Food selection and guidance for physically active people

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The everyday nutritional goals of athletes and physically active people reflect the special, and often increased, nutrient requirements arising from the commitment to regular exercise, as well as the practical challenges of achieving these goals in a busy lifestyle. Issues include achieving and maintaining a body weight and body fat level that is appropriate for optimal sports performance and health, as well as meeting increased requirements for protein and some micronutrients such as iron and calcium. While inadequate intakes of vitamins will impair exercise importance, the current view is that additional vitamin supplementation will not improve exercise performance. Attention to fluid and carbohydrate intake will be an important factor in exercise performance and recovery from exercise, particularly high intensity exercise which is carried out in hot conditions for prolonged periods. Guidelines to promote optimal fuel and fluid status include strategies before, during and after exercise. The dietary guidelines of many developed countries which emphasise dietary variety, based on high-carbohydrate, reduced-fat eating, provide an appropriate blue-print for the athletes diet'. Since sportspeople are well recognised and often hero-worshipped within the community, they provide a worthy example of the potential benefits of a well-chosen diet.

Introduction

The nutritional needs of the athlete reflect the physiological stresses resulting from high level exercise, both in training and competition, as well as the practical issues involved in their unusual lifestyle. While these factors are most extreme at the elite levels of sports participation, they must still be considered in the case of the much larger number of committed recreational athletes and physically active people. In this paper the basic or everyday nutrition needs of physically active people will be discussed; this is often termed "the training diet". Although much publicity is directed towards special nutritional strategies that are undertaken to aid competition performance, it is actually the training program that largely determines the nutritional needs of most athletes, since it is the predominant influence on energy expenditure as well as lifestyle and dietary practices. Specific nutritional needs will vary between individuals according to the type and level of their exercise program; however the following goals are common to all physically active adults:

GOAL 1: To enjoy food and the pleasure of social eating opportunities.

Although the achievement of sports nutrition goals summarised in this article may require some modification of typical dietary patterns (particularly those of affluent countries), this can be done without resorting to extreme dietary changes and the exclusion of all favourite foods. Moderation and variety are key elements in preserving not only nutritional adequacy, but also the pleasures derived from food and eating. Some physically active people are attracted to fad diets and dietary extremism. This problem arises most often in relation to issues of body fatness and improved performance, but is also common in individuals with perfectionist and compulsive personalities who undertake rigid and unvaried diets, in addition to excessive and rigid exercise programs. The area of supplementation lends itself to both extremism and reduced focus on eating food.

GOAL 2: To achieve and maintain an appropriate body weight and body fat level by balancing energy intake and exercise.

Body fatness is an important risk factor in the development of many of the diseases of affluent societies. Regular physical activity is recommended in community dietary guidelines, for its direct effect on energy balance as well as independent effects on coronary heart disease, non-insulin dependent diabetes, hypertension and hyper-triglyceridemia[1]. However, in addition to effects on health and well-being, body fatness plays a role in determining exercise performance in a number of sports. Physically active people who wish to improve their performance or enjoyment in a range of sports and exercise pursuits may look to manipulate physique characteristics such as muscle mass and body fatness.

Sports or exercise in which body mass or body fatness

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are important include those with specific weight divisions for competition (weightlifting, lightweight rowing, boxing, wrestling, judo) and those in which low body mass, and in particular, low body fatness are considered necessary for optimum performance. The advantages of low body fat levels include physical and mechanical gains, whereby decreases in body fat cause an increased "power to weight" ratio, or simply a reduced amount of "dead weight" that must be moved by the individual. This is a particular advantage in exercise such as distance running, triathalons and road cycling where the individual transports their own body weight. However, low body fat levels are also important for values of aesthetics and appearance in sports such as diving, gymnastics and figure skating. For review, see Brownell et al[2].

Although some individuals easily achieve body composition that is suited to their exercise or sport, others may need to manipulate characteristics such as muscle mass or body fat levels through changes in diet and training. It is important that active people can identify suitable and realistic goals, take appropriate measures to achieve the desired changes in a suitable time period, and to have an appropriate means of measuring the results[3]. Measurements of body weight can not distinguish between muscle mass or body fatness, yet many athletes, like members of the general community, often judge the suitability of their size and body composition by this simple measure. Physically active people might be advised that the only valuable use of scales is to determine short-term changes in hydration (by weighing before and after an exercise session), and thus estimate sweat losses that must be replaced. Instead, techniques that assess body fatness such as determination of subcutaneous fat with calipers (the "pinch test") may be used to monitor changes in body composition and help to set desirable levels for individuals.

Loss of body fat by physically active people should be achieved by a gradual program of sustained and moderate energy deficit that results from a decrease in dietary energy intake and, perhaps, an increase in energy expenditure through aerobic exercise or activity. It appears, however, that even elite athletes are as susceptible as members of the general community to myths and programs that offer false "quick weight loss" claims. Guidelines for safe and healthy loss of body fat are summarised in Table 1.

Table 1. Guidelines for fat loss in the physically active person

1. Identify individual "ideal" body fat and body weight targets that are consistent with good health and performance, and are achievable.
2. If loss of body fat is required, plan for a realistic rate loss of about 0.5 kg per week. If a substantial loss is to be undertaken, set both short-term and long-term goals.
3. Examine your current exercise and activity plans. If your training is primarily skill or technique-based, or is based on brief sessions of very high-intensity exercise, then you may benefit from scheduling in some aerobic exercise activities that will encourage fat oxidation. This should always be done in conjunction with your coach. Look also for ways to increase energy expenditure in your daily lifestyle (walking, using stairs, etc.). Many athletes are almost sedentary between training sessions.
4. Keep a food diary for a week so that you can take an objective look at what really goes into your mouth. Many athletes who feel that they "hardly eat anything" will be amazed at their hidden eating opportunities.
5. Reduce your typical energy intake by an amount that is appropriate to produce loss of body fat (500-1000 kcal/ day) but still ensures adequate food and nutrient intake. Do not decrease below 1200-1500 kcal/ day. Achieve energy savings by cutting back on unnecessary energy intake. Do not skip meals; rather spread food intake over the day, particularly to allow for efficient refuelling after training sessions.
6. Combat situations where you generally overeat. Make meals filling by choosing high-fibre forms of foods. Fight the need to finish everything on your plate. Spread food intake over the day so that you do not approach meals feeling extreme hunger.
7. Focus on opportunities to reduce intake of fats and oils. Choose low-fat versions of nutritious protein foods; minimise added fats and oils in cooking and food preparation, and enjoy high fat snack and sweet foods as occasional treats rather than everyday foods.
8. Alcohol and sugar also represent "empty" Calories, and should also be kept to a prudent level in everyday eating plans. Since alcohol intake causes you to relax, it is often associated with unwise eating.
9. Be aware of inappropriate eating behaviour -- such as eating when bored or upset, or eating too quickly. Redirect your stress or boredom to alternative activities.
10. Consult a sports dietitian if you are having difficulties with your weight loss goals or would like a more supervised program.
11. Consider a broad-range low-dose multivitamin/ mineral supplement if you will be consuming a low energy intake (1200-1500 kcal or less) for a prolonged period.

Weight gain -- or more correctly, gain of muscle mass -- is desired by many individuals whose exercise activities are linked to size and strength. Greater strength and power may be valuable in weight lifting or throwing sports, in gymnastics, and also in combative and team games such as football codes. Appearance is important in sports such as body building. Many individuals pursue additional muscle hypertrophy gains through a program of progressive muscle overload. It is important to realise that these gains are only made as a result of the stimulus of muscle overload, commonly known as strength training, resistance training or weight training programs.

The major nutritional requirement to gain muscle mass while undertaking a strength-training program, is additional kilojoules of energy. Additional energy is required for the manufacture of new muscle tissue and other factors needed to support this tissue (additional enzymes, capillaries and red blood cells), as well as to provide fuel for the training program which supplies the stimulus for this muscle growth. The role of protein remains the most controversial aspect of nutrition for muscle gain. Experts on protein metabolism[4] believe that the protein requirements of strength-training athletes (estimated to be 1.2-1.6 g/ kg body weight/ day) are higher than those of sedentary individuals. However, these protein requirements are easily met by the higher energy intakes of physically active

people. Moreover, the value of very high protein intakes in optimising muscle gain remains unsupported[4].

Individuals undertaking strength training programs to increase muscle mass should achieve positive energy balance, principally by increasing intake of a high-carbohydrate diet that will fuel their training sessions[5]. Increased intake of nutritious foods will ensure increased intakes of other important nutrients including protein. Guidelines are provided in Table 2.

Table 2. Guidelines for eating to increase muscle mass for the physically active person

1. Ensure you are following a well-devised weight training program that will stimulate muscle development and growth.
2. Set goals for weight and strength gain that are practical and achievable. Continued increases of 2-4 kg/ month are generally considered a good return for your efforts.
3. Be organised. You will need to apply the same dedication to your eating program that you apply to training. You will need to increase your intake of nutrient dense foods to supply a daily energy surplus of approximately 500-1000 kcal. This additional food should supply carbohydrate to fuel your training sessions, and adequate protein and micronutrients for the development and support of new tissue.
4. Increase the number of times that you eat rather than the size of meals. This will enable greater intake of food with less risk of "overfilling" and gastrointestinal discomfort. This will require a supply of nutritious high-carbohydrate snacks to be available between meals, particularly after training sessions.
5. Increase the energy content of high-carbohydrate foods by adding a little sugar or low-fat protein. For example, add jams and syrups to toast or pancakes, and make two or three layer fillings in sandwiches. This adds extra kilojoules to a nutritious meal, without adding greatly to the bulkiness of the food.
6. Avoid excessive intake of fibre, and make some use of "white" cereals with less bulk (e.g., white rice, white bread). You may find it impossible to chew your way through a diet that is solely based on wholegrain and high-fibre foods.
7. Drink high-energy fluids. Make milkshakes and fruit smoothies, or try commercial liquid meal supplements. These drinks provide a compact and low-bulk source of energy and nutrients, and can be consumed with meals or as snacks, including before or after training sessions.
8. If you feel that you are always eating, yet not gaining weight, it is useful to keep a food diary to document your actual intake. Many athletes do not eat as much – or more importantly, as often -- as they think. Commitments such as training, sleep, medical/ physiotherapy appointments, work or school often get in the way of eating opportunities. A food record will identify the hours and occasions of minimal food intake. You should use this information to reorganise your day, or to find creative ways to make nutritious foods and drinks part of the activity.

GOAL 3: To achieve basic nutrient requirements, including any increase in requirements that arise from a strenuous exercise program.

Whether physically active individuals have increased requirements for protein and micronutrients, and whether increased intakes of these nutrients will improve exercise performance, continue to be points of controversy between and among athletes and sports scientists. It is generally agreed that increased energy intake due to increased energy requirement, in conjunction with a variety of nutritious food choices, will provide the athlete with nutrient intakes well in excess of the population Recommended Dietary Intakes. Individuals at highest risk of inadequate nutrient intake are those with reduced energy intakes (on chronic weight loss or maintenance diets) and those who limit their food variety (with eating disorders or following vegetarian, fad or other restrictive diets).

It is now agreed that individuals undertaking heavy training (strength or endurance) have increased protein requirements in the order of 1.2-1.6 g/ kg/ day, provided that both carbohydrate and energy requirements are also met[4]. However, dietary surveys of a variety of athletic groups show that with increased energy intake, and protein intake at the typical Western level of 12-15% of total energy, there seems little problem in reaching these targets[5].

The present consensus on vitamins is that studies have failed to support a beneficial effect of vitamin supplementation on athletic performance, except in the cases of a pre-existing vitamin deficiency[6,7]. Some individuals, particularly females and those undertaking restrictive diets may benefit from dietary counselling to increase energy intake and/ or dietary variety and thus achieve the full nutrient intake potential from food sources. Nevertheless, problems remain for those who continue to be chronic low-energy consumers. In such cases, supplementation with a low dose broad range vitamin/ mineral supplement may be necessary.

Iron status is crucially involved in exercise performance through the role of iron in oxygen transport (myoglobin and haemoglobin) and in aerobic energy production (cytochromes and other ferro-enzymes). Inadequate iron status may therefore reduce exercise performance[8,9]. There is a lack of consensus between sports scientists on many issues -- for example, the haematological/ biochemical parameters of "optimal iron status", whether iron deficiency without anaemia impairs exercise performance, and how to distinguish reduced iron status from exercise-mediated changes in iron metabolism. Nevertheless, it is conceded that at least some active individuals are at risk of low iron status due to increased iron requirements (to cover menstrual losses, growth, pregnancy), increased iron losses due to exercise (red blood cell trauma, sweat loss of iron, gastrointestinal bleeding), or poor dietary intake of bio-available iron. Strategies to maintain iron status include education to improve dietary iron intake and strategies to reduce excessive iron losses. This should include consumption of iron-rich foods containing the better-absorbed heme iron from animal foods, as well as strategies to increase the availability of poorly absorbed non-heme iron. Consuming ascorbic acid or animal foods at the same meal and reducing absorption-inhibiting factors such as tannin (tea) and phytates (excess bran fibre) will help absorption.

Interest in the calcium status of active females has intensified with recent studies reporting low bone density

and stress fractures in various groups of female athletes[10,11]. However, the concern should widen to include consideration of menstrual function and oestrogen status of these athletes, since proof of a link between secondary amenorrhoea and reduced bone density has strengthened in recent years. Physically active females are encouraged to follow eating and training programs that maintain regular menstrual status; nevertheless all active individuals should consume diets that provide adequate calcium intake.

GOAL 4: To prevent dehydration during exercise by drinking before, during and after exercise.

A considerable amount of the energy expended during exercise is lost as heat, and sweating provides the primary mechanism to dissipate heat and maintain temperature. Sweat rates are determined by factors such as the acclimatisation of the athlete, the intensity of exercise, and environmental conditions, and can be as high as 1-2 litres/ hour. Dehydration is known to impair exercise performance, particularly prolonged exercise in the heat, when fluid losses exceed 2% of body weight[12-14]. For good health, improved performance and enjoyment of exercise, the active individual is advised to drink during exercise to help replace sweat and to fully replace lost fluids after exercise. This is especially important in hot environments and during heavy exercise programs where daily sweat losses may exceed 10 litres. Behavioural strategies will be needed to achieve such goals, since thirst will not be adequate to gauge acute sweat losses leading to involuntary dehydration. Table 3 provides a summary of such strategies.

Table 3. Guidelines for fluid intake for a physically active individual

1. Weight changes before and after exercise may give you a guide to sweat losses and your success in replacing these losses during exercise. (A loss of 1 kg is approximately equal to 1 litre of sweat that should be replaced.) Check this periodically, more often when you are exercising in very hot conditions.
2. Staying well-hydrated will mean better training. You can not train your body to "get used to" dehydration or "toughen up".
3. Begin all exercise sessions well-hydrated. This includes strategies to recover fluid losses from previous sessions, and having a drink before you start any exercise in hot conditions.
4. Drink during exercise sessions. Previous weight calculations (see point 1) may give you a guide to expected sweat losses. Aim to replace most of this while you exercise; keeping net fluid losses below 1-2kg. Drink early and frequently at a comfortable rate.
5. Organise strategies to have fluid needs on hand during exercise. Practical needs will vary according to the sport or type of exercise. You may need to take a drink bottle with you or to set up your own "aid stations".
6. During very strenuous exercise in hot environments sweat losses may greatly exceed reasonable rates of fluid intake. Do the best you can.
7. Choose fluids that are cool and palatable. Remember that sports drinks may allow you to look after fluid and carbohydrate needs simultaneously.
8. Rehydrate fully after exercise with water or carbohydrate-containing drinks. Note that alcohol and caffeine-containing beverages may promote urine production and are not ideal rehydration beverages.

GOAL 5: To provide adequate fuel for exercise activities and to promote recovery between sessions.

A challenge of an exercise program is to provide and replenish fuel used during prolonged exercise, particularly when exercise fuel requirements are substantial and where there may be only 8-24 hours between training sessions. A heavily training athlete may need to set a special schedule of carbohydrate intake to promote optimal recovery, since typical Western eating patterns are unlikely to provide adequate carbohydrate. Failure to consume sufficient carbohydrate to match the demands of training will lead to chronically depleted muscle and liver glycogen stores. This may interfere with optimal training performance and adaptation, and in some cases has been shown to cause overwhelming fatigue in the athlete[15].

Commencing carbohydrate intake soon after the finish of exercise may be a useful strategy in promoting recovery. The early provision of substrate to the depleted muscle hastens the restoration of muscle glycogen. There is some evidence that the rate of glycogen storage is slightly enhanced by increased muscle cell sensitivity during the first 1-2 hours post-exercise[16-17]. It has been recommended that 1-1.5g/ kg body weight of carbohydrate be consumed as soon as possible after the cessation of a prolonged exercise bout.

Nutrition guidelines for individuals undertaking a general exercise program recommend that carbohydrate intakes should be increased above the levels currently typical of the Western diet (55% of total energy intake) and this should be achieved principally by increasing the consumption of complex carbohydrate and fibre-containing food[18]. These recommendations are similar to healthy nutrition guidelines aimed at the general community[1]. In the case of the heavily training athlete, carbohydrate intake guidelines have been set in order to maximise the capacity for daily glycogen restoration. These recommendations have been made both on the basis of absolute carbohydrate intake (8-l0g/ kg body mass per day[19]) or as a contribution to total energy intake (65-70% of total energy[18]).

The focus on nutritious carbohydrate-rich foods may assist the athlete to meet requirements for other nutrients simultaneously. Nevertheless, sugar and refined carbohydrate foods offer the advantages of being compact and pleasant to eat, and can provide a useful but smaller contribution to the athlete's total carbohydrate intake. Liquid sources of carbohydrate may also provide a compact and practical way to help achieve the very high carbohydrate requirements of some individuals in heavy training.

These attributes may be most appreciated during or immediately after exercise. Indeed, consumption of carbohydrate during exercise has been identified as an important strategy for promoting endurance and reducing fatigue during prolonged aerobic performance. Numerous studies have reported benefits to performance when carbohydrate is consumed during prolonged exercise events[20-2]. Although both solid foods and carbohydrate

drinks have been successfully used to supply carbohydrate during exercise[23], carbohydrate drinks are favoured because of the decreased risk of gastrointestinal side-effects, and the consideration of fluid requirements. The commercially available sports drinks, 5-7% solutions of various simple carbohydrates, provide a simple way for a physically active person to look after fluid and fuel considerations during most exercise situations. Table 4 provides guidelines for carbohydrate intake for the physically active individual.

Table 4. Guidelines for high carbohydrate eating for a physically active individual

1. Be prepared to be different -- a Western diet is not a high-carbohydrate diet
2. Base meals and snacks around nutritious carbohydrate foods. Let these foods take up at least half of the room on your plate
   - wholegrain breads and breakfast cereals -- rice, pasta, noodles and other grain foods
   - fruits
   - starchy vegetables such as potatoes and corn
   - legumes (lentils, beans, soy-based products)
   - sweetened dairy products such as fruit flavoured yoghurt and milkshakes
3. "Carbo-load" don't "garbo-load". Many of the foods commonly believed to be high in carbohydrate are actually high-fat foods. Keep to low-fat ideas, and promote fuel foods rather than high-fat foods.
4. Make good use of compact sugar and sugar-based foods, especially when added to a nutritious high carbohydrate meal, or when needed during and after exercise.
5. Carbohydrate drinks are also a compact source for special situations or very high-carbohydrate diets. This category includes many of the supplements made specially for athletes -- such as sports drinks, high carbohydrate powders and liquid meal supplements.
6. Eat a high-carbohydrate meal or snack within 15-30 minutes of lengthy training sessions to speed glycogen recovery.
7. Consume carbohydrate during lengthy training and competition sessions when additional fuel is needed. Sports drinks and other sugary drinks will look after fluid and carbohydrate needs simultaneously, with sports drinks being specially designed to rapidly deliver these nutrients.

GOAL 6: To incorporate nutritional practices that promote long-term health, and reduce the risk of chronic disease patterns of affluent Western countries.

The community nutrition education programs of many countries include dietary guidelines that not only address nutrient adequacy, but deal with long-term health and the dietary factors implicated in the development of the chronic health problems of Western society[1]. These guidelines recommend a reduced intake of fats and oils, increased intake of nutritious carbohydrate and fibre foods, and moderation with salt, sugar and alcohol intake. These principles are identical to those outlined in this article for optimal training nutrition. While this provides further incentive to the physically active individual to follow a healthy training diet, we should also be aware of the opportunity for such people to provide role models for the community. Since sportspeople are well-recognised and often hero-worshipped within the community, they provide a worthy example of the potential benefits of a well-chosen diet.

Louise Burke *Asia Pacific J Clin Nutr (1995) 4, Suppl 1*
Food selection and guidance for physically active people

积极从事体力活动者的食物选择指南

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摘要：

适用于所有喜爱运动的成人的膳食准则为：（1）享受食物及在社交场合进食的乐趣，而运动员没有必要极端地改变膳食结构。（2）通过热量摄入和运动的平衡来达到和保持合适的体重和体脂。增大肌肉块的训练需要热量正平衡，主要是增加碳水化合物，而不是蛋白质。（3）满足基本的营养素需要，包括激烈运动时的营养素需求增加。一般以为补充维生素并不能提高运动表现。（4）为了预防脱水，在比赛前、中，后都应饮水。（5）为运动员提供足够的热量，以有利于运动间歇期的体力恢复。主要的措施是提供高碳水化合物膳食，使肌糖元迅速恢复。液态碳水化合物食物更具优点。（6）将促进长期健康的营养实践与减少西方国家慢性病的危险性相结合。文后附有 4 个表分别为：喜好运动者减少体脂的准则；增加运动员肌肉量的饮食指南；运动员摄入液体的准则；喜爱运动者的高碳水化合物摄入准则。

References

1. National Health and Medical Research Council. Dietary guidelines for Australians. Canberra: Australian Government Publishing Service. 1992.
2. Brownell KD, Steen SN, Wilmore J. Weight regulation practices in athletes: analysis of metabolic and health effects. Med Sci Sports Exerc. 1987;19:546-556.
3. Burke LM. Sport and body fatness. In: Hill AP, Wahlqvist ML, eds. Exercise and obesity. London: Smith-Gordon, 1994; Chapter 19: 217-231.
4. Lemon PWR. Effect of exercise on protein requirements. J Sports Sci. l991b; 9(special issue): 53-70.
5. Burke LM, Inge K. Protein requirements for training and bulking up. In: Burke LM, Deakin V, eds. Clinical sports nutrition. Sydney: McGraw-Hill, 1994 (in press)
6. Van der Beek EJ. Vitamins and endurance training: food for running or faddish claims? Sports Med . 1985; 2: 175- 197.
7. Williams MH. Nutritional aspects of human physical and athletic performance. 2nd edn. Springfield: Charles C Thomas, 1985: Chapter 6.
8. Newhouse IJ, Clement DB. Iron status: an update. Sports Med. 1988; 5:337-352.
9. Haymes EM, Lamanca JF. Iron loss in runners during exercise: implications and recommendations. Sports Med. 1989; 7:277-285.
10. Drinkwater BL. Amenorrhea, body weight, and osteoporosis. In: Brownell Kd, Rodin J, Wilmore JH (eds) Eating, body weight and performance in athletes: disorders of modern society Philadelphia: Lea & Febiger; 1994: pp 235-247.
11. Martin AD, Bailey D. Skeletal integrity in amenorrheic athletes. Aust J Sci Med Sport 1987; 19(1):3-7.
12. Buskirk ER, Puhl S. Nutritional beverages: exercise and sport. In: Hickson JF, Wolinsky I, eds. Nutrition in exercise and sports. pp 201-231. Boca Raton: CRC Press, 1989.
13. Williams MH. The role of water and electrolytes in physical activity. In: Nutritional aspects of human physical and athletic performance, 2nd ed. pp 219-271. Springfield: Charles C Thomas, 1985.
14. Coyle EF, Montain SJ. Benefits of fluid replacement with carbohydrate during exercise. Med Sci Sports Exerc. 1992; 24(suppl):S324-30
15. Sherman WM, Wimer GS. Insufficient dietary carbohydrate during training: does it impair performance? Int J Sport Nutr 1991; 1:28-44.
16. Robergs RA. Nutrition and exercise determinants of post-exercise glycogen synthesis. Int J Sport Nutr. 1991; 1 : 307-337.
17. Ivy JL. Muscle glycogen synthesis before and after exercise. Sports med. 1991; 11:6-19.
18. American Dietetic Association and the Canadian Dietetic Association: Position stand: Nutrition for physical fitness and athletic performance for adults. J Am Dietet Assoc. 1993; 93:691-696.
19. Costill DL. Carbohydrates for exercise: dietary demands for optimal performance. Int J Sports Med. 1988; 9: 1-18.
20. Coyle EF, Coggan AR. Effectiveness of carbohydrate feeding in delaying fatigue during prolonged exercise. Sports Med. 1984; 1:336-458.
21. Lamb DL, Brodowicz GR. Optimal use of fluids of varying formulations to minimise exercise-induced disturbances in homeostasis. Sports Med. 1986; 3:247-74.
22. Murray R. The effects of consuming carbohydrate electrolyte beverages on gastric emptying and fluid absorption during and following exercise. Sports Med 1987; 4:322-351.
23. Burke LM. Food and fluid intake during competition. In: Burke LM, Deakin V. eds. Clinical sports nutrition. Sydney: McGraw Hill, 1994; 333-64