

BODY FLUID LOSS IN COSTA RICAN RUNNERS DURING A 21K RUN

by
Mario Calderón, B.S.
Luis F. Aragón-Vargas, M.S.
University of Costa Rica

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This was one of the first research studies from the University of Costa Rica School of Physical Education and Sports presented at an international conference, the International Council of Health, Physical Education, and Recreation World Congress. It is reproduced here because of general interest. Full information from the study is available as an undergraduate thesis by Mario Calderón Navarro, University of Costa Rica.



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Abstract

The present study was pursued in order to determine the level of involuntary body fluid loss in a non-random sample of Costa Rican top long-distance runners, during the 1988 La Gloria half-marathon race. Forty subjects were measured before and after the race, for Body Weight, Resting Heart Rate, Blood Pressure and Oral Temperature. During the competition they ran at $80 \pm 5\%$ of their predicted Maximum Heart Rate, finishing in 82 ± 8 minutes; the temperature was between 29° and 26.3°C , and relative humidity between 60 and 62% (average WBGT = 25.65°C). Subjects were instructed to restore fluids *ad libitum*. Differences in blood pressure and body temperature were not statistically significant for $p=.05$. Both RHR and BW showed a statistically significant difference at $p=.05$. Average body fluid loss was calculated as 2.2 kg (3.61% of average total body weight), exceeding for the average and each individual the threshold for involuntary dehydration. It was concluded that none of the subjects restored body fluid loss properly. This confirms previous studies where runners showed very little knowledge about proper rehydration procedures.

Thermoregulatory roles of sweating and blood flow are well known. Skin blood flow carries heat, by convection, from the core of the body to the skin. The main effect of this procedure, in the absence of sweating, is an increase of skin temperature and a greater heat loss by conduction, convection and radiation. With sweating, the role of blood flow is hindered when humidity is high, causing high fluid losses with little cooling benefits (Frye, 1983; Lamb, 1985; Morehouse & Miller, 1984; Nadel, 1979).

Body fluid loss during exercise depends upon relative humidity, exercise duration and intensity, and clothing (Fox, 1986). Wyndhan (1973) shows a body water deficit of up to 6-10% of total body weight, during a marathon run. According to Costill (1970), fluid loss during a prolonged competition may reach seven liters, with a sweating rate of 2 liters per hour. Other studies show sweating rates larger than $1 \text{ L}\cdot\text{m}^{-2}\cdot\text{hr}^{-1}$. In spite of conscious efforts to drink different fluids during exercise, total body weight loss of 8% and body water loss of 13% to 14% have been reported (Costill, 1984).

During dehydration, the sweating process is compromised; sweating rate was diminished between 9% and 12% after one hour of continuous exercise (Nielsen, 1986).

During exercise, dehydration causes a decrease in performance throughout the activity (Costill, 1984). Harrison (1986), based on Graig & Cummings (1966 & 1964), concluded that a dehydration of only 1% of body weight can affect athletic performance negatively and reduce prolonged exercise tolerance. Lamb (1985) considers that dehydration is severe when water loss exceeds 2.5L; Greenleaf (1983) states that the dehydration process was initiated when body weight is reduced by .5% to 1% setting the threshold for involuntary dehydration at $260 \text{ g}\cdot\text{h}^{-1}$ of sweat loss.

In an attempt to determine the degree of involuntary dehydration, a total body weight loss larger than 1.5% was considered as resulting from an inappropriate rehydration procedure.

PROCEDURE

Forty men, previously informed about the goals of the investigation, participated in the study during the X Edition of the La Gloria half-marathon race (1988), one of the most important and best organized races in Costa Rica. Runners were selected considering their recent accomplishments, status of training and previous results in this race, in order to obtain a non-random sample of the best runners.

Subjects were tested for five variables: body weight, systolic blood pressure, diastolic blood pressure, resting heart rate, and body temperature, both before and after the race. Post exercise heart rate was also obtained right after the end of the race.

Before the race, subjects were required to rest for five minutes in the sitting position. Following this, resting heart rate was determined by taking the radial pulse for a full minute. Body temperature was measured by placing an oral thermometer in the closed mouth for of each subject for three minutes. Resting blood pressure was measured with an aneroid sphygmomanometer. Finally, subjects were weighed naked on a Detecto Weight Scale with a capacity for 140kg. All subjects entered the competition wearing their regular uniforms plus a distinctive stripe on their numbers for identification purposes. They were instructed to restore body fluids ad libitum, but were asked to refrain from drinking or going to the bathroom before the second testing.

Runners were received at the finish line and exercise heart rate was determined in ten seconds. They were then led to the testing area where the same procedure as before the race was followed.

Dry-bulb temperature and relative humidity were measured at several points along the race, in order to see the environmental heat stress to which runners were subject.

Water loss was obtained from the total body weight difference before and after the race.

RESULTS

All the subjects finished the 21.6 K race in less than 1:30 hours (average was 1:22 hours). Average age was 30.6 years old (range 18-44) and initial average body weight was 60.8 kg. (range: 47.3-70.7).

Results are summarized on Table 1. Differences in pre and post-exercise body temperature and blood pressure were not statistically significant for $p=.05$. Resting heart rate was statistically different at p levels of $.05$. A statistical difference was also obtained when comparing resting heart rate before the race and exercise heart rate

Concerning body weight, there was a statistically significant difference between pre and post-test ($p<.05$): average weight loss was 2.2 kg, or 3.61% of the average body weight. Overall, individual weight loss was similar; the range was from 1.6 kg to 3.4 kg.

Variables	pre- competition data \bar{x}	post-competition data \bar{x}	average difference	significance of t-test
Weight of body	60.8	58.6	2.22	S
Resting heart rate	63.8	100.8	34.6	S
Exercise heart rate		160		S
Systolic blood pressure	111.8	119.5	7.77	ns
Diastolic blood pressure	67	71.3	4.35	ns
Oral temperature	36.77	36.79	0.067	ns

DISCUSSION

Several studies have indicated that dehydrated athletes cannot withstand exercise and heat stress. Both heart rate and body temperature are higher when athletes reach dehydration levels above 2 % body weight (Costill, 1984). In the present study, resting heart rate was elevated after the race, responding not only to heat stress but logically to the exercise stress. Body temperature did not show a significant increase. The latter was measured with an oral thermometer, a procedure known to be affected by foreign variables. Arterial blood pressure did not show a significant difference, suggesting an appropriate recovery for all subjects.

According to the parameters mentioned above, all runners exceeded the limit for involuntary dehydration (1.5% body weight loss). This was very likely due to the duration of the race (more than one hour) and the environmental heat stress prevailing at the time of the race (WBGT=26.76° C at the start, 24.37° C on K-10, and 25.82° C at the finish line). Scheduling was part of the problem, because the race started at 2 o'clock in the afternoon, although the time of the year was not very warm. It must be mentioned that there are no policies for scheduling long-distance running events in Costa Rica, where temperatures and humidity tend to be high.

High body fluid loss was also attributed to bad fluid restitution protocols, as well as bad fluid composition. Previous studies in Costa Rica have shown that long-distance runners have little or no knowledge about fluid ingestion during and after the race, especially regarding how much, what, and how often they should be drinking (Calderon, 1987). These problems caused that none of the 40 subjects were able to restore body fluids appropriately.

SOURCE:

Calderón, M. & L.F. Aragón-Vargas (1989): "Body fluid loss in Costa Rican runners during a 21K run" in *Proceedings of the 32nd ICHPER Anniversary World Congress*, pp.387-390. Sullivan-Haberlein, S. & H.J. Cordts (editors). Frostburg State University, Frostburg, Maryland, U.S.A.

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