

HYDRATION STATUS EVALUATION OF COMBAT SOLDIERS DURING MARCHES

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INTRODUCTION

Negative body fluid - dehydration, even as low as 2%, results in a decline of cognitive and physical abilities [1]. Significant dehydration is a risk factor for serious heat illness [2]. On the other hand, exertional hyponatremia, which is a decrease of sodium levels below 135 mEq/l, might develop from activities lasting more than 8 hours [3]. Deterioration rate depends on absolute sodium level and the decrement rate. When plasma sodium level rapidly decreases and is below 125 mEq/l [4] it can become life threatening due to cerebral edema.

Evaluation of hydration status is based on indirect hematological and biological indices [5]. The hematological indices - hemoglobin and hematocrit - do not indicate the whole body hydration status, but rather only the plasma hydration status [6]. The three most valid indices for dehydration (> 2% body mass) are plasma osmolality [6, 7], urine osmolality and urine specific gravity [5, 7]. Plasma osmolality above 290 mosm/kg indicates negative hydration status [5]. Specific gravity above 1.02 indicates dehydration of 2% and specific gravity above 1.03 indicates dehydration of 5% [8]. Urine osmolality above 700 mosm/kg indicates negative hydration status [5, 9] and urine osmolality above 900 mosm/kg indicates dehydration of more than 1.9% [6].

In order to avoid dehydration or hyponatremia, special fluid intake guidelines have been issued by the Israeli Defense Forces (IDF). The aim of this study was to assess hydration status in soldiers performing physical activity and consuming water according to these guidelines.

METHODS

Subjects

The participants in this study were 15 healthy and fit males, ages 20.2±1.2, height 178±6 cm, weight 76.6±10.2 kg with 15.3±2.4% body fat. They were briefed on the nature and purpose of the study, including medical risks. All participants provided written informed consent to participate in the study, which was approved by the Human Subjects Research Review Board and the Human Use Committees of the Sheba Medical Center and the IDF Medical Corps institutional review board of the IDF.

Study protocol

Each subject underwent 3 marches of 24km, 29km, and 37km while carrying load of approximately 45% of his body weight. Terrain data and climate data were constantly monitored during marches by a GPS monitor and a temperature-humidity monitor (KESTREL) (Table 1).

March (n)	Length (km)	Duration (h:min)	AVG Climate conditions (°C/RH%)	Heat Load (Discomfort Index)
A (11)	24	5:30	25.0 / 72	23.1
B (6)	29	5:45	20.8 / 80	19.6
C (8)	37	7:00	17.4 / 65	15.4

Table 1: – The climate conditions, duration, and length of the 3 different marches.

Blood samples were drawn from an antecubital vein, before and after each march, while the subjects were in a sitting position. During the marches fluid intake and urine output were monitored (± 10 g). Prior to and immediately after the march each participant's nude weight was measured (± 10 g).

RESULTS

Hydration status

During the first march the average weight loss, representing the total fluid loss, was 1.33% of nude body weight. This was associated with normal values of urine specific gravity and Ur/Cr ratio (Table 2). During the second and the third marches the average weight loss was 2.27% of nude body weight. This very mild negative hydration status was not indicated by average urine specific gravity (Table 2). Plasma osmolality was not analyzed due to technical laboratory error.

March	A	B	C
Fluid intake (g/hr)	1150 \pm 240	1210 \pm 80	1050 \pm 220
*Fluid recommended (g/hr)	900-1250	800-1100	800-1100
Urination (ml/hr)	160 \pm 70	340 \pm 130	450 \pm 180
Dehydration (%)	1.33	2.27	2.25
**SG (urine)	1.018 \pm 0.012	1.013 \pm 0.009	1.009 \pm 0.007
**Na (mEq/l)	134.9 \pm 2.8	135.6 \pm 2.8	134.1 \pm 2.3

*The range accounts for inter-individual differences

**values are from the end of the march

Table 2: Fluid balance, blood and urine analysis of the subjects from the 3 different marches.

Hyponatremia

During the first march 6 of 11 subjects (55%) had sodium levels of less than 135 mEq/l. During the second march 3 of 6 subjects (50%) had sodium levels of less than 135 mEq/l, and during the third march 6 of 8 subjects (75%) had sodium levels of less than 135 mEq/l. The mild hyponatremia events can be explained by the combination of sodium loss through sweat and no sodium intake, mainly in the last march that lasted 7 hours. To note, in none of the subjects were sodium levels less than 130 mEq/l and all subjects were asymptomatic.

CONCLUSIONS

In general, hydration status for the participants was within the expected normal range during the 3 marches. Therefore, the amount of fluid intake according to the IDF guidelines appropriately matches this activity in comfort climate conditions and mild heat load.

IDF recommendations for marches include sodium intake by diet every 2 hours. Unfortunately, this was not implemented in these marches and was probably the reason for the mild hyponatremia diagnosed in more than 50% of the subjects.

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