Fluid replacement in sport and exercise – a consensus statement

Loss of fluid and reduction of the body's carbohydrate stores are the two major causes of fatigue in prolonged exercise. When the ambient temperature and humidity are high, the capacity to perform prolonged exercise is reduced. Small losses of body water can decrease the capacity for exercise, and dehydration resulting from sweat loss, and the consequent thermoregulatory problems, may be the primary cause of fatigue even in moderate climatic conditions. Sweat losses in high-intensity, short-duration exercise are necessarily small, but exercise capacity is impaired if there is a pre-existing fluid deficit. The importance of adequate hydration for the maintenance of physical and mental performance is, however, generally underestimated.

Adequate hydration before exercise is essential for optimum performance. During prolonged exercise the ingestion of appropriate fluids will improve performance, not just of the elite athlete but of all people involved in sport and physical activity. Fluid ingestion during exercise has the twin aims of supplying water to replace the losses incurred by sweating and of providing a source of carbohydrate fuel to supplement the body's limited stores. The composition of drinks to be taken will thus be influenced by the relative importance of the need to supply fuel and water; this in turn depends on the intensity and duration of the exercise task, on the ambient temperature and humidity, and on the physiological and biochemical characteristics of the individual athlete.

The effects of the consumption of different types and amounts of beverages during exercise have been extensively investigated, using a variety of experimental models. The evidence clearly indicates that sports drinks which contain an energy source in

the form of carbohydrate together with electrolytes, particularly sodium, are more effective than plain water in improving performance. The type of carbohydrate appears not to be of major importance, although it may influence palatability which is a major factor in encouraging consumption. Fructose in high concentrations is best avoided because of the risk of gastrointestinal problems. There are no studies showing that fluid ingestion will have an adverse effect on performance, with the exception of a few investigations where the composition of the drinks administered was such as to result in gastrointestinal disturbances.

Rehydration after exercise is especially important for recovery and restoration of physical and mental performance. Where the exercise has to be repeated after a short interval, appropriately formulated carbohydrate-electrolyte drinks will provide the fastest possible water replacement, and will also provide an energy source. Plain water causes a rapid fall in plasma osmolality and reduces the drive to drink, even before sufficient fluid has been consumed to replace losses. Addition of electrolytes, especially sodium and potassium, reduces urine output in the post-exercise period, and is effective in increasing the fraction of the ingested fluid that is retained. Inclusion of carbohydrate in the rehydration fluid consumed immediately after exercise is important to ensure rapid replenishment of the glycogen stores.

Individuals must learn from experience what is most suitable for them in different situations, and must practise using these drinks as a part of training and preparation for competition. Maintaining an adequate hydration status during training will allow the optimal training load to be maintained and thus improve the effectiveness of the training programme.

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Rehydration during and after exercise – accompanying statement

It is widely recognized that performance of endurance exercise is generally impaired in hot weather. Many athletes are not aware, however, that performance of short duration high-intensity exercise can also suffer if the body's water reserves are depleted before exercise begins. The World Athletics Championships in Tokyo in 1991 and the 1992 Barcelona Olympics are recent examples of major sporting events where the climate was a factor influencing the results. It seems probable that many, if not most, of the major games in the near future will be held in conditions which place those who habitually train and compete in temperate climates at a disadvantage – this includes the next Olympic Games in Atlanta in 1996, where the heat and humidity will present a serious problem. In spite of extensive scientific research on the effects of dehydration on exercise and on optimization of fluid intake, it has been apparent at recent championship events that many competitors, from the UK and elsewhere, were not adequately prepared for the conditions and suffered accordingly.

For the relatively sedentary individual, the body's requirement for water may increase from about 2 l day^{-1} in a temperate climate to something in excess of 10 l day^{-1} in hot, humid conditions. During exercise, sweat rates may be as high as 2 l h^{-1} , and body water turnover is increased accordingly. Hard training is therefore a challenge to the body's water and electrolyte homeostasis, even in the acclimatized individual. Most athletes arrive only a few days before competition begins, and acute dehydration during this time appears to be almost inevitable, leading to substantial impairment of performance. In spite of this, the need for rehydration is commonly underestimated by athletes and coaches alike. There also seems to be some confusion as to the best type of fluid for rehydration during and after exercise.

To address some of these issues, a group of scientists, doctors and nutritionists working in the area of sports medicine or sports science and having a special interest in the issues relating to rehydration spent a weekend debating questions relating to the role of fluid replacement in improving performance and reviewing the evidence as to the optimum type of drink that should be consumed to maximize performance and minimize the dangers of dehydration.

The outcome of the weekend meeting was a consensus statement on the role of fluid replacement in sport and exercise. The statement was agreed only after an extensive review of the available evidence, and represents the consensus view of UK experts working in this field.

The conclusion was that there is a need to make athletes more aware of the dangers of dehydration and of the importance of adequate fluid intake. Water is not the best fluid for rehydration, either during or after exercise – plain water is less well absorbed into the body than are dilute carbohydrate–electrolyte drinks, and the sugar in these drinks can also provide extra energy to supplement the body's limited carbohydrate stores. Excessive intake of sodium-free drinks can lead to hyponatraemia, and post-exercise rehydration requires replacement of electrolytes lost in sweat in addition to replacement of water – if electrolyte (primarily sodium) losses are not made good, a significant part of the fluid is lost as urine. Ingestion of sodium-free fluids also leads to a rapid fall in serum sodium concentration and serum osmolality. Both of these effects will inhibit thirst, leading to a reduction in fluid intake. Sports drinks are formulated to optimize the provision of both energy and water and also provide essential electrolytes which promote post-exercise rehydration.

Perhaps the most significant difficulty in giving practical advice to athletes is that there is no single drink that is ideal for all individuals and all situations. This is a large part of the reason for the confusion that appears to exist. Commercial products are inevitably a compromise, aimed at meeting the needs of most of the population in most situations. The formulation of the major commercial sports drink products on sale in the UK is based on sound scientific principles, and the differences in formulation between the brand leaders are small, at least as far as the major components are concerned. As well as being effective in improving exercise performance, however, drinks must be palatable in order to encourage consumption. The commercial drinks, which rely heavily on palatability to encourage sales, are generally suitable for most sportsmen and women. The elite athlete may wish to experiment with different formulations, and certainly must practice drinking during and after training to establish personal preferences.

For a detailed review of the evidence on which this statement is based, see: R.J. Maughan. Fluid and electrolyte loss and replacement in exercise. *Sports Sci* 1991; 9 (Special Issue) 117–42.

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