they should not be consumed before, during or after exercise when you need to replace sweat loss. These drinks may also be potentially dangerous if used in excess or in combination with other stimulants or alcohol. Lastly, energy drinks may be tainted with prohibited substances, such as those derived from unregulated herbals. Most drinks are not tested for purity or contamination and could lead to a positive doping test.

Buffering agents. In very hard exercise, the muscles produce lactic acid. This is both good (giving energy to allow hard efforts) and bad (causing pain and interfering with muscle function). In the same way that excess stomach acidity can be neutralised by taking bicarbonate, so can taking sodium bicarbonate (in a dose of about 0.3 g per kg BW) before an event to counter the harmful effects of lactic acid. This

can help in all-out events lasting from about 30 seconds to 8 minutes. There is a risk of gastrointestinal problems, and athletes should experiment in training. Sodium citrate may also be effective. More recently, β -alanine supplements have been shown to increase muscle levels of carnosine, an important buffer, and to improve performance in some high-intensity exercise models.

A number of sports foods have been developed to supply a specific formulation of energy and nutrients in a form that is easy to consume. These can be valuable in allowing athletes to meet their special nutrition needs when everyday foods are unavailable or impractical to eat. This is most often the case just prior to, during, or after an exercise session. Examples of useful sports foods include:

- sports drinks (providing fluid and carbohydrate during exercise)
- sports gels (additional carbohydrate intake, especially during exercise)
- liquid meals (carbohydrate, protein, vitamins and minerals for a pre-event meal, post-exercise recovery or a high-energy diet)
- sports bars (carbohydrate, protein, vitamins and minerals — often a solid form of the liquid meal)

Of course, the cost of these sports foods must be taken into account when deciding to use them.



Supplements and doping

Athletes who are liable for drug testing under national or international programs should be especially cautious about supplement use.

Some supplements are prepared in unhygienic conditions and contain toxins that may cause gastrointestinal problems. Others do not contain some or all of the ingredients — especially the expensive ones — that are listed on the label. Contamination of dietary supplements with substances that may cause an athlete to fail a doping test is widespread — some surveys have suggested that as many as one in four supplements may result in a positive test. These prohibited compounds have not been declared on the label, so there is no way for the athlete to know that they are present. Purchases through the Internet pose an even greater risk, and extreme caution should be taken. A sports nutrition expert should be consulted before taking any supplements.

At present, there can be no guarantee of the purity of any commercial supplement. The only way to be sure is to avoid supplements altogether, but many athletes are unwilling to accept this advice. The sensible athlete will want to see very good reasons for using a supplement and a very low risk of an adverse test before deciding to use it.

There is no evidence that prohormones such as Androstenedione and Norandrostenedione are effective in enhancing muscle mass or strength. These prohormones are promoted for use by athletes and are readily available in shops and via the Internet, but they will result in negative health consequences as well as positive drug tests.

Many herbal supplements are claimed to increase testosterone levels and hence have an anabolic action. These include: Tribulis Terrestris; Chrysin; Indole-3-Carbinol; Saw Palmetto; Gamma-oryzanol; Yohimbine; Smilax; Mummio. All of these claims are based on studies in test tubes and none has been shown to work in humans. Athletes are cautioned against the use of these supplements.

Athletes must be aware of the strict liability principle that makes them responsible for everything they eat and drink.

Ignorance is not an acceptable excuse for a positive doping result.

Check all supplements with a medical officer or qualified sports nutrition specialist. If there is any doubt at all, don't take it.



Special needs for power and sprint sports

Training issues

The goal of many power and sprint athletes is to enhance muscle mass and strength through specially designed resistance-training programs. In most cases, these athletes believe that their food focus should be on protein intake. In fact, there is no evidence that very high intakes of protein (>2 g per kg BW) are necessary or even advantageous for optimizing the results of resistance training. It is likely that the best results are achieved through enhanced recovery strategies, such as providing a source of protein and carbohydrate soon after the workout, and achieving adequate total energy intake over the day. It is probably also valuable to spread protein intake over the day's meal and snack schedule rather than stacking it all into one or two meals.

Many power and sprint athletes forget to bring a drink bottle to training. However, workouts are best undertaken when the athlete is well-hydrated and well-fuelled. Fuelling with a sports drink can help the athlete to keep lifting or training with a good technique, right to the end of a long session.

There are numerous supplements that claim to promote recovery, increase muscle mass, reduce body fat and enhance performance. These claims are attractive to all athletes, but seem particularly entwined with the world of body building and strength training. Many athletes are not aware that the claims made for most products are unsupported or exaggerated, and that the industry operates with little regulation.

Competition issues

Most sprint events are conducted over a short time, with minimal impact on fluid and carbohydrate levels. However, competition can require the athlete to compete in a series of heats, semis and finals, or with long periods between rounds of a field event or multi-sport competition. This calls for special eating strategies to recover between events or to manage fluid and energy levels over a long day.

Eating strategies for power and strength athletes

A key ingredient in a plan designed to enhance muscle size and strength is adequate energy intake. Energy should be supplied both by carbohydrate-rich foods that provide fuel for training as well as protein- and nutrient-rich foods that can provide building blocks for the results.

Recent evidence suggests that enhanced effects on protein balance are achieved by following up a resistance workout with a meal or snack providing a good source of protein and carbohydrate soon after the session. When total energy needs for the day are high, having a snack before and after the workout can help to meet targets.

A few supplements and sports foods provide valuable benefits to the athlete's training and competition program. It is important for the athlete to seek up-to-date and independent advice from a sports nutrition expert to identify these products and how to use them to suit the athlete's current program, budget and performance goals.



On the day of competition, the athlete should consume a comfortable pre-event meal and organise appropriate carbohydrate-rich drinks and light snacks to stay fuelled and hydrated between events or bouts in a multi-event program.

Strategies for high-energy eating

It is usually more efficient to increase the number of times that food is eaten each day — for example, a series of 5-9 meals and snacks — rather than trying simply to increase the size of meals. Drinks such as fruit smoothies, liquid meal supplements and fortified milkshakes and juices can provide a substantial source of energy and nutrients that are quick and compact to consume, and less likely to cause gastrointestinal discomfort than bulky foods. Sugary foods and specialised sports products (drinks, bars) can provide a more compact form of carbohydrate and other nutrients, which is particularly useful when energy needs are high. A food record can identify the times in a busy day that aren't being well used for fuelling up. The athlete should use creative ideas and good planning to arrange a supply of portable snacks and drinks that can travel with them over their day.

Food combinations supplying carbohydrate and protein

- Breakfast cereal and milk
- Sandwiches with meat, cheese or egg fillings
- Meat/fish/chicken stir-fries served with rice or noodles
- Fruit smoothies or liquid meal supplements
- Fruit and yoghurt
- Dried fruit and nut mixes
- Meals or snacks can be quickly partnered with a missing nutrient by adding 500 ml of milk (protein), 500 ml of juice (carbohydrate) or 500 ml of flavoured milk (protein + carbohydrate)



Special needs for endurance sports

Training issues

A demanding endurance training program usually involves daily or twice-daily workouts. Inadequate refuelling leads to fatigue and ineffective training.

Low body fat levels may benefit performance and are pursued obsessively by some athletes. Severe restriction of energy intake and dietary variety can lead to chronic fatigue, reduced performance, nutritional deficiencies, hormonal imbalances and disordered eating. In addition, endurance athletes' weights will often flux in the season, and it may be unhealthy, stressful and impractical to maintain very low body weights/fatness all year long.

Lengthy, high-intensity workouts lead to high sweat losses, particularly in hot weather.

Requirements for protein, vitamins and minerals may also be increased by a heavy training load.

Competition issues

The main factors causing fatigue during competition are fuel (carbohydrate) depletion and dehydration. Strategies for eating before, during and after the event are important to reduce these effects.

Competition is often undertaken in multiple stages, or as a series of heats and finals. Recovery between sessions can be important in determining the final winner.

Eating strategies for the endurance athlete

To achieve carbohydrate intake targets to meet the fuel demands of training and recovery,

meals and snacks should be based around carbohydrate-rich foods such as:

- Breads and flour-based foods (e.g., rolls, scones, low-fat muffins)
- Rice, pasta, noodles and other grain foods
- Breakfast cereals (cold or hot)
- Fruits (fresh, frozen or canned)
- Starchy vegetables (corn, potatoes), beans and legumes
- Flavoured dairy foods (e.g., chocolate milk and fruit yoghurt)
- Sugary foods and drinks (juices, occasional sweets)

Nutrient-dense carbohydrate choices, and the addition of protein-rich foods and vegetables to meals, will help to balance fuel needs and other nutrition goals. Sugary foods and drinks provide a compact form of carbohydrate, which is particularly useful when energy needs are high or in situations when it is impractical to eat bulky foods.

Endurance athletes with very high energy needs may find it valuable to spread their daily food intake over a series of meals and snacks. Drinks providing carbohydrate (sports drinks, soft drinks, juices, fruit smoothies and milkshakes) also provide a compact way to refuel.

Key strategies to achieve lighter and leaner physiques include low-fat eating and attention to portion sizes. Well-placed snacks may help prevent hunger and energy drain over the day and may prevent overeating at the next meal.



Fluid and fuel replacement are key issues during most competitive events, and the athlete should prepare for competition by fuelling up in the day(s) leading up to the event and ensuring that they are well-hydrated. For events lasting longer than about 90-120 minutes, many athletes carbohydrate load, by tapering their training and increasing carbohydrate intake for 2-3 days prior to the race.

The pre-event meal offers a final way to top-up fuel and fluid levels, and menu choices should be based around carbohydrate-rich eating. The ideal amount and type of foods and drinks, and the timing of the pre-event meal, will vary between athletes and should be fine-tuned with experience to avoid gastrointestinal disturbances during the event.

In long events there may be a need and opportunity to refuel and rehydrate 'on the run'. Sports drinks provide a good balance of fluid and carbohydrate to meet both goals, and are designed to taste good to encourage intake. Each athlete should develop a fluid intake plan based on knowledge of expected sweat losses and how much of this is practicable to replace. Fluid intake should not exceed sweat losses. In very long events, sports bars, gels and everyday carbohydrate foods provide an additional source of carbohydrate for variety and extra fuel intake. Typically, a fuel intake of ~20-60 g per hour is suitable, but should be fine-tuned according to individual needs and experience. Race day strategies should be tried in training, both to enhance the session and to fine-tune the competition plan.

After a race or workout, the athlete should eat and drink to promote quick recovery. Light

and portable recovery snacks are a useful choice until the normal meal pattern is resumed.

Carb choices for race fuel: 30 g carb is provided by:

- 400-500 ml of a sports drink — 250 ml of a defizzed soft drink
- ~1 packet sports gel
- ~ $\frac{3}{4}$ sports bar (low-fat, moderate protein)
- 1 large or 2 small bananas
- 1 thick slice of bread and jam/honey
- 35-40 g candy/confectionery
- Remember fluid needs too!



Special needs for team sports

Training issues

Many team sports involve seasonal competition. At the recreational level, the off-season can be lengthy and players often lose fitness and gain body fat as a result of detraining and poor eating practices. This may also occur during the season when players are injured. At the elite level, most team athletes train all year, with just a brief break between seasons.

Refuelling is an important part of the recovery between matches, and from the team and individual training sessions that occur between games. Traditionally, many team players have focussed on fuelling up only on the day before a match or in the pre-event meal. However, the daily demands of training are best met by a permanent approach to adequate fuel intake.

Physique is important in the performance of some sporting codes, or positions within a code. Many team athletes have special nutritional needs to support a resistance training program, or a rapid growth spurt. While protein needs are often emphasised, total energy and fuel intake and the timing of meals/snacks in relation to training are perhaps more important.

Large fluid losses often go unrecognised in team sports, or are even promoted as a means to lose weight or 'toughen up' players. High-intensity work creates large sweat losses even in cold weather, and special needs should be recognised in warm conditions or when heavy clothing and protective gear is worn. In addition, many athletes (often in hockey) swish and spit, and may fail to recognise that this does not aid hydration.

Match issues

Competition can be played in weekly league games, or as a tournament with games every day or several days. Recovery needs must be adjusted according to the schedule.

Depletion of fuel stores can be an issue for team games lasting longer than 60 minutes, especially for players in mobile positions or with a running game style. High carbohydrate strategies — fuelling up for the game and consuming extra carbohydrate during the match — have been shown to enhance performance in team sports. Hydration strategies are also important for optimal performance. Better match nutrition may not only keep players running further and faster in the second half of a match but may help to maintain skills and judgement when players would otherwise become fatigued both physically and mentally. Games are often won and lost in the last minutes of the match, and fatigued players are at increased risk of injury.

Eating strategies for team athletes

Team-sport players may adopt the eating strategies outlined for endurance athletes, and should eat well and stay active all year round. The following strategies may be of additional value.

Many team sports have a large contingent of young players who are 'fresh from home'. It is a good team strategy to organise cooking and shopping classes for young players to help them develop the domestic skills and nutrition knowledge that will allow them to reach their full potential as players. Athletes looking after



themselves for the first time can find it hard to juggle the team commitments, as well as work/school. Many recipe books developed for athletes offer quick and nutritious meal ideas suited to the special needs of sport.

The pre-event meal is a good opportunity for a shared meal, ensuring good last-minute nutritional preparation as well as an opportunity to boost morale and share final tactics. Ideas for pre-event meals are found on pages 16-17, and are best provided as a buffet, to allow each team member to choose their individual needs and likes.

Various opportunities exist for players to refuel and rehydrate during team sports — these include quarter or half-time breaks, substitutions and time-outs. Some codes even allow trainers to carry drinks to players on the arena during breaks in play. A creative plan should be developed for each team.

Post-game or post-training recovery is another good opportunity for team nutrition. Alcohol is often a large part of post-game activities in team sports but should be discouraged, unless in moderation and after recovery eating goals are achieved. Post-game snacks and light meals providing nutritious forms of carbohydrate and protein as well as rehydration options will help players to recover effectively while celebrating or commiserating the results of the match.

Ideas for post-exercise recovery snacks

Each choice provides ~50 g carbohydrate and a valuable source of protein and other nutrients

- 250-350 ml fruit smoothie or liquid meal
- 60 g (1-2 cups) breakfast cereal + milk + 1 fruit
- 200 g carton of yoghurt + cereal/ breakfast bar
- 1 round of meat/cheese and salad sandwiches or roll + 250 ml fruit juice
- 150 g thick-crust pizza — lean meat and vegetable toppings and easy on the cheese
- 60 g sports bar + 250 ml sports drink



Special needs for weight-conscious sports

Training issues

The key nutritional interest of many athletes is to reduce body weight and body fat. A low level of body weight and body fat often provides a benefit to performance. In other sports involving subjective outcomes (e.g., gymnastics, diving, body building), the athlete who is lean and trim is judged to have a higher aesthetic appeal. Although certain body shapes and physiques are held up as *de rigueur* for many sports, each athlete must be realistic in setting targets for the weight- and fat-loss programs they undertake.

Challenges occur for the athlete whose training does not involve high-energy expenditure work — for example, the athlete who undertakes lengthy training sessions that are primarily based on skill and agility. It is more difficult to create the energy deficit needed to reduce weight and body fat when basal energy needs are low to moderate.

Restrictive eating and fad diets can lead to dehydration and fuel depletion, marring training performance and increasing the risk of injury and accidents, rather than achieving effective loss of body fat.

Competition issues

In many combat sports (boxing, wrestling, martial arts), some strength sports (weight lifting) and lightweight rowing, competition involves weight divisions that attempt to provide a match between athletes of equal size and performance. In such sports, athletes typically try to lose weight in the days before the competition (and its pre-event weigh-in),

in order to qualify for a weight division that is lighter than their habitual body weight and gain an advantage over a smaller opponent. Acute strategies to make weight expose the athlete to health and performance risks arising from dehydration, fuel depletion, inadequate nutrient intake and psychological stress.

Strategies for athletes in weight-conscious sports

Athletes will benefit from professional advice from an expert such as a sports dietitian to set realistic goals for weight- and fat-loss attempts, and a suitable long-term eating plan.

The athlete in skill-based sports should seek their coach's input to introduce or increase aerobic workouts that can increase overall energy expenditure without detriment to key training sessions. This may include changes to lifestyle to increase incidental exercise or activity in the day.

Athletes who compete in weight division sports should settle for a weight category that is close to the training weight that can be achieved with a safe and healthy plan. Final fine-tuning of weight prior to the event should not involve changes of >1-2% body weight, and should be undertaken without resorting to extreme techniques of dehydration and fasting. Proper and timely refuelling after weigh-in is also critical to ensure optimal competition performance.

Athletes in weight-conscious sports may be at higher risk of disordered eating and eating disorders than other athletes or the sedentary population. It is important that



athletes who develop warning signs of such problems are referred at an early stage for expert team-based advice.

Strategies for staying lean and trim

Assess portion sizes at meals to ensure that over-eating does not occur due to habit or unnecessary hunger.

Use well-chosen snacks between meals to maintain fuel levels for training sessions or to avoid excessive hunger. However, avoid snacking for entertainment or comfort. Snacks can often be organised by saving part of a meal for a later occasion, rather than by eating extra food.

Use low-fat strategies in choosing foods and while cooking or preparing meals.

Make meals and snacks more filling by including plenty of salads and vegetables, by taking the higher-fibre option, and by including low glycaemic forms of carbohydrate.

A food record will help to identify the difference between an athlete's desired eating plan and their actual intake. Many people are unaware of the habits that sabotage their eating goals.

Examples of incorporating low glycaemic index carbohydrate foods into meals

- Enjoy rolled oats (porridge or low-fat versions of Bircher Muesli) instead of Cornflakes for breakfast
- Replace white and whole meal breads with whole grain and multi-grain choices
- Add lentils and legumes to casseroles and pasta sauces
- Enjoy flavoured yoghurt as a snack
- Replace mashed potatoes with al dente pasta or buckwheat



Special needs for the travelling athlete

Most elite athletes are well-seasoned travellers, seeking competition or specialised training environments far away from home. In many team sports, high-level competition is organised in a national or regional league that requires weekly or biweekly travel to matches. Frequent travel can pose a number of challenges:

- Disruptions to the normal training routine and lifestyle while the athlete is en route
- Changes in climate and environment that create different nutritional needs
- Jet lag
- Changes to food availability including absence of important and familiar foods
- Reliance on hotels, restaurants and takeaways instead of home cooking
- Exposure to new foods and eating cultures
- Temptations of an all-you-can-eat dining hall in an Athletes' Village
- Risk of gastrointestinal illnesses due to exposure to food and water with poor hygiene standards
- Excitement and distraction of a new environment
- Changes in digestion and/or pattern of bowel movements due to travel

The keys to eating well while travelling are:

1. Plan ahead.

Investigate food patterns and availability at your destination before you leave home. This may help you to plan useful food supplies to take on your travels that can replace missing and important items.

Contact the catering organisers at your destination to let them know of your needs for meal timing and menus.

Make an eating plan for travel that incorporates the best of the available food supplies (e.g., airline catering, restaurants en route) as well as self-supplied snacks.

2. Eat and drink well while on the move.

Recognise that enforced rest while travelling will reduce energy needs, but create more opportunities for excessive energy intake if the athlete succumbs to 'boredom eating'. Be aware of eating to real need.

When moving to a new time zone, adopt eating patterns that suit your destination as soon as the trip starts. This will help to adapt your body clock.

Be aware of unseen fluid losses in air-conditioned vehicles and pressurised plane cabins. Have a drink plan that keeps you well hydrated.

3. Be wary of food and water hygiene.

Find out whether it is safe to drink the local water supply. If risky, stick to sealed bottles of water and other drinks or hot drinks. Be wary of ice added to drinks — it is often made from tap water.

In high-risk environments, stick to food produced in good hotels or well-known restaurants. Avoid eating food from local stalls and markets, however tempting it is to have an authentic cultural experience.

Stick to food that has been well-cooked, and avoid salads or unpeeled fruit that has been in contact with local water or soil.



4. Choose well from local cuisine and supplement with nonperishable food supplies brought from home.

It is often a good idea to bring some snacks and favourite foods with you, especially if you are away from home for a long time and your favourites are not available at your destination. Remember, though, that many countries prohibit the import of fresh foods: check ahead to see what is permitted and do not risk having these confiscated at the airport. Do not take the risk of trying to smuggle food — you may be refused entry.

Ideas for portable supplies for the travelling athlete

- Breakfast cereal and powdered milk
- Cereal and breakfast bars
- Meal replacement, sport and protein bars
- Rice cakes, crackers, pretzels
- Spreads — honey, jam, peanut butter
- Powdered sports drinks and liquid meal supplements
- Dried fruit and nuts

5. Use clever tactics in restaurants, all-you-can-eat dining halls and when choosing takeaways.

Stick to an eating plan based on what is normally eaten at home, or what meets new nutritional needs, rather than being mesmerised by all the food on offer. Walk around the dining

hall before you start filling your plate. This will help you make informed decisions on your eating choices rather than the typical see-and-grab approach.

Be assertive in asking for foods to be prepared to your needs — for example, with low-fat cooking methods, or with an added carbohydrate serving.

Avoid hanging around in restaurants or dining halls for entertainment — it can often lead to unplanned and unnecessary eating.

Remember that your normal eating patterns probably involve well-timed and well-chosen snacks. If your new catering arrangements provide only for main meals, ensure that the menu at meals includes some items that can be taken away for snack needs.





Environmental challenges

Athletes train and compete in every country of the world, and they may face a number of different environmental challenges at home or when they travel for competition. The athlete who trains in winter in Russia or the American Midwest is confronted with wind, snow and bitter cold, while the Saudi Arabian athlete who trains in mid-summer may face temperatures of 50°C and high humidity. In every case, however, athletes learn to cope, and it is often a matter of pride never to miss a session because of adverse weather conditions.

Athletes are sometimes required to compete in environments that are very different from those they are accustomed to at home, and this can pose special challenges. Every challenge, though, should be seen as an opportunity, and nutritional strategies can be adopted to help athletes cope with environmental extremes.

Special issues for exercise in hot climates

Most athletes enjoy opportunities for warm-weather training and competitions, but these can be challenging for all athletes, especially endurance and team sports athletes.

Those who normally live in cold climates will benefit from a period of heat acclimation before competing in major events held in a hot climate. It is also essential for these athletes to gain heat experience so that they know how to adapt training and competition strategies, as well as drinking behaviours and lifestyle factors when they are suddenly exposed to hot weather.

Heat acclimation is achieved best by about 60-100 minutes of modest exercise in warm environment: about 10-12 sessions at intervals of not more than 2-3 days will achieve this.

Athletes not used to hot weather must be aware of the need to make some changes to their routine:

- It may be necessary to modify the warm-up and reduce the amount of clothing worn to prevent over-heating and excess sweat loss before competition begins.
- Extra fluids may be necessary, and cool fluids may be especially welcome, so insulated drinks bottles can help.
- Sports drinks contain calories: too much can upset the athlete's energy balance, so this must be part of the overall eating plan.



Cultural and regional issues

An infinite variety of different food combinations can be chosen by athletes to meet their nutritional goals. All the essential nutrients can be obtained from normal foods, and variety is a key to meeting nutrient needs, but many different foods can be interchanged. Good sources of carbohydrate may be bread, rice, pasta, potatoes, couscous or the maize porridge favoured by many Kenyan athletes. Protein will be provided by many different foods; the obvious protein-rich foods are meat, fish, eggs and dairy produce, but bread, cereals, pasta, lentils and beans are only a few of the other

excellent sources of protein. The fruits and vegetables that are commonly available will differ from region to region, although many staples or favourites are exported around the globe. Our eating habits are much more international than they were, and athletes can enjoy foods from different countries of the world.



Vegetarian considerations

Many athletes, often endurance athletes and/or female athletes, adopt a vegetarian lifestyle. This personal choice can be very healthy, and is in no way incompatible with success in sport. However, it does mean that athletes must be more aware of the food choices that they make in order to maintain energy levels, meet training and recovery needs, and to support proper immune function.

Plant-based, high-fibre diets may reduce energy availability and athletes should monitor body weight and body composition to ensure energy needs are being met.

Female athletes may use vegetarianism as a means to restrict calorie intake in order to achieve a desired physique. Female athletes should seek help from a trusted health professional if they feel out of control with calorie restriction and/or trying to achieve excessive leanness. Severe calorie restriction may compromise performance as well as reproductive health and bone health.

Although most vegetarians meet or exceed their protein requirements, plant protein quality and digestion is decreased and often requires an intake of approximately 10% more protein than if consuming animal proteins. Therefore, protein recommendations for vegetarian athletes are approximately 1.3-1.8 g/kg/day from a variety of plant protein sources. This fact may be of more concern for vegans — those who avoid all animal proteins, such as meat, eggs and milk.

If there are no animal foods in the diet, then a Vitamin B12 supplement may be necessary.

Some vegan food products, such as meat substitutes, are B12 fortified — read food labels.

Avoiding red meat means that special attention must be paid to ensuring that the diet contains enough iron, especially during periods of rapid growth (e.g., adolescence). Iron intake from plant sources should be combined with other foods that aid iron absorption: for example, iron-fortified breakfast cereals, consumed at a meal containing Vitamin C (a glass of orange juice).

Dairy produce should be included in the diet to ensure an adequate calcium intake, but many calcium-fortified foods are also available.

Vegetarian athletes may also be at risk for low intakes of fat (essential fatty acids are especially important), riboflavin, Vitamin D and zinc, which should be monitored and supplemented in the diet if necessary.

There may be special circumstances that cause athletes to change their normal training and dietary habits. Muslims must avoid food and fluid intake during daylight hours during the holy month of Ramadan. This can mean changes to training times, especially in very hot weather, to ensure that adequate hydration is maintained. Where athletes must compete during Ramadan, they should be aware that prior preparation is necessary to ensure good liver and muscle glycogen stores and good hydration. Performance will not necessarily suffer if the athlete is well prepared.

Athletes with special nutrition needs may face challenges when travelling away from home for long periods as the foods they are



accustomed to may not be easily available. However, with today's multi-cultural world, there should be no real difficulties with a little forward planning. Hotels are usually willing to cater to special needs, but need adequate warning to allow them to source foods. Remember that many countries do not allow the import of fresh foods and seeking local sources is usually the best option.

Ethnic restaurants can be found in almost every major city of the world and may be a special treat for athletes, but these should be checked beforehand. The advice of local athletes may be very useful in identifying suitable options.





References

Nutrition for the athlete is based on information discussed at the IOC Consensus Conference on Nutrition for Sport, held in Lausanne in June 2003. The papers presented at that meeting were published as a Special Issue of the *Journal of Sports Sciences* (Volume 22, No 1, January 2004)

1. Energy balance and body composition in sports and exercise
Anne Loucks
2. Carbohydrates and fat for training and recovery
Louise Burke, Bente Kiens, John Ivy
3. Pre-exercise carbohydrate and fat ingestion: effects on metabolism and performance
Mark Hargreaves, John A Hawley, Asker E Jeukendrup
4. Fluid and fuel intake during exercise
Ed Coyle
5. Fluid and electrolyte needs for preparation and recovery from training and competition
Susan Shirreffs, Samuel Cheuvront, Lawrence Armstrong
6. Protein and amino acids
Kevin Tipton, Bob Wolfe
7. Dietary antioxidants and exercise
Scott Powers, Keith C DeRuisseau, John Quindry, Karyn L Hamilton
8. Dietary supplements
Ron Maughan, Doug King, Trevor Lea
9. Exercise, nutrition and immune function
Mike Gleeson, Bente Pedersen, David Nieman
10. Nutritional strategies to influence adaptations to training
Lawrence Spriet, Marty Gibala

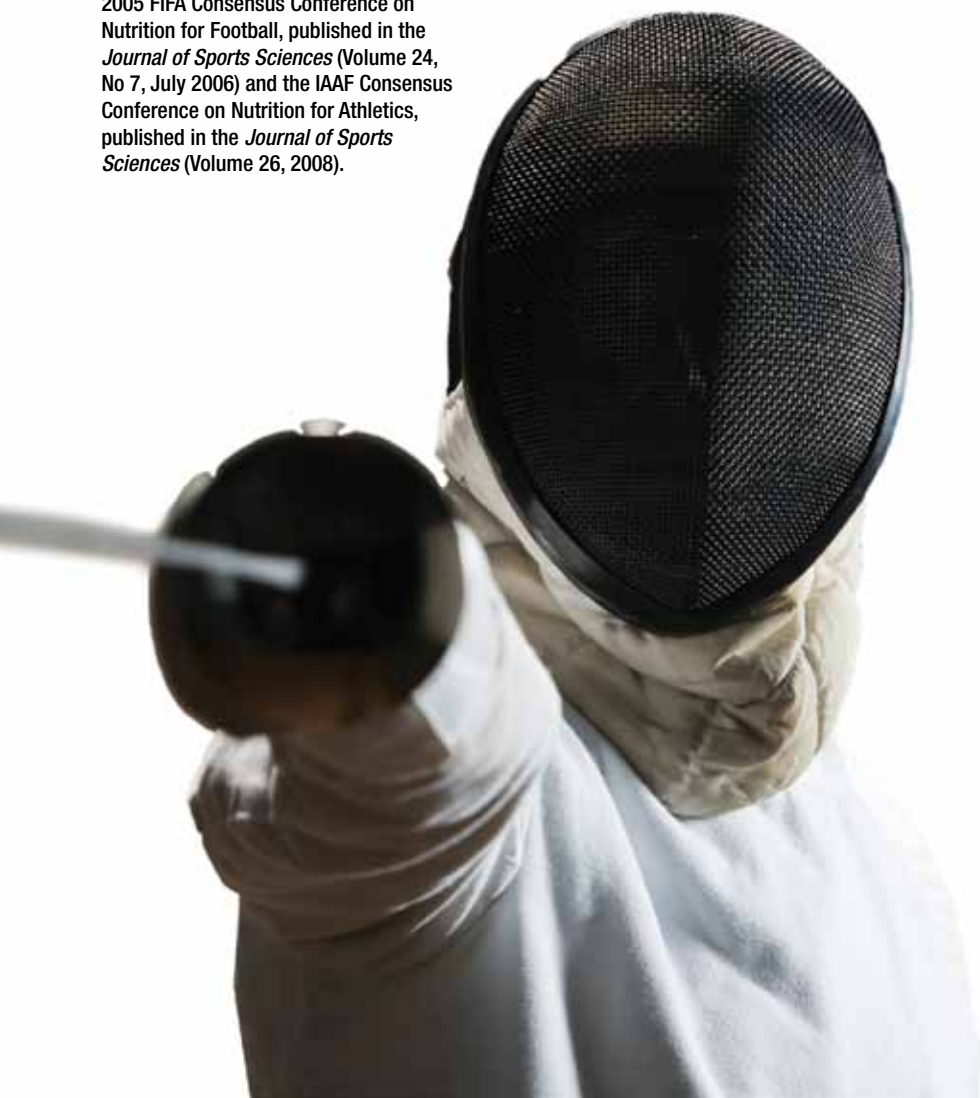
Commentaries

1. Protein and amino acid requirements of athletes
D Joe Millward
2. Exertional Hyponatraemia
Lawrence E Armstrong





This booklet has been substantially updated and revised (February 2010) and has relied in part on the information presented at the 2005 FIFA Consensus Conference on Nutrition for Football, published in the *Journal of Sports Sciences* (Volume 24, No 7, July 2006) and the IAAF Consensus Conference on Nutrition for Athletics, published in the *Journal of Sports Sciences* (Volume 26, 2008).



IOC Consensus Statement on Sports Nutrition 2003

The amount, composition and timing of food intake can profoundly affect sports performance. Good nutritional practice will help athletes train hard, recover quickly and adapt more effectively with less risk of illness and injury. Athletes should adopt specific nutritional strategies before and during competition to help maximise their performance. Athletes will benefit from the guidance of a qualified sports nutrition professional who can provide advice on their individual energy and nutrient needs and also help them to develop sport-specific nutritional strategies for training, competition and recovery.

A diet that provides adequate energy from the consumption of a wide range of commonly available foods can meet the carbohydrate, protein, fat and micronutrient requirements of training and competition. The right diet will help athletes achieve an optimum body size and body composition to achieve greater success in their sport. When athletes restrict their food intake, they risk nutrient deficiency that will impair both their health and their performance. Careful selection of nutrient-dense foods is especially important when energy intake is restricted to reduce body and/or fat mass. Fat is an important nutrient and the diet should contain adequate amounts of fats.

Athletes should aim to achieve carbohydrate intakes that meet the fuel requirements of their training programs and also adequately replace their carbohydrate stores during recovery between training sessions and competition. This can be achieved when athletes eat

carbohydrate-rich snacks and meals that also provide a good source of protein and other nutrients. A varied diet that meets energy needs will generally provide protein in excess of requirements. Muscle mass is maintained or increased at these protein intakes, and the timing of eating carbohydrate and protein may affect the training adaptation.

A high carbohydrate intake in the days before competition will help enhance performance, particularly when exercise lasts longer than about 60 minutes. Dehydration impairs performance in most events, and athletes should be well hydrated before exercise. Sufficient fluid should be consumed during exercise to limit dehydration to less than about 2% of body mass. During prolonged exercise the fluid should provide carbohydrate. Sodium should be included when sweat losses are high, especially if exercise lasts more than about 2 hours. Athletes should not drink so much that they gain weight during exercise. During recovery from exercise, rehydration should include replacement of both water and salts lost in sweat.

Athletes are cautioned against the indiscriminate use of dietary supplements. Supplements that provide essential nutrients may be of help where food intake or food choices are restricted, but this approach to achieving adequate nutrient intake is normally only a short-term option. The use of supplements does not compensate for poor food choices and an inadequate diet. Athletes contemplating the use of supplements and



sports foods should consider their efficacy, their cost, the risk to health and performance, and the potential for a positive doping test.

Excessive training and competition are associated with some negative consequences. Robust immunity and reduced risk of infection can be achieved by consuming a varied diet adequate in energy and micronutrients, ensuring adequate sleep and limiting other life stress. Attention to dietary intake of calcium and iron is

important in athletes at risk of deficiency, but use of large amounts of some micronutrients may be harmful. Female athletes with menstrual disorders should be promptly referred to a qualified specialist physician for diagnosis and treatment.

Food can contribute not only to the enjoyment of life but also to success in sport.

Lausanne, 18 June 2003



