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THE SIGNIFICANCE OF WATER IN SPORT AND WEIGHT CONTROL

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ABSTRACT

Intake of food and drink during exercise can be effective in enhancing performance, in so far as it prevents or ameliorates exercise-induced changes to body homeostasis. Loss of body fluids containing water and electrolytes during exercise is mostly by sweating.

Sweat rates during a sporting event or activity will vary according to a number of factors, including the size of the athlete and his or her degree of acclimatization, the intensity of exercise, environmental conditions and the clothing worn. The mismatch of fluid intake and fluid losses may lead to a body water deficit.

It has generally been considered that decreases in performance become apparent when hypohydration exceeds 2% of body weight; that performance decrements become substantial when fluid losses exceed 5% of body weight; and that when fluid losses approach 6–10% of body weight, heat stroke and heat exhaustion become life-threatening. Hypohydration also affects mental functioning. Therefore, the effect of hypohydration on real-life sport may be greater than that shown in laboratory studies of physiological performance.

INTRODUCTION

In any sport or activity with a duration of at least 30 minutes of continuous exercise, there is a risk of impaired performance and even health damage due to hypohydration, which may be removed or at least diminished through the provision of fluids to competitors during the event.

As the duration of the sport or activity increases and the environmental conditions become hotter, then fluid intake during the event becomes more important. The chain of events leading to the conservation of body fluid balance begins with the loss of water via the faeces, urine, breath and sweating. Sweating is usually the form accounting for most water loss during exercise or high environmental temperatures. The amount of heat that can be

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removed via evaporation is approximately 580 Kcal for every litre (Kg) of sweat that evaporates.[1]

Pivarnik (1994)[2] notes that for humans, fluid replacement during exercise is largely a behavioral rather than physiological adaptation, and that thirst is not a reliable guide to the need for fluid. The major nutritional challenge during any sports event is to prevent or at least minimize hypohydration. Since several deaths per year among exercising individuals, including healthy athletes, are attributed to dehydration and/or heat stroke, attention to proper hydration is vital to life.

WATER

If water be defined as a nutrient, then it is the most important nutrient for the body. Lack of water causes the cells to become dehydrated. A total lack of water can cause death within a few days. Fifty to seventy percent of body weight is water; which constitutes 65 to 75% of the weight of muscle and approximately 50% of the weight of body fat. In the body, water is distributed in the extracellular fluid (surrounding the cells, 20–25%, is outside the cells including the vascular system); and interacellular fluid (inside the cells, 40–45%).

Water serves many important functions and acts as a solvent; a component of all body cells, giving structure and form to the body; a body temperature regulator; lubricant; medium for the digestion of food; transport medium for nutrients and waste products; participant in biological reactions; and regulator of acid-base balance.[3]

BODY WATER BALANCE

Water requirements are dependent upon many factors, including the amount of solids in the diet, air humidity, environmental temperature, type of clothing worn, type of exercise performed, respiratory rate, and the state of health. The body obtains water from beverages, foods, and small amount from metabolic breakdown of food for use by the body (oxidation of energy nutrients). Normally, approximately 2.5L of water is required each day for a fairly sedentary adult in a normal environment.

The output of water is normally balanced by input. If extra water is ingested, urinary output increases. The body maintains a steady state with respect to water content. It is lost from the body in many ways: through the kidney as urine, from skin as perspiration (sweating), from the lungs in breathing (water vapor), in the faeces, and great water losses under certain disease conditions and injury such as acute diarrhea, burns, and blood losses.[3]

The sources of water intake and output are shown in the table.[4]

Water balance in the body

Normal Temperature (little or no exercise)

Daily water input source	ml	**Daily water output** source	ml
Food	1000	Urine	1250
Fluids	1200	Faeces	100
Metabolism	350	Skin	850
		Lungs	350
Total	2550	Total	2550

Hot weather (heavy exercise)

Daily water input source	ml	**Daily water output** source	ml
Food	1000	Urine	500
Fluids	1200	Faeces	100
Metabolism	350	Skin	5000
		Lungs	700
Total	2550	Total	6300

DEHYDRATION

A deficiency or excess of water can produce harmful effects to the body. The major outcome of water deficiency is dehydration. The fluid deficit occurs from both the intracellular and extracellular compartments and can rapidly reach levels that impede heat dissipation, reduce heat tolerance, and severely compromise cardiovascular function and exercise capacity. For men and women, a pre-exercise dehydration equivalent to 5% of body mass significantly increases rectal temperature and heart rate and decreases sweating rate, Vo2 max*, and exercise capacity compared to conditions of normal hydration.[5]

Prolonged dehydration leads to cell death, and multiple cell losses kill the organism. During kidney or other disorders where the body suffers a fluid imbalance, edema, ascites, and congestive heart failure may result.

A convenient method for assessing fluid loss is through changes in body weight during exercise and/or heat stress. Each 1 lb of body weight loss corresponds to 450 ml (15 oz) of dehydration.

*Maximal oxygen uptake is the usual measure of aerobic fitness: 30–40 ml/kg/min in inactive sedentary individuals, to as high as 70–85 ml/kg/min in highly trained endurance athletes.

The most serious consequence of profuse sweating is the loss of body water. The amount of water lost depends on the severity of physical activity and environmental temperature. It is noteworthy, however, that plasma volume becomes reduced when sweating causes a fluid loss of 2–3% of body mass. This loss of fluid places a significant strain on circulatory function, which ultimately impairs the capacity for both exercise and thermoregulation. Excessive sweating can cause circulatory failure, and core temperature may rise to lethal level.[6]

DEHYDRATION AND WEIGHT LOSS

Rapid weight loss among wrestlers and body builders prior to competition in order to make their weight class is commonplace. It is generally achieved by restricting fluid and food intake leading to inadequate glycogen stores and some loss of body protein, as well as other dehydrating practices, which include the use of saunas, sweat suits, laxatives, and even spitting. The short term negative side effects include reduced muscular strength and endurance, increased fatigue, anxiety, anger and feelings of isolation, decreased plasma volume, which is associated with impaired cardiac function (i.e., higher heart rate, decreased stroke volume, and reduced cardiac output), decreased glomerular blood flow*, and, consequently, reduced filtration rate, liver and muscle glycogen depletion, increased electrolyte losses, decreased oxygen consumption and impaired thermoregulation. Weigh-in times are held close to the competition event, leaving insufficient time for rehydration and refuelling. These practices and attitudes may be a predisposition to developing an eating disorder, such as anorexia nervosa or bulimia nervosa.[7] Heat exhaustion and heat stroke are possible outcomes, particularly when fluid loss exceeds 5% or more of total body water.[8]

During heat exhaustion the thermoregulatory mechanisms are functioning, but can not dissipate heat rapidly enough, primarily owing to reduced blood flow to the skin. Symptoms may vary but usually include a temperature of less than 39.5°C, malaise, weakness, fatigue, headaches, anorexia, nausea, vomiting, diarrhoea and muscle cramps. Although irritability, anxiety and impaired judgment may be present, the subject is alert and capable of responding to questions.

However, in heat stroke the victim may be unresponsive or comatose. If left untreated, heat exhaustion can progress to heat stroke.

Heat stroke is not as common as heat exhaustion but is much more serious. It is a life-threatening disorder that requires immediate medical treatment. Following severe heat overload, the failure of the body's thermoregulatory mechanisms is present. As core temperature rises, cell function deteriorates, culminating in massive cell damage.

*Decreased blood flow through the kidneys as a result of the blood concentrating and thickening by dehydration.

Core temperature is higher than that seen in heat exhaustion, generally in the range 41–42°C and temperatures greater than 39.5°C reduce the function of motor centres in the brain and subsequently the ability to recruit motor units required for muscular activity. Exertional heat stroke is characterized by cessation of sweating, hot and dry skin, physical deterioration, confusion, collapse, and seizure.[9]

There are other physiological consequences of dehydration which are not as serious as heat illness but contribute to decreased performance capacity.

REHYDRATION

Management of dehydration consist of anticipating and preventing dehydration and, if that fails, identifying the specific type of dehydration present and treating it by administering fluids such as water or water containing electroytes. Fluid intake should commence early in the event or exercise to attenuate the development of hypohydration rather than reverse an already established condition.

During strenuous exercise the thirst mechanism may be masked and it becomes difficult to meet fluid requirements.

Elite endurance athletes, in training as well as in competition, may sweat in excess of 1.5 L/h.[10] As the rate of gastric emptying water is generally thought to be about 1 L/h, meeting water requirements under environmental conditions that promote large fluid losses is not possible. Athletes, therefore, should be encouraged to hydrate adequately before, during and after each training session. In events of 30–60 minutes duration of continuous exercise, water is probably the most economical and practical fluid, since fluid replacement is the primary need. Ideally, fluid intake should occur at regular intervals during the event, with the athlete drinking the largest comfortable quantity on each occasion (probably 150–250 ml). Cold drinks are more refreshing and palatable.

With such a pattern, it is unlikely that significant dehydration will build up over the time course of the event, and the athlete may then seek to replace full sweat losses after the event. There are, however, instances when water containing sodium and potassium is the proper hydrating agent. Oral administration of fluid and electrolytes is always preferred in mild (3–5%) to moderate (6–9%) dehydration; however, intravenous fluids may be required in cases of severe dehydration (>9%) and vomiting or if the patient is in a comatose state. When I.V. fluids are administered, 0.45% saline usually with 5% dextrose is an effective hydrating agent.

In most instances involving heavy sweating as the primary mode of fluid loss, plain water containing 1.25 g of NaCl per litre is a good rehydration solution. Increasing the concentration of NaCl to 5–6 g per litre may promote a more rapid rate of rehydration but may not be palatable for some individuals.[9]

CONCLUSION

Athletes who undertake imprudent weight loss strategies may suffer a number of problems—that is, athletes who try to change their usual body size by chronically restricting their food and fluid intake. Overweight athletes and their coaches are just as susceptible to false ideas about weight loss and dieting as the rest of the community. Inappropriate weight loss causes a loss of lean tissue and can reduce, rather than enhance, athletic performance. Thus it is important that athletes, sports coaches and others involved in training and caring for athletes understand the principles of effective and appropriate weight reduction. It is generally recommended not to use dehydrating techniques to reduce body weight to meet a weight division. There is no evidence that hypohydration benefits performance and an athlete can not adapt to chronic dehydration.

In general, any athlete undertaking an event with a duration of 30–60 minutes or more of high-intensity exercises, especially in hot weather, should consider the benefits of consuming fluids during the event to reduce the degree of hypohydration. This may be even more critical in cases where the athlete is already hypohydrated from previous exercise sessions or from methods undertaken to "make weight" for a competition weight limit.

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