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Fluid replacement for sports safety and performance

Professor William O Roberts MD, MS

Department of Family Medicine and Community Health, University of Minnesota Medical School, Minneapolis, Minnesota, USA

Abstract

Fluid replacement is important for sport performance, recovery, and safety. Athletes can monitor fluid status with daily weights and urine colour. For most athletes, fluid replacement during activity can be based on thirst. Athletes in hot conditions, especially those wearing barrier-type equipment and those who are not acclimatised to the heat, may need to replace fluids on a schedule to stay ahead of sweat losses. Between practices and competitions, much of the day-to-day fluid replacement comes from food, in addition to the fluids ingested with and between meals. There is danger to health from ingesting too much fluid if the body's system of retaining and removing fluid is disrupted by non-osmotic release of vasopressin resulting in exercise associated hyponatremia. **Keywords:** sports drinks, hyponatremia, dehydration, hydration monitoring

Professor William O Roberts MD, MS

Professor William Roberts is the Program Director at the University of Minnesota St John's Family Medicine Program and a member of the Family Medicine Division of Sports Medicine in Minneapolis-St Paul, Minnesota, USA. He specialised in family medicine and sports medicine. He is a member of the Science Commission of FIMS and a past President of the American College of Sports Medicine.

Email: rober037@umn.edu

Fluid replacement for sports activity performance and safety can be divided into three phases: before, during, and after. Maintaining body fluid balance is important to preserve intravascular volume for oxygen, nutrient, waste product, and metabolic heat transport throughout the core and shell of the body, and for thermal control through sweating. Athletes can monitor fluid balance by thirst, by measuring and recording before and after practice body weights, and by noting urine colour.

Fluid lost during a practice or a game will be reflected by the drop in pre to post activity weight. This fluid loss should be replaced

before the next activity with a combination of normal diet and extra fluid intake. Urine colour can give an indication of round the clock hydration status as dark urine, like apple juice, indicates dehydration and light yellow urine, like lemonade, indicates normal hydration. Thirst kicks in when the serum osmolality rises to a preset level, much like a thermostat for a home air conditioning unit. Osmolality rises as body water content drops. Thirst is a marker of dehydration and should not be ignored during practices or games; it can be used to safely pace hydration. Acclimated soldiers on a 4 hour, 16 km march drinking fluids based on thirst maintained adequate



hydration with no adverse effects on exercise capacity, core temperature, plasma osmolality, or serum sodium concentration¹. Athletes in high intensity sports, especially wearing heavy or heat occlusive equipment may lose fluid faster than the body can respond with a thirst response and need to be aware of early losses to maintain and adequate intravascular fluid level for optimum performance.

In general, decrements in performance do not occur until there is at least a 2-3% of decrease in body mass², and runners in a 30 minute time trial did not show any performance decrement with 2-3% body mass loss over 48 hours³. For some athletes, this loss of body mass means less weight to move with potential benefit to performance, although there may be concurrent decrements in heat tolerance. Bikers tested in a lab demonstrated a reduction in hill climbing performance while dehydrated 2-3% in warm conditions⁴. Active subjects dehydrated to 2-4% of body weight did not demonstrate any adverse effect on anaerobic exercise performance in the lab⁵.

The greatest challenge to keeping fluid in balance occurs when there is more than one practice or game on the same day, especially if it is hot and sweat volumes are high. Replacing weight lost between sessions requires more than a litre per kilogram of weight loss and is difficult to accomplish if there are large fluid losses and less than 3 hours between events. As a general rule, 150% of weight loss replacement with fluid is necessary to normalize body water content after an event⁶. That translates to 1.5 litres of fluid replaced post activity for each kilogram of weight loss. Ingesting that much fluid in a short time span can be difficult and requires an athlete to monitor urine colour, weight, and thirst. One of the easiest fluids to use for post event recovery and replacement is chocolate skim milk as it contains carbohydrate, protein, and salt in addition to water and has added benefits to muscle protein turnover and performance measures compared to glucose drinks⁷. Intravenous fluid replacement does not have any advantages over oral with respect to heat

tolerance, perceived exertion, or physiological strain⁸.

When the next event is the following day, the replacement schedule is a little more relaxed and the regular meals help with fluid replacement. In a normal diet, half of the food content is water and this helps with fluid intake. Elite Kenyon runners acclimated to the local environment ingest very little fluid in addition to their normal diets, maintain normal hydration markers, and perform well drinking fluids on an "as needed" basis⁹.

Replacing fluid during a practice or game helps maintain fluid balance for performance and heat safety, and replacement during the exercise session decreases the need for aggressive post game fluid intake. Ingesting a small amount of fluid compared to rinsing the mouth and spitting or no water at all increased the time to exhaustion in dehydrated cyclists¹⁰. Adolescent basketball players were tested after fluid restriction, ad libitum fluid water, and ad libitum sports drink during exercise; and body water loss of up to 3.5% had no impact on basketball performance compared with the other groups, but the dehydrated players did experience increased perceived exertion¹¹. Athletes with more knowledge about hydration and better self-reported hydration behaviours ingested more fluids during training sessions. Water is fine for events lasting less than an hour and is adequate for longer events too. For events that last an hour or more, there is some advantage to using a sports drink that contains carbohydrate, sodium, and potassium for energy and electrolyte replacement, but the primary ingredient in a sports drink is water⁶. There may be some advantage to using sports drinks when there is more than one game or practice on the same day.

The volume of fluid replacement needed during activity is highly variable from athlete to athlete. Sweat rates vary from 400 to 2400 or more ml/hr depending upon environment, sport, intensity of activity, sex, and individual variability; so a single statement of "x" ml every 20 minutes is nearly impossible to determine and safely recommend for a group of athletes⁶. The body cannot absorb more than 1000ml an



hour so athletes who sweat heavily will always end a long exercise session with a fluid deficit. Likewise an athlete with a very low sweat rate who ingests more than needed over a longer period of time will run the risk of fluid overload, which can be fatal¹². Sports drinks are hypotonic, so the risk of exercise associated hyponatremia remains present with over consumption during prolonged activity¹². The serum sodium is also affected by sweat sodium losses, so athletes may benefit from sodium contained in sports drinks provided they are not overhydrated¹³. Athletes can calculate their fluid needs based on weight lost during practice and increase fluid intake during practice if the post practice weight is greater than 2-3% lower than the pre practice weight. Children athletes may require closer supervision by parents and coaches to assure adequate fluid intake to maintain adequate hydration during and after practices and games¹⁴.

Fluid ingested before the game or practice is often recommended to help start the activity fully hydrated, but humans do not store excess water so timing is important. Drinking 360-480ml of water about 2 hours before the activity should give time for absorption of the ingested fluid and excretion of any excess through the kidneys. An additional 120-180ml about 20 minutes before taking the field may help start replacement during the game.

There are down sides to drinks taken during activity, the most frequent being gastrointestinal (GI) complaints. Using sports drinks as a model, it was found that sport drink ingestion led to higher incidences of GI complaints compared to water. Adding caffeine to the sports drink no effect on GI complaints and the carbohydrate component may be the culprit for the GI distress that occurred in some of the athletes.

Hydration tips

- Water is fine
- Sports drinks help with activity greater than an hour
- Energy drinks should not be used for sports

- Try to replace sweat losses during activity to remain within 2-3% of baseline weight
- Replace weight losses with fluid before the next activity
- There is adequate sodium and potassium in the normal diet
- Weigh before and after activities
- Keep urine light yellow like lemonade
- Listen to your body and do not ignore thirst

Summary

Fluid replacement that avoids excessive body water loss is critical for athlete safety and performance. Fluids and foods in the normal diet help maintain body water. An individual hydration plan to replace weight lost during activity will help ensure good hydration for the next day. Sports drinks may help performance in longer duration games and activities, but water is fine for most short duration events. Energy drinks, as opposed to sports drinks, should be avoided and their use prior to and during sports events is not recommended.

Address for correspondence

Professor William O Roberts, Phalen Village Clinic, 1414 Maryland Avenue East, St Paul, Minnesota 55106, USA
Email: rober037@umn.edu

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