Rehydration before and during exercise

If sweat losses of at least 1–2 L h^{-1} are experienced while performing low-intensity exercise, is it possible to maintain **euhydration** during exercise by drinking? Thirst is not a good indicator of body water requirements since it is not perceived until an individual has incurred a water deficit of around 2% body weight loss. Therefore studies which rely on *ad libitum* intake of water, result in incomplete replacement of body water losses and invariably lead to some level of dehydration. Forcing subjects to drink can prevent dehydration as long as the sweat loss is not too great, i.e. approximately 1 L h^{-1}. It is difficult and

uncomfortable to drink more than 1 L h^{-1}, and this is normally achieved by regular ingestion over that time i.e. 150–200 ml every 10–15 min.

It is desirable for those who are engaged in exercise to become hydrated before starting the bout. This can be achieved by drinking fluids with the meal before the exercise, and also ingesting 300–500 ml of fluid immediately before the exercise.

What kind of fluid should be given? It is clear from numerous studies that a **carbohydrate-electrolyte** solution helps to maintain blood volume, assists thermoregulation, reduces the risk of heat injury, provides exogenous energy, and thus enhances performance during prolonged exercise. However, in order to prove beneficial, the drink should be capable of being emptied from the stomach (**gastric emptying**) rapidly and then **absorbed** across the **intestine** rapidly. The rate of gastric emptying is affected by numerous factors such as exercise intensity, as well as concentration, **osmolality**, and temperature of the drink. Exercise intensities greater than 65% $\dot{V}O_{2max}$ impair gastric emptying as does an increase in concentration and increase in temperature of the ingested solution. Pure, cool water would thereby empty at a greater rate than a concentrated, warm glucose drink.

If the major factor to offset fatigue is dehydration, then water would be the optimal drink. If however the major concern is maintenance of carbohydrate levels, then a carbohydrate-electrolyte drink would be preferable. The various **isotonic** sports drinks have been produced in an attempt to address the issue concerning rehydration and energy provision. *Fig. 2* illustrates the fact that as there is an increase in the glucose content of a drink there is a greater provision of carbohydrates but an attenuation of water availability. The compromise appears to occur at a glucose concentration of around 6%, since at concentrations above this value there is a significant negative impact on water delivery.

A 6% glucose solution is likely to have an **osmolarity** of around 280 mOsm L^{-1} which is isotonic with body fluids (which have an osmolarity of around

290–300 mOsm L^{-1}). As the concentration of dissolved material in the drink increases, so does the osmolarity. Osmolarity is a measure of the osmotic pressure exerted by dissolved particles in a fluid. The greater number of dissolved particles the greater the osmolarity. So a 6% glucose solution has a lower osmolarity than a 10% glucose solution, and a 6% glucose solution has a lower osmolarity than a 6% glucose-electrolyte solution (because the electrolytes add to the osmolarity). Therefore drinks can be classified as **hypotonic** (<270 mOsm L^{-1}), isotonic (270–300 mOsm L^{-1}), or **hypertonic** (>330 mOsm L^{-1}). *Table 1* highlights osmolarities and concentrations of carbohydrates in selected drinks.

The addition of the electrolyte, sodium, aids gastric emptying and **intestinal absorption** of both water and glucose. It must be remembered that glucose is co-transported with sodium across the intestinal lumen wall, and that water is thereby 'dragged' across the membrane passively. The faster the rate of movement of glucose across the membrane, the faster the rate of water movement;

the more **sodium** in the solution, the faster the movement of sodium and glucose. Hence sports drinks are often known as carbohydrate-electrolyte drinks because of the fact that sodium is normally present as the electrolyte. The amount of sodium is usually rather low in order to make the drink palatable, and although an ideal content of about 1 g L^{-1} would be desirable, the actual amounts in most sports drinks is rather less.