

Hydration by water or saccharose drinks during exercise on cold: effects on leukocyte counts

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INTRODUCTION

Dehydration is a common problem during military exercise in cold due to several reasons, which increase the needs and/or decrease the consumption of fluids. As a consequence of dehydration physical performance, especially endurance, is decreased in a similar way as in warm environment (Rintamäki et al. 1995). Eventually dehydration may lead to total loss of performance and causes an immediate need for evacuation. However, strong cooling of the body counteracts the effects of dehydration on performance (Cheuvront et al. 2005), probably by causing a strong redistribution of circulation into central parts of the body.

Proper maintenance of fluid balance is equally important in cold as in hot environments. The quality of the drink may be of importance especially if nutrition is impaired. Stressors like heat, cold, exercise and malnutrition are known to affect immune function, e.g., leukocyte counts (Walsh and Whitham 2006). This study was carried out to examine, if the energy content of the drink has any effect on leukocyte counts during exercise in cold.

METHODS

The effect of a 5 % saccharose solution on blood cell counts during a 6 h walking with an intensity of ca. 45 % of VO₂max was studied. Water was used as a control drink. The test subjects (8 healthy young men, age 22 ± 2 years (mean ± SD), height 180 ± 4 cm, mass 73 ± 8 kg), wearing three layer military winter clothing with thermal insulation of ca. 2.2 clo, were walking 5 km/h for 6 hours at -20 °C (wind velocity was 1 m/s). After every 50 min walking they rested for 10 min. Every 30 min, the test subjects ingested 250 ml water or 5 % saccharose solution (12.5 g saccharose; total amount 150 g). There was two weeks interval between water and saccharose measurements, which were performed in a random order. For leucocyte and glucose assessments, blood samples were drawn from the antecubital vein before and after the exercise and 24 h after the end of exercise. After every walking period the test subjects had possibility to urinate.

Skin (7 sites) and rectal temperatures were measured continuously and stored at 1 min intervals (YSI-400 series thermistors, Squirrel 1200 datalogger, Grant, England). Mean skin temperature (T_{sk}) was calculated as an area-weighted mean. Thermal sensations (ISO 10551) were recorded at the end of each exercise period. Body mass was measured before and after exercise (Mettler ID1 Multirange, Mettler-Toledo GmbH, Albstadt, Germany; 1 g accuracy).

RESULTS

Rectal temperature was increased by work by ca. 0.6 °C. T_{sk} decreased during the first 60 min to ca. 29.5 °C and increased slowly to ca. 30.3 °C in both groups. Hand temperature decreased during the first 150 min to ca. 19 °C in both groups. At the end of the measurement, hand temperature was 17.8 ± 1.9 °C and 21.7 ± 1.9 °C in water and saccharose measurements, respectively. General and local thermal sensations were usually neutral, the thermal sensations of face were slightly cool and fingers were slightly cool - cool.

Blood glucose concentration decreased (not significantly) during the exercise in the water group, while saccharose kept the glucose level unchanged (Table 1). The circulating leukocyte count was increased by 100 % ($p < 0.01$) in the water group immediately after exercise, while in the saccharose group the corresponding increase was 35 % ($p < 0.05$). The leukocytosis was due to the increase in the granulocyte count. The lymphocyte count was nearly unchanged (Table 2). However, the relative amount of lymphocyte subsets was changed: the amount of CD4 and CD8 cells (T-helper and T-suppressor cells) was decreased especially in water measurements while the amount of B-cells was nearly unchanged (Table 3). The leukocyte count was recovered 24 h after the exercise while the proportion of CD4 and CD8 cells was still slightly lowered especially in the water group.

Table 1. Blood glucose concentration (mmol/l) (mean \pm SE, n = 8).

Drink	Before exercise	After exercise	24 h after exercise
Water	3.6 ± 0.2	3.0 ± 0.1	3.8 ± 0.3
Saccharose	3.7 ± 0.3	3.6 ± 0.2	3.3 ± 0.3

Table 2. Total number of leukocytes and number and relative proportion of lymphocytes (mean \pm SE, n = 8).

	Drink	Before exercise	After exercise	24 h after exercise
Leukocytes (*10 ⁹ /l)	Water	5.8 ± 0.6	11.6 ± 2.0	6.2 ± 0.7
	Saccharose	6.0 ± 0.8	8.1 ± 1.6	6.2 ± 0.8
Lymphocytes (*10 ⁹ /l)	Water	2.3 ± 0.3	2.5 ± 0.2	2.0 ± 0.3
	Saccharose	2.2 ± 0.2	2.1 ± 0.3	2.1 ± 0.2
Lymphocytes (%)	Water	39.7 ± 3.2	23.9 ± 2.7	33.8 ± 3.7
	Saccharose	37.3 ± 3.1	29.1 ± 3.3	34.6 ± 3.7

Table 3. Relative proportions of lymphocyte subsets (% from mononuclear cells): CD4 (T-helper), CD8 (T-suppressor) and CD21 (B-cells). The values are medians, n = 8.

	Drink	Before exercise	After exercise	24 h after exercise
CD4 (%)	Water	25.4	13.4	15.3
	Saccharose	27.8	19.9	19.8
CD8 (%)	Water	21.0	8.3	8.1
	Saccharose	17.5	14.0	16.7
CD21 (%)	Water	6.2	5.6	5.8
	Saccharose	5.8	6.4	5,4

CONCLUSIONS

In this study the stressors affecting leukocyte counts were both exercise and cold. Obviously the role of exercise is superior to cold, as the level of cooling (heat dept ca. 3.5 kJ/kg) denotes uncomfortable cold strain, but not performance decrement (Lotens 1988). Heat production by exercise and adequate clothing helped to keep good heat balance in spite of cold environment. On the other hand, the experimental conditions were well comparable to exercise in winter.

The results show that moderate amount of saccharose, corresponding to ca. 25 % of total energy consumption, ingested during prolonged exercise was able inhibit the development of leukocytosis. Leukocytosis was mainly due to the increase in the number of granulocytes, most probably neutrophils. Moreover, the proportion of T-cells (CD4 and CD8) was decreased especially in the water group. The effects of saccharose could be explained by a slightly lower energy dept and/or by direct effects on hormonal or metabolic responses.

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