Energy demands of training and match play

Most serious football players play in one or more competitive games per week for a large part of the year and will train most days of the week, sometimes twice a day, throughout this time. The energy demands of training must be met to maintain performance capacity and prevent the development of chronic fatigue.

Energy for match play

Soccer is a game of intermittent work. Players generally perform low intensity activities for more than 70% of the game, but heart rate and body temperature measurements suggest that the total energy demand is high. The high energy demand may be partly explained by the repeated high intensity efforts that players are called upon to perform. A top class player performs about 150-250 brief intense actions during a game. These efforts place high demands on the anaerobic energy systems, so the rates of creatine phosphate (CP) utilization and glycolysis are high during the course of a game.

Carbohydrate, which is stored in the muscles and in the liver as glycogen, is probably the most important substrate for energy production, and fatigue towards the end of a game may be related to depletion of glycogen in some of the individual muscle fibres. If even a few of these are unable to contract, then sprinting ability is reduced, and skill may also be impaired. Free fatty acid (FFA) levels in blood increase progressively during a game, partially compensating for the progressive lowering of muscle glycogen.

There are major individual differences in the physical demands on a player during a game related to physical capacity and tactical role in the team. Fatigue also occurs temporarily during a game, but it is still unclear what causes the reduced ability to perform maximally. These differences should be taken into account in the training and nutritional strategies for a top class player.

The total distance run by a player during a game depends on many different factors, including the level of competition, the player’s position, and the playing style and fitness level of the individual. At the elite level, male outfield players typically cover about 10-13 km, making football an endurance sport. The demands are increased, however, by the fact that more than 600 m are covered at sprinting speed and about 2.4 km at high intensity. Over the whole duration of the game, heart rate is about 85% of the maximum rate and the oxygen demand is about 70% of the maximum oxygen uptake (VO₂max). These values suggest that the total energy cost of a game for a typical player weighing about 75 kg would be about 1600 kcal (about 6.5 MJ). The value for players at lower levels of the game is somewhat less than this, because the VO₂max is also lower, the total energy expended will be less. Of course, energy needs will vary greatly between individuals.

Energy demands of training

The energy demands of training will vary depending on the intensity, frequency and duration of the training sessions, but they will also change over the course of the season. Most players will follow a weekly cycle that involves a reduced training load to allow recovery from the previous game, days of harder training, and a reduction in training load in preparation for the next game.

In pre-season, the training load is usually at its greatest as players strive to reach full fitness for the opening games of the season.

Energy demands in a training session focussed on fitness may reach those of a hard game. In sessions where the emphasis is on recovery and regeneration or on skill, the energy cost will be much less.

Energy needs

The foods we eat and the fluids we drink provide for the immediate energy needs of the body as well as influencing body energy stores. Energy stores play a number of important roles related to exercise performance, since they contribute to:

- size and physique (e.g. body fat and muscle mass)
- function (e.g. muscle mass)
- fuel for exercise (e.g. muscle and liver carbohydrate)

The energy needed for training and match play must be added to the energy required for normal daily activities. As outlined above, the energy demands of training will depend on the intensity and duration of the training session. These will vary across the season and at different levels of competition.

How much food a player needs will depend largely on energy needs, and there is no simple formula to predict this. Energy needs depend not only on the demands of training and match play, but also on activities outside the game. For those who train infrequently, or where training sessions are short or easy, the energy demands will not be high. Similarly, energy needs are lower during periods of inactivity such as the off-season or while a player is injured, and players should adapt their food intake accordingly.
Body Fat

An individual's body fat stores represent a lifetime history of the balance between energy intake and energy expenditure. Fat is the major energy store in the body, and is an efficient way to store excess energy for use in times of need.

A player will perform best when the amount of body fat is within his or her individual optimum range. This will vary between individuals, and will also vary across a player's career, so there is no single value that is ideal. If the body fat stores fall too low, health will suffer. If body fat stores are too high, the player will be slowed down by having to carry unnecessary additional weight. It is important, therefore that players manage their food intake and energy output to achieve an optimum body size and body composition.

Strategies for managing energy intake and energy balance:

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

Players should follow an eating plan that achieves their specific goals rather than relying on appetite to guide energy intake. Advice from a sports nutrition expert is often required to develop this plan.

Players should have a number of separate bio-markers to monitor their progress in achieving each of their energy-related goals.

- Body weight is not a reliable or accurate indicator of energy balance. Monitoring body weight can be misleading, and the information can be misinterpreted.
- Monitoring of skinfold fat thicknesses across the season, especially when undertaken by a trained kinaanthropometrist, can provide useful information about changes in body fat stores.
- Urinary ketones can provide a marker of inadequate carbohydrate intake.
- Measurements of changes in muscle strength and endurance provide a useful biomarker of muscle development.

Special concerns about restricting energy intake

Although many players reduce their energy intake at times to assist with the loss of body weight and body fat, it is harmful to restrict energy intake below levels that interfere with healthy body function.

Energy availability = total dietary energy intake – energy used in daily activity/exercise

There is evidence from recent research that when energy availability drops below a daily intake of 30 kcal (135 kJ) per kg fat-free mass (FFM), there are substantial impairments of metabolic and hormonal function, which affect performance, growth and health.

In females, one outcome of low energy availability is a disturbance of reproductive function and menstrual regularity. Other problems are likely to occur in male players.

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

If a reduction in body fat content is necessary, this should be achieved gradually. Players can avoid potential problems by taking care to avoid excess weight gain in the off-season. Careful management of both diet and activity levels in the off-season and in the pre-season can help the player to reach his or her ideal weight and body fat level with minimal impact on health or performance.

To avoid irreversible skeletal damage, any female player with disruption of normal menstrual function should be referred without delay to a medical expert for investigation.

Example of low energy availability

60 kg female with 20% body fat = 48 kg FFM

Daily energy intake is 1800 kcal (7560 kJ)

Cost of daily exercise (1 h/d) = 500 kcal (2100 kJ)

Energy availability = 1800-500 = 1300 kcal (5460 kJ)

Energy availability = 1300/48 or 27 kcal/kg FFM (113 kJ per kg FFM)