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The importance of hydration in sport

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Abstract

Water is an essential constituent of living matter; and rehydration is very important for athletic performance. The body loses through sweat salt and minerals, together with water; and only water intake causes a decrease in blood sodium concentration that inhibits the nerve center that is responsible for the triggering of thirst. The aim of the study was to identify the relevant aspects of hydration in sport. The loss of 25% of the body water is incompatible with survival; and a decrease in body fluids of only 2%, a drop that is not even perceived as thirst, determines a reduction in exercise capacity by 15%, a highly significant percentage when talking about sports. Moreover, dehydration is highly correlated with fatigue.

Regarding the amounts of liquid that must be managed in a training session, they differ depending on the amount of fluid loss in each athlete. The most accurate determination method is to weigh the athlete at the beginning and at the end of training sessions; the weight variation (considering the liquids ingested during exercise) representing the amount of fluid loss. The amount of liquid that must be ingested to balance the proportion of water is 1.5/1 to 1.5 liters of fluid intake per 1 liter of liquid loss.

Key words: performance, sport, rehydration

Introduction

It is important to draw attention to the fact that the thirst of athletes is not an accurate indicator of the state of hydration of the body. The body loses through sweat salt and minerals, together with water; water intake causes a decrease in blood sodium concentration that inhibits the nerve center responsible for the triggering of thirst. The health of athletes must be a constant concern to facilitate the obtaining of athletic performance, by optimizing the functional capacity of the body (Gürses et al., 2018; Bădău & Paraschiv, 2007). Studies have shown that a water deficit up to 1.6% of body weight negatively affects health through: thermal stress, cognitive disorders, cardiovascular and functional overload of the body, occurrence of fatigue, increase in the recovery time (O'Connell et al., 2018; Logan-Sprenger et al., 2015; Lopez et al., 2011).

The aim of the study was to identify the relevant aspects of hydration in sport.

Hydration

There is a precise balance of electrolytes between the intracellular and extracellular compartments, which maintains nerve and muscle function (Von Duvillard et al., 2004; Speedy et al., 2001). Electrolyte balance is maintained by oral administration of substances containing electrolytes, while excesses are excreted by the kidney. The rate of absorption and excretion of fluids and electrolytes is mediated hormonally, basically by the antidiuretic hormone (ADH), aldosterone and the parathyroid hormone (PTH). Variations in physiological levels may cause cardiac and neurological changes. Doctors should know and carefully manage risks such as dehydration and hyperhydration, especially hyponatremia. The most important electrolyte is sodium, which is lost through sweat. Low sodium levels may lead to changes that can be exacerbated by the effects of dilution by fluid overload. Intake of potassium - another important electrolyte - also needs to be monitored due to urine and sweat losses.

Dehydration

Heat and fluid losses through stressful exercise are stressors which cause normal homeostasis in athletes. Replacing fluids reduces the risk of disorders caused by heat and improves exercise performance. More than 2% of weight loss during training sessions can affect the cardiovascular response (Wharam et al., 2006; Saunders et al., 2004). Maintaining skin perfusion and cardiac output enables cooling by evaporation through perspiration. Fluids should be consumed in quantities equivalent to losses occurring through perspiration. Athletes need to rebuild their reserves of depleted fluids by drinking large amounts of water with electrolytes (Reid et al., 2004; Saunders et al., 2004). Often, the athlete is instructed to

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"drink more than he needs." However, in recent years, hyperhydration dangers, especially in the case of non-elite athletes, have been found to gain ground. Hypo-osmolar fluid hyperhydration leads to hyponatremia, which results in many deaths among runners worldwide and especially in the US, where most of the studies on this subject have been conducted.

Optimum oral rehydration during exercise

The best way to determine the rehydration needs is weighing the athlete before and after the race. Weighing before and after training can be a guide for the body fluid needs. Training should simulate the ambient conditions of the respective race: the land, duration, etc. By regularly checking weight before and after training, the athlete will gradually learn to use subjective perceptions such as thirst, sweating and the amount of ambient conditions, and will learn to estimate the need for liquids (Dallam et al., 2005; Noakes, 2003).

This is an analog exercise scale designed by Borg. Daily water requirements for a medium size adult (70 kg) is about 2 liters plus the losses related to training. The recommendations are mixed benefits of prehydration 1-2 (235 ml) glasses of water, 2 hours before, and ½-1 (115 ml) glass before training. Although this is only intuitive sense, most liquids could be eliminated through the urine, draining the body of sodium. Other 150-300 ml of water are needed for every 15-20 minutes of exercise, but this may be variable. Post-workout, water supply is required, about 1-1.5 liters of water for every kilo lost.

Regarding the amounts of liquid that must be managed in a training session, they differ depending on the amount of fluid loss in each athlete. For example, an athlete who weighed 72 kg before exercise, weighs around 71.5 kg after exercise, with 0.5 liters of drinking water for the duration of the session, one liter of liquid lost. The amount of liquid that must be ingested to balance the proportion of water is 1.5/1 to 1.5 liters of fluid intake per 1 liter of liquid lost. Since the competitor in the example above only had 0.5 liters of liquid in practice, he is found at the end of workout in a state of dehydration to be compensated with an input of a further 1 liter of liquid.

Prevention and treatment of dehydration

The first treatment line is represented by oral rehydration. Minor dehydration is best treated with an oral rehydration solution containing electrolytes such as beverages dedicated to athletes. Aqueous mixtures of salt, sugar and water would have to be administered orally. The optimum concentration for efficient gastric emptying to reach osmotic equilibrium is available in the form of sports drinks marketed by companies specialized in their production such as the Multipower Company. However, these sports drinks might not have enough sodium, because if they were equivalent to the levels of sodium sweat losses, they could be unpleasant to taste. Most soft drinks contain little or no sodium, affecting the osmotic balance and do not help the body to recover the losses during training (Shirreffs et al., 2004). The rehydration strategies can be simple: after a workout, rehydration can be performed with milk, which is rich in electrolytes.

Sports drinks contain, in principle, a suitable carbohydrate (6%) to optimize absorption in the intestine after gastric emptying. Emergency medical care should be applied in more severe cases, e.g. fainting, loss of consciousness, altered mental status, or persistent nausea accompanied by vomiting. These symptoms require intravenous rehydration. Rehydration solutions, either oral or IV, must contain electrolytes to replace sweat losses or renal excretion. Generally, only prolonged workouts that exceed 60 minutes require rehydration through drink consumption. With little effort, suitable electrolytes and calories should be administered to a balanced diet, while excess can be detrimental. Juices (juices, water, not only sugar and food coloring) or milk, and sports drinks can fill the void left by the lost electrolytes and can saturate the muscle glycogen (Table I).

Hyperhydration and hyponatremia

Hyponatremia occurs in a very high proportion of marathon runners and may be severe, especially in runners that are not performant. The use of NSAIDs may increase the risk of hyponatremia. Ultra-marathon supplements may require the use of salt. Attempts to charge water are useless, because water is generally eliminated in the urine, leading to depriving the athlete of more valuable salts. In recent marathons, it was attempted to use water in combination with glycerol and isomers; however, this technique, although legal in international competitions, has not yet been fully assessed regarding the safety of athletes (Ayus et al., 2005; Hew et al., 2003).

Table I

The composition of the beverage replete (personal contribution of Dan Costin)

Beverages	Sodium (mg/100 ml)	Potassium (mg/100 ml)	Carbohydrates	Observations
Gatorade	46	12.5	5.8	
Skimmed milk	50-55	140-170	5.4	It contains a variety of animal fat Proteins = 3.5 g/100 ml
Chocolate milk	75-85	135-175	11	Proteins = 3.3 g/100 ml
Isodrink	28	5	3.1	
Water from Bucharest	2.99	2.99	0	
Amino Vital	4	15	1.7	Amino acids – 308 mg/100 ml
Coca Cola	9-10	negligible	11	
Perla Harghitei	8.22	1.67	0	
Orange juice	0	188	11	

The symptoms of hyponatremia

Amateur endurance runners are in the greatest danger of dehydration, especially those who are not ahead in the competition, but those behind the group of runners, who spend several hours in the heat. Performant athletes will complete a marathon before they become too exhausted, while amateur athletes may require several hours to complete it (Orchard et al., 2006). Recent reviews have reported a high incidence rate of hyponatremia in different runners who finished the marathon (Halperin et al., 2005; Peate, 2005). Participants should also be advised on strategies for cooling, instead of drinking too much water. For example, some runners bear a white cap containing ice cubes to reduce the temperature of the body. Obstacles to perspiration such as inappropriate clothing or using too much sunscreen should be avoided. Athletes should consume sodium to saturate losses. Oral foods such as pretzels or crisps are good sources of sodium, salt and fat. Some athletes would also require medicines containing salt. Guidelines suggest that marathon runners need 400-800 mg of sodium per hour during heating and hot weather conditions (Coyle, 2004; Montain et al., 2006).

Athletes must also be advised that urination may continue even in a state of dehydration if hyponatremia develops while the body tries to hemoconcentration.

Conclusions

1. Consequently, thirst is quenched by lowering blood serum sodium, before fluids are repleted at an optimum level. This physiological mechanism is that water is not the ideal rehydration fluid in sports.

2. A suitable rehydration solution contains 6% glucose (energogenic role during effort) and a small amount of sodium chloride (salt). A solution with a higher glucose concentration decreases the rate of absorption of fluid in the intestine, as well as an osmotic solution that is too concentrated.

3. The most accurate determination method is to weigh the athlete at the beginning and at the end of the training sessions; the weight variation (considering the liquids ingested during exercise) represents the amount of fluid loss.

4. The amount of liquid that must be ingested to balance the proportion of water is 1.5/1 to 1.5 liters of fluid intake per 1 liter of liquid lost.

5. It is recommended that the training sessions contain several rehydration breaks every 15 to 20 minutes, when the athlete may be given 150-200 ml fluid intake.

6. Administration of larger quantities of fluids at rare time intervals is not recommended because it exceeds the intestinal fluid absorption rate.

7. The administration of rehydration fluids during the training sessions is beneficial for sports performance and may prevent fatigue.

Conflicts of interest

There are no conflicts of interest.

References

Ayus JC, Arieff A, Moritz ML. Hyponatremia in marathon runners. N Engl J Med. 2005;353(4):427-428.

Bădău D, Paraschiv F. Jocurile sportive: teorie și metodică. Ed Univ „Transilvania" din Brașov, 2007.

Coyle EF. Fluid and fuel intake during exercise. J Sports Sci. 2004;22(1):39-55. DOI:10.1080/0264041031000140545

Dallam GM, Jonas S, Miller TK. Medical considerations in triathlon competition: recommendations for triathlon organisers, competitors and coaches. Sports Med. 2005;35(2):143-161. DOI:10.2165/00007256-200535020-00004

Gürses VV, Ceylan B, Sakir M, Baydil B, Al Hussein H, Bădău D. Dehydration and Acute Weight Gain of Athletes Before Sport Competitions. Rev Chim. 2018;69(11):3196-3198.

Halperin ML, Kamel KS, Sterns R. Hyponatremia in marathon runners. N Engl J Med 2005;353(4):427-428.

Hew TD, Chorley JN, Cianca JC, Divine JG. The incidence, risk factors, and clinical manifestations of hyponatremia in marathon runners. Clin J Sport Med. 2003;13(1):41-47.

Logan-Sprenger HM, Heigenhauser GJF , Jones GL, Spriet LL. The effect of dehydration on muscle metabolism and time trial performance during prolonged cycling in males. Physiol Rep. 2015;3(8). pii: e12483. doi: 10.14814/phy2.12483.

Lopez RM, Casa DJ, Jensen KA, DeMartini JK, Pagnotta KD, Ruiz RC, Roti MW, Stearns RL, Armstrong LE, Maresh CM. Examining the influence of hydration status on physiological responses and running speed during trail running in the heat with controlled exercise intensity. J Strength Cond Res. 2011;25:2944-2954.

Montain SJ, Cheuvront SN, Sawka MN. Exercise associated hyponatraemia: quantitative analysis to understand the aetiology. Br J Sports Med. 2006;40(2):98-105. doi: 10.1136/bjsm.2005.018481.

Noakes T. Fluid replacement during marathon running. Clin J Sport Med. 2003;13(5):309-318.

O'Connell SM, Woodman RJ, Brown IL, Vincent DJ, Binder HJ, Ramakrishna BS, Young GP. Comparison of a sports-hydration drink containing high amylose starch with usual hydration practice in Australian rules footballers during intense summer training. J Int Soc Sports Nutr. 2018;15(1):46. doi: 10.1186/s12970-018-0253-8.

Orchard JW, Fricker PA, White SL, Burke LM, Healey DJ. The use and misuse of performance-enhancing substances in sport. Med J Aust. 2006;184(3):132-136.

Peate WF. Hyponatremia in marathon runners. N Engl J Med 2005;353:427-428. DOI:10.1056/NEJM200507283530424.

Reid SA, Speedy DB, Thompson JM, Noakes TD, Mulligan G, Page T, Campbell RG, Milne C. Study of hematological and biochemical parameters in runners completing a standard marathon. Clin J Sport Med 2004;14(6):344-353.

Saunders MJ, Kane MD, Todd MK. Effects of a carbohydrate-protein beverage on cycling endurance and muscle damage. Med Sci Sports Exerc 2004;36(7):1233-1238.

Shirreffs SM, Armstrong LE, Cheuvront SN. Fluid and electrolyte needs for preparation and recovery from training and competition. J Sports Sci. 2004;22(1):57-63. DOI:10.1080/0264041031000140572.

Speedy DB, Noakes TD, Schneider C. Exercise-associated hyponatremia: a review. Emerg Med (Fremantle) 2001;13(1):17-27.

Von Duvillard SP, Braun WA, Markofski M, Beneke R, Leithauser R. Fluids and hydration in prolonged endurance performance. Nutrition. 2004; 20(7-8):651-656. doi:10.1016/j.nut.2004.04.011.

Wharam PC, Speedy DB, Noakes TD, Thompson JM, Reid SA, Holtzhausen LM. NSAID use increases the risk of developing hyponatremia during an Ironman triathlon. Med Sci Sports Exerc 2006;38(4):618-622. DOI:10.1249/01.mss.0000210209.40694.09.