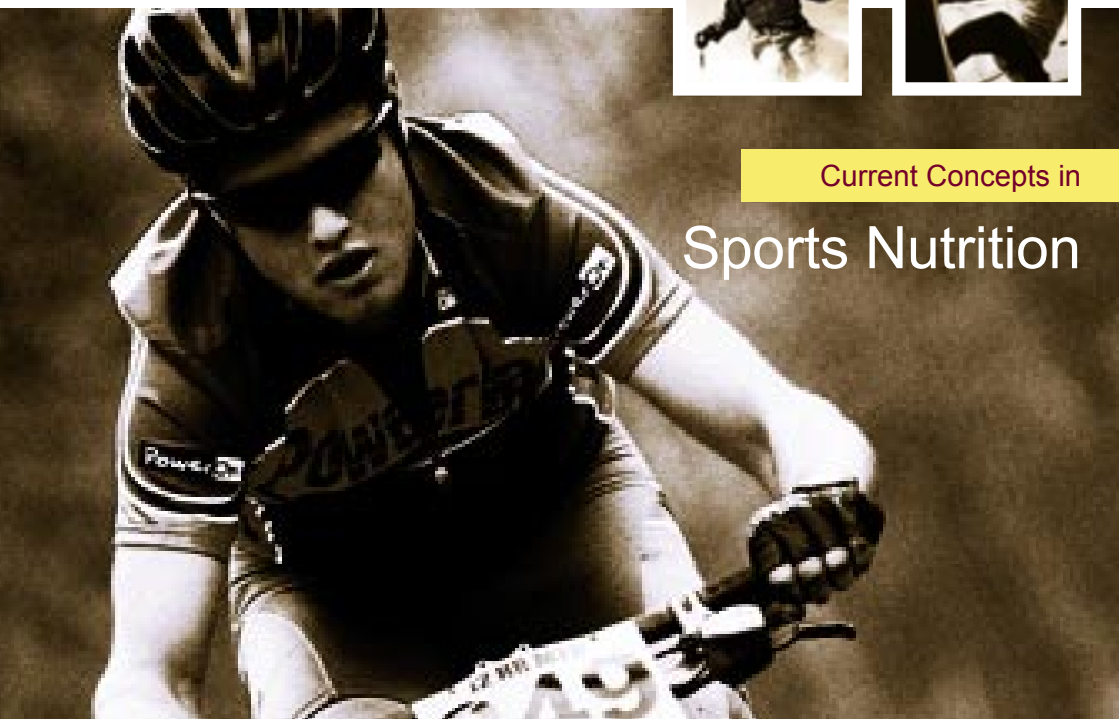
PowerBar
Premium Sports Nutrition







Current Concepts in

Sports Nutrition

AUSTRALIAN
INSTITUTE OF SPORT

Written by the Department of Sports Nutrition, Australian Institute of Sport, Dr Louise Burke, Louise Bell, Michelle Cort, Greg Cox, Lesley Farthing, Bronwen Greenaway, Michelle Minehan, Nick Petrunoff, Clare Wood and brought to you by PowerBar.
The Australian Institute of Sport is a program of the Australian Sports Commission.

Introduction

Energy Balance 01

Managing Body Composition 09

Fuelling Up 17

Pre-event Preparation 21

During Exercise 25

Recovery 31

Immune Function 37

Dietary Supplements 39

PowerBar Product Range 43

INTRODUCTION



Whether you exercise to keep fit, participate regularly in an organised sporting activity, or are training to reach the peak level of your sport, good nutrition is an essential tool to help you perform at your best.

Making smart choices about the type, timing and quantity of food to eat can all play a role in realising your best. Eating well is specific to you and your individual nutritional needs, as well as your training and competition schedule.

This booklet provides an up-to-the-minute coverage of current concepts in sports nutrition. It examines the most recent research and sets out guidelines to help you apply this knowledge to the practicalities of your own sport and individual situation. With the aid of this booklet, you will be able to optimise your response to training, stay healthy, prepare for events, recover effectively and make informed choices about the use of supplements and ergogenic aids.

ENERGY BALANCE



Setting the framework

Sports nutrition is a science that requires a solid understanding of the nutritional factors effecting performance, recovery and health, a knowledge of the nutritional value of food and fluids, and the necessary skills to implement appropriate nutritional strategies into daily training and competition.

A key priority for athletes is to establish a well-chosen training diet that can be easily manipulated when special situations emerge (for example, changes to training load, changing body composition goals, or special competition needs). A good base diet will provide adequate nutrients and energy to enhance adaptations from training, support optimal recovery and avoid excessive food-related stress. Heavy training increases the need for nutrients, particularly carbohydrate, protein and micronutrients (vitamins and minerals).

These increased requirements are usually met when an athlete consumes a diet that:

- provides adequate total energy (kilojoules)
- balances carbohydrate intake with daily exercise loads
- includes a wide variety of nutrient-rich foods including protein-containing foods.

Energy balance

Maintaining energy balance is a key goal for athletes. Energy balance occurs when total energy intake from food matches energy expenditure from daily activity. Energy is provided by the carbohydrate, protein, fat and alcohol in food and fluids. The energy requirements of an individual are influenced by factors such as body size, body composition goals and the energy cost of training.

Many athletes are faced with the challenge of achieving very high energy intakes to support extremely high training loads and/or the cost of growth or maintaining a large, lean body mass. Other athletes need to restrict their energy intake in order to maintain a low body mass and body fat levels. At times it can seem that following all sports nutrition guidelines works against goals of achieving energy balance, particularly for athletes with lower energy needs such as females. It may not be practical to have a large pre-exercise snack, consume carbohydrate during exercise, follow recovery guidelines and still achieve an energy intake compatible with one's body composition goals. Smart planning is needed to optimise the benefits provided by sports nutrition within the framework of each athlete's unique total energy allowance.

Carbohydrate

Carbohydrate remains a key nutrient for athletes. It provides the major fuel for exercise, especially during prolonged continuous exercise or high-intensity work. The body has a limited capacity to store carbohydrate (as glycogen in the muscles and liver) and stores must be replenished regularly to support training. Low body stores of carbohydrate can result in fatigue, impairment of performance at training or during competition, and a negative impact on the immune system.

Carbohydrate requirements are largely influenced by training loads (frequency, duration and intensity of training sessions) and the demands of competition. Given this, daily carbohydrate intake should reflect daily exercise levels. On high activity days, carbohydrate intake needs to be increased to facilitate optimal exercise performance and promote recovery between exercise sessions. Conversely, on low activity days, carbohydrate intake (particularly from nutrient-poor sources such as cordial, soft drink, lollies and cakes etc.) may need to be reduced to reflect a decreased training load. Carbohydrate needs must be taken care of while meeting other dietary goals. Fortunately, very few foods are made up of single nutrients. Opting for nutrient-rich carbohydrate foods allows carbohydrate intake goals to be met while also addressing other nutrient needs.

ENERGY BALANCE

Carbohydrate intake goals

Minimal physical activity	2-3g CHO per kg BM
Light physical activity (3-5 hr/week)	4-5g CHO per kg BM
Medium physical activity (10 hr/week)	6-7g CHO per kg BM
Professional/elite athletes (20+ hr/week)	7+g CHO per kg BM
Carbohydrate loading for endurance and Ultra-endurance events	7-12g CHO per kg BM

CHO = carbohydrate
BM = body mass

The following tables will help you determine the amount of carbohydrate in some of the foods you eat. More detailed information is available on the AIS Sports Nutrition web site (www.ais.org.au/nutrition).

Nutrient-rich food choices providing 30g of carbohydrate

150–250 ml of liquid meal supplement*
150–200 ml of milk shake or fruit smoothie*
300ml flavoured low fat milk*
200g carton of fruit-flavoured yoghurt *
150g (½ cup) creamed rice*
Sports bars (check labels for protein and carbohydrate content)*
30–40g (1–1½ cups) breakfast cereal with milk*
¾ cup of cooked porridge with milk
1 round of sandwiches, including cheese/meat/chicken plus salad filling*
2 slices of bread
3 rice cakes
1 crumpet or English muffin
1 cup of cooked pasta
¾ cup of cooked rice
½ cup (150g) baked beans*
1½ cups of cooked lentils*
200g (large) potato
1½ cups of sweet potato
1 large corn cob
1 cup of thick vegetable soup
2 medium pieces of fruit or 1 large banana
1 cup of fruit salad
⅔ cup of tinned fruit in syrup
⅓ cup (45g) dried fruit

* also a good source of protein

Other food choices providing 30g of carbohydrate

500ml of sports drink
300ml of cordial
250ml of fruit juice, soft drink or flavoured mineral water
35–40g packet of jellybeans or jube sweets
1 sports gel
40–50g chocolate bar
60g (1 small) American muffin or scones
60g (2 medium) pancakes
3 tablespoons of jam or honey
2 tablespoons of sugar
2 flavoured ice blocks

Protein

Our knowledge of protein requirements comes from a limited selection of studies. Although much research remains to be done in this area, the current view is that heavy training causes a small increase in protein requirements. Protein is needed to support the repair of damaged body tissues and the building of new proteins in response to the training stimulus. Endurance athletes undertaking heavy training may require extra protein to cover a proportion of the energy costs of their training, and for repair and recovery after a workout. Strength-trained athletes look for additional protein to increase muscle size and strength in response to resistance training. Negative energy balance and inadequate carbohydrate intake during heavy training can also increase protein needs. Several experts have suggested guidelines for protein intakes for athletes that reflect these possible increases in protein requirements (see below).

There is evidence to suggest that the greatest increases in protein requirements occur in the early stages of a new exercise program or a new level of exercise stress (for example, a change in the type, volume or intensity of training). However, once the body adapts to this stress, protein requirements may be reduced to levels closer to those of generally active people. Therefore, the guidelines for protein intake presented in this booklet might be best considered to represent the maximal protein needs for athletes.

Current sports nutrition guidelines do not promote the need for high protein diets or special protein supplements. Dietary surveys consistently indicate that most sportspeople achieve protein intakes well beyond the following targets just by consuming the extra energy required to support high training loads. Protein comes from a variety of sources. Many high carbohydrate foods are good sources of protein. Protein needs are easily taken care of when a varied diet that focuses on nutrient-

rich foods is consumed. Athletes at risk of inadequate protein intake are those with restricted energy intakes and unusual dietary practices (poorly chosen vegetarian diets, extremely high carbohydrate or low-fat diets).

Guidelines for maximum protein needs for different groups of athletes

Sedentary	0.8g per kg BM
General training program	1.0g per kg BM
Endurance athlete undertaking heavy training program	1.2–1.6g per kg BM
Endurance athlete undertaking extreme training program, competition or race	2.0g per kg BM
Strength athlete undertaking heavy training program	1.2–1.7g per kg BM
Adolescent athlete	2.0g per kg BM

Foods that provide approximately 10g of protein

2 small eggs
30g (1½ slices) reduced fat cheese
70g cottage cheese
1 cup (250mL) reduced fat milk or soy milk
35g cooked lean beef, lamb, pork
40g cooked lean chicken
50g grilled fish
50g canned tuna or salmon
200g reduced fat yoghurt
4 slices wholemeal bread
3 cups of wholegrain cereal
2 cups of cooked pasta or 3 cups cooked rice
¾ cup of lentils or kidney beans
200g baked beans
120g tofu
60g nuts and seed
100g soy meat

What about protein supplements?

In general, it is possible to obtain all the protein required for training from a varied diet that focuses on nutrient-rich foods. Occasionally, a supplement or special sports food may provide a practical and convenient way to consume energy, especially when everyday foods are not available or cannot be tolerated. The best type of supplement is one that provides both protein and carbohydrate. Some examples include PowerBar ProteinPlus Powder Drink and PowerBar ProteinPlus bars. Homemade versions include fruit/milk smoothies and reduced-fat milk fortified with extra skim milk powder.

Other nutrients

Population health messages recommend a reduced intake of fats and oils, increased intake of fibre-rich foods and a moderate alcohol intake. These are still important goals for athletes. Moderation and variety remain key elements in achieving a balanced food intake. Athletes need to remember that food plays a valuable role in psychological pleasure and social happiness and that foods eaten today can have long-term effects on health well beyond the end of an athletic career.



ENERGY BALANCE

Tips for a achieving a varied diet

Include wholesome cereal foods such as wholemeal, multi-grain or seeded breads, fibre-rich cereals, brown rice or wholemeal pasta.
Select a wide variety of fruit and vegetables during the day. Fresh fruit makes an excellent, portable nutritious snack between training. Add a range of colourful vegetables to stir-fries and meals — the more colour the better.
Include different salad or vegetable choices on sandwiches. It is easy to fall into the trap of having plain sandwich fillings at lunch, particularly when you are busy and have numerous work, study and training commitments.
Plan ahead so you will not have to rely on take-away meals or snacks. Prepare lunch the night before and pack a variety of portable, nutritious snacks in your training bag.



Reading list

American College of Sports Medicine, American Dietetic Association and Dietitians of Canada. Joint Position Statement: Nutrition and Athletic Performance. *Med Science Sports Exercise*, 2000 Dec: 32(12): 2130-45.

Burke LM et al. Guidelines for Daily Carbohydrate Intake. Do Athletes Achieve Them? *Sports Med*, 2000: 31(4) 267-299.

Lemon PWR. Effects of exercise on protein metabolism. In *Nutrition in Sport* edited by RJ Maughan, 2000: 133–52. Oxford: Blackwell Science.

Tarnopolsky M. Protein and amino acid needs for training and bulking up. In *Clinical Sports* Nutrition edited by L Burke and V Deakin, 2000: 90–123. Sydney: McGraw–Hill.

Tipton KD and Wolfe RR. Protein and amino acids for athletes. *Journal of Sports Sciences,* 2004: 22: 65-79.

MANAGING BODY COMPOSITION



There is considerable variability in the physical characteristics of athletes, even within the same sport. Genetics, dietary intake and the conditioning effects of the sport influence these characteristics. At times it becomes necessary to modify body composition in order to improve performance. Goals for body mass, body fat and muscle mass must be consistent with good health, be motivated by performance goals and involve a realistic time frame.

Increasing muscle mass

To increase body mass and gain lean tissue muscle, an athlete needs to follow a well-structured resistance training program and to consume a diet providing an energy intake that is greater than daily energy expenditure (that is, achieve positive energy balance). Total energy intake should be increased by **2000–4000 kilojoules per day** (approximately 500–1000 calories), with extra serves of both protein-rich and carbohydrate-rich food sources. A pattern of frequent meals and snacks is helpful in achieving additional energy requirements, and in promoting the outcomes of training by providing key nutrients at important times. The athlete will need to be organised to achieve such a pattern.

Tips for achieving a high-energy diet

Spread your total food intake across the day and increase the number of times that you eat: Avoid becoming too full at a meal — aim for three meals and 2–3 snacks over the day.
Add high-energy fluids to meals and snacks: Fluids can supply a compact form of energy and nutrients. Good choices are fruit juice, flavoured milks, smoothies, liquid meal supplements like PowerBar ProteinPlus Powder Drink, cordials and sports drinks.
Set limits on bulky, high-fibre foods: Although fibre-rich foods are often valuable in key nutrients, an oversupply can lead to fullness and gastrointestinal discomfort. For balance, replace some of these foods with lower fibre or less-filling alternatives. Choose lower-fibre forms of breads and cereals. Juices, smoothies, canned and dried fruits, and hearty soups provide easy eating options while supplying the goodness of fruits and vegetables.
Add extra energy to meals/snacks: Add compact energy to existing foods. For example, add sugar, honey or jam to breads or cereals; ice-cream, yoghurt and honey to smoothies; small amounts of olive/canola oils in cooking; and spreads such as avocado on sandwiches.
Plan ahead: Pack portable snacks such as cereal bars, canned fruit, tubs of yoghurt, and tetra-paks of milk or juice. PowerBar ProteinPlus Powder Drink and PowerBar ProteinPlus bars are also convenient and portable choices.
Remember, it is quality and quantity: To minimise body fat gains while gaining muscle mass, avoid 'pigging out' on nutrient-poor foods. Excessive energy intake will promote fat deposition, while a reliance on nutrient-poor foods may mean that requirements for some nutrients are not met.

Protein needs for increasing muscle mass

Most athletes easily meet their protein requirements. Simply increasing total energy intake from a well-chosen eating plan will allow most athletes to achieve or exceed protein intake goals. New research suggests that the clever timing of protein intake may be more effective in optimising gains in lean muscle tissue rather than simply eating large amounts of protein. Protein intake in excess of requirements is used to provide energy, and once energy requirements are met, surplus protein intake may be stored as body fat. Although there is some speculation that very high protein intakes (>2–3g per kilogram body mass per day) may have negative side-effects such as decreased testosterone levels and increased calcium excretion, most athletes who have chosen such diets over long periods do not appear to develop major problems. The major disadvantages of high protein eating are likely to be the expense and failure to consume sufficient nutrients such as fibre.

MANAGING BODY COMPOSITION

Getting the timing right

Timing the intake of key nutrients can improve the gains achieved by hard work in the gym. Consuming protein prior to a resistance workout will provide the building blocks for protein synthesis, while carbohydrate consumed at this time can provide fuel for the session. Post-training intake of these nutrients will enhance the recovery processes of refuelling, repair and adaptation. Unfortunately, in many cases, appropriate food choices are not readily available in the training environment. A motivated athlete should plan ahead for situations where food is either unavailable or unable to meet the athlete's nutritional goals.

For best results, the athlete should consider a number of nutrition strategies for each resistance training session: a snack 30–60 minutes prior to the session, special attention to fuel needs during lengthy sessions, and recovery eating as soon after the workout as is practical.

- Choose a quick and easy snack before early morning workouts. A liquid meal supplement, such as PowerBar ProteinPlus Powder Drink, is a convenient and readily digested source of protein and carbohydrate.
- Where there is not time, or you are unable to tolerate a meal or snack before a hard morning session, fuel the workout by drinking a sports drink during the session.
- Think ahead to have a light snack before the afternoon workout (for example, a tub of yoghurt and 1–2 cereal bars or a PowerBar Performance bar).
- As soon as possible after the workout, kick-start recovery processes by consuming **10–20g of protein** and **1gm of carbohydrate per kilogram body mass.** If it is not convenient to have a meal soon after the session, start with a snack that can provide these nutrients, and resume normal meal patterns later.

Working with a qualified sports dietitian can help maximise the timing of meals and snacks by devising a plan to suit an individual's training schedule and daily routine.

Case study: Men's Basketball and PowerBar ProteinPlus Powder Drink

The AIS Men's basketball team consists of tall and talented athletes with very high-energy requirements to match a heavy training load and continued growth through their teenage years. The coach is keen for the athletes to gain muscle bulk to increase their strength and improve their presence on the court. A resistance training program aimed at increasing lean body mass adds another dimension to their daily energy needs. The team trains two to three times each day with one rest day (Sunday). Many of the players find it difficult to eat the quantity of food required to meet the high-energy demands of regular training and growth. The prolonged daily training load reduces the time available for athletes to actually sit and eat a meal. In addition, many of the players find the total bulk of food quite tiresome to manage.

The AIS sports dietitians have devised some nutritional strategies to assist the players to increase their energy intake. PowerBar ProteinPlus Powder Drink has been identified as an ideal aid for these plans, effectively increasing energy, carbohydrate and protein intake without adding the bulk of extra food. The players find it easy to consume a drink before or after practice, and note that it does not spoil their appetites prior to a main meal. In addition to mixing it with water straight from the tin, the players like to use a blender to mix PowerBar ProteinPlus Powder Drink with milk, and a banana or some low-fat flavoured yoghurt to create a different flavour every time.

The team enjoys using the PowerBar ProteinPlus Powder Drink as it assists them to reach their goals of increasing muscle mass and improving their performance on court.

MANAGING BODY COMPOSITION

Reducing body fat and mass

An athlete's decision to lose weight or body fat should take into account what is realistically achievable, as well as how important it will be for performance. In most cases, a sustained moderate energy deficit is required to avoid any performance impairment caused by an inadequate fuel intake.

Which diet works best?

The 'one diet fits all' approach typically does not work. However, the general aim for weight loss is to decrease total energy intake by **2000–4000 kilojoules per day** (approximately 500–1000 calories), while maintaining adequate intakes of protein, carbohydrate and other nutrients. Consideration needs to be given to the demands of the sport, the intensity, frequency and duration of training and an individual's physical size. It can often be challenging to find the balance between reducing energy intake and providing the nutritional needs of training. Menu patterns must also attempt to address the athlete's appetite, and the social and enjoyment aspects of eating. The input of a sports dietitian can help the athlete to understand their individual requirements and set realistic goals.

Maintain adequate carbohydrate intake

Muscle stores of carbohydrate, refilled from dietary carbohydrate intake, provide an important source of fuel for training, particularly quality workouts. Even when total energy intake is reduced, daily carbohydrate intake needs to be aligned to the training load. At present there is no simple method of monitoring glycogen stores, other than expensive or invasive laboratory procedures such as muscle biopsies. Adjusting carbohydrate intake based on daily training requirements must therefore be done by 'trial and error'. General guidelines can be provided as a starting point, particularly for athletes who must undertake prolonged sessions of moderate and high-intensity activity. Such athletes are encouraged to maintain a carbohydrate intake above **5g per kilogram body mass** to minimise the impact on training quality. Nevertheless, all athletes should monitor training performances and recovery and adjust carbohydrate intake when their success at daily refuelling appears to be compromised.

How low can you go? Impact of low-carbohydrate diets on performance

Extensive research supports the benefits of a high-carbohydrate diet in improving the performance of endurance exercise, 'stop and go' high-intensity sports such as team and racquet games, and high intensity events lasting 2–7 minutes.

However, popular diets proclaim that a reduction of carbohydrate intake is the key to successful weight loss. In some cases, like the Atkins diet, followers are told to restrict carbohydrate intake to very low levels, while continuing to eat generous amounts of foods that are high in fat and/or protein. The rationale is that low-carbohydrate diets cause a shift in fuel use to increase fat burning. However, high-intensity exercise is reliant on muscle glycogen stores, and fat utilisation is unable to sustain such high power outputs. Therefore, a low-carbohydrate diet that depletes muscle glycogen stores is likely to impair an athlete's ability to undertake prolonged exercise of a high-intensity nature. This may include competitive events in some sports as well as quality training sessions in others.

In summary, many popular weight loss diets may not meet the fuel requirements typical of most training regimens. Very low carbohydrate diets typically provide no additional weight-loss benefit when compared to a calorie-controlled low-fat diet, providing adequate levels of carbohydrate. Because they are unable to cater for the special fuel needs of high-intensity exercise, they are unsuitable for most athletes.

MANAGING BODY COMPOSITION

Maintain adequate protein intake

A reduced-energy diet still needs to provide an adequate amount of protein, spread across meals and snacks over the day. Ensuring that protein requirements are met is important to help minimise muscle wasting and loss of strength during periods of weight loss. Protein added to a meal or snack can increase the satiety value or 'fillingness' of the food choice, helping with appetite control. Finally, many lean protein-rich foods also provide other key nutrients to the menu, such as iron, calcium and B-vitamins.

Target high fat foods

Energy reductions can be achieved by removing surplus amounts of fat from the diet. Strategies to meet this goal include choosing lower-fat versions of everyday foods and using low-fat cooking methods where possible. Keeping a food record can be a useful way to see where hidden extras sneak into the diet. Learning to read food labels is another asset that can help the athlete to address the quantity and quality of their food choices.

Tips for healthy intake of fat

Reduce sources of saturated fat such as butter, cream, full-cream dairy products, fatty meat, cakes, pastries and deep fried foods.
Be aware of hidden fat in processed foods and takeaways.
Choose reduced-fat dairy foods.
Trim visible fat from meat and chicken.
Use small amounts of healthy oils in cooking, such as olive and canola oils.
Include sources of mono-unsaturated and polyunsaturated fats in the diet such as fish (fresh or canned), olive oil, avocado, linseeds, nuts and seeds.

Timing of weight loss

Losing body fat should be a long-term goal. Consistent weight loss of **½–1 kilogram per week** is a suitable goal for most athletes and can usually be achieved by a small reduction of daily energy intake. When large reductions in body fat are required, weight loss efforts should be undertaken during a period that is well removed from competition. Realistic goals and an achievable time frame are important for successful long-term loss of body fat.

Long-term energy restriction — the downside

Long-term energy restriction can lead to reductions in metabolic rate, a disturbed menstrual cycle and decreased testosterone levels. These outcomes can lead to decreases in strength/power and an impairment of bone health. It is important to have close guidance from a sports dietitian to ensure that key nutrients are being provided (especially iron and calcium) and to have regular ways to assess that long-term health and performance are being maintained.

A note on injury and off-season

The injured or tapering athlete has reduced energy requirements compared to their needs during regular training. Some athletes continue to eat the same amount of energy despite a reduction in training, leading to weight gain. The guidance of a sports dietitian can help athletes adjust their energy intake to their specific needs.

Reading list

Burke LM. Energy needs of athletes. *Canadian Journal of Applied Physiology*, 2001; 26 (Suppl): S202-19.

Loucks AB. Energy balance and body composition in sports and exercise. *Journal of Sports Sciences*, 2004; 22: 1–14.

Maughan R, Greenhaff J, Leiper D, Ball Lambert C, Gleeson M. Diet composition and the performance of high intensity exercise. *Journal of Sports Sciences*, 1997; 15: 265–75.

FUELLING UP



Fuel up for training

Every meal is important for athletes who train for many hours at a time or have two or three training sessions in one day. Training and eating become a cycle of preparation and recovery, with meals and snacks consumed after one session becoming the pre-event meal for a subsequent workout. Continual replacement of carbohydrate is essential to reduce the risk of chronic carbohydrate depletion. Low muscle-glycogen stores can impair training performance, leading to poor outcomes in a single session and sub-optimal training adaptations in the long term. Daily refuelling is a crucial strategy to enhance recovery during training and event preparation. It also allows competition nutritional strategies to be practised and refined.

Fuel up for competition

Optimal performance during competition is achieved by targeting the factors that would otherwise cause fatigue or a reduction in work output and skill. Nutritional factors that can cause fatigue include depletion of glycogen stores, low blood-glucose levels (hypoglycaemia), dehydration, low blood-sodium levels (hyponatraemia), and gastrointestinal upset. Eating strategies should be undertaken to avoid or reduce the impact of these problems.

In many sports, competition preparation involves continuing with everyday eating practices in the days leading up to the event then following special eating strategies on competition day. For other sports, dietary modification is required in the days leading up to an event, either because a training taper results in decreased energy needs or because special strategies are needed to increase muscle glycogen stores.

Fuelling for high intensity and moderate duration events

Competition schedules for short duration sports, such as swimming and running sprints, involve single or several bouts of high intensity exercise over one or more days. Carbohydrate is utilised at high rates during many of these events. However, unless pre-event muscle glycogen stores are substantially depleted, fuel is not the limiting factor in the performance of these sports. Instead, fatigue is generally related to changes in the pH of the cell as hydrogen ions accumulate as a by-product of anaerobic metabolism. As a result, there is little value in elevating pre-exercise muscle glycogen content above normal resting values and specialised dietary preparations such as carbohydrate loading are considered unnecessary. The main focus of competition eating in these sports is to refuel after each race in preparation for the next.

The normal resting glycogen stores of a well-trained athlete are also sufficient to fuel the performance of moderate-intensity events or ‘stop and go’ sports lasting 60–90 minutes. This list includes most team games, cycling races of 40–50 kilometres and running races from 10 kilometres up to the half marathon. The athlete can achieve suitable fuel stores for these sports by a combination of tapered exercise or rest, plus adequate carbohydrate (7–10g per kilogram body mass) over the 24–36 hours prior to the event. In many situations, this dietary prescription is already achieved in the everyday training diet. However, for some athletes increased carbohydrate intake is needed to achieve fuelling up goals.

FUELLING UP

Fuelling for prolonged events — carbohydrate loading

During many endurance events, glycogen stores reduce to critically low levels, resulting in a reduction in power output and, possibly, skill. Starting the competition with elevated muscle glycogen stores can help postpone such fatigue. Carbohydrate loading increases muscle glycogen significantly (50–100 per cent) above normal resting values. This potentially results in a 20 per cent enhancement of endurance, or in fixed distance events, an improved race time of 2–3 per cent. It may also improve movement patterns and maintain skill at the end of prolonged team games.

Carbohydrate loading strategies have evolved significantly over the last 30 years. The most recent evidence suggests that optimal muscle glycogen levels can be achieved in well-trained athletes by combining an exercise taper with a high carbohydrate intake (7–12g per kilogram body mass). In most cases, 36–72 hours will be required to fully carbohydrate-load.

Carbohydrate loading for endurance and ultra-endurance events

Aim for a daily carbohydrate intake of 7–12g per kilogram body mass over the period of loading. For example, an athlete of 65 kilograms might aim for a daily carbohydrate intake ranging from 455g to 780g. The following meal plan provides a guide to such targets.

Timing	Food item	Carbohydrate content
Breakfast	2 cups of cereal	50g
	1 cup of skim milk	15g
	2 large white toast slices	40g
	1 tablespoon jam	14g
	1 glass of juice	25g
Snack	1 serve of PowerBar ProteinPlus Powder Drink	44g
	1 glass of skim milk	15g
Lunch	2 rolls with salad filling	60g
	Banana	20g
	1 tub of low-fat flavoured yoghurt	26g
Snack	PowerBar Performance bar	42g
	600ml sports drink	36g
Dinner	3 cups of cooked pasta with tomato-based sauce	120g
	1 slice of bread	15g
Dessert	250g tinned fruit	35g
	3 scoops of low-fat ice cream	30g
Approximate carbohydrate content of total diet		**587g**

You can manipulate this example to suit your needs by increasing or decreasing the quantity of foods on the menu. You could also be adventurous and start reading food labels to identify carbohydrate content of your preferred food items.

Reading list

Burke L. Preparation for Competition. In *Clinical Sports Nutrition* edited by L Burke and V Deakin, 2000: 341–68. Sydney: McGraw–Hill.

Bussau VA, Fairchild TJ, Rao A, Steele P, and Fournier PA. Carbohydrate loading in human muscle: an improved 1 day protocol. *European Journal of Applied Physiology and Occupational Physiology*, 2002; 87: 290–5.

Costill DL, Sherman WM, Fink WJ, Witten MW and Miller JM. The role of dietary carbohydrates in muscle glycogen resynthesis after strenuous running. *American Journal of Clinical Nutrition*, 1982; 34: 1831–6.

Hawley JA, Schabort EG, Noakes TD and Dennis SC. Carbohydrate loading and exercise performance: An update. *Sports Medicine*, 1997; 24: 73–81.

PRE-EVENT PREPARATION



Foods and fluids consumed in the four hours prior to competition complete an athlete's nutritional preparation. The pre-event meal adds to muscle glycogen stores if they have not been fully restored since the last exercise session. It also restores liver glycogen for early morning events, ensures the athlete is hydrated and prevents hunger. Food choice also impacts on gastrointestinal comfort and the athlete's psychological outlook.

Timing of carbohydrate intake

Individual tolerance and competition schedule dictate the ideal timing for the pre-event meal. General guidelines suggest a meal or series of snacks should be consumed 1–4 hours before exercise. The longer time frame allows carbohydrate intake to contribute to liver and muscle glycogen stores. However, early morning events often mean a shorter time frame is more practical. A small proportion of athletes respond negatively when carbohydrate is consumed close (within one hour) to exercise. An exaggerated carbohydrate oxidation and subsequent decrease in blood glucose concentration at the start of exercise can cause symptoms of hypoglycaemia, including fatigue.

The exact cause is unknown but useful strategies for these athletes may be to allow longer between eating and exercise, consume a substantial amount of carbohydrate in the pre-event snack (more than 1g per kilogram body mass or ~ 70g for the typical athlete) and include low glycaemic index (GI) foods in the pre-event meal. Athletes who experience gastrointestinal problems during exercise may also benefit from allowing a longer period of time between eating and exercise.

Amount of carbohydrate

Research suggests that endurance performance is improved when athletes consume a substantial amount of carbohydrate (200–300g) in the 2–4 hours before exercise. This is achievable when events are held later in the day but is not always practical before early morning events. In many situations athletes must settle for a smaller meal or snack before the event, then make up for lower than recommended carbohydrate intakes by consuming carbohydrate during the event.

Suggestions for pre-event food and fluid intake

2–4 hours prior to exercise:
• Pasta/rice with low fat pasta sauce
• Fruit salad with low fat yoghurt
• Baked potato served with baked beans
• Meat/salad sandwiches
• Toast with jam and sports drink
• Crumpets or English muffins with jam/honey + fruit smoothie
• Breakfast cereal with low fat milk plus tinned fruit
• Lean meat, vegies and noodle stir fry
• PowerBar ProteinPlus Powder Drink + PowerBar Performance Bar
60 minutes prior to exercise:
• Sports drink
• Cereal/muesli bars + banana
• PowerBar Performance Bar or PowerBar PowerGel + sports drink or water
• Vegemite sandwich + juice and fruit

PRE-EVENT PREPARATION

Type of food

The carbohydrate foods most suited to pre-exercise eating are choices that are low-fat, low-fibre and low-moderate in protein; these are less likely to cause gastrointestinal upset. Liquid meal supplements (such as PowerBar ProteinPlus Powder Drink) or carbohydrate-containing sports bars (such as PowerBar Performance Bar) can be useful for athletes who suffer from pre-event nerves or an unpredictable pre-event timetable.

Consuming low GI foods has been proposed as a clever pre-event strategy for endurance events. GI is a measure of the blood glucose response following ingestion of carbohydrate-containing foods. Foods with a high GI are digested and absorbed more rapidly by the body, delivering glucose quickly into the bloodstream. Foods with a low-GI are digested and absorbed more slowly, resulting in a gradual release of glucose. It is thought that low-GI foods might reduce the sudden increase in blood glucose levels prior to an event, and prevent the subsequent drop in blood glucose once exercise is commenced. In addition, a low-GI pre-event meal might provide a continued supply during the exercise session.

In general, studies have failed to show a universal benefit to performance from consuming low-GI foods prior to exercise. When carbohydrate is consumed during exercise according to sports nutrition guidelines, any effect of consuming low-GI foods in the pre-event meal is negated. When fuel cannot be consumed during a prolonged exercise session, some athletes may derive benefits by consuming a low-GI pre-event meal. However, for most occasions, the athlete can choose the foods consumed in their pre-event meal based on personal preference, availability and gastrointestinal comfort.

Examples of low-GI foods (GI value <55)

Pasta served with a mixed bean pasta sauce
Vegetable curry made with vegetables and lentils
Fresh fruit, such as apples and oranges
Full-cream or low-fat yoghurt
Fruit smoothie made with milk and/or yoghurt
Wholegrain sandwich made with Burgen® Soy and Linseed bread
Breakfast cereal (such as All-Bran® Fruit ‘n Oats) plus low fat milk
Stir-fry of lean meat and vegetables served with boiled Basmati rice

Fluid requirements

Dehydration causes fatigue, impaired muscle endurance, reduced gastric emptying and impaired mental functioning. Fluid deficits as little as 2 per cent body mass may cause measurable impairments in performance and the degree of impairment increases directly in proportion to the fluid deficit. Even with model drinking practices, athletes find it difficult to keep pace with rates of fluid loss during exercise. A key strategy to minimise the effects of dehydration is to correct any fluid deficit before commencing exercise.

In normal circumstances, thirst is a sufficient stimulus for adequate fluid intake. However, when following a heavy training schedule, especially in challenging environmental conditions, athletes need to be more aggressive with fluid intake. Hyperhydration (with or without glycerol) may be warranted in some cases. This should always be planned and monitored with the aid of an experienced sports science professional.

Most athletes can tolerate a large amount of fluid immediately before exercise (about 5ml per kilogram body weight or 300–400ml) and then adopt a pattern of consuming small, frequent amounts of fluid during exercise. While water is suitable for adequate hydration prior to shorter events, the use of sports drinks may assist in meeting both fluid and carbohydrate needs before longer events.

Reading list

Hargreaves M. Pre-exercise Nutritional Strategies: Effects on Metabolism and Performance. *Canadian Journal Applied Physiology*, 2001; 26: S64–70.

Hawley JA and Burke LM. Effect of meal frequency and timing on physical performance. *British Journal of Nutrition*, 1997; 77: S91–103.

Gisolfi C. Fluid balance for optimal performance. *Nutrition Reviews*, 1996; 54(4): S159–67.

Moseley L, Lancaster GI and Jeukendrup AE. Effects of timing of pre-exercise ingestion of carbohydrate on subsequent metabolism and cycling performance. *European Journal of Applied Physiology*, 2002; 88: 453–8.

Walsh RM, Noakes TD, Hawley JA and Dennis SC. Impaired high-intensity cycling performance time at low levels of dehydration. *International Journal of Sports Medicine*, 1994; 15(7): 392–8.

DURING EXERCISE



Foods and drinks consumed during exercise have the potential to reduce the negative effects of fluid or fuel deficits that might otherwise occur. The plan for such intake should be constructed with consideration of pre-exercise preparation, the duration and intensity of the exercise, and the practical opportunities for eating and drinking during the session.

Fluid

When exercise extends beyond approximately 30 minutes, there may be a need and opportunity to consume fluid during the session to counteract sweat losses. Fluid needs are specific to each individual and are influenced by factors such as exercise intensity, body size, individual metabolism, environmental conditions and acclimatisation. Typically, across a range of sports, athletes appear to drink fluids to replace 30–70 per cent of their losses. Ideally, athletes are encouraged to drink sufficient fluid to keep pace with rates of sweat loss or at least to maintain fluid losses at less than 2 per cent of pre-exercise body weight. This requires monitoring individual fluid balance (see box) during training and competition sessions and developing a plan to better match fluid losses in subsequent sessions. A typical fluid intake plan might see an athlete drinking **400–1000ml per hour**, however this should be individualised through monitoring and practice.

When sweat losses are high (>800ml) it becomes difficult to consume fluid at rates that fully replace these losses. In some situations, it is not practical to match sweat rates, as the nature of the sport means that the effort to drink causes more disadvantage than the benefits gained from reducing the fluid deficit. Fluid intake needs to be a trade-off between how much fluid can be managed and tolerated and the potential benefit to performance. Gastric emptying rates, individual tolerance and drinking opportunities all influence the amount of fluid that can be consumed comfortably during exercise. Fluid intake during exercise is likely to be better tolerated when small amounts are consumed at frequent intervals rather than trying to guzzle larger amounts on a few occasions.

Excessive drinking can cause a life-threatening condition called hyponatraemia. This occurs when there is a dilution of the normal concentration of sodium in the blood, and is associated with symptoms such as confusion, headaches, fatigue and coma. Hyponatraemia is not common but can occur in prolonged (>2–3 hours) endurance events such as marathons and Ironman-distance triathlons when individuals drink in excess of their rates of sweat loss.

Those most at risk of hyponatraemia are small athletes with low rates of sweat loss (that is, low-moderate exercise intensity) who consume large amounts of sodium-free fluids. Since there is no benefit to overhydrating during an event, athletes are now warned against drinking fluid at rates in excess of their sweat losses. This provides an additional reason for the athlete to monitor their unique rates of sweat loss over a range of their sporting activities and develop fluid intake plans accordingly.

Fluid balance and sweat loss calculations

Step 1: Change in body mass - Measure body mass before exercise in minimum clothing (eg 60kg) and immediately after exercise in same clothing towel dried (eg 58kg).

Step 2: Fluid intake - Measure mass or volume of drink bottle/s before exercise (eg 800ml) and immediately after exercise (eg 300ml).

Step 3: Urine or toilet losses - Measure difference in mass before and after going to the toilet.

Calculations:

1. Fluid deficit(ml) = Change in body mass from before to after exercise x 1000 (eg 60kg-58kg=2kg x 1000 = **2000ml**
2. Fluid intake(ml) = Change in mass of fluid bottle from before to after exercise (eg 800ml-300ml=**500ml**)
3. Urine losses(ml) = Change in body mass before and after toileting x 1000 (eg 59kg-58kg=1kgx1000=**1000ml**)
4. Total sweat loss = Fluid deficit (ml) + Fluid intake (ml) - urine losses (ml) (eg 2000ml+500ml-1000ml= 1500ml sweat loss).
5. Hourly sweat rate = Simply divide total sweat loss during exercise by the duration of the exercise.
6. % dehydration = Total fluid deficit (kg) divided by pre-exercise mass (kg) x 100 (eg 2/60x100=3.3%).

Any weight loss reflects a mismatch between fluid intake and fluid loss during exercise. A deficit of one kilogram indicates that you have failed to replace approximately one litre of fluid during exercise.

DURING EXERCISE

Commercially available sports drinks (4–8 per cent carbohydrate, 10–25mmol/L sodium) promote effective rehydration during exercise and simultaneously deliver an additional source of fuel for the muscle and brain. The inclusion of sodium and flavouring in sports drinks has been shown to improve voluntary fluid intake, making it easier for athletes to achieve fluid intake goals. Water can be a suitable choice in lower-intensity exercise or exercise lasting less than 60 minutes.

Carbohydrate

Many studies have shown that consumption of carbohydrate during prolonged (>60–90 minutes) exercise enhances endurance and performance. More recently, carbohydrate intake has also been shown to benefit performance during shorter (~60 minutes) events and 'stop and go' intermittent sports such as tennis and soccer. The performance benefit may occur due to sparing of muscle glycogen stores, the prevention of low blood-glucose levels (hypoglycaemia) or effects on the central nervous system that are not well explained as yet. The benefits can translate into faster race times, a delay in the onset of fatigue towards the end of the event, ability to cover more ground at faster speeds in the last half or quarter of a game, and better maintenance of skills and concentration right to the final siren.

The optimal rate of carbohydrate ingestion during exercise is unknown. However, in events lasting longer than 60 minutes, athletes are encouraged to consume carbohydrate at a rate of **30–60g per hour**. Experimentation in training or less important events may allow the athlete to finetune this plan for their specific needs and opportunities. It makes sense for refuelling during the event to start well before fatigue is experienced and before a fluid deficit can build to a level where gastric emptying is reduced.

The effects of consuming fluid and carbohydrate during exercise are additive. A variety of options exist for carbohydrate intake, however sports drinks offer a convenient strategy for meeting fluid and carbohydrate needs simultaneously. If other carbohydrate choices are used, care should be taken to consume adequate amounts of fluid.

Application to sport

Guidelines for endurance sports (for example, long-distance running, cycling, triathlon)

Strategies for refuelling and rehydration during these sports need to be individualised for each event and each athlete. Assessment of likely sweat losses and the general guidelines for carbohydrate intake during prolonged exercise provide a starting point for experimentation. Supplies may be provided at aid stations or may need to be carried by the athlete.

Examples of how to meet both carbohydrate and fluid requirements per hour of moderate intensity exercise lasting longer than 60 minutes.

750ml sports drink	(CHO ~ 50g)
400ml sports drink, 400ml water, and 1 PowerBar PowerGel	(CHO ~ 50g)
1000ml water with 1 PowerBar Performance bar, or a banana and 1 PowerBar PowerGel	(CHO ~ 40–50g)
Longer events, such as Ironman triathlon or multi-discipline adventure races, may allow for the inclusion of a greater variety of food options such as a sandwich (made with vegemite, honey or jam), instant soup, PowerBar ProteinPlus drink or degassed soft drink.	

Team sports (for example, netball, AFL, soccer, basketball, waterpolo)

Opportunities to drink are usually limited to breaks in play and at half or quarter time. Each person should have their own drink bottle and monitor their weight before and after games (and training) to get an understanding of their fluid losses. Sports drinks provide a convenient means to meet fluid and carbohydrate needs simultaneously during exercise. Some team sport athletes, particularly those drinking water during the game, may benefit from consuming a PowerBar PowerGel at half-time as an easily digested, immediate source of carbohydrate.

DURING EXERCISE

Power and aesthetic sports (for example, gymnastics, rowing, boxing, judo)

The priority for these sports is to ensure good nutrition throughout day-to-day training and to prepare well for competition. Due to the short nature of the competitive events, it is usually impractical and unnecessary to take in food or fluids during exercise.

Athletes involved in these sports are often required to compete in several events throughout the day. In this situation, athletes need to plan their food and fluid intake in order to maintain adequate fuel and fluid stores, while avoiding any gastrointestinal discomfort.

Cramping, stitch and gastrointestinal comfort

The causes of cramping and stitch during exercise are still largely unknown. Some things to consider are:

1. Timing of fluid intake — start drinking early in exercise, as this is better tolerated when the fluid deficit is still small. Frequent intake of small amounts of fluid is likely to be better tolerated than large amounts of fluid.
2. Fluid type — large amounts of concentrated carbohydrate drinks (>8 per cent) may cause gastric discomfort or cramping.
3. Fibre — lower-fibre options of food are typically digested and absorbed more readily during exercise



Sydney University Boat Club Members

Reading list

Below PR, Mora-Rodriguez R, Gonzalez-Alonso J and Coyle EF. Fluid and carbohydrate ingestion independently improve performance during 1 h of intense exercise. *Medicine and Science in Sports and Exercise*, 1995; 27: 200–10.

Convertino VA, Armstrong LE, Coyle EF, Mack GW, Sawka MN, Senay LC Jr and Sherman WM. American College of Sports Medicine position stand: exercise and fluid replacement. *Medicine and Science in Sports and Exercise*, 1996; 28: i–vii.

Jeukendrup AE and Jentjens R. Oxidation of carbohydrate feeding during prolonged exercise: current thoughts, guidelines and directions for research. *Sports Medicine*, 2000; 29: 407–24.

McGregor SJ, Nicholas CW, Lakomy HK and Williams C. The influence of intermittent high-intensity shuttle running and fluid ingestion on the performance of a soccer skill. *Journal of Sports Sciences*, 1999; 17: 895–903.

Nicholas CW, Tsintzas K, Boobis L and Williams C. Carbohydrate-electrolyte ingestion during intermittent high-intensity running. *Medicine and Science in Sports and Exercise*, 1999; 31: 1280–6.

Rehrer NJ, Wagenmakers AJ, Beckers EJ, Halliday D, Leiper JB, Brouns F, Maughan RJ, Westerterp K and Saris WH. Gastric emptying, absorption, and carbohydrate oxidation during prolonged exercise. *Journal of Applied Physiology*, 1992; 72: 468–75.

RECOVERY



Post-exercise recovery is an important challenge for many athletes. Optimal recovery can enhance adaptations to training and help prepare for the next workout. In competitions involving a series of games or races, recovery is important for good performances in the subsequent and final bouts. Recovery nutrition incorporates a range of nutrition-related processes, including:

- refuelling/restoring muscle and liver glycogen stores
- repair, regeneration and adaptation of muscle tissue following the damage caused by exercise
- rehydration and replacement of fluid and electrolytes lost in sweat.

A number of factors can interfere with recovery strategies in both the training and competition phases. These include fatigue, loss of appetite, poor access to foods, post-exercise commitments such as team debriefings and injury treatments, and traditional post-exercise celebratory activities. A planned approach ensures recovery needs are taken care of, despite this array of distractions.

Refuelling post-exercise

It may take up to 24 hours for restoration of muscle glycogen levels when stores are fully depleted. Several strategies have been investigated to speed up the replenishment of glycogen stores. These include altering the frequency of carbohydrate ingestion, manipulating the type of carbohydrate consumed and combining carbohydrate with other nutrients. While these factors can fine tune the rate of glycogen storage, the most important factor in the process is the amount of carbohydrate consumed.

Special tactics are needed if there is **less than eight hours** between exercise sessions (for example, when the athlete trains more than once each day or where a tournament is played over a single day). This is especially important following glycogen-depleting exercise such as a prolonged session of endurance training or intermittent work such as in team sports. Aggressive refuelling should be undertaken so that carbohydrate stores are adequate for the subsequent exercise session. Current research suggests that optimal refuelling occurs when **1–1.5g of carbohydrate per kilogram body mass is consumed every hour** in the early stages of recovery, contributing to a total carbohydrate intake of 6–10g per kilogram body mass over 24 hours.

These guidelines are based on achieving maximal glycogen storage during a passive recovery period. Athletes with extremely high workloads may require additional carbohydrate. Athletes who do not fully deplete glycogen stores in their daily training will require less. Athletes with smaller energy budgets will need to incorporate recovery eating into their normal meal pattern in order to avoid over-consumption of kilojoules. When the recovery period is longer than eight hours, aggressive refuelling is not necessary and athletes can consume their carbohydrate intake targets within their usual meal schedule.

Muscle repair and regeneration post-exercise

Consuming protein in recovery snacks or meals enhances post-exercise protein synthesis. This is certainly important in promoting an increase in muscle mass and strength following resistance training. It may also enhance repair and adaptations following other types of exercise. Further studies are needed to determine the amount, type and timing of protein required for optimal effects. However, substantial enhancement of post-exercise protein synthesis can be achieved by consuming 3–6g of essential amino acids. This can be obtained from **10–20g of high quality protein.**

RECOVERY

Recovery snack options providing approximately 60g of carbohydrate and 10g of protein:

300ml milk shake or fruit smoothie
500ml low-fat milk
300ml PowerBar ProteinPlus Powder Drink
PowerBar Performance bar or ProteinPlus Bar and 250ml sports drink
1½–2 cups of breakfast cereal with ½ cup of low fat milk
1 sandwich with lean meat/cheese/chicken filling and a piece of fruit
1 cup of fruit salad with a 200g tub of low-fat fruit yoghurt
200g tub of low-fat yoghurt or a 300ml flavoured milk and 1 cereal bar

Extra hints for recovery snacks and meals

- If appetite is reduced or gastric discomfort occurs after exercise, choose foods that are compact sources of carbohydrate and protein. Liquids, lower-fibre foods and sports foods such as PowerBar Performance and PowerBar ProteinPlus bars can be useful in this situation.
- Carbohydrate-rich fluids are a good choice to simultaneously address fluid and fuel needs. Sports drinks, soft drinks and fruit juice provide an easily consumed source of carbohydrate. Liquid meal supplements (for example, PowerBar ProteinPlus Powder Drink mixed with low-fat milk or water), flavoured milk shakes and smoothies provide an all-round approach to recovery by contributing substantial amounts of protein as well as carbohydrate.
- Athletes with a restricted energy budget (such as gymnasts, lightweight rowers, boxers) should make sure their post-exercise recovery snacks do not contribute unwanted energy to their daily intake. Instead of consuming extra food in the day, recovery eating can be achieved by arranging training and meal times for a more strategic 'fit'. For example, meals should be arranged so that they are consumed straight after exercise. Alternatively, a part of the meal can be saved and consumed as a small post-exercise snack.
- Research has indicated that moderate to high GI carbohydrate foods may be better choices for fast glycogen replenishment.
- Small, frequent meals and snacks can help meet energy requirements without the discomfort of feeling too full.
- Always plan ahead to ensure that appropriate recovery snacks are available for

consumption after training sessions and competition events. It is often best to pack your own supply of well-chosen foods and drinks.

Rehydration

Since most athletes can expect to be mildly dehydrated at the end of an exercise session, restoring fluid balance is a priority for recovery. Ideally, fluid deficits incurred during one exercise bout should be corrected before commencing the next exercise session. When fluid losses are high (for example, greater than two litres), thirst is unlikely to be sufficient to encourage adequate intake of fluid. Instead, a strategic drinking strategy is required. Of course, fluid losses continue throughout the recovery period due to urine losses and ongoing sweating. Therefore, a volume equal to 150 per cent of the fluid deficit may need to be consumed over the 2–4 hours post-exercise to fully rehydrate.

Cool (15^{o}C) flavoured drinks have been shown to increase voluntary fluid intake. Carbohydrate-containing drinks are useful in simultaneously assisting with refuelling goals. Sports drinks, cordial, juice and soft drinks may be better options than water in terms of palatability and fluid retention. The inclusion of sodium in beverages enhances rehydration by reducing urine output as well as by increasing intake. For modest fluid losses, sports drinks (10–25mmol/L sodium) are adequate. When fluid losses are high (greater than two litres), sodium intakes of 50–80mmol/L may be required to better replace the electrolytes lost in sweat. This can be achieved with the use of commercial oral rehydration solutions (for example, Gastrolyte) or including salty foods in recovery snacks and meals.

Caffeine-containing fluids (such as cola drinks, tea, coffee) and alcoholic beverages are generally not considered to be ideal rehydration choices as they increase diuresis (urine losses). However, a recent review indicates that the diuretic effect is overstated particularly in habitual caffeine users. If caffeine-containing drinks are well-liked, it is probable that any increase in urine loss that occurs due to the caffeine is more than compensated for by the increased volume of intake.

Alcohol and recovery

Heavy alcohol intake is discouraged in the recovery period. Alcohol may directly affect physiological processes such as rehydration and glycogen storage, delay repair of soft tissue damage and distract the athlete from following guidelines for optimal recovery nutrition. Athletes who choose to drink alcohol should first attend to their recovery nutrition needs (carbohydrate and protein food, plus replacing lost fluids) before alcohol is consumed. No alcohol should be consumed for 24 hours if a soft tissue injury has been suffered.

RECOVERY

Case study: Sydney Swans and PowerBar ProteinPlus bars

Players from the Sydney Swans AFL club train numerous times per week. Training sessions consist of football-specific skills sessions, endurance work and weight training sessions. Increasing lean muscle mass and strength is one of the major goals for most players in the pre-season period. Maintaining this strength and muscle is then important throughout the season.

Players who were identified as needing to increase lean muscle mass were provided with individualised nutrition plans to complement their weight session goals. A key strategy for these players was to consume a snack providing both carbohydrate and protein immediately after weight training. In the past, a variety of recovery snack options had been tried. As a new strategy, the Swans were given access to the PowerBar range of products. They selected PowerBar ProteinPlus bars as an ideal post-weights snack, rating the taste and convenience of this product highly. They were able to use the bars to provide a nutritional recipe for refuelling and muscle growth.

Having access to the right type of recovery fuel means that the Swans players are on the right path to build and maintain their muscular strength and mass throughout the long footy season.



Sydney Swans reaping the rewards of PowerBar.

Reading list

Armstrong LE. Caffeine, body fluid-electrolyte balance, and exercise performance. *International Journal of Sports Nutrition and Exercise Metabolism*, 2002; 12: 189–206.

Borsheim E, Tipton KD, Wolf SE and Wolfe RR. Essential amino acids and muscle protein recovery from resistance exercise. *American Journal of Physiology Endocrinology and Metabolism*, 2002; 283: E648–57.

Burke LM, Kiens B and Ivy JL. Carbohydrates and fat for training and recovery. *Journal of Sports Sciences*, 2004; 22: 15–30.

Burke LM, Collier GR and Hargreaves M. Muscle glycogen storage following prolonged exercise: effect of the glycaemic index of carbohydrate feedings. *Journal of Applied Physiology*, 1993; 75: 1019–23.

Burke LM, Collier GR, Broad EM, Davis PG, Martin DT, Sanigorski AJ and Hargreaves M. Effect of alcohol intake on muscle glycogen storage after prolonged exercise. *Journal of Applied Physiology*, 2003; 95: 983–90.

Coyle EF. Timing and method of increased carbohydrate intake to cope with heavy training, competition and recovery. *Journal of Sports Sciences*, 1991; 9: 29–52.

Maughan RJ and Leiper JB. Sodium intake and post-exercise rehydration in man. *European Journal of Applied Physiology*, 1995; 71: 311–19.

Shirreffs SM, Armstrong LE and Cheuvront SN. Fluid and electrolyte needs for preparation and recovery from training and competition. *Journal of Sports Sciences,* 2004; 22: 57–63.

Tipton KD, Borsheim E, Wolf SE, Sandford AP and Wolfe RR. Acute response of net muscle protein balance reflects 24-h balance after exercise and amino acid ingestion. *American Journal of Physiology Endocrinology and Metabolism*, 2003; 284: E76–89.

IMMUNE FUNCTION



Kate Bates - National, Oceania, Commonwealth, Cycling Champion.

Nutrition strategies to boost immune function in athletes

Athletes undertaking regular strenuous exercise walk a knife-edge between extreme physical wellbeing and impaired immune function. Research indicates that athletes are at increased risk of upper respiratory tract infection during periods of heavy training and 1–2 weeks following competitive events. This increased risk is most likely due to the immunosuppressive actions of stress hormones such as adrenaline and cortisol.

Many athletes turn to supplements to boost their immune system. However, research indicates that immune suppression is multifactorial and no one supplement will address the problem. The athlete should try a range of useful strategies:

- Manage training loads and daily physical activity associated with work and other routine activities.
- Manage psychological stress including stress associated with work, family, training and competition.
- Incorporate sufficient rest.
- Minimise exposure to germs and bugs by practicing good hygiene.
- Ensure adequate (quality) sleep.

- Maintain (or for some athletes, introduce) a diet providing adequate fuel for training and recovery, with a good mix of essential nutrients.

Despite the heavy reliance of athletes on nutritional supplements, there is currently a lack of evidence to support benefits from high doses of antioxidant vitamins, glutamine supplementation or echinacea extracts in preventing exercise-induced immune suppression and providing protection from infection. However, critical factors for the maintenance of optimum immune function include an adequate dietary intake of carbohydrate, protein and specific micronutrients including vitamins A, C, E, B6 and B12, and iron, zinc, copper and selenium. Higher doses of these nutrients have not been shown to offer any advantage over what can be provided by a well-chosen diet. Current opinion is that athletes should invest in nutrient-rich foods and fluids that provide energy, a wide range of vitamins, minerals and other important substances, such as phyto-chemicals, found naturally in foods.

A low carbohydrate intake is thought to contribute to immunosuppression via increased production of stress hormones and depletion of glucose, which is a key substrate for immune cells. Research indicates that consuming adequate carbohydrate in the days preceding strenuous exercise acts as an effective counter-measure to the suppression in immune function that occurs post-exercise. Matching carbohydrate intake with daily fuel requirements is a key strategy to protect immune function following prolonged strenuous exercise.

Reading list

Gleeson M, Nieman DC and Pedersen BK. Exercise, nutrition and immune function. *Journal of Sports Sciences*, 2004; 22: 115–25.

Lancaster GI, Khan Q, Drysdale P, Jeukendrup AE, Drayson MT and Gleeson M. Effect of feeding different amounts of carbohydrate during prolonged exercise on human T-lymphocyte intracellular cytokine production. *Journal of Physiology*, 2004; 548P: 98.

Nieman D. Potential nutritional countermeasures to exercise-induced immunosuppression. European College Sports Science, Salzburg, Austria, 2003.

Nieman DC, Johanssen LM, Lee JW and Arabatzis K. Infectious episodes in runners before and after the Los Angeles Marathon. *Journal of Sports Medicine and Physical Fitness*, 1990; 30: 316–28.

Pyne DB, Gleeson M, McDonald WA, Clancy RL, Perry C Jr and Fricker PA. Training strategies to maintain immunocompetence in athletes. *International Journal of Sports Medicine*; 2000: S51–60.

DIETARY SUPPLEMENTS



Supplements are appealing to athletes looking to gain an edge over competitors. Throughout the world, the supplement industry is poorly regulated and athletes are ambushed with tantalising yet unsubstantiated claims. Athletes need to look for supplements that have been investigated by well-controlled research, are a reasonable cost and have a low risk of negative outcomes, including doping offences.

Supplements can be divided into three groups:

- specialised sports foods that address special nutritional needs of athletes
- vitamin and mineral supplements
- nutritional ergogenic aids that offer a direct physiological benefit to exercise performance or recovery.

Sports foods

Sports foods such as sport drinks, bars, gels and liquid meal supplements offer practical and convenient options to help athletes meet their special nutritional needs. When used appropriately, these products are a useful addition to the nutrition program of many athletes. Care should be taken when using these products to ensure they are free from high-risk ingredients that might lead to an anti-doping rule violation.

PowerBar has made a commitment to have their products involved in the Supplement Information Scheme coordinated by the Australian Sports Drug Agency, Australian Institute of Sport and Australian Goverment Analytical Laboratories. This scheme assesses the doping risk of sports foods and supplements. Many manufacturers have not made a commitment to have their products assessed by the Supplement Information Scheme. Athletes need to be aware that all supplements carry a doping risk and athletes are personally responsible to ensure any products they choose to use do not contain banned or harmful substances. In particular, care should be taken when purchasing products overseas. Athletes should be aware of the dangers of potential contamination of supplements and of the significant effect of the principle of strict liability - athletes are ultimately responsible for substances found in their bodies and ignorance is no excuse. Further information is available via the Australian Sports Drug Agency website (www.asda.org.au).

Vitamins and minerals

Regular, prolonged strenuous exercise may result in an increased dietary requirement for certain vitamins and minerals. However, if the daily energy intake is high and a well-chosen diet is consumed, supplementation is not necessary, unless a specific deficiency is identified.

Calcium

Calcium is important for strong bones and teeth. The best sources of calcium are dairy products, as well as calcium-fortified foods (such as soy milk, bread and juice), canned fish with bones, green leafy vegetables, nuts and tofu.

Iron

Iron is a key component of haemoglobin in red blood cells that helps transport oxygen through the blood. Inadequate iron stores can result in fatigue, loss of performance and anaemia. The best sources of iron include lean red meat, chicken, fish, eggs, fortified breakfast cereals, green leafy vegetables, spinach, whole grains and legumes.

Supplementation with a vitamin/mineral supplement may be useful in a number of situations or for certain athletes. These include situations in which food intake is severely restricted in either quantity or variety (for example, extreme weight loss practices, elimination of one or more food groups from the diet, food intolerances and picky eating). Travel may also limit the variety and adequacy of food choices. In all cases, dietary inadequacy needs to be simultaneously addressed through improvements in food selection.

DIETARY SUPPLEMENTS

Nutritional ergogenic aids

Despite convincing claims and promise of sporting greatness, few nutritional ergogenic aids are supported by credible science or evidence of positive outcomes. Performance is the result of many factors, including talent, training, equipment, diet and mental attitude.

Nutritional ergogenic aids should be used with caution, and only after careful evaluation of the product for safety, efficacy, potency and whether or not it contains a banned substance. There is limited evidence to support the use of most ergogenic aids. Creatine, bicarbonate, glycerol and caffeine may be beneficial in some circumstances.

The Australian Institute of Sport has a well-established program that provides information to athletes to ensure that supplements and sports foods are used appropriately, and that supplement use does not lead to an inadvertent anti-doping rule violation.

The program includes a categorisation of sports supplements and ergogenic aids based on the level of scientific support currently accumulated:

- Group A includes products where scientific support exists for performance enhancement or for a role in assisting the athlete to meet their nutritional goals. It is noted that these performance benefits are limited to specific uses — particular athletes in certain situations or types of events.
- Group B includes products that are still under scientific scrutiny to assess their benefits or practical uses.
- Group C includes products with minimal proof of beneficial effects.
- Group D includes products containing banned substances that should not be used by competitive athletes.

For more information on the AIS Supplement Program, go to the AIS Department of Sports Nutrition web site (www.ais.org.au/nutrition) and click through to the section on supplements in sport.

Alternatively, the Australian Sports Drug Agency (www.asda.org.au) web site also contains information about various supplements in addition to procedures and protocols involved with drug testing.

Reading list

Burke L. Sports supplements and sports foods. In *Physiological Bases of Sports Performance* edited by M Hargreaves and J Hawley, 2003: 183–253. Sydney Australia: McGraw–Hill.

Fogelholm M. Vitamin, mineral and antioxidant needs of athletes. In *Clinical Sports Nutrition* edited by L Burke and V Deakin, 2000: 312–40. Sydney, Australia: McGraw–Hill.

POWERBAR PRODUCT RANGE



PowerBar Performance bar

PowerBar Performance bars are specially formulated with valuable amounts of carbohydrate, protein and fat, plus vitamins and minerals that help maintain energy production.

PowerBar Performance bars contain:

- At least 40g of carbohydrate to provide fuel for your brain and working muscles
- 10g of high quality protein
- Approximately 30–90 per cent of the recommended daily intake for 15 vitamins and minerals.

Recommended uses by the AIS Department of Sports Nutrition

- Snack — Suitable for athletes with high-energy requirements (for example, athletes undertaking a heavy training load, adolescent athletes undergoing a period of growth, or strength or power athletes training to increase muscle mass). Also a convenient, portable snack for athletes with a busy lifestyle.
- Pre-exercise — Low residue (fibre), carbohydrate-rich pre-exercise snack. Useful as part of a pre-event meal for athletes at high risk of gastrointestinal problems during exercise. Provides a source of fuel prior to prolonged workouts.
- During exercise — Portable, convenient source of carbohydrate. Can help satisfy hunger during prolonged training sessions and competitive events (for example, road cycling).
- Post-exercise — Convenient, portable source of carbohydrate and other nutrients for post-exercise recovery. Provides a reasonable source of protein but may not meet (yet to be determined) goals for optimal protein resynthesis after resistance training. Ideal for refuelling or replacing energy and nutrients following exercise when appetite is suppressed, access to food is limited, or the athlete has minimal time to eat between exercise sessions. Useful between events or in multi-event competition.
- Making weight — Low residue (fibre) source of carbohydrate and micronutrients which can be used by weight-making athletes to replace some meals in the period before weigh-in. By reducing fibre intake, the athlete can reduce the weight of their gastrointestinal contents and overall body mass while still consuming fuel and nutrients.
- Travel — Portable and non-perishable food alternative for travelling athlete who has minimal facilities for food preparation/storage or is travelling to locations where food availability is limited.

Considerations

Bars should always be consumed with adequate fluid to assist digestion/absorption and to help meet hydration needs. If the athlete intends to consume performance bars during a competitive event, this strategy should be practised and assessed during training sessions. Post-exercise use targets post-exercise refuelling and general energy and nutrient replacement. Although the nutritional recipe for optimal post-exercise protein synthesis is yet to be determined, performance bars may not provide sufficient protein to meet the post-exercise needs of resistance training. Food sources should always be considered as the first option for meals and snacks. Overuse may lead to inappropriate replacement of whole foods.

Available in three flavours: Chocolate, Vanilla, and Cappuccino
(Coming soon – Cookies & Cream & Caffeinated Raspberry & Cream)

POWERBAR PRODUCT RANGE



PowerBar ProteinPlus Bar

PowerBar ProteinPlus is scientifically formulated to promote recovery, repair and refuelling after a workout. Targeted to situations where protein synthesis is important.

PowerBar ProteinPlus contains:

- 18g of a high quality Trisource protein blend of whey protein isolate, calcium caseinate and soy protein isolate
- At least 17g of carbohydrates to provide energy.

Recommended uses by the AIS Department of Sports Nutrition

- Snack — Suitable for athletes with high-energy requirements (for example, athletes undertaking a heavy training load, adolescent athletes undergoing a period of growth, or strength or power athletes training to increase muscle mass). Also a convenient, portable snack for athletes with a busy lifestyle.
- Pre-exercise — Provides a source of protein and carbohydrate prior to weight training workouts. Pre-exercise intake of these nutrients may be important to promote recovery and adaptation to the session.
- Post-exercise — Compact, portable source of protein, carbohydrate, and other nutrients for post-exercise recovery. Post-exercise use is targeted to recovery after resistance training workouts and other exercise requiring optimal protein synthesis. Ideal for use when appetite is suppressed following exercise or access to food is limited.
- Travel — Portable, non-perishable food alternative for the travelling athlete who has minimal facilities for food preparation/storage or is travelling to locations where food availability is limited.

Considerations

Food sources should always be considered as the first option for meals and snacks. Overuse may lead to inappropriate replacement of whole foods. Additional source of carbohydrate may be needed for post-exercise situations where refuelling is important. Higher energy content may not be suitable for all athletes.

Available in three flavours: Chocolate Fudge Brownie, Vanilla Yoghurt and Cookies and Cream

POWERBAR PRODUCT RANGE



PowerBar PowerGel

PowerBar PowerGel is a concentrated source of carbohydrate available in an easy-to-eat format that is quick to digest.

PowerBar PowerGel contains:

- At least 26g of carbohydrate

Recommended uses by the AIS Department of Sports Nutrition

- Pre-exercise — Low-fibre, convenient form of fuel for athletes who are unable to tolerate normal foods and fluids.
- During exercise — Convenient form of carbohydrate to provide fuel during endurance exercise lasting longer than 60 minutes, or during breaks in extended training or competition sessions for team sports.
- Post-exercise — Provides an easily consumed form of carbohydrate when regular foods cannot be tolerated by the athlete.

Considerations

PowerBar PowerGel should always be consumed with adequate fluid to assist digestion/absorption and to help meet hydration needs. If the athlete intends to consume PowerBar PowerGel during a competitive event, this strategy should be practised and assessed during training sessions. During prolonged exercise (>2–3 hours) additional sodium from sources such as sports drinks or food may be required.

Available in three flavours: Chocolate, Vanilla and Tropical Fruit

POWERBAR PRODUCT RANGE



PowerBar ProteinPlus Powder Drink

PowerBar ProteinPlus Powder Drink provides a convenient form of energy, with a supply of essential macro and micronutrients. Easily prepared and versatile, it can be mixed with water or low-fat milk, combined with other ingredients such as ice cream, yoghurt and fresh fruit to make a smoothie, or added to foods such as breakfast cereal.

A 250ml serve of PowerBar ProteinPlus Powder Drink, when made up with water according to instructions, provides:

- 43g of carbohydrate
- 15g of protein
- Approximately 25–50 per cent of the recommended daily intake of 17 vitamins and minerals

Recommended uses by the AIS Department of Sports Nutrition

- Snack — Suitable for athletes with high-energy requirements (for example, athletes undertaking a heavy training load, adolescent athletes undergoing a period of growth, or strength or power athletes training to increase muscle mass). Also a convenient, portable snack for athletes with a busy lifestyle.
- Pre-exercise — Low residue (fibre), carbohydrate-rich pre-exercise snack. Useful as part of a pre-event meal for athletes at high risk of gastrointestinal problems during exercise. Provides a source of fuel prior to prolonged workouts. Pre-exercise intake of protein and carbohydrate may be important to promote recovery and adaptation to the session.
- Post-exercise — Convenient, portable source of carbohydrate, protein and other nutrients to assist post-exercise recovery. According to the needs of the situation, drinks can be formulated to target both refuelling and post-exercise protein synthesis. Ideal for use when appetite is suppressed following exercise or where access to food is limited.
- Making weight — Low residue (fibre) source of carbohydrate, protein and micronutrients which can be used by weight-making athletes to replace some meals in the period before weigh-in. By reducing fibre intake, the athlete can reduce the weight of their gastrointestinal contents and overall body mass while still consuming fuel and nutrients.
- Travel — Portable, non-perishable, easily prepared meal or snack that provides energy, carbohydrate, protein and a source of micronutrients. Useful for travelling athlete who has minimal facilities for food preparation/storage, or when travelling to countries with an inadequate or inaccessible food supply, or problems with food hygiene.

Considerations

Food sources should always be considered as the first option for meals and snacks. Overuse may lead to inappropriate replacement of whole foods.

NOTES


-Josh Cox
Marathoner
2001 World Championships
PowerBar user since 1994
"In running there is no off-season, because running isn't just a sport, it's a lifestyle."
PowerBar
Be great.
OFFICIAL SUPPLIER
AUSTRALIAN INSTITUTE OF SPORT
A program of the Australian Sports Commission
PowerBar
Be great.
www.powerbar.com.au

