Dehydration and Estrogen

Changes in body water content can exert profound effects on physiological function and performance. For example, dehydration limits sweating and heat dissipation, causing increased core temperature, reduced exercise tolerance and increased risk for heat-related injury. Sophisticated mechanisms have evolved to maintain body fluid volume and composition despite sudden fluxes in water intake or loss. These regulatory mechanisms involve reflexes within the blood vessels, brain and intestines that act to modify rates of fluid intake and fluid output. Dehydration is a normal physiological state following prolonged exercise in the heat, which leads to the loss of water and increase of sodium in the blood. This state leads, in turn, to thirst, fluid intake and sodium/water retention by the kidneys. There are a number of “fluid retention” hormones that exert a profound control over this fluid regulatory system. Hormones are substances in the body that act to promote certain activity by specific organs. The fluid regulatory hormones act primarily on the brain and kidney to control both intake and output of water and sodium. The most important hormone of this type is the antidiuretic hormone, which responds rapidly to changes in body water status, and is responsible for controlling the rate of water retention by the kidneys. To complicate matters, antidiuretic hormone regulation maybe modified by a variety of factors, one of which may be the female sex hormone estrogen.

Estrogen levels fluctuate widely throughout the normal menstrual cycle, with the major estrogen peak occurring in the early phase, days 7-13 after the start of menstrual bleeding (just prior to ovulation). In addition, estrogen is one of the most commonly administered hormones, in the form of oral contraceptives to young women, and estrogen replacement therapy to post-menopausal women. Body water retention is common in high estrogen states, such as that immediately preceding ovulation, during pregnancy, and while taking estrogen or estrogen-dominant oral contraceptives. Some of this excess water is retained in the blood vessels (i.e., in the plasma), leading to plasma volume expansion, which has potent effects on physical performance during heat stress. In fact, variations in plasma volume observed following estrogen administration and during different phases of the menstrual cycle are comparable to the effects of posture, skin temperature and exercise intensity.

There have been few studies directly examining the effects of sex steroids on body water regulation. However, early research suggests that the greater body water content in high estrogen states is likely due to changes in both water intake and output. Thirst sensation and antidiuretic hormone are more sensitive to changes in body water status in pregnant women, in whom blood estrogen levels remain elevated. In addition, fluctuations in antidiuretic hormone parallels those of estrogen throughout the menstrual cycle, and are increased following estrogen administration in postmenopausal women, suggesting that fluid retention is also likely to be increased. Thus, the combination of enhanced fluid intake and retention causes the increase in total body water content during high estrogen states.

Why is the regulation of body water important during exercise? Recall that body water content regulates sweating, and sweating provides our best method of heat loss during exercise. So, adequate body water is essential to avoid heat injury (e.g., heat exhaustion or heat stroke). The effect of estrogen on the systems that control body water during exercise is only now being studied, but there is reason to suspect that the greater water retention induced by estrogen may have beneficial effects during exercise. For example, many women find that their blood volume is greater and exercise body temperature responses lower during exercise in the heat when blood levels of estrogen are high. In support of this theory, we find that women had greater antidiuretic hormone responses during estrogen administration with oral contraceptives, compared to their responses while not on the pill. Finally, we find that estrogen administration in the form of oral contraceptives improves sweating during exercise and during body heating at rest.

These studies examining the effects of estrogen on the fluid regulatory and temperature responses to exercise in the heat in young women are ongoing. Further, estrogen affects most body systems (reproduction, cardiovascular, metabolic, central nervous system), so it would be inadvisable to use this hormone solely for the purpose of altering or improving body fluid regulation. However, women taking this hormone for other reasons, such as birth control or protection of bone content, may find an increase in water retention to be one of the more common side effects of this treatment.

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