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DIET AND PHYSICAL PERFORMANCE: WATER AND SALT.(U)
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Ammunition can be defined as any material used to attack or defend a position. If that position happens to include a battle against the hot and arid climate, then the primary ammunition will be water (1). Sun Tzu (a 6th century B.C. Chinese general and military theorist) put it quite succinctly when he said: "An Army that does not suffer from 100 diseases is said to be certain of victory." Heat illness is no respector of rank nor numbers. It is to the advantage of all concerned with the performance of US Forces on the modern battlefield to recognize the potentially devastating impact that heat injuries can produce. Adequate

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water intake is a singularly important factor in avoiding heat injury (2). The misconception that dehydration toughens up the troops was prevalent in the early days of WWII. T.F. Whayne (3) reported: "Line officers believed in 'water discipline' and it was thought that the drinking of water during work in the heat was harmful. Many shared the conviction that men could be trained to work in the heat on intakes of water that became lower each day, until the ideal 'desert fighter' was developed who could fight on a pint of water a day. We now know that this concept is a myth".

Diet and Physical Performance: Water and Salt

Roger W. Hubbard, Ph.D., Heat Research Division, US Army Research Institute of Environmental Medicine, Natick, MA 01760

Ammunition can be defined as any material used to attack or defend a position. If that position happens to include a battle against the hot and arid climate, then the primary ammunition will be water (1). Sun Tzu (a 6th century B.C. Chinese general and military theorist) put it quite succinctly when he said: "An Army that does not suffer from 100 diseases is said to be certain of victory." Heat illness is no respector of rank nor numbers. It is to the advantage of all concerned with the performance of US Forces on the modern battlefield to recognize the potentially devastating impact that heat injuries can produce. Adequate water intake is a singularly important factor in avoiding heat injury (2). The misconception that dehydration toughens up the troops was prevalent in the early days of WWII. T.F. Whayne (3) reported: "Line officers believed in 'water discipline' and it was thought that the drinking of water during work in the heat was harmful. Many shared the conviction that men could be trained to work in the heat on intakes of water that became lower each day, until the ideal 'desert fighter' was developed who could fight on a pint of water a day. We now know that this concept is a myth".

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Recent military history is not without its examples of this widely discredited belief. According to the Soviet publication, Military Hygiene (Moscow, 1959), Soviet water discipline urged: 1st and 2nd halts. No drinking or one or two mouthfuls held as long as possible. 3rd and 4th halts - one or two glasses of water. Major halt - one or two glasses. Night halt -quench thirst. It is not known to what degree this Soviet doctrine impacted on the Egyptian Army via their Soviet advisors but intelligence reports indicate that during the 1967 (Six-Day War) with Israel, the Egyptians suffered 20,000 deaths from heatstroke and/or dehydration. During this period, Israeli heat casualties were minimal.

Subsequent to this battlefield debacle, Soviet hot climate water doctrine changed (Lt.Col. Klimov, 1972): "At 36 C (96 F) air temperatures or above, exertion causes a loss of 8-10 L of sweat per 24 hours. Work ability declines sharply at a 5-8% body weight loss. Thirst occurs at a 1-1.5% loss of body weight as water. Fully quench thirst only in morning and evening." On 7 October 1973, the Egyptian 2nd and 3rd Armies attacked across the Suez Canal. The Egyptians, making full use of surprise tactics, did three times better as this war lasted 18 days and only great political intervention saved the encircled Egyptian 3rd Army from dehydration and heatstroke annihilation.

By 1974, Soviet hot climate water doctrine had changed again: "When plentiful, daily water norm is 10 L per man. During an attack or march, it is reduced to 8 L. When scarce, it is 2.5 L per man (limit 2-3 days). In defense or rest, it is up to 15 L.

In the Israeli Defense Forces, by contrast, soldiers drink at regular intervals, by command, in the absence of thirst. This assures that the large quantities of water lost through perspiration, urination and respiration are adequately replaced. It is forbidden to have the administration of fluids be dependent on the soldier's thirst or his wish to drink. This drinking policy is the responsibility of the Commanding Officer of the unit. It is backed up by severe disciplinary measures. Heat stroke due to training exercises is considered command failure and usually results in court martial and a mandatory 35 days in jail for the training officer in charge. These strict procedures for preventing dehydration could, in part, explain observed differences in heat stroke symptomatology between the U.S. and Israel. For example, in Israel heat stroke is often accompanied by profuse sweating (3) whereas in the U.S. it is uncommon (4).

Leaving aside dehydration due to salt deficiency, diarrhea or vomiting, the dehydration due to inadequate fluid intake is generally of two types: (1) involuntary - due to situations which prevent the person from obtaining water (stranded without water or, incapacitated in some way) and (2) voluntary - due to a number of factors but primarily the inadequacy of the thirst mechanism to monitor or assess the severity of dehydration and to stimulate the amount of drinking required for rehydration.

The various signs and symptoms of dehydration are well known and have been adequately described in Adolph's classic text, Physiology of Man in the Desert (5). The physiological range of dehydration most important to the military commander is quite narrow, from 2-6% loss of body weight as body water. Thirst usually occurs at a 2% deficit. This is equivalent to approximately 1.5 qts of sweat in the average 75 kg soldier. Battlefield deficits of 2-3% loss of body weight as body water are very common. 5-6% losses represent an upper range, unless water is unavailable since thirst is intense (5). However, body water deficits representing 6-10% of an athletes body weight can occur during prolonged strenuous sporting events (6). Between 3-5% occur a series of symptoms including vague discomfort lassitude, weariness, sleepiness and apathy, all of which could clearly impact on the success of a military campaign.

The following account of Minard (7) is a classic example: Tulungan Operation. "On 26-31 March 1962, units of the third Marine Division from Okinawa conducted an amphibious combat exercise on Mindoro Island, P.I. In this exercise the landing force was opposed by "aggressors" consisting of units from Hawaii who had been training on Mindoro for approximately four weeks. Although the weather was moderate (less than 90 F air temperature) compared with the Beacon Hill exercise, effects of heat on the unacclimatized "defenders" were nonetheless distressingly similar. In one unit of 300 men, whose mission was to capture an air strip 13 miles north of the landing area, there occurred 75 heat casualties of sufficient severity to require medical treatment with one fatal case of heat stroke. The bulk of the casualties fell out along the route of forced march, overwhelming available treatment facilities. Although the route of march was along an open level road, observers reported that the survivors arrived at their destination in such a state of fatigue that they collapsed in their tracks, falling asleep in full gear and failing even to post sentries." The contributing causes would appear to be hyperthermia and dehydration due to heavy work, inadequate rest during the march and inadequate water consumption.

Heat exhaustion due to salt and water depletion is caused by the inadequate replacement of salt losses in prolonged sweating. It is characterized by fatigue, profound weariness, muscular weakness, nausea, vomiting, giddiness, muscle cramps and in the later stages by circulatory failure. Marriott (8) divided salt depletion into three clinical grades and the first or "Early" represented a deficit of 0.5 g salt per kg of body weight. This is equivalent in a 70-kg man to a 35 gm (600 mEq) deficit or to a depletion of 4 liters of isotonic saline. As shown in Table 1, a deficit of this magnitude due primarily to sweating (other sodium losses or gains being ignored) depends on the sweat sodium concentration and the volume of sweat losses per day. If 8 liters of sweat are produced per day, then a 35 g deficit could occur as early as the first day or as late as the eighth day of heat exposure.

TABLE 1.

SWEAT VOLUMES AND SODIUM CONCENTRATIONS EQUIVALENT TO AN EARLY SALT DEPLETION DEFICIT [1]

Sweat Sodium (mEq/L)	Sweat NaCl (%)	Sweat Volume (L)	Sweat Sodium (Total mEq)
75	0.43	8	600
40	0.23	15	600
10	0.06	60	600

[1] Early deficit: 0.5 g NaCl per kg body wt. X 70 kg = 35 g (600 mEq), after Marriott (1950).

This depends on the sweat sodium concentration which varies with the state of heat acclimatization. Generally, in large scale operations the participating units are drawn from a variety of geographical locations and, thus, there is a lack of uniformity in acclimatization. Under these circumstances, a period of approximately two weeks with progressive degrees of heat exposure and physical exertion is advised (TB MED 507/NAVMED P-5050-5/AFP 160-1). By limiting excessive sweat losses in the early stages of acclimatization, these work schedules will help prevent salt depletion heat exhaustion. Due to the very high salt content in field rations, adequate salt intake to balance sweat losses is available by eating 3 meals per day.

A common battlefield error is to reduce the weight of the field pack by carrying fewer field rations and to forget that this also reduces the salt intake. When food intake is restricted, or voluntarily limited, as it may be during the first few days of heat exposure, salt must be provided by other means in conjunction with a balanced water intake.

The advocacy of using water as a tactical weapon (9) is based on historical, logistical, physiological and psychological evidence, in addition to personal observations of Army, Marine and Navy units maneuvering at 29 Palms, Ft. Irwin, Camp Lejeune, the Phillipine Islands, Vietnam and Israel. New guidelines for the prevention of heat casualties were field-tested (80 & '81) during large scale tactical maneuvers and found highly effective in meeting both operational and physiological requirements. This proposed doctrine requires field monitoring of environmental conditions with a simple small device (Botsball) by each unit, and increasing individual water intake from 0.5 qt/hr during mild heat conditions (code 1) to 2.0 qt/hr during extreme heat conditions (code 4). During these changes in environmental conditions, simultaneous alterations in work-rest cycles from 50/10 (min) to 20/40 are necessary to maintain body temperatures near normal. With these adjustments, commanders can operate in extremely hot environments, albeit at a slower rate, and complete their mission without undue deterioration of their units' physical and mental capabilities.

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