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Investigation and compare the effects of two weight loss protocols on lactic acid in wrestlers

Javad Ghaemi[1*], Amir Rashidlamir[2], Seyyed Reza Attarzadeh Hosseini[3] and Gholam Rasul Mohammad Rahimi[4]

[1] MSc, Department of Exercise physiology, Ferdowsi University of Mashhad, Mashhad, Iran,
[2] Associate Professor, Department of Exercise Physiology, Faculty of Sport Sciences, Ferdowsi University of Mashhad, Mashhad, Iran
[3] Professor, Department of Exercise Physiology, Faculty of Sport Sciences, Ferdowsi University of Mashhad, Mashhad, Iran
[4] PhD student, Department of Exercise Physiology, Faculty of Sport Sciences, Ferdowsi University of Mashhad, Mashhad, Iran

ABSTRACT:

Weight loss in many sports that involve weight classes is very important; the weight can have a major role in the success of athletes. The aim of this investigation was examining the effect of rapid and gradual weight loss protocols on lactic acid in trained wrestlers. Twenty-two trained wrestlers [age 20–25 years] volunteered to research and randomly assigned into two groups: rapid and gradual weight loss group. Group 1 applied rapid weight loss method in 48-h and group 2 used twelve days gradual method. All subjects asked for a reduction of about 4 percent of their weight. Before and after weight loss intervention, lactic acid was measured. The results demonstrated that the amount of increase in lactic acid in the rapid weight loss group was more than gradual group after tests. Comparison of these two weight loss protocols exhibited that in compare with rapid weight loss, the gradual weight-loss method leads to a lesser decrease in wrestlers' metabolic changes.

Keywords: Weight loss, Lactic acid, Wrestling

INTRODUCTION

Wrestling is an Olympic sport that is practiced worldwide. Wrestle competition is organized following weight class, which is also the case for other combat sports. The purpose of weight class divisions is to create equitable matches among competitors in terms of strength, agility, and leverage. Rapid weight loss has been reported to be detrimental to performance in terms of power, force, resistance, flexibility, and skillfulness [1, 2]. The desire to be at a low weight has led to the common practice of reducing body mass in a short period before a competition [3, 4]. Unfortunately, this practice has even reached children's sports [5]. The methods used by athletes for achieving rapid weight loss may cause dehydration, an increased load on the cardiovascular system, impairment of the thermo-regulatory system, depletion of glycogen stores, hypoglycemia and loss of body protein, electrolytes and vitamins [6]. Dehydration is associated with a decrement in endurance performance [7-9] which has been linked to reductions in plasma volume and increased plasma osmolality. The physiological consequences of dehydration are thought to lead to a reduction in cardiac output which in turn can alter VO_{2max} and reduce the ability to regulate core body temperature. Additionally, alterations in muscle metabolism [glycogen utilization and lactate production] have also been reported during prolonged submaximal exercise [10] and high-intense short-term exercise [7] without fluid ingestion. Horswill et al. suggested that alteration in acid/base status mediated the decrease in anaerobic performance coincident with weight loss in wrestlers in their study [6]. Evidence for this hypothesis was the significantly greater reduction in resting base excess and anaerobic performance in wrestlers who lost weight while consuming a low carbohydrate diet [41.9%] compared with those who consumed a higher carbohydrate diet [65.9%].

Several studies have revealed the negative impact of rapid weight loss on performance [11-13]. However, the results of other studies have shown some performance characteristics do not change [2, 14, 15] or even improve [16]. Intracellular acidosis due mainly to lactic acid accumulation has been regarded as the most important cause of skeletal muscle fatigue. Recent studies on mammalian muscle, however, show a little direct effect of acidosis on muscle function at physiological temperatures [17]. Anaerobic breakdown of glycogen leads to an intracellular accumulation of inorganic acids, of which lactic acid is quantitatively the most important. Since lactic acid is a strong acid, it dissociates into lactate and H^+. Lactate ions would have little effect on muscle contraction [18]; however, the increase in H^+ [i.e., reduced pH or acidosis] is the classic cause of skeletal muscle fatigue. Thus, there is a need to examine the influences of lactic acid on this form of exercise. The purpose of this study was investigation and compare the effects of two weight loss protocol on lactic acid in wrestlers.

***Table 1**. Guidelines to evaluate the performance of wrestlers*

Pre-test		4% Weight loss	Post-test 1		Rest [20min]	Post-test 2	Rest [20min]	Post-test 3	
Morning	Evening		Morning	Evening		Arm Wingate		Evening	immediately
Body composition	Arm Wingate		Body composition	Arm Wingate					
	Leg Wingate							Arm Wingate	Blood Sample [phase C]
Blood Sample [phase A]			Blood Sample [phase B]	Leg Wingate		Leg Wingate			
	Bruce Test			Bruce Test				Leg Wingate	

Method

The population of this study was the trained wrestlers with a history of at least 5 years of continuous practice. Besides, they often have participated in national competitions and all of them had at least a provincial or national championship rank. From trained wrestlers living in Khorasan-Razavi province, 22 wrestlers, with a mean age of 22.5 ± 2.3 years and BMI of 23.9 ± 2 volunteered to participate in the study. They were randomly assigned into two weight loss groups. Group 1 used the acute [rapid weight loss] and group 2 used the gradual weight loss method. Blood samples were collected in three phases: before weight loss [phase A], 14 hours after the weight loss period [phase B] and after the last test [phase C]. This timeline is shown in Table 1.

Percentage changes in plasma volume were calculated according to the Dill and Costill formula [19]. Before weight loss and 14 h after the weight loss, body composition was analyzed using bioelectric impedance analysis. Aerobic capacity and anaerobic power were measured by the Bruce treadmill and Wingate [arms and legs] tests respectively.

All subjects were required to lose 4% of their body weight. Participants in the rapid group reduced their weight during 48 hours via traditional methods [severe diet, fluid restriction and using sauna]. Participants in the gradual group were monitored and evaluated to determine the amount and type of food intake. Then, they were asked to reduce their weight according to Rashidlamir's method for 12 days and are shown in Table 2. In this method, there are three four-day phases. In the first three days of each phase, nutrition is decreased and on the day there is a return to the diet to the previous phase. In the first phase, the subjects decreased their food intake by 10% for three days [lunch and dinner] and then they returned to their usual eating habits on the fourth day [daily dietary habit before the protocol]. In the second period, first they decreased their food intake by 20% for three days, then they returned to 10% on the fourth day. In the third phase, first they decreased their food intake by 30% for three days and then they returned to 20% on the fourth day [20]. There was no limitation on drinking water and no decrease in breakfast, but the subjects avoided fat in all meals.

The data were analyzed using Kolmogorov-Smirnov, one-way ANOVA and repeated measures tests, at the minimum significant level of $P < 0.05$ using SPSS software [version 16].

Table 2. *A decrease in food for wrestlers to lose weight*

	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day	8th day	9th day	10th day	11th day	12th day
Reduction in lunch	10%	10%	10%	Eating as usual	20%	30%	30%	30%	10%	20%	20%	20%
Reduction in dinner	10%	10%	10%	Eating as usual	20%	30%	30%	30%	10%	20%	20%	20%

Results

As can be seen in Table 3 and 4, in between-group comparison, there are significant differences between the two groups on lactic acid [$P < 0.05$].

Table 3. *A comparison of the wrestlers' lactic acid.*

	Group	Phase		
		Phase A	Phase B	Phase C
Lactic acid [mmol.l]	Rapid weight loss	2.2 ± 0.3	1.5 ± 0.2*	12.0 ± 1.3*
	Gradual weight loss	2.0 ± 0.4	1.2 ± 0.1*	10.3 ± 1.2*

Data are shown as mean ± SD.

Table 4. *Results of repeated measures ANOVA design [P<0.05=*]*

Variable	Within group		Interaction		Between group	
	F	P	F	P	F	P
Lactic acid [mmol.l]	1.2	0.01	7.5	0.01	14.2	0.001

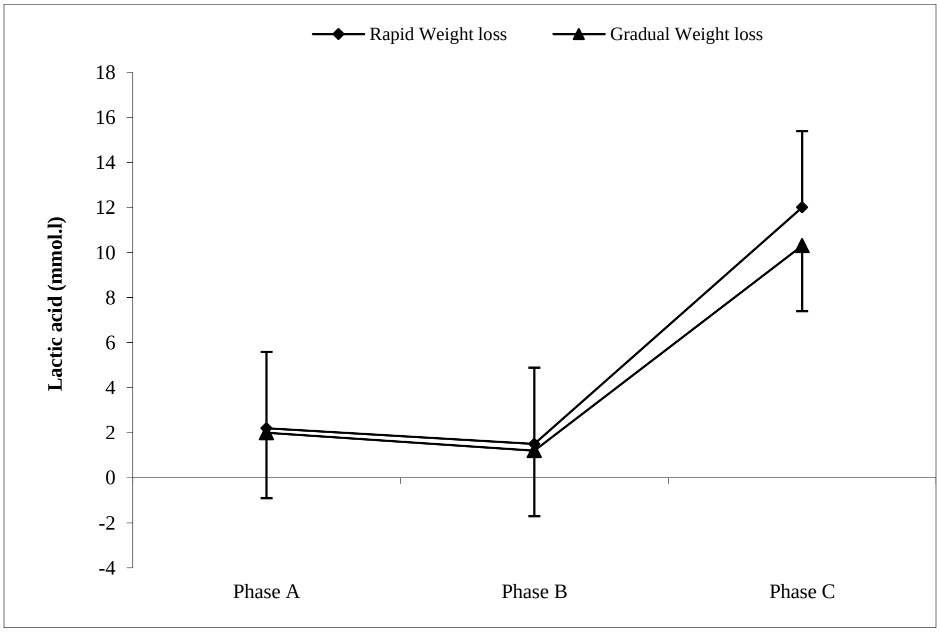

Figure 1. *Lactic acid changes in three Phase*

Discussion and Conclusion

The results of this study indicate that: lactic acid in both rapid and gradual groups in phase B [14 hours after weight loss] was significantly decreased [P < 0.05]. On the other hand, lactic acid in both rapid and gradual groups in phase C [after the final stage of the athletic performance tests] were significantly increased [P < 0.05]. However, compared to the gradual group, lactic acid in phase B were the more in the rapid group. On the other hand, lactic acid in both rapid and gradual groups significantly increase in phase C as compared with phase B, the increase was the more in the rapid group as compared with the gradual group. Physical stress induced by exercise and potentiated by dehydration stimulates increased secretion of catecholamines via the hypothalamic-adrenal neural pathways [8, 21, 22].

It has been found that dehydration alone can cause an increase in catecholamine production [22-24]. This increase is attributed to stimulation of the hypothalamus by osmoreceptors [25], atrial stretch receptors, and the temperature-regulating center of the brain [26]. During an acute bout of exercise, catecholamines enhance the rate of muscle glycogenolysis via b-adrenergic mechanisms resulting in an increased rate of lactate production [27-29]. Elevated rates of muscle glycogen utilization lead to glycogen depletion and can contribute to fatigue. The mechanism for the effect of dietary carbohydrate on anaerobic performance is unclear. The role of muscle glycogen in fatigue during high-intensity exercise is controversial since a brief, anaerobic exercise does not typically deplete this muscle fuel.

Houston et al. confirmed a 21.5% reduction in muscle glycogen as a result of a wrestling match [30]. Muscle glycogen is likely to be even more depressed with the exercise protocol used in this study since post-bout blood lactate levels in some studies suggested that the negative impact of a lower carbohydrate diet on performance of high-intensity exercise is mediated by changes in the body's acid/base environment [30-32]. These studies identified a reduced resting base excess after 3-4 d of a reduced carbohydrate diet. They hypothesize that this would reduce the ability of the blood to accept hydrogen ions produced in the muscle during anaerobic work and lead to earlier fatigue. Plasma lactate values after this performance test were higher than those reported by Horswill et al. for a similar protocol using an isokinetic bike and a longer low-intensity interval period [30 s] [33]. Our average post blood lactate, ranging from 17.5 to 26.4 mmol.l, is closer to the average of 20 mmol.l reported by Triplett et al. [34] shortly after a tournament wrestling match than the 14 mmol.l averages found after the anaerobic test used by Horswill et al. [33]. A possible reason for the lack of an effect of the combined weight loss on short and intense efforts in the present study is that water loss could have been lower than that experienced using other diet procedures and was not sufficient to affect acid-base balance. The weight loss [3.9 %] of the experimental group may have been partly due to a reduction in fat mass [10 %] as well as to dehydration, as is observed when a rapid weight loss procedure is followed [1]. The effect of rapid weight loss on the glycogen content in skeletal muscles using the direct method [biopsy sample analysis] has only been assessed in a few studies. The results show that rapid weight loss by 5-8% may be accompanied by a significant decrease [36- 54%] in muscle glycogen concentration [7, 35]. A considerably smaller increase in the concentration of lactate in blood following body mass reduction compared with normal body mass has been observed in many studies [7, 12, 32] and this finding has been interpreted as an indirect confirmation of decreased glycogen reserves in the organism [12, 32]. In contrast, the data published by two groups [36, 37] show that the blood lactate response to high-intensity exercise is not necessarily related to muscle glycogen concentration. Hence, the unchanged blood lactate response to the performance tests should not be taken as evidence about the maintenance of muscle glycogen stores during rapid body mass loss [34]. Rapid weight loss through the use of sauna, plastic suits, and diuretics causes a decrease in wrestlers' anaerobic power [38]. Researchers believe that fast movements have a close relationship with the nervous system, and the first impact of acute weight loss endangers the nervous system and, consequently, result in a decline in athletic performance. Similarly, another cause for a reduction of power generation following dehydration can be the disruption of metabolic pathways and interference in the body's heat dissipation. Any disruption in the conduction and transmission of nerve impulses and/or muscle responses to the nervous system disrupts the nervous system activity, resulting in detrimental effects on athletic performance. The rise and fall of lactic acid as a direct cause of skeletal muscle dysfunction in fatigue during intense muscle activity, the intracellular pH may fall by ~0.5 pH units. There are two major lines of evidence that have been used to link this decline in pH to the contractile dysfunction in fatigue. First, studies on human muscle fatigue have often shown a good temporal correlation between the decline of muscle pH and the reduction of force or power production. Second, studies on skinned skeletal muscle fibers have shown that acidification may reduce both the isometric force and the shortening velocity

[17].

Another mechanism by which intracellular acidosis may induce fatigue is by inhibition of energy metabolism. Key enzymes in glycogenolysis and glycolysis are phosphorylase and phosphofructokinase, respectively. Both of these enzymes are inhibited at low pH in vitro, and hence the rate of ATP supply to energy-requiring processes [e.g., cross-bridge cycling and sarcoplasmic reticulum [SR] Ca^{2+} pumping] might be diminished in muscles that become acidic during fatigue [17]. However, a recent human study failed to detect a reduction in the rate of glycogenolysis/glycolysis in the acidified muscle [39]. Restriction in caloric intake affects the levels of liver and muscle glycogen which can have an important role in athletic performance [40], it can be expected that the wrestlers who reduced their weight via acute weight loss methods were exposed to a more severe reduction in liver and muscle glycogen stores, compared to the wrestlers in the gradual group [even after 16 hours, the reservoir was not completely rebuilt, and this had an effect on their performance]. In general, we can state that weight loss via both gradual and rapid protocols leads to an increase in blood lactate; however, compared with the rapid model, gradual weight loss, in addition to a maintenance of liver and muscle glycogen levels, lower lactic acid accumulation, as well as water storage, all contribute to maintaining better performance.

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