Original Article

The Effect of Cold Water Immersion on the Rate of Sweat-Loss from the Body

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SUMMARY

The purpose of this study was to examine the effect of cold water immersion(CWI) on the rate of sweat-loss from the body. Ten participants (mean age 30.5±5.54 years; height1.84.1±5.10; body mass 76.62± 9.48 kg, Max Vo2. 63.28 ± 6.27 ml/kg/dk) completed two testing-sessions separated by one week. Each trial consisted of two bouts of a 30-min running on hot environment (30.90°±1.28°C, 72.6±5.68% relative humidity). The two bouts were separated by 22 min of seated recovery. During the 22 min, the athlete was immersed in cold water (mean 15±1°C (5th –17th minute), whereas in the second test he was not immersion to cold water (non-CWI) and the decision of exposure was made randomly. The average rate-of-sweat lost for athletes after the second half in the CWI test (2833.97±530.64gr) was less than that of the non-CWI test (3239.97 ± 580, 26 gr) during a 60-min running in the track. The water volume consumed during the test was highly variable (649.97± 328.81 gr; 653.97±285.49 gr) but there was a strong relationship between the rate of sweat loss and water volume consumed for non- CWI, while there was no strong relationship on CWI test. Total drink volume consumed during the both was the same, but a sweat rate for CWI was less than non-CWI. The results indicate that running in hot and humid environment the body loss fluids. This can cause a sodium deficit among many athletes. The researcher recommends to use cold water immersion to improve exercise-performance in high temperature and humidity.

Keywords: Hot Environment, cold water immersion, sweat water loss, athlete

INTRODUCTION

The high temperature is one of the most challenging factors that is long-distance runners (endurance sport) are suffering from (Lawrence et al., 1996; Susan. 2005; Darren and Scott. 2006). Thus, running for long distances in a hot weather causes an increment in coetaneous blood flow to get rid of the excessive temperature which is a result of metabolic heat production and the increment of the local temperature. So that the runner could have thermal fatigue, and straining cardiovascular as well, running for a long time in hot weather caused to compete in the amount of blood between the skin, muscles working and the other tissues, especially the brain, where the cerebral blood flow decreased when excessive heat 38.5 and more (Todd et al., 2005).

Exercise in the heat adds thermal stress to the body and it typically responds by sweating in an attempt to control body temperature. This, however, has the potential to disrupt body water and electrolyte balance. These losses can be highly variable between individuals even when performing the same exercise at the same time in the same conditions (Shirreffs et al., 2006).

Also, at present, there are far more data available from training scenarios than from running for 400 meter in the track situations and indeed there are currently no

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data in the scientific literature describing the sweating, some components of blood and body-temperature responses of running in a warm environment. This was the aim of current study.

MATERIALS AND METHODS

Data were collected before and after 2 sessions of running in the track with cold water immersion (CWI) or non- cold water immersion (non-CWI) in the summer 2015. Ten subjects (mean age 30.5±5.54 years; height 1.84.1±5.10 cm; body mass 76.62± 9.48 kg, Max Vo2. 63.28 ± 6.27 ml/kg/dk) completed two testing-sessions separated by one week. Each trial consisted of two bouts of a 30-min running on hot environment (30.90°±1.28°C, 72.6±5.68% relative humidity). The two bouts were separated by 22 min of seated recovery. During the 22min, the athlete was exposed to CWI (mean 15±1°C (5^{th}–17^{th} minute), whereas in the second test he was not exposed to it (non-CWI) and the decision of exposure was made randomly. Before undertaking any data collection, ethics committee approval was obtained from Marmara University and all subjects gave their written informed consent to participation. Approximately 5 h before the start of the test, the runners swallowed an ingestible temperature pill (Vital Senses, Mini Mitter Co. Inc., Bend, Oregon, USA). Subjects ate a standardized pre-running meal of sandwiches 3 h before the start of the running. This meal was the same before both running. Over a 15-min period from 30 to 15 min before the start of the running, all athletes were weighed to the nearest 20 g on an electronic device ("Tanita" SC-330) when wearing only their underwear. On completion of the 60-min for two sessions, athletes were reweighed on the same device as their pre-test mass was determined, again wearing only their underwear. This was completed within 15 min of the end of the running: athletes were not allowed to eat or drink until after they had been weighed. All drink bottles were weighed on electric scales (SF-400), measuring to the nearest 1 g, before and at the end of the second session running to determine the volume consumed by each player. A volume of 1 mL of water/sports drink was assumed to weigh 1g for the purposes of this study.

Statistical Analysis

Data were tested for normality of distribution by the Kolmogorov-Smirnov and Shapiro-Wilk tests, for skewness and kurtosis by looking at the ratio of the mean of the relevant value to its standard error and for homogeneity of variance. Relationships between parameters were investigated by Pearson correlations. Comparisons between paired data were made using the Wilcoxon Signed Ranks Test. All statistical analyses were performed using SPSS v 19. Data are presented as mean and SD.

RESULTS

There was a significant decline ($p<0, 05$) in body weight in non-CWI test more than CWI test; the decline in body weight when using CWI test was (2.18 ±.501 kg) compared to the non-CWI (2.59±.583 kg). There was a significant decline ($p<0, 05$) in the rate of sweating between non-CWI vs. CWI; the rate of sweating when using CWI test was (2833.97±530.64gr) compared to non-CWI test (3239.97 ±580.26 gr), which means that the difference was (406.97 gr) for CWI. There was no significant difference ($P>0.721$) in any parameter of the water consumed between CWI and non-CWI (Table.1, Figure 3). To identify the relationship between sweat rate and drink volume consumed the spearman correlation was used, in the CWI test there was no significant correlation ($r^2=0.467$, $P=0.174$*) (Figure 1). But there was a significant correlation ($r^2=0.648$, $P=0.043$*) between

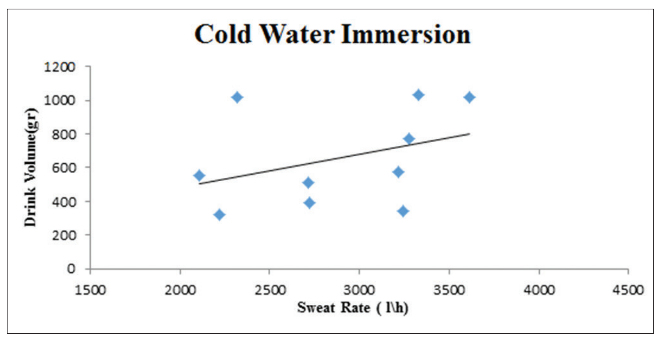


Figure 1: Sweat rate (l/h) and the drink volume consumed (gram) after the test

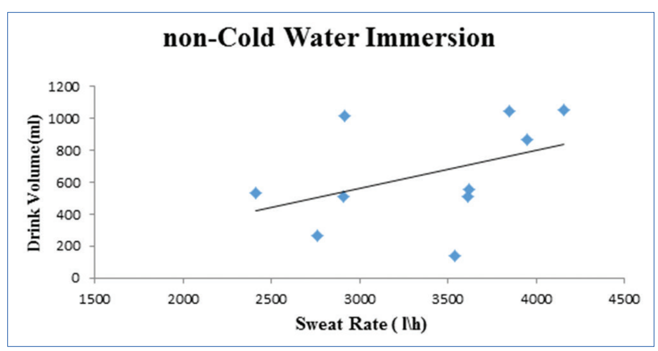


Figure 2: Sweat rate (l/h) and the drink volume consumed (ml) after the test

Figure 3: Sweat and weight Loss, test session measurement PRE and POST

sweat rate and the drink volume consumed after the non-CWI test (Figure 2).

DISCUSSION

There was a significant incline in performance-trial in the second half between (CWI) and non-CWI tests. Joudallah et al., (2016). However, average total distance covered in CWI test more than non-CWI; by using (CWI) test the distance covered was (7010 ± 495.92 meter) compared to the change in non-CWI test (6494± 757.89 meter). For the CWI, it has been noticed that the total average-distance-covered was 516 meter more than the non-CWI.

From the above mentioned results, it can be inferred that using CWI recovery improves exercise performance in hot environment. According to the current study, during a recovery session of 22 minutes there was 12 minutes of CWI. It was noticed that there is a declination in both core temperature and the high-intensity exercise performance without affecting submaximal economy of motion in the hot weather conditions. Moreover, this valuable result concerts with the study of Wilcock et al., (2006). His study says that cooling techniques in hot conditions aim to rapidly reduce elevated thermoregulatory and cardiovascular strain, alleviate impaired neuromuscular functions and facilitate the maintenance of subsequent exercise performance. Athletes performing multiple exercise bouts in hot environmental conditions should consider using a CWI intervention to reduce the harmful effects of hyperthermia, which in turn improves exercise performance.

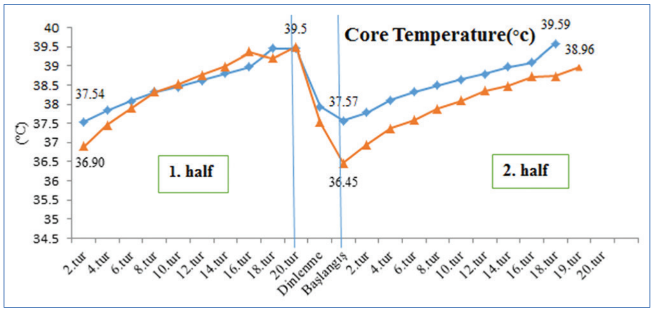
This result coincided with the study of each of the Yeargin et al., (2006); peiffer et al., (2009); proulx et al., (2003); and Clements et al., (2002), where the CWI has contributed to improve the athlete's performance. Moreover, these results coincide with Hasegawa et al., (2005) they have used in the cooling jacket to improve the athlete's performance and reduce the rate of sweat loss. Yeargin et al., (2006) showed that 15 min of whole-body cold-water immersion (14°C) after 90 min of running in the heat can significantly improve subsequent 2-mile running time trial performance and reduce body fluid depletion.

The improved running performance and reduced rate of sweat loss occurred with a mean rectal temperature that was 0.5°C lower than in the control condition Yeargin et al., (2006). We found a comparable 0.59 °C reduction in core temperature before the second time trial after cold-water immersion(CWI) intervention, and 0.41°C reduction in core temperature before the second time trial after non-CWI recovery. These findings imply that a core temperature reduction of approximately 0.5°C may be needed to elicit improvements in performance under hot conditions. (Graph.1)

The results of this study indicate that substantial rate of sweat-loss and electrolyte losses can occur during running for 60 minutes in hot conditions; the athletes body core temperature rises, sweating rate increases. The physiological defense mechanisms are invoked to dissipate the heat load and reduce the thermal stress as well as fatigue. This result concerts with the study of Nybo group (Nybo, 2008).

These rate of sweat and electrolyte losses are similar to those reported previously for elite professional players training in hot environments (Shirreffs et al., 2006); e.g. in 26 male professional players, training for 90 min when the environment was 32± 3°C, 5-20 % rh and wet bulb globe temperature (WBGT) was 22 ±2°C, the estimated sweat volume lost was 2193± 365 mL (1672– 3138 mL) (Shirreffs et al., 2005). It is thought that this result contributed to a high degree in the stability of blood pressure and size, which reflected the payment of adequate blood to the muscles to continue working with sprint for a longer distance (Shirreffs et al., 2005).

It is noticed that the relation is proportional to the lack of immersing experience. The more the drunk water is, the more sweating level will be, see Figure (2). However, in Figure (1) there was no significance from the statistical point of view. Therefore, there is no direct correlation between sweating level and the water drunk be the gymnastic during the experiment performance. This can be related to a sequence of actions followed by the cold-water immersion. Cold-water immersion helps to construct blood vessels and reduces the blood



Graph 1: Core temperature during first and second half (30 min) of the test. (Blue: CWI; Orange: non-CWI)

amount the goes to the human limbs and subsequently maintain the mineral salts in the blood plasma. The results of cold-water immersion can be stated as follows: 1. keeps the performance to the best level. 2. Maintains the internal body temperature in the normal range without ascending for long period, see Graph (1).

The data showes a large elevation in core temperature during the test, with the highest values tending to be achieved toward the end of the first half of the test. This is similar to the response observed in similar conditions as reported in the companion paper (kurdak et al., 2010). In that study, the peak Tc was also recorded at about the 30th minute of the first test, both test CWI and non-CWI values was 39.5 ± 0.4 1°C for a test athlete at 30.90 ±1.28°C and 72.6 ± 5.68 % relative humidity. However, the value in the second test for CWI was 38.96 ± 0.3 °C, non-CWI was 39.59 ± 0.3 °C.

This contrasts with the data of Edwards and Clark (2006), who, also used an ingestible temperature sensor system, found that the highest temperatures were recorded at the end of games played in cooler conditions (16–19 °C).

There may be limitations to the use of the ingestible temperature sensor system when cool water is ingested during exercise, as was the case in this study. The intestinal temperature if the athletes, over the same distance covered, was not the same. Therefore, the sweating rate response will be different as well.

Perspectives

In summary, our data indicate that 12 min of cold-water immersion (14±1°C) during a 22-min recovery session can decrease core temperature and attenuate the decline in high-intensity exercise performance without affecting submaximal economy of motion in hot environmental conditions and decrease the rate of sweat loss. Athletes performing multiple exercise bouts in hot environmental conditions should consider using a cold-water immersion intervention to reduce the deleterious effects that hyperthermia has on exercise performance.

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