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Dietary Considerations For Soldiers Exposed To Heat

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Abstract

Much has been written about the modification of dietary habits considered to be necessary in different climates. Most of this has little scientific background. The effect of climate on
the need for nutriment have often been exaggerated. In hot climates the body can only be maintained at an even temperature by sweating. In this paper the author summarises the dietary considerations for soldiers exposed to heat and calls attention to the risk of the excessive heat and to the possibility to avoid it.

INTRODUCTION

Living and working in the heat are associated with large turnovers of water and electrolytes in soldiers, due to high sweat. Thus, sodium and chloride losses may be twice as great in the heat as in cool environment, and potassium losses are slightly increased by heat exposure ([1]). A man at rest in an equable climate loses at least 800ml. of water daily by evaporation from the skin and lungs. This may be increased fourfold or more by the necessity to do hard physical work or in a hot environment ([14]). Although an evaluation has been made of sodium chloride requirements and the effect of its lack on performance in the heat ([9]), a similar evaluation has not been attempted for potassium. Bass et al ([2]) showed that exposure to heat may produce a relative potassium deficiency in the presence of "normal "potassium intakes (78mEq./man/day). It is possible, therefore, that more prolonged heat exposure and a consequently greater potassium deficiency could lead to decrements in performance ability.

When men are exposed to hot environments, hematocrit ratio, plasma specific gravity and plasma protein concentration decrease during the first week ([3]). These changes appear to result from an increased plasma volume ([2]) and have been observed both in man and animals ([3]).

Heat loss is dependent upon physical factors- physiological regulation. Heat is lost from the body through: radiation, convection, conduction, evaporation of water from the lungs and, raising the inspired air to body temperature, urine and feces.

Under the ordinary conditions of every day life over 95 per cent of the total heat loss occurs through radiation, convection, conduction, and evaporation of water from the lungs and skin.

A rise in temperature causes an increase in blood volume and the blood is diluted by fluid drawn into the circulation from the tissues, chiefly the skin, muscles and the liver ([4], [5]).

Blood is expelled from the spleen. At a temperature above 35°C evaporation accounts for all nearly all the heat lost from the body ([3]).

Sweat which is not evaporated but simply drips from the skin, of course does not increase heat loss. For this reason the sweating mechanism for the elimination of heat is badly crippled when the relative humidity is high. The actual concentration of nitrogen in the sweat falls, however when sweating becomes profuse, whereas the concentrations of sodium chloride and potassium rise ([3], [10]). Therefore, if strenuous work is performed for a long time in high temperature, and large quantities of water drunk, depletion of the body' supplies of chloride and a lowered concentration of this element in blood and tissues fluids result ([3]). Severe cramps occur in the muscles of the limbs and abdominal wall. In order to prevent these effects it is recommended that the thirst be quenched with salt solution, which is provided by the addition of 2 teaspoonfuls salt to the 50 gal. of water. Salt tablets are not advisable, because of their slow resorption ([4], [8,9,10,11]). When the sweating became profuse, headache, collapse and cramps has occurred in the muscles of the soldiers limbs. Since the body temperature represents the balance struck between heat production and heat loss, a disturbance in the value of one of these factors in relation to other obviously will be followed by a temperature change. In 1945 it was considered that a low protein diet is more suitable in hot weather ([4]). Alleman and Leclercq concluded that reducing crude protein content did not seem a good way to help broilers to withstand hot conditions ([1]).

Excessive heat can be an important cause of illness among merchant seaman and soldiers and at least half the cases were attributable to insufficiency of salt and water ([4], [7]). In the 'mild' cases there is collapse and syncope, which arise from circulatory disorders. Two syndromes are responsible for the 'severe' cases. The first is caused directly by salt and water deficiency. As in mild cases there is evidence of circulatory shock, but the collapse is more marked and there may be vomiting.

The muscle cramps characteristics of salt deficiency are frequently present. Anhydrotic heat exhaustion, the second syndrome, is attributable to a failure of sweat glands to secrete, due to fatigue. The principal clinical features are dizziness, palpitations, breathlessness, and lack of sleep. The 'dangerous' states are heatstroke and hyperpyrexia ([6]).Heat stroke is due to exhaustion or inadequacy of the heat dissipating mechanisms and occur as a result of exposure to a hot humid atmosphere, the hyperthermia may seriously damage the nervous tissues and prove fatal. Sunstroke is simply a form of heatstroke, but in addition to the reduction in heat loss as a result of the high atmospheric temperature there is the absorption of solar radiant energy ([4]). It is clearly important to reduce exposure as far as possible. Shade and shelter against sun are obviously desirable. It is important to arrange that no unnecessary physical work for soldiers is carried out and that, as far as possible, they do not have to work in the midday heat ([6]). An adverse climate, whether very hot or very cold imposes considerable strains, both physical and physiological, on an individual.

In cold- exposed adult humans, significant or lethal decreases in body temperature are delayed by reducing heat loss via peripheral vasoconstriction and by increasing rates of heat production via shivering thermogenesis.

Over the last decades, a number of studies have quantified the contributions of carbohydrate (CHO) and lipid to total heat generation. However, the exact contributions of these fuels still remain unclear because of large differences in fuel selection measurements even at the same metabolic rate. Recent advances on the mechanisms of fuel selection during shivering provide some plausible explanations for these discrepancies between shivering studies. This new evidence indicates that muscles can sustain shivering over several hours using a variety of fuel mixtures achieved by modifying diet (changing the size of CHO reserves) or by changing muscle fiber recruitment (increasing or decreasing the recruitment of type II fibers) ([11]).

From a practical perspective, how does the choice of fuel selection mechanism affect human survival in the cold? Based on a glycogen-depletion model, estimates of shivering endurance show that, whereas the oxidation of widely different fuel mixtures does not improve survival time, the selective recruitment of fuel-specific muscle fibers provides a substantial advantage for cold survival. By combining fundamental research on fuel metabolism and applied strategies to improve shivering endurance, future research in this area promises to yield important new information on what limits human survival in the cold ([11]).

Despite advances in the art and science of fluid balance, exertional heat illness -- even life-threatening heat stroke -- remains a threat for some athletes today. Risk factors for heat illness include: being unacclimatized, unfit, or hypohydrated; certain illnesses or drugs; not drinking in long events; and a fast finishing pace. Heat cramps typically occur in conditioned athletes who compete for hours in the sun. They can be prevented by increasing dietary salt and staying hydrated. Early diagnosis of heat exhaustion can be vital. The same occured to the soldiers of the 2nd Hungarian Army in Russia in August 1942, when the temperature was 39°C ([13]). Early warning signs include: flushed face, hyperventilation, headache, dizziness, nausea, tingling arms, piloerection, chilliness, incoordination, and confusion. Pitfalls in the diagnosis of heat illness include: confusion preventing self-diagnosis; the lack of trained spotters; rectal temperature not taken promptly; the problem of “seek not, find not;” and the mimicry of heat illness. Heat stroke is a medical emergency. Mainstays of therapy include: emergency on-site cooling; intravenous fluids; treating hypoglycemia as needed; intravenous diazepam for seizures or severe cramping or shivering; and hospitalizing if response is slow or atypical. The best treatment is prevention. Tips to avoiding heat illness include: rely not on thirst; drink on schedule; favor sports drinks; monitor weight; watch urine; shun caffeine and alcohol; key on meals for fluids and salt; stay cool when you can; and know the early warning signs of heat illness ([9]).

CONCLUSIONS

During exercise in the heat, sweat output often exceeds water intake, resulting in a body water deficit (hypohydration) and electrolyte losses. Because daily water losses can be substantial, soldiers need to emphasize drinking during exercise as well as at meals. For persons consuming a normal diet, electrolyte supplementation is not warranted except perhaps during the first few days of heat exposure. Exercise is likely to be adversely affected by heat stress and hypohydration; the warmer the climate the greater the potential for performance decrements. Hypohydration increases heat storage and reduces a person's ability to tolerate heat strain. The increased heat storage is mediated by a lower sweating rate (evaporative heat loss) and reduced skin blood flow (dry heat loss) for a given core temperature. Heat-acclimated persons need to pay particular attention to fluid replacement because heat acclimation increases sweat losses, and hypohydration negates the thermoregulatory advantages conferred by acclimation. It has been suggested that hyperhydration (increased total body water) may reduce physiologic strain during exercise heat stress, but data supporting that notion are not robust ([12]). However even in the best of management, soldiers will always be exposed to excessive heat and its consequent risks. It is essential that all exposed soldier should know these risks and how they can best be avoided. Soldiers must learn that thirst is not always a reliable guide to water requirements, nor is the natural appetite for salt always reliable.

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