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THE PHYSIOLOGICAL ROLE OF HYDRATION IN EXERCISE PERFORMANCE

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Abstract:
Water, composing almost 65% of the body, is a fundamental element for human metabolism. It has the ability to control various metabolic processes such as organising blood volume, temperature of body and muscle contractions. When a person exercises, the body temperature has to be taken under control to maintain the optimal metabolic and physiological balance which will make the physical endurance last longer. In order to achieve that, the person sweats. This process occurs as drops of water gather on skin and evaporate, taking away the heat. Thus, while sweating, there is a significant fluid loss and if the body doesn't have as much water as it needs, then the risk of dehydration happens which lead to serious systematic problems of metabolism that cannot function properly. Therefore, the hydration carries a great importance in exercise performance.

Keywords: hydration, exercise performance, athlete's performance, health

1. Introduction

Air temperature, air humidity and heaviness of exercise are factors affecting the loss of body fluid. To maintain the metabolic balance, the person must consume fluids. In this way, the heat stress risk and possibility of underperformance caused by lack of fluid can be decreased and muscles can function normally. Dehydration on a serious level affects every physiologic system in a person's body. The amount of risk these systems are under depends on the severeness of dehydration. Alterations in thermoregulatory,

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cardiovascular, plasma, gastrointestinal, endocrine, muscular, and metabolic responses may be affected by dehydration. (Casa, 1999)

1.1. Physiologic Effects of Dehydration

Thermoregulatory system in human body may be affected from dehydration. (Sawka, Montain, Latzka, 1996; Sawka, Young, Francesconi, Muza, Pandolf, 1985; Adolph, 1947)In one study, subjects that were dehydrated by 8% of their weight were examined. It was stated in the study the dehydrated subjects showed less heat tolerance than normal. In addition, the subjects showed signs of tiredness at low body temperatures. (Sawka, Young, Latzka, Neufer, Quigley, Pandolf, 1992).Although most athletes do not dehydrate at such high level as 8%, the result to gain from this study is the close relation between dehydration and heat tolerance. (Casa, 1999)

Approximately 65% of a person's body consists of water. This fluid may be divided into two categories as extracellular fluid which include plasma and interstitial and intracellular fluid. (Greenleaf and Morimoto, 1996) A hydrated person's body weight would contain 45% of intracellular fluid, 15 % interstitial fluids and 5% plasma at the state of rest. (Greenleaf Morimoto, 1996) These amounts of fluid however may differ accordingly with the state of hydration/dehydration, exercise and heat stress. Thus, hydrostatic and osmotic pressure in one's body may be altered. (Greenleaf and Morimoto, 1996; Senay, 1979; Casa, 1999)

When an athlete has lost body fluid by sweating, the body is under the effect of plasma hyperosmolality. This is a result of sweat being hypotonic compared to plasma. (Sawka and Pandolf, 1990) And the percentage of intracellular, interstitial fluid and plasma in the body may change with the effect of this situation. Dehydration that is not at a severe level, affects mainly the loss of extracellular fluid. (Costill, Cote,Fink, 1976; Durkot, Martinez, Brooks-McQuade, Francesconi, 1986) However, intracellular fluid is influenced as the dehydration gets more severe. These fluids are mostly lost from muscles and skin. (Sawka and Pandolf, 1990; Casa, 1999)

There are 2 main hypotheses that indicate the relationship between thermoregulatory system and hyperosmolality. (Casa, 1999) The first hypothesis suggests the interstitium's serious effect of osmotic pressure. (Nielsen, Hansen, Jorgensen, Nielsen, 1971) The second hypothesis, on the other hand, argues the strong effect of brain regulation. Brain regulation is considered to have a greater impact on the issue. The center of thermoregulatory system is located in hypothalamus. The neurons encircling these centers are known to be easily affected by osmolality. (Nakashima, Hori, Kiyohara, Shibata, 1984; Silva and Boulant, 1984) Along with all its metabolic functions, a person's body can also detect even the unnoticeable alterations happening internally and react to it as necessary. (Casa, 1999)

1.2. Dehydration and Performance

There are several studies searching the impact of dehydration on athletic performance. However, there are differentiating results. While some of these studies suggest that dehydration reduces the performance, some suggest that it does not affect it. (Bosco, Terjung, & Greenleaf, 1968; Webster, Rutt, Weltman, 1990; Ahlman and Karvonen, 1961; Saltin, 1964) The studies defending the decrease show that dehydration of more than 5 % of body weight is likely to affect an athlete's performance. (Sawka, Montain, Latzka, 1996; Adolph, 1947) It is also stated that limitation of fluid intake is more likely to influence the performance compared to dehydration through exercise and heat stress. (Sawka, Montain, Latzka, 1996) The muscle strength focused studies on the other hand show more consistent results. (Casa, 1999) A general outcome of these researches state that, in terms of muscle strength, an athlete's performance is reduced when dehydration is 3% or 4 % of body weight. However, there are researches showing different results and argue that dehydration even at a higher level may not at all affect muscle strength. (Sawka, Montain, Latzka, 1996; Adolph, 1947; Casa, 1999) The studies about the aerobic power and physical work capacity also show similar outcomes. When dehydration reaches a level of 2-3% decrease of body weight, maximal aerobic power is likely to be reduced. In addition, when the athlete exercises in a hot environment, this reduction exceed to greater percentages. (Sawka, Montain, Latzka, 1996; Casa, 1999) According to the great majority of the studies, physical work capacity also shows similar conclusions. Physical work capacity decreases even when the body is in under hypohydration of 1-2 % < in a cool place. (Caldwell, Ahonen, Nousiainen, 1984; Armstrong, Costill, Fink, 1985) The same situation occurs when the athlete is heavily exercising in a hot environment and is dehydrated by less than 2% of body weight. (Pinchan, Gauttam, Tomar, Bajaj, 1988; Walsh, Noakes, Hawley, Dennis, 1994) Dehydration and physical work capacity demonstrate a inverse relationship. The more dehydrated a person, more her/his physical capacity decreases. (Casa, 1999) When dehydration reaches to a more serious level, the athlete is likely to demonstrate nausea, vomiting, diarrhoea and similar problems related to stomach and intestinal. (Buskirk and Puhl, 1996) However, it must be noted that heaviness and period of exercise, the environmental factors and personal variables affect physiologic changes. (Casa, 1999)

1.3. Fluids for Hydration

Performance of an athlete depends on various parameters including dehydration. There are various fluids to get hydrated and the types of these fluids also known to affect performance. (Meigs, Osborne, Smyth, Bailey, 2017)After exercising, the body loses fluid through sweating and it is in need of electrolytes such as sodium. (Ismail, Singh, Sirisinghe, 2007) Sodium is an important electrolyte since it is fundamental for the extracellular fluid. Potassium, being important to the intracellular space, is also considered to be a significant electrolyte. (Nadel, Mack, & Nose, 1990) These are lost during sweating and need to be replaced. (Ismail, Singh, Sirisinghe, 2007)

1.3.1. Water

Plain water is the most common drink to restore the fluid. It has a great role in organising heart rate, blood volume, stroke volume and cardiovascular functions.

(Danielson, 2006) It is particularly preferable when consumed during light workouts or exercises of short periods. Still, plain water is lack of the electrolytes and carbohydrate and may not be considered enough for heavy and long exercises.

1.3.2. Sodium-enriched Coconut Water

Coconut water is a more recently used fluid for rehydrating. It is known to carry the necessary electrolytes. (Ismail, Singh, Sirisinghe, 2007) While the sodium level inside is not as much as commonly used sports drink, coconut water includes a large amount of potassium. (Iqbal, 1976) A study was conducted on sodium-enriched fresh coconut water to observe its effectiveness after exercise compared to plain water, coconut water and sports drinks. (Ismail, Singh, Sirisinghe, 2007) The results revealed that when the dehydrated subject rehydrated with these fluids after exercise, after 2 hours, the percentage of rehydration was higher with the subject that consumed sodium enriched coconut water. (Ismail, Singh, Sirisinghe, 2007)

1.3.3. Sports Drinks

A sports drinks contains carbohydrate, electrolytes, flavour and sometimes other ingredients such as vitamins, minerals etc. Carbohydrates are energy providers for body, especially for muscles. For instance, ATP may be formed as muscle cells demolish glucose. The generated ATP supplies the necessary energy to the athlete. (Meigs, Osborne, Smyth, Bailey, 2017)A study comparing water and Gatorade(sports drink) stated that Gatorade provided glucose and that way the body used that glucose to find new energy instead of using its own stored one, the glycogen. (Ellingwood, 1993) Therefore, it is considered to be a factor for athlete performances. Carbohydrates and water are absorbed through intestines if the density of carbohydrates is under 8%. Fructose, a type of carbohydrates, is sometimes put inside sports drinks to increase the absorption. As for electrolytes, sports drinks are rich in sodium and potassium. The amount of sodium included in sports drinks is generally around 10-25 mmol/L. Absorption of water and carbohydrate is affected by sodium. It also increases thirst and the athlete is likely to consume more fluids. Another ingredient in a sports drink is flavour. It gives the fluid a pleasant taste and encourages the athlete to drink.

1.4. Fluid Control

Over-hydration is a situation that is not commonly seen, however it can happen. When an athlete exercises lightly or in a cool environment, he/she doesn't sweat on a high level. Therefore, dehydration is little. In this case, consuming an amount of fluid far more than the amount of fluid that was lost, would not benefit the body. In fact, with as sodium density in blood gets lower, it might cause certain problems such as headaches, problems with orientation, coma and even death. Still, this is a rarely seen situation.

2. Conclusion

Dehydration is an important factor that affects athlete's performance and health. The athlete must be hydrated before starting the exercise and consume fluid on a regular basis based on the sport. The amount and type of drink is important, and it must be decided depending on the duration and type of sport and personal factors.

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