Isotonic, Hypertonic, Hypotonic or Water
Which sports drink is the best for athletes? Fluid Facts for Winners

Why is fluid intake so important for runners?

• Fluid is a vital part of any athlete’s diet for three main reasons: it helps us to get rid of heat through the skin by sweating; it helps the body to get rid of waste products and toxins in urine and also helps to transport glucose in the blood to our muscles so that we can exercise. Without it the body cannot perform at its best and a dehydrated runner will end up going nowhere fast.

Which fluid should I choose?

• Water is the most important fluid for anyone - runners included. You can splash out pounds on sports drinks but none of them will supply your body with any more fluid than plain old water at a fraction of the price. It is easy to digest, quickly absorbed and, combined with a healthy sports diet, is the perfect fluid for anyone running for less than 90 minutes.
• Watery foods are another good choice for boosting your fluid intake. Eat plenty of fresh fruit, tomatoes, soups, cucumber and other snacks with high water content.
• Sports drinks usually have some added extras in the form of carbohydrate or electrolytes, the body salts lost through sweat. Studies have shown that carbohydrate drinks are most effective in intensive exercise which lasts for 90 minutes or longer, such as a marathon. But if you find a sports drink that suits you, there is no reason why you shouldn’t drink it on a more regular basis - if you can afford to! Look for drinks which contain long chain polysaccharides - easily digestible carbohydrate - which is quickly absorbed. Added electrolytes are unnecessary in a sports drink since water and a good post race diet will replace them just as well.

What is the difference between an isotonic sports drink and a hypotonic drink?

• Isotonic drinks contain particles of carbohydrate and/or electrolytes at the same concentration as the body’s own fluids which mean they are absorbed into the blood stream at around the same rate as water.
• Hypotonic drinks contain particles that are less concentrated than body fluid which means they are more quickly absorbed by the body. It is thought that they increase the rate at which water is absorbed by the body and speed up the rehydration process.
• Hypertonic drinks are the third category of sports drink. They contain particles which are more concentrated than the body’s fluids and are absorbed more slowly. They are best used as a recovery drink or whenever you need extra energy during the day.

How do I know if I taken in enough fluids?

• A simple way to test if you are drinking enough is to check the color of your urine. If it is bright yellow it is probably a sign that you aren’t drinking enough and your urine has become concentrated with metabolic wastes.
• Look out for warning signs that you may be dehydrated: feeling tired all the time, having headaches and general weakness could all be indications that you aren’t taking in as much fluid as your body needs.

When should I drink in a race?

• Rule number one is to drink before you feel thirsty. The sensation of thirst is your body’s way of telling you that it is already becoming dehydrated - the last thing you need during a race - and you could have lost about one per cent of your body weight by then. Start drinking fluids as early as you can and then take a few sips every 15-20 minutes throughout the race - remember that in very hot or humid weather you might need to drink more.
**What should I do if I become dehydrated in a race?**

- Unfortunately there is only one thing you can do and that is to stop running. If you don’t stop, your body will eventually make its own decision to call it a day. The only way around it is to make sure you are well-hydrated before you start and to keep topping up your fluid stores as you run.

**Are there any fluids that I shouldn’t drink?**

- You should avoid alcohol and caffeine based drinks such as tea, coffee and cola which all promote dehydration. Fizzy drinks can cause bloating and some of the popular soft drinks, such as cola, are laden with sugar but contain very little else.

**Dehydration**

Sweating is the way in which the body maintains its core temperature at 37 degrees centigrade. This results in the loss of body fluid and electrolytes (minerals such as chloride, calcium, magnesium, sodium and potassium) and if unchecked will lead to dehydration and eventually circulatory collapse and heat stroke. The effect of fluid loss on the body is as follows:

<table>
<thead>
<tr>
<th>% body weight lost as sweat</th>
<th>Physiological Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>2%</td>
<td>Impaired performance</td>
</tr>
<tr>
<td>4%</td>
<td>Capacity for muscular work declines</td>
</tr>
<tr>
<td>5%</td>
<td>Heat exhaustion</td>
</tr>
<tr>
<td>7%</td>
<td>Hallucinations</td>
</tr>
<tr>
<td>10%</td>
<td>Circulatory collapse and heat stroke</td>
</tr>
</tbody>
</table>

**Electrolytes**

Electrolytes serve three general functions in the body:

- many are essential minerals
- they control osmosis of water between body compartments
- they help maintain the acid-base balance required for normal cellular activities

The sweat that evaporates from the skin contains a variety of electrolytes. The electrolyte composition of sweat is variable but comprises of the following components:

- Sodium
- Potassium
- Calcium
- Magnesium
- Chloride
- Bicarbonate
- Phosphate
- Sulfate

A liter of sweat typically contains 0.02g Calcium, 0.05g Magnesium, 1.15g Sodium, 0.23g Potassium and 1.48g Chloride. This composition will vary from person to person.
Carbohydrate

Carbohydrate is stored as glucose in the liver and muscles and is the most efficient source of energy as it requires less oxygen to be burnt than either protein or fat. The normal body stores of carbohydrate in a typical athlete are:

- 70kg male athlete - Liver glycogen 90g and muscle glycogen 400g
- 60kg female athlete - Liver glycogen 70g and muscle glycogen 300g.

During hard exercise, carbohydrate can be depleted at a rate of 3-4 grams per minute. If this is sustained for 2 hours or more, a very large fraction of the total body carbohydrate stores will be exhausted and if not checked will result in reduced performance. Recovery of the muscle and liver glycogen stores after exercise will normally require 24-48 hours for complete recovery.

Rehydration & Fluid absorption

There are two main factors that affect the speed at which fluid from a drink gets into the body:

- the speed at which it is emptied from the stomach
- the rate at which it is absorbed through the walls of the small intestine

The higher the carbohydrate levels in a drink the slower the rate of stomach emptying. Isotonic drinks with a carbohydrate level of between 6 and 8% are emptied from the stomach at a rate similar to water. Electrolytes, especially sodium and potassium, in a drink will reduce urine output, enable the fluid to empty quickly from the stomach, promote absorption from the intestine and encourage fluid retention.

What's wrong with water during an endurance event?

Drinking plain water causes bloating, suppresses thirst and thus further drinking. It stimulates urine output and therefore is inefficiently retained. A poor choice where high fluid intake is required. Water contains no carbohydrate or electrolytes.

Calculating personal fluid needs

During an endurance event you should drink just enough to be sure you lose no more than 2% of pre-race weight. This can be achieved in the following way:

- Record your naked body weight immediately before and after a number of training sessions, along with details of distance/duration, clothing and weather conditions
- Add the amount of fluid taken during the session to the amount of weight lost - 1 kilogram (kg) is roughly equivalent to 1 liter of fluid.
- After a few weeks you should begin to see some patterns emerging and can calculate your sweat rate per hour
- Once you know what your sweat losses are likely to be in any given set of environmental conditions, you can plan your drinking strategy for any particular event

Sports Drinks

There are three types of Sports drink all of which contain various levels of fluid, electrolytes and carbohydrate.

<table>
<thead>
<tr>
<th>Type</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isotonic</td>
<td>Fluid, electrolytes and 6 to 8% carbohydrate</td>
</tr>
<tr>
<td>Hypotonic</td>
<td>Fluids, electrolytes and a low level of carbohydrate</td>
</tr>
<tr>
<td>Hypertonic</td>
<td>High level of carbohydrate</td>
</tr>
</tbody>
</table>

The osmolality of a fluid is a measure of the number of particles in a solution. In a drink these particles will comprise of carbohydrate, electrolytes, sweeteners and preservatives. In blood plasma the particles will comprise of sodium, proteins and glucose. Blood has an osmolality of 280 to 330mOsm/kg. Drinks with an osmolality of 270 to 330mOsm/kg are said to be in balance with the body's fluid and are called Isotonic. Hypotonic fluids have fewer particles than blood and Hypertonic have more
Intracellular fluid and interstitial fluid have the same osmotic pressures under normal circumstances.

Consuming fluids with a low osmolality, e.g. water, results in a fall in the blood plasma osmolality and reduces the drive to drink well before sufficient fluid has been consumed to replace losses.

When is each type the most suitable?

Isotonic - quickly replaces fluids lost by sweating and supplies a boost of carbohydrate. This drink is the choice for most athletes - middle and long distance running or team sports. Glucose is the body's preferred source of energy therefore it may be appropriate to consume Isotonic drinks where the carbohydrate source is glucose in a concentration of 6% to 8%.

Hypotonic - quickly replaces fluids lost by sweating. Suitable for athletes who need fluid without the boost of carbohydrate - jockeys and gymnasts.

Hypertonic - used to supplement daily carbohydrate intake normally after exercise to top up muscle glycogen stores. In ultra distance events high levels of energy are required and Hypertonic drinks can be taken during exercise to meet the energy requirements. If used during exercise Hypertonic drinks need to be used in conjunction with Isotonic drinks to replace fluids.

Dental Health

Sports drinks commonly contain citric acid. All acids have an erosive potential but the method of drinking will influence whether or not those acids affect the teeth. Sports drinks should be consumed as quickly as possible, preferably with a straw and not be held or swished around the mouth. Retaining drinks in the mouth will only increase the risk of erosion. Refrigerated drinks will have a reduced erosive potential as the acid dissolution constant is temperature dependant and cold drinks are absorbed more quickly.

Food for thought

In a trial conducted by scientists in the city of Aberdeen it was determined that a 2% carbohydrate-electrolyte drink provided a more effective combat to exercise fatigue in a hot climate when compared to a 15% carbohydrate-electrolyte mixture. [Galloway SDR & Maughan RJ. The effects of substrate and fluid provision on ermoregulatory and metabolic responses to prolonged exercise in a hot environment. Journal of Sports Sciences, Vol 18, No5, pp339-351]

Seven Rules of Hydration

1. The rate of passage of water from your stomach into your small intestine depends on how much fluid is actually in your stomach. If there is lots of water there, fluid flow from stomach to intestine is like a springtime flood; if there is little water, the movement resembles a lightly dripping tap. Therefore, to increase stomach-intestinal flow (and overall absorption of water) you need to deposit a fair amount of liquid in your stomach just before you begin your exercise. In fact, 10-12 ounces of fluid is a good start. This will feel uncomfortable at first, so practice funneling this amount of beverage into your "tank" several times before an actual competition.

2. To sustain a rapid movement of fluid into your small intestine during your exertions, take three to four sips of beverage every 10 minutes if possible, or five to six swallows every 15 minutes.

3. If you are going to be exercising for less than 60 minutes, do not worry about including carbohydrate in your drink; plain water is fine. For more prolonged efforts, however, you will want the carbohydrate.

4. Years of research have suggested that the correct concentration of carbohydrate in your drink is about 5 to 7%. Most commercial sports drinks fall within this range, and you can make your own 6% drink by mixing five tablespoons of table sugar with each liter of water that you use. A bit of sodium boosts absorption; one-third teaspoon of salt per liter of water is about right. Although 5 to 7% carbohydrate solutions seem to work best for most individuals, there is evidence that some endurance athletes can fare better with higher concentrations. In research carried out at Liverpool John Moores University, for example, cyclists who ingested a 15% maltodextrin solution improved their endurance by 30 per cent compared to individuals who used a 5% glucose drink. The 15% drink also drained from the stomach as quickly as the 5% one, though many other studies have linked such concentrated drinks with a slowdown in water movement.

5. A 6% "simple sugar" drink will empty from your stomach at about the same rate as a fancy 6% "glucose polymer" beverage, so don't fall for the idea that the latter can boost water absorption or enhance your performance more than the former, and don't pay more for the glucose-polymer concoction.

6. Contrary to what you've heard, cold drinks aren't absorbed into your body more quickly than warm ones. However, cold drinks are often more palatable than warm ones during exercise, so if coldness helps you to drink large quantities of fluid while you exert yourself, then keep your drinks cool.

7. Swilling drinks during exercise does NOT increase your risk of digestive-system problems. In actuality, most gut disorders that arise during exercise are caused by dehydration, not from taking in fluid. Dehydration induces nausea and discomfort by reducing blood flow to the digestive system, so by all means keep drinking!

Water Intoxication

Intracellular fluid and interstitial fluid have the same osmotic pressures under normal circumstances. The principal cation inside
the cell is K+ (Potassium), whereas the principal cation outside is Na+ (Sodium). When a fluid imbalance between these two compartments occurs, it is usually caused by a change in the Na+ or K+ concentration. Sodium balance in the body normally is controlled by aldosterone and ADH (antidiuretic hormone). ADH regulates extracellular fluid electrolyte concentration by adjusting the amount of water reabsorbed into the blood by the distal convoluted tubules and collecting tubules of the kidneys. Aldosterone regulates extracellular fluid volume by adjusting the amount of sodium reabsorbed by the blood from the kidneys which, in turn, directly affects the amount of water reabsorbed from the filtrate.

Certain conditions, however, may result in an eventual decrease in the sodium concentration in interstitial fluid. For instance, during sweating the skin excretes sodium as well as water. Coupled with replacement of fluid volume with plain water, these conditions can quickly produce a sodium deficit. The decrease in sodium concentration in the interstitial fluid lowers the interstitial fluid osmotic pressure and establishes an effective water concentration gradient between the interstitial fluid and the intracellular fluid. Water moves from the interstitial fluid into the cells, producing two results that can be quite serious:

- The first result, an increase in intracellular water concentration, called overhydration, is particularly disruptive to nerve cell function. In fact, severe overhydration, or water intoxication, produces neurological symptoms ranging from disoriented behavior to convulsions, coma, and even death.
- The second result of the fluid shift is a loss of interstitial fluid volume that leads to a decrease in the interstitial fluid hydrostatic pressure. As the interstitial hydrostatic pressure drops, water moves out of the plasma, resulting in a loss of blood volume that may lead to circulatory shock.