What Effect Does Hydration Status Have on Physical Performance?

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Proper hydration is frequently emphasized as a crucial component of daily nutritional health. However, what impact does it have on physical performance? How can one measure hydration status? What is the most effective method to ensure your body is adequately hydrated? This article aims to explore and provide answers to these questions.

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Water constitutes about 60% of an adult male's body weight. This total water is divided among different compartments: 30% within cells (intracellular fluid), 20% in the spaces between cells (interstitial fluid), and 5% in the blood plasma. Together the previous two form the extracellular fluid. The term <span class="cursive">euhydration</span> means an individual has normal body water content, whereas <span class="cursive">hypohydration</span> means an individual has lost body water i.e. water loss in urine, sweat, feces and expired air has not been compensated by water intake. Note that a state of euhydration can't be represented as a spesific point but it rather refers to a fluctuating average (<1 % of body weight). Dehydration refers to the actual process of water loss and it can be divided into extracellular and intracellular dehydration. Extracellular dehydration occurs when fluid lost from inerstitial fluid and plasma is iso-osmotic, meaning it has the same proportion of water and electrolytes as the extracellular fluid. This results only in loss of plasma volume and it can be triggered by diuretics, clinical conditions, or hypoxia. On the other hand, intracellular dehydration occurs when the fluid is hypo-osmotic (more water than electrolytes) which results in osmotic movement of water from the intracellular space to the more concentrated extracellular space. Fluid lost through regular means, like sweating, is hypo-osmotic and thus causes intracellular dehydration. This is characterized by loss of both plasma and intracellular fluid volume.

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The most prevalent technique for measuring fluid volumes in the human body relies on what is known as the “dilution principle”. This method involves injecting a known amount of substance, defined by the formula (n = concentration x volume), into a fluid compartment. This substance will then spread throughout the compartment until the concentration is uniform. According to the conservation of mass, the quantity of the substance doesn't change during this process, and therefore n[initial] = n[final]. Thus, calculating the compartment's fluid volume is straightforward: take a sample after the substance has been dispersed and measure its final concentration (volume = n[initial] / concentration[final]). In practice, total body water is measured by injecting a stable isotope, like deuterium oxide, into the bloodstream, where it evenly disperses throughout all body water. Similarly, the volume of extracellular fluid can be determined using the same principle but with substances that distribute into both the blood and interstitial fluid, but NOT to the intracellular fluid. This method is consired as a highly accurate golden standard.

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Another approach is to just measure plasma osmolality (concentration of solutes) which, as mentioned previously, increases as the body loses water due to sweating. This technique is among the most commonly utilized due to its practicality; however, it faces criticism for a couple of reasons. First, it may lack the sensitivity required to detect low to moderate levels of hypohydration. Second, although there's a strong correlation with intracellular fluid levels it might be affected by exercise-induced fluid shifts and thus falsely indicate intracellular dehydration. Urine, saliva or tear osmolality can be used similarly. Finally, one can simply look at short term changes in body mass to estimate the level of fluid loss. When considering the detrimental effects of hypohydration on physical performance, it might be beneficial to consider changes across all body compartments, not just total body water. However, in the literature hydration status is often measured with these aforementioned methods.

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Studies indicate that a decrease in total body water by 2% of body weight can notably hinder aerobic performance, primarily through a reduction in plasma volume. This reduction leads to lower ventricular filling pressures and, as a result, decreases stroke volume and maximum oxygen uptake. Additionally, reduced blood flow to the peripheries impairs the body's thermoregulation capabilities, exacerbating the negative effect in hot environments. From this perspective one might conclude that fluid loss does not significantly affect strength or anaerobic performance. Actually, a rapid water loss leading to a decrease in body weight could increase relative strength and power output (watts per kilogram). Interestingly, there is evidence showing that non-bodyweight-dependent strength and anaerobic power actually decline with hypohydration exceeding 3% of body weight, implying that neuromuscular function might be compromised by intracellular dehydration.

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When it comes to sports-specific performance, it's crucial to examine how hypohydration influences cognitive functions. Research findings have been mixed, but it appears that significant hypohydration (3-5% body weight loss) adversely affects processing speed, alertness, and reaction times. In addition, this type of substantial fluid loss also increases rating of perceived exertion. It's worth noting that the exact mechanisms through which decreased plasma volume or increased osmolality lead to cognitive deficits are not well understood.

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So, how can you ensure optimal hydration before or during physical activity? The goal is to begin your exercise euhydrated, maintaining normal plasma osmolality, and to replace water and electrolytes lost through sweat with equivalent amounts. Given the considerable individual differences in sweating rate and sweat composition, as well as the influence of environmental temperature, universal recommendations may not suit every situation. A practical starting point is to drink 1.5-2 liters of water daily, including 0.5 liters 2-3 hours pre-exercise, and approximately 0.2 liters following the warm-up. During exercise, adjusting fluid intake to about 0.8-1.2 liters per hour (or 0.2 liters every 15 minutes), contingent on the exercise intensity and other varying factors, is advisable. For extended periods of activity, rehydration solutions containing 0.5-1.5 grams of sodium per liter can be beneficial. It is advisable for athletes to experiment with proper hydration strategies by, for example, observing urine concentrations, weight loss and mood, to optimize for individual variances.

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