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The Effect of Sauna Induced-Rapid Weight Loss on Lactate Response and Stability of Cardiovascular System in Well-Trained Wrestlers

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Abstract: Dehydration has significant complication on cardiovascular stability during exercise. So, the purpose of this study was examining the potential dehydration-induced cardiovascular change in wrestlers during exercise as well as lactate response. Eleven well-trained wrestlers (mean age, 22.3±3.0 yrs; weight, 66.2±5.1 kg; BMI, 23.1±1.1 kg/m^2; body fat, 11.9±3.5 %; VO_2max, 59.3±10.4 ml/kg/min) performed an 11-min progressive running test on treadmill after rapid weight loss via sauna exposure, once in non-weight loss condition. Post exercise serum lactate, blood hemoglobin and hematocrit concentration, in addition, heart rate, systolic and diastolic blood pressure were measured. ANOVA with repeated measure and paired t-test were performed at $p \leq 0.05$ significant to analyze the data. Average body weight loss in subjects was 2.3±0.4 % of body mass. Significant differences were not observed in blood hemoglobin and hematocrite concentration between trails, as well as, in serum lactate Heart rate during exercise has no significant changes, however, it was significant higher in rest and during 15 min recovery for dehydration trail compare to control trail ($p \leq 0.05$). Systolic blood pressure immediately after exercise was significantly higher in control trail compare in dehydration trail (169.8±25.9 *vs.* 147.0±14.0 mmHg in control and dehydration trail, respectively; $p \leq 0.05$).We shown that rapid weight loss via dehydration up to this extent by trained athletes may be has no considerable effect on substrate metabolism. But, lead to dysfunction in cardiovascular system and has unfavorable effect on cardiovascular stability. Such effects may hazard recovery of wrestler in rest interval during competition; in consequence, athletic performance is declined.

Key words: Wrestling · Rapid Weight Loss · Health · Lactate

INTRODUCTION

For more than a half century, rapid weight loss in wrestling has remained a concern among coaches, health professionals, exercise scientists and parents. In sports such as boxing and wrestling, whereas athletes use rapid weight-loss techniques to qualify for lower weight divisions, the practice of rapid weight loss due to dehydration is common [1, 2].

Most wrestlers practice these weight-loss techniques believing their chances of competitive success will increase. Ironically, weight cutting may impair performance and endanger the wrestler's health. The combination of food restriction and fluid deprivation creates an adverse physiological effect on the body, leaving the wrestler ill-prepared to compete. In addition, forms of dehydration, such as sweating and catharsis (laxatives and forced vomiting), contribute to the loss of electrolytes as well as water. Wrestlers hope to replenish body fluids, electrolytes and glycogen in the brief period between the weigh-in and competition [1, 2].

Plasma volume reduction by dehydration is the most important physiological changes in the body that has potentially serious consequences for the stability of cardiovascular and thermoregulation systems. Even a slight reduction in plasma volume can increase cardiovascular stress. Sympathetic nervous system activity is increased in order to maintain cardiovascular function and body fluid balance in dehydration and exercise conditions, which increases the blood

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concentration of catecholamines [3]. These hormones stimulate glycolysis and glycogenesis and increase availability and utilization of glucose in active muscles. On the other hand, if blood flow to muscles is reduced then low oxygen delivery in the mitochondria may have been disrupting energy supply via oxidative phosphorylation [4].

Thus, our hypothesis is that sauna-induced rapid weight loss increase lactate production during exercise and the athlete will be exhausted earlier and disrupted athletic performance. Generally, in the last few decades, there has been a great amount of research done in the effects of rapid weight loss and dehydration on physiological aspects associated with these on athletic performance on athletes and untrained and reported the different results. However, few studies have been examining the blood lactate response that is an important factor in fatigue. Therefore, the purpose of the present study was to investigate the effect of rapid weight loss on lactate response and stability of cardiovascular system in wrestlers.

MATERIAL AND METHODS

Subjects: Eleven well-trained wrestlers (mean age, 22.3±3.0 yrs; weight, 66.2±5.1 kg; BMI, 23.1±1.1 kg/m^2; body fat, 11.9±3.5 %; VO_2max, 59.3±10.4 ml/kg/min) were recruited as subjects in this study. They all had at least 10 years training experience and were representative of the top wrestlers of North Khorasan competing in national competitions in Iran. All Subjects were informed of the potential risks and gave their written informed consent to participate in this study, which was consistent with the human subject policy of the University of Guilan.

Testing Procedure: Dehydration was achieved by sauna at 4:30 pm. Subjects were interred dry sauna in 15-min intervals with cold showering and weighting in each break. Sauna temperatures were set between 70-90°C. It performed until about 2% weight loss was achieved. However, the time of sauna used for all subjects was less than 90 min. They have 60 min rest period before the test and were avoided from eating and drinking. For euhydration session (control) to ensure of normal hydration, each subject consumed a bottle of water (equal 2% of their body weight) during 12 hours before the test.

The subjects were asked to avoid from vigorous exercise and caffeine consumption before the test. Body weight and height were measured. Subcutaneous body fat was measured at 3 sites (chest, abdominal and thigh) on the right side of the body using the Lafayette skinfold Caliper. Body fat percent was estimated using the formula developed by Jackson & Pollock [5]. Then, subjects performed 11 min graded exercise test on a treadmill after 2 min warm up [6]. Exercise test started at 10 km/h speed and 0% incline for 3 min and followed by constant speed and 2.5% incline increments every 2 min until end.

Heart rate was monitored by Polar (model F11) before, during and 15 minutes after exercise. Blood pressure was recorded at rest and immediately after exercise. 5 ml blood was drawn from antecubital vein 5 minutes after the exercise test [7] and transferred immediately to the lab for assessing lactate and CBC analysis.

Statistical Methods: All descriptive data are expressed as means±SD. Data were analyzed using ANOVA with repeated measure and paired t-test, to compare the mean of each variable between two trials. Statistical analysis was conducted using SPSS 16.0 for Windows and significant level was set at $p \leq 0.05$.

RESULTS

Average weight loss was 2.3±0.4%. Although, hemoglobin (16.0±1.3 vs. 15.8±1.0 mg/dl) and hematocrit levels (46.7±3.0 vs. 46.5±2.7 %) in dehydration condition were higher than control condition but they were not statistically significant. Furthermore, there were no significant differences in blood lactate concentration between two conditions (8.5±3.8 and 9.2±4.6 mmol/l, in dehydration and control, respectively).

Resting heart rate of subjects in dehydration condition was significantly higher than control (78.5±8.9 *vs.* 65.6±5.3 bpm, $p \leq 0.05$). Heart rate increased during the test in both conditions, similarly. Instead, heart rate was declined after exercise while it was slowly in dehydration condition. So that, heart rate in euhydrated condition was significantly lower compare to dehydration condition at 10 and 15 min time point ($p \leq 0.05$) (Fig 2).

Systolic blood pressure (110.5±11.6 and 112.4±22.1 mmHg in control and dehydration conditions, respectively) and diastolic blood pressure (67.4±11.8 and 68.4±14.5 mmHg in control and dehydration conditions, respectively) were similar in both conditions at rest. Nevertheless, a significant exercise-induced increase in systolic blood pressure observed in both conditions; but it was significantly higher in control condition compare to dehydration trail (169.8±25.9 *vs.* 147.0±14.0 mmHg).

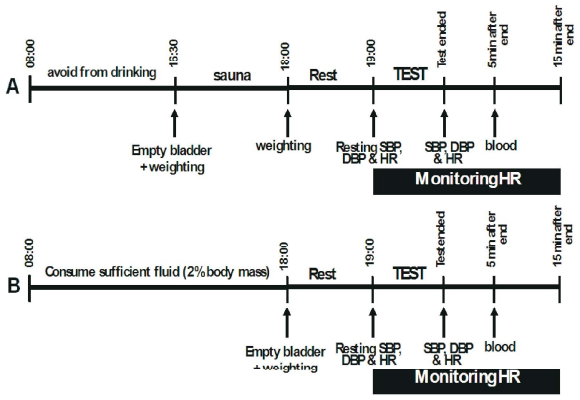

Fig. 1: A) Dehydration and; B) Control trail protocols.

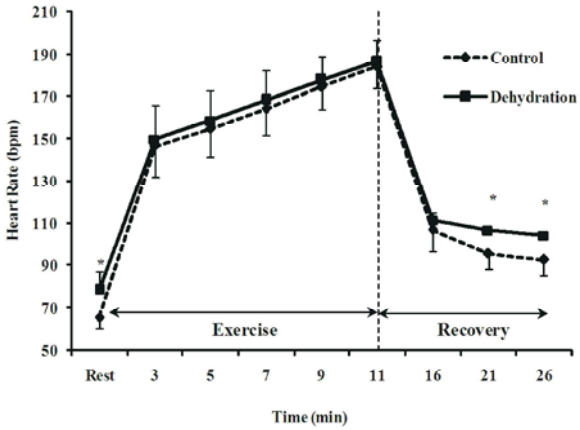

Fig. 2: Heart rate changes in Dehydration and Control trails. * Significant difference between trails ($p \leq 0.05$)

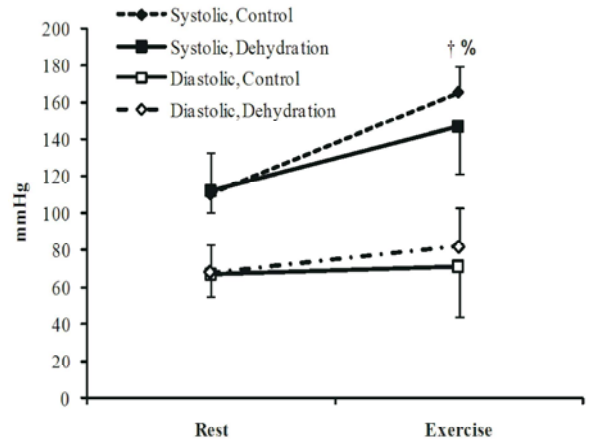

Fig. 3: Changes in systolic and diastolic blood pressure at rest and immediately in Dehydration and Control conditions. * Significant difference between exercise and rest in Dehydration trail ($p \leq 0.05$), † Significant difference between exercise and rest in Control trail ($p \leq 0.05$)

DISCUSSION

The purpose of this study was to investigate of rapid weight loss-induced cardiovascular changes during exercise in wrestlers and also, lactate response to exercise in dehydration status. In fact, as it was stated in the introduction, our hypothesis was that dehydration makes a shift in energy source and eventually greater use of carbohydrate lead to increased lactate production. Furthermore, we expected that the heart rate during exercise would be higher than the normal condition after rapid weight loss. However, in this study there were no statistically significant changes in lactate concentration between dehydration and euhydration status.

Explain these findings according to our research hypothesis are somewhat difficult. However, it seems that other factors may be having some role. For example, epinephrine and norepinephrine hormones that increase in response to exercise and dehydration [8, 9], have different effects on substrate oxidation. These hormones in addition to increase glycogenolysis, increase lipolysis that supply more FFA available to oxidize in muscle [9, 10].

Another reason is that amount of weight loss due to dehydration which is studied in current research may not have significant effects on substrate metabolism. However, some studies indicated that mild dehydration can change substrate oxidation [4, 10] and lactate threshold [3]. But it has been noted that unlike other that studied on endurance trained women [3] and untrained [24] subjects, our subjects were trained wrestlers who experience rapid weight loss at least for 2 to 3 times a year.

Moquin *et al.* [3] were used 45 minutes submaximal workloads for weight loss that can explain increased blood lactate prior to testing [3]. Furthermore, in some studies [11, 12] exercise was performed in a hot environment which may be an important determining factor for the increase in lactate response to dehydration alone [13]. Although, body temperature of our subjects didn't measure, but after sauna subjects were asked to shower with cold water and taken at least an hour to rest at room temperature to return the body temperature to normal levels. In addition, the exercise was performed under normal room temperature (24°C). Therefore, it may be has no remarkable metabolic responses to mild dehydration and according to previous studies that have reported increased lactate after 5% [14], 5.1% and 5.8% [15], 3.9% [16] and 2.9% [17] dehydration, it seems that 2.3% dehydration has no considerable effect on lactate production.

Another result was that, although, heart rate has no significant change during exercise under the dehydration condition compare to control, but it was significantly higher at rest and recovery period. Furthermore, systolic blood pressure immediately after exercise was somewhat lower than which in normal condition.

As will be discuss later, according to many studies, these changes mainly are due to reduced blood volume and stroke volume and catecholamines. A recent study reported that for every 1 percent reduction in weight due to dehydration, heart rate and body temperature during exercise will increase 6 beats per minute and 0.22°C, respectively. Furthermore, heart rate at 10 min after exercise cessation was higher about 10 bpm for every 1 percent reduction in weight [18]. These authors suggested that this issue may have considerable stress for athletes in interval sports.

It is demonstrated that dehydration is responsible for half of reduction in stroke volume (and then increased heart rate) during exercise in a warm environment. However, reduction in stroke volume in the absence of heat stress is completely due to dehydration [19].There is a strong relationship between heart rate and plasma volume reduction as well as stroke volume under a dehydration condition [19]. Reduction of stroke volume can be a very important factor in progress of fatigue under a dehydration condition [20]. Exercise-induce reduction in stroke volume is due to the reduction in plasma volume and increase in body temperature [13]. It is supported by previous findings that when the reduction of plasma volume and increase of body temperature is prevented by injection of intravenous fluid and exercise in a cold environment, despite the occurrence a dehydration of extracellular fluid (3-4 liters), no reduction of stroke volume, cardiac output and mean arterial blood pressure were observed [13].

Previous studies reported that reduction in subcutaneous vessels conductance and increased norepinephrine concentrations under the dehydration condition during exercise regardless of increased body temperature (at least in the upright position as same as current study), is associated with blood volume reduction and arterial hypotension [16]. So it seems logical that during exercise in weight loss condition that is widely done via dehydration by wrestlers, their cardiovascular system attempts to compensate the reduction of the left ventricular end diastolic volume.

Left ventricular end diastolic volume, considerably is a function of filling pressure and diastolic time. Thus, it is probably that 200 to 300 ml decrease in blood volume increases ventricular filling pressure and further increase in heart rate reduces the diastolic time.

Generally, according to our study, although lactate response to mild rapid weight loss in wrestlers has no considerable negative effect on energy metabolism, but this effect may be important in less-trained wrestlers. However, cardiovascular system that plays an important role during wrestling is impaired by, even, mild dehydration and experiences some stress. Furthermore, heart rate of dehydrated wrestler after exercise returns later to the rest level and on the other hand, wrestlers need to recover themselves quickly in rest intervals of competition. Thus, this is an important factor in success of wrestlers.

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