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Ertuğrul GENÇAY
Faculty of Sports Sciences, Istanbul Yeni Yüzyil University, Turkey

Selçuk GENÇAY
Faculty of Sport Sciences, Kahramanmaras Sutcu Imam University, Turkey

Corresponding Author:
Ertuğrul GENÇAY
Faculty of Sports Sciences, Istanbul Yeni Yüzyil University, Turkey

Effects of fluid ıntake and loss on performance ın athletes: A systematic review

Ertuğrul GENÇAY and Selçuk GENÇAY

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Abstract
Drinking enough fluids is an important part of a sports diet. Because adequate hydration helps performance and protects the organism against medical hazards. Most of the information about fluid intake often causes confusion about what to drink, when and how much. 15-20 years ago, it was said that fluids should not be consumed before or during exercise. However, today, it is stated through excessive commercial advertisements that sports drinks should be used as much as possible (7).
As it is known, approximately 60% of the human body is water, and it is stated that when this water balance is disrupted by water loss, performance is affected and even death may occur if the water loss is too much (14).
The aim of this study, which was carried out with the literature review method; It aims to reveal the fluid intake of athletes and the effects of loss on performance, the changes in the organism due to fluid loss, the amount, content, timing and similar features of the fluid to be taken.

Keywords: Fluıd intake, fluid loss in athletes, sports drink

1. Introduction

1.1. Physical Activity and Water Metabolism

Two hormones regulate the body's water balance and extracellular fluid volume. These are ADH (Antidiuretic hormone) and aldosterone. When the body loses water (for example, through sweat, urine and diarrhea), if the lost water is not replaced, the blood plasma becomes hypertonic. Even an increase in blood osmolarity to just 3 mosm/L reduces ADH discharge from the hypothalamus and the posterior lobe of the pituitary. At the same time, the feeling of thirst leads to the completion of body water [20].
During physical exercise, ADH release gradually increases and shows a continuous secretion. This ensures the reabsorption of more water from the kidney tubes. However, this situation varies depending on the type of exercise. Secretion increases during short exercises, and decreases during long exercises.
The effectiveness of the ADH response is determined at the beginning of exercise by the decrease in urine volume. During long-term exercise in a hot environment, urine volume may increase due to increased catabolism and the secretion of cortisone, which has a diuretic effect [11].

1.1.1. Feeling of Thirst

Any factor that causes intracellular dehydration generally causes a feeling of thirst. The most important reason for this is the increase in the osmolar density of the extracellular fluid. Another reason is the loss of too much potassium from the body. Almost everyone feels that their mouth is dry when they are thirsty. Presumably, the same factors that stimulate the thirst center also cause dry mouth. Therefore, we can conclude that dry mouth and feeling of thirst are the same thing. However, contrary to this idea, in experiments conducted, it was observed that people whose dry mouth was relieved felt thirst again after 10-15 minutes, and this situation continued until the need for water was satisfied [12].
In this regard, the thirst mechanism is insufficient to fully compensate for its loss. If 200 grams

of water is lost per hour, it compensates for 95% of the water loss caused by the feeling of thirst. If the hydric loss reaches 500 grams per hour, it can compensate for 75% of the loss, and if it is 750 grams per hour, it can compensate for 55%. Thus, after exercises in which excess water is lost, the thirst mechanism does not prevent water loss. Therefore, one should drink more water than necessary [11].

The voluntary desire to drink water normally manifests itself when water loss is 1% of body weight. If more than 2% of body weight is lost during long-term exercise in a hot environment, circulation and thermogulatory functions will be negatively affected.

1.2.1. The Importance of Water in the Organism

Water is the most basic element for human life after oxygen. Although humans can survive for weeks without food, they can only survive for a few days without water(2,5,14,19). Even a 2% decrease in body weight due to water loss causes a decrease in work capacity. A 5% loss leads to a state of "delirium". A 10% loss may cause death [14].

The water content of the human body varies between 42-72% depending on age and gender. On average, 59% of an adult human is water. 60% of the water in the body is inside the cell and 40% is outside the cell.

1.2.2. Functions of Water

The main functions of water are digestion, absorption and transportation of nutrients, transportation of wastes resulting from the metabolism of nutrients in cells to the kidneys, control of body temperature, lubrication of joints and transportation of electrolytes [5, 17].

All elements of the human body, except bones, skin, connective tissues and lipids, exist as solutions in water. Biochemical reactions in cells occur in this solution [6].

1.2.2.1. Thermoregulation Function of Water

The meaning of thermoregulation in sports is the process of keeping the body temperature unchanged (stable) against temperature changes due to exercise [23].

During physical activity, heat appears as a product of muscle contraction. While most of this heat is lost to the environment, body temperature reaches dangerous levels, which negatively affects exercise performance. It increases the risk of fatigue and causes cramps. It can cause heat exhaustion, heat stroke and death. In order to avoid such effects, the body's sweating mechanism is activated and high heat is dissipated.

Thermoregulation is met by a balanced loss of heat production (thermogenesis) and heat loss mechanisms in the body. Heat problems occur when the body's cooling mechanism, one of the heat regulation mechanisms, cannot reduce the excessive heat production that occurs during sports. This is an inevitable situation in athletes.

One of the main functions of water is to maintain body temperature. If the athlete's body has enough water, the cooling mechanism works well. The heat removed from the body with one liter of sweat is approximately 580 kcal 1 [20, 23].

In long-lasting sports (such as marathons), the body temperature may reach 38-40 C when measured orally. If there were no thermoregulation mechanism in the body, body temperature would increase by 1 C in 5 minutes of exercise. In this regard, temperature balance is of great importance in long-term sports such as marathons.

1.3. Water Requirements and Sources Fluid Balance During Exercise (21)

Leaving Water Entering Water
With stool - 150 ml Metabolic water - 350 ml
By expiration - 800 ml Water in food - 750 ml
With sweating - 3000 ml Water from liquids - 3350 ml
With urine -700 ml
Total: 4650 ml Total: 4650 ml
Normal Daily Water Balance 21.
Leaving Water Entering Water
With stool - 150 ml Metabolic water - 350 ml
With sweating - 500 ml Water in food - 750 ml
With urine - 1250 ml Liquids - 1200 ml

The body's water needs are generally met from three main sources: metabolism, food and drinks.

Metabolic water: It is formed as a result of the metabolism of nutrients. The amount of metabolic water varies depending on the composition of the diet. A high amount of carbohydrates in the diet increases the amount of metabolic water(5). 1 gram of carbohydrate holds approximately 3 cc of water1. An adult person takes an average of 1200 ml of water with drinks. The average amount of water taken with food and fresh fruits and vegetables is 750 ml.

1.4. Dehydration

The loss of water by the organism is called dehydration. There are two types: acute and chronic. Both are important in sports. During exercise, more or less water is lost through sweat depending on the intensity, duration and ambient temperature of the exercise, and if this loss is not compensated, a condition called acute dehydration occurs. Thus, if acute dehydration lasts longer than 24 hours, chronic dehydration occurs1. Replacing the fluid lost as a result of dehydration is called rehydration. Dehydration is divided into 3 types according to the fluid and electrolytes lost.

1. Isotonic: Water and salt loss are equal.
2. Hypotonic: Salt loss is greater than fluid loss.
3. Total body Water decreased 13.

1.4.1. Symptoms of Dehydration and Its Effects on Performance

The following changes occur in the organism as a result of dehydration:

1. Blood volume decreases.
2. Rectal temperature increases.
3. The heart rate increases.
4. Exhaustion occurs early.
5. The time to sustain the effort becomes shorter (Endurance) [15].

Moreover; Dehydration reduces both aerobic and anaerobic capacity. Especially in individual sports where weight is taken into consideration, methods of losing weight through dehydration are resorted to before the competition day. It has been determined that with this weight loss in the form of acute dehydration, the maximal work capacity is shortened, maxVO2 is reduced and performance is impaired [1].

When water loss of 3% of body weight is reached, undesirable conditions such as decreased muscular endurance time and strength occur. These problems are especially important for sports that require weight control such as wrestling, boxing and gymnastics [14, 22].

Studies examining the effect of dehydration and subsequent rehydration on isometric and isotonic exercises show that

following the loss of 4% of body weight due to dehydration, muscle endurance time is 3% shorter during isometric exercises and 29% shorter during isotonic exercises. 4 hours after rehydration, dehydration It has been shown that by ingesting a volume of fluid equal to the weight lost, isometric and isotonic endurance times are 13% and 21% below their previous levels, respectively [21].

Dehydration not only affects characteristics such as strength, aerobic and anaerobic capacity, but can also cause a decrease in mental responses. It has been found that, following dehydration, the rifle aimer's accuracy rate drops 15% to 20% below control scores [21].

1.4.2.The Effect of Dehydration on Blood Electrolyte Balance

Approximately 60% of body weight is water and is distributed in extracellular and intracellular compartments. In both sections, water is in balance both in quantity and composition. When water is lost with exercise, fluid is transferred to the tissues within the veins and hemaconcentration develops. Then, with compensated functions, a state of balance occurs again between intravascular and extravascular fluids.

There is no change in the electrolyte distribution in intracellular and extracellular fluids under normal conditions, but disruptions in electrolyte balance may occur after intense and long-term exercises [14].

During long-term exercises, attention should be paid to balancing the missing electrolytes along with fluid intake. If these electrolytes are not taken with fluid, they cause hypotonic dehydration, which further increases performance loss. On the other hand, if only minerals are taken without taking water, these will be thrown out with additional water, causing a new loss of performance [8].

The most important electrolyte that plays a role in the distribution of water between parts of the body is Na+. In the extracellular fluid, Na+ and Cl are high and K+ (potassium) is low. Inside the cell, K+ is more, Na+ and Cl - is less. After exercises, K+ concentration in the extracellular fluid increases [2, 14, 26].

There is no significant change in the density of Na, Ca, and Cl ions.

Potassium is an effective electrolyte in the organism. These effects can be listed as carbohydrate metabolism, protein metabolism, muscle neuronal stimulation and contraction.

According to the findings obtained by Aydos *et al*. in the blood parameters of wrestlers as a result of rapid weight loss of 5%, a significant change in extracellular electrolytes occurred in potassium with a 10.85% increase in extracellular density [4].

1.5. Sports Drinks

1.5.1. Characteristics of Sports Drinks

It is very important for athletes to consume beverages during exercise to stay healthy and achieve optimal performance. Consuming liquids containing carbohydrates provides significant benefits, especially during long-term exercises in hot weather. These drinks reduce the stress that may occur in the circulatory system by reducing dehydration caused by excessive sweating. A small amount of water that does not contain carbohydrates is absorbed directly from the stomach, and the water and sugar ratio of the drink is of great importance in absorption.

Studies on the effects of fluid consumed during exercise reveal how consumed fluid affects the passage from the stomach to the intestine. These studies show that the carbohydrate content of the drink greater than 2.5% delays gastric emptying. Üstal and his colleagues measured the gastric emptying rates of subjects who consumed drinks and water containing 10%, 5%, and 2.5% carbohydrates during the rest period after consuming these drinks. As a result, they found that the gastric emptying rates of drinks containing 10% and 5% carbohydrates were slower than those of 2.5% drinks and water [23].

The speed at which the consumed liquid leaves the stomach is very important. This liquid is part of the absorption process and the rate of absorption through the small intestine membrane is also important. Therefore, complete absorption of the consumed liquid should be taken into consideration. The speed at which any beverage clears the stomach; It depends on excitement, menstrual cycle, environmental conditions, amount, temperature, sodium content and pH of the drink [10].

Sports drinks are commercial solutions containing fructose, glucose, glucose polymers or a combination of these in powder or liquid form. The most commonly used ones are those that provide fluid and electrolytes [18, 23]. Since minerals such as sodium, potassium and chlorine are generally lost due to sweating during sports, these drinks are supplemented with minerals as well as carbohydrates [23].

Carbohydrate and mineral concentrations in one liter of sports drink are as follows [23].

Glucose 25 g/l
Sodium 20 mmol/l
Potassium 2.5 mmol/l
Chlorine 15 mmol/ l

Sports drinks should be cold (4-10 C). If consumed cold, they are absorbed more quickly from the stomach into the blood. 3,23. The presence of sodium in sports drinks increases water absorption from the intestine. Oral rehydration solutions used in clinics in cases of diarrhea contain sodium and glucose together. Because both together are effective stimulants of fluid absorption. This is the physiological reason for the combined use of glucose and sodium [10, 16].

While glucose and glucose polymers stimulate the absorption of water from the intestine, fructose, which is absorbed more slowly than other sugars, does not stimulate the absorption of water from the intestine. In this regard, fructose consumption during exercise does not increase performance [10].

Milk should be consumed as a nutrient, not as a sports drink. Because milk contains protein, when consumed in large amounts, it reduces the endurance of the athlete. It also increases the body's water need. The milk sugar (lactose) contained in milk lowers blood sugar. In this regard, milk as a food should not be taken more than 2 glasses a day [24].

1.5.2.When and How Much Water Should Athletes Take?

The easiest way to determine whether sufficient fluid is consumed is to monitor urine. Light colored urine indicates adequate hydration status. Dark urine is concentrated with metabolic wastes and indicates dehydration.

Sufficient fluid supply is important for those who do sports both for leisure and competition. Because the fluid in the blood carries O2 to the working muscles and removes lactic acid from the muscles. However, sweating is minimal in those who do low-intensity sports for less than 1 hour for leisure purposes. In this regard, they do not have to provide as much fluid as those who do long-term and intense sports. Since walking 2-3 km, cycling for pleasure or playing volleyball for 30-40 minutes for fun cannot cause excessive dehydration,

adequate daily fluid intake should be maintained by controlling urine color. If more than 2000 kcal of energy is consumed per day, the rule of "drink eight glasses of water a day" is correct.

1.5.2.1. Fluid Intake Before Exercise

You should drink 1-2 glasses of water 15 minutes before you start working out. This water will wait to be used. By drinking only water or sugar-free liquids 0-15 minutes before exercise, fat metabolism will increase, thus preventing depletion of muscle glycogen [7]. The use of sports drinks before exercise is to ensure that glycogen stores reach maximum saturation. Especially in endurance exercises, starting to drink high-carbohydrate fluids three days before the competition is effective in terms of satiety [18].

1.5.2.2. Hydration During Exercise

During exercise, approximately one glass of fluid should be consumed every 20 minutes. Water is the popular drink and is suitable for workouts lasting less than an hour. However, for longer exercises, care should be taken to consume carbohydrates along with water. Carbohydrate is provided by polymers of glucose and sucrose added to water [7, 18].

Depletion of stores of Na, K, and other electrolytes lost through sweat is unlikely unless competing in a long-term event such as a triathlon. The main purpose of electrolytes is to increase water absorption [7]. Sports drinks are effective in weight sports where rapid recovery is important. Since the time between the weigh-in and the competition is limited, consuming carbohydrate-electrolyte fluids instead of just water after the weigh-in accelerates recovery18. Due to sweating during exercise, 2 glasses of liquid should be consumed for 500 grams of sweat [7].

1.5.2.2. Fluid Consumption After Exercise

After exercise, you should weigh yourself and replace fluid loss1, and continue fluid intake until the urine becomes light colored. Because the glycogen consumed in the muscles after exercise can be quickly replaced by carbohydrate fluid. Although beer appears to be a popular post-workout beverage, the alcohol in it has a dehydrating effect, causing significant fluid loss at a time when full hydration needs to be met. A substance called tannin, which gives a brown color, is found in beverages such as tea and coffee for reasons that athletes can easily find, especially after training, and because it is economical and quenches thirst. When tea and coffee are consumed in large quantities with a meal, tannin binds with iron and reduces the absorption of iron. This effect does not appear if consumed 1-2 hours after the meal [9]. The caffeine in the coffee drank 20-30 minutes before the competition stimulates the heart activities and the circulatory system in a short time. It is stated that it has a positive effect on muscle activity due to its positive effect on muscle activity [9].

2. Result

In this study, where the effects of fluid intake and loss on performance are stated, it can be said that the thirst mechanism that comes into play with the feeling of thirst is insufficient to completely compensate for the lost water, and in this regard, water supply should be more than the desire to drink water. It can be said that with dehydration, blood volume decreases, heart rate increases, fatigue comes early and endurance decreases. A 2% fluid loss causes mental work capacity to decrease, a 5% fluid loss causes mental memory loss. A 10% loss can lead to death. One of the most important functions of water is thermoregulation. Thanks to thermoregulation, excessive body temperature is prevented.

Under normal conditions, no significant decrease in electrolyte distribution is observed during short-term exercises, but a decrease is observed during intense and long-term exercises. The biggest loss is potassium with a rate of 10.85%. Potassium regulates neurotransmission, muscle contraction, carbohydrate and protein metabolism [4].

The quality and amount of fluid taken before and during exercise affects the rate of absorption. 1-2 glasses of water should be consumed 15 minutes before exercises, and 1 glass of water should be consumed every 15 minutes during exercise. For long-term exercises exceeding 1 hour, the fluid should contain carbohydrates, but not more than 6% density. The liquid to be drunk should be at a temperature of 4-10 C and should not be taken suddenly in large amounts.

As a result of the study; It can be said that appropriate and sufficient fluid intake before and during exercise protects and increases performance, while fluid loss negatively affects performance. For this reason, athletes should be made aware of fluid

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