THE EFFECTS OF RAPID WEIGHT LOSS ON AEROBIC AND ANAEROBIC POWER ON ATHLETES IN WEIGHT-SENSITIVE SPORTS

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Abstract
The purpose of this study is to investigate the impact of rapid weight loss on aerobic and anaerobic power on athletes participating in weight-sensitive sports. Twenty-four wrestlers were chosen according to standard criteria. They were informed of all procedures in the project. Participants were grouped randomly into an experimental or a control group. Before beginning the weight loss protocol aerobic and anaerobic power was calculated in each participant. The experimental group then underwent a 5 percent rapid weight loss intervention that involved heavy exercises, the use of plastic clothes, and limiting water and food consumption. t-test for correlated samples was performed to investigate within-group differences and independent samples t-test was performed for measuring the inter-group differences. After the weight loss intervention calculation was performed on research variables as the post-test. In order to determine the difference between the pre-test and post-test for the experimental and control groups, t-test was performed using SPSS software. The following results were obtained: A significant 5 percent decrease was observed for the aerobic power in the experimental group (P<0.039), and a significant increase (32 percent) in their anaerobic power (P<0.009) compared to the control group. It would read better as follows: The treatment group experienced a 5% decrease in aerobic power (P<0.039); however, anaerobic power increased 32% (P<0.009) compared to the control group.

Key words: weight loss, aerobic power, anaerobic power

Introduction
The acute loss of weight is a severe physiological stress that can have a negative effect on the immune system and make people more susceptible to illnesses, such as upper respiratory tract infections. This knowledge is of great importance for athletes who must be in their best physiological condition at times of competition (Harms, 1992). This style of referencing is incorrect. Athletes in weight-class sports, such as wrestling, make use of weight loss techniques because of the ergogenic effects (not really; they do it to compete in lighter weight classes). For some of these athletes, the weight loss may be more than needed, and many will use techniques that lead to the reduction of lean body mass and overall water weight. There is sufficient evidence to suggest that the methods used for rapid weight loss are harmful. In addition, wrestlers and other athletes in weight-sensitive sports who have not surpassed the growth and developmental stages are more susceptible to the negative effects from these methods. The harmful effects include delaying the process of development, reducing the overall educational performance, and functional changes to glands, as well as damage to various vital organs within the body (Perriello, et al., 1995). Frequent cycles of weight loss and re-gaining, whether slow and gradual (seasonal), or fast (weekly) has been called Weight Cycle. It is frequently seen among athletes who have to get to a particular weight to be classified into a special weight category in order to take part in a competition (Maccargar et al., 2002). The majority of athletes in weight-class sports (e.g., wrestling, judo, karate, mixed martial arts, etc) compete in a category that is typically 5 to 10 percent below their natural weight (Brownell, et al., 1997). The American College of Sports Medicine has advised that the body composition of all wrestling athletes have to be analyzed before every sport season, and those whose body fat is less than 5 percent of their ideal body weight have to undergo medical exams (Oppliger et al., 1996). Wrestlers make use of rapid weight loss methods and frequently lose their weight in order to reach a specific weight (usually 3 to 9 Kg below their weight). Such methods may include increase training, limiting the consumption of food and water, dehydration, low and step-by-step dieting, using sauna, wearing plastic clothes in order to increase perspiration, and making use of diuretic or laxative medications. These methods do have harmful impacts on the athletes’ health, including reduction for blood plasma, reduction of heart productivity, disorders in responses related to the regulation of body temperature, the reduction of blood flow in kidneys, and increased rate of lost electrolytes (Freihsclag, 1994). Studies on weight loss reveal that athletes lose 3 to 20 percent of their weight before the start of season during the last day(s) before weighing. In fact, athletes can do this several times during a season, since successful wrestlers can take part in 15 to 30 matches. Athletes will lose weight combining methods such as limiting food and drinking, perspiring through high temperatures and/or exercising.
Weight loss through perspiration is the most commonly used. When using perspiration as a weight loss method, there is not sufficient time to re-gain water weight. The study conducted by Gulkan et al., confirms the vital role water plays for an athlete to reach his/her top of the career. They argue that dehydration (even at a low level) reduce features of performance (Housh, et al., 1999). In order to investigate the impact of dehydration on an athlete’s body, Fleming made use of a diuretic medicine (Lazix). Although the intensity of dehydration was very insignificant (about 2-3 percent), it led to a 3-percent reduction of athletes’ capabilities in 1500 meter running, and a 6- to 7-percent reduction in 5000-meter running tests (***, 1993). It is surprising that in strict diets, such as those designed to lose weight, the percentage of body fat does not differ significantly.

In such diets, weight is lost but the fat percentage within the body does not change a lot. In addition, it has been shown that strict diets have to be avoided since they cause a phenomenon that can lead to muscle catabolism. At the beginning of the 1991 academic, Wisconsin was the first state to set a standard minimum weight for high school wrestlers and implement a comprehensive dietary program (Oppliger, et al., 1998). The project of minimum weight was performed during two years. Its objective was to scientifically guarantee and predict a minimum weight for high school wrestlers so that their lives would not be endangered. Up to that point no guidelines had been provided to help ensure the maintenance of an appropriate weight. In addition, unhealthy methods of weight loss had been applied. Usually, the weight of an athlete was being determined as a function of the coach’s or the team’s requirements to fill in a category and not according to scientific foundations. Before the project, wrestling coaches attempted to follow their own personal programs to such an extent that no group endeavor was made to determine a minimum weight for wrestlers (Harms, 1992). McMurray et al. (2005) conducted a study titled “the impacts of caloric deficits and dietary manipulation on aerobic and anaerobic exercises”. In that study, 12 professional wrestlers limited caloric intake by 92 KJ per a kilogram by the use of two types of diets: the first one was full of carbohydrates, and the second one was having normal amounts of carbohydrates. They wanted to investigate the impact of caloric deficit on aerobic and anaerobic performance, as well as the impact on the levels of growth hormone and insulin growth factors, such as IGF-1. These factors were measured during the consumption of foods with similar calories, and at the end of the caloric restriction period. It was found that neither the caloric restriction, nor the food composition had any effect on individuals’ ability to perform an 8-minute running with an intensity of 85 percent. However, both of those methods increased fat burning during the exercise. The subjects’ responses to the aerobic Wingate test showed that the group who consumed foods having normal amounts of carbohydrates faced a significant reduction in the total output. Nevertheless, the athletes who had been placed in the group for high-carbohydrates diet maintained all of their power. Caloric limitation (without any regard to food composition) increased the responses of growth hormone to exercises more in the normal carbohydrate group than in the high-carbohydrate group. The levels of Insulin growth factors, such as IGF-1, decreased due to the caloric deficit, while food composition did not have an impact on it. The above results point to the fact that even in a period of caloric restriction, a high-carbohydrate diet can excel other methods in preventing anaerobic performance to experience a decrease. Furthermore, it seems that food composition does not have any impact on resting levels of growth hormone and growth factor during the period of caloric restriction (McMurray, et al., 2005). Vogelholm et al investigated the impact of rapid weight loss and its gradual decrease on nutrition and performance of male athletes by assigning 7 wrestlers and 3 judoka (weighing between 55 to 93 Kg) into two groups for weight loss. Within the group of gradual loss, a 5 ± 0.4 percent reduction was obtained through the limitation of input energy over three weeks. Within the group of rapid weight loss, 6 ± 0.6 percent of body weight was reduced over 24 hours through the reduction of water and food consumption and obligatory perspiration. Following that, the consumption of water and food was optional and free for the participants. The net reduction on body weight in the latter group was observed as 2.7 ± 0.5 percent. In that study, the protein consumed in foods was 71±16g for the gradual reduction and 56±17g for the fast reduction groups. With regard to the carbohydrates consumed for the two groups, fast reduction group consumed 182±55g while gradual reduction used 239±56g. Other data for the two groups are as follows: the mean use of Thiamin, Magnesium, and Zinc was according to the advised levels and a bit below them. The amounts of Thiamin, Riboflavin, Potassium, Iron, and Zinc were constant in both groups. Changes in the index of vitamin B1 and the density of Magnesium were different for the groups, and it was more negative for the gradual reduction group. Speed performance (30-meter running test) and anaerobic performance (one-minute Wingate test) was constant all over the study. As a result of gradual weight loss, the height of vertical jump was increased 6 to 8 percent. The results of jumping were not affected by fast weight loss. Consequently, a 5-percent loss or less in body weight (by the use of both methods) does not interfere with the performance of experienced athletes (Fogelholm, et al., 2003). Crawford investigated the metabolic and anthropometric changes resulting from cycles of rapid reduction and re-gaining of weight. He conducted a study on 14 wrestlers, and assigned them to a group of rapid weight loss (8 people) and a group without any cycle (Freihslag, 1994) based on their self-reported dietary history. Methods of measurement in the study consisted of a three-day documentation of food consumption, energy consumption at rest periods, the skinfold thickness
ratio, the diameter of body organs, and biochemical tests were performed before the start of season, in the peak of the season, and after the season. The findings revealed that all anthropometric measurements changed during the study. A correlation was observed for the nutritional group and test time with skinfold thickness ratio in such a way that a more intense cycle of fat loss and regaining of it was observed on the body of wrestlers who had been placed in the weight cycle group. In addition, no difference was seen for the energy consumed at rest periods between the two groups. The amount of triiodothyronine (T3) decreased during the study. According to the researcher, the higher rate of weight loss had happened because of the effects of both nutrition and short-term loss of water weight. Although physiological changes were observed, a training session can affect metabolic impacts of weight cycle (Maccargar et al., 2002).

**Methods**

The current study can be classified as a quasi-experimental study having a pretest-posttest design. Participants were divided into an experimental group or control group. The impact of rapid weight loss on aerobic/anaerobic power and body composition on athletes participating in weight sensitive sports was researched. The training sessions were conducted under the complete supervision of the examiner in Razi University and the population consists of all wrestling athletes within the city of Kermanshah. Among those who had at least 5 years of experience in regional and national competitions and who were used to lose weight (4 to 8 percent and 2-4 times in a year) before matches (according to their self-reports). Twenty- four wrestlers were chosen as the sample and were divided into an experimental or a control group.

**Table 1. Characteristics of the examinees**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Bounds</th>
<th>SD</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>20-27</td>
<td>1.33</td>
<td>22.60</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>165-187</td>
<td>4.27</td>
<td>179.00</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>68.8-80.0</td>
<td>3.69</td>
<td>73.67</td>
</tr>
<tr>
<td>Body Mass Index (Kg/m²)</td>
<td>20-24.1</td>
<td>5.60</td>
<td>22.94</td>
</tr>
<tr>
<td>Fat percentage (%)</td>
<td>4.5-8.4</td>
<td>1.17</td>
<td>10.73</td>
</tr>
<tr>
<td>V̇O₂max (ml/kg)</td>
<td>49.0-55.3</td>
<td>2.01</td>
<td>51.26</td>
</tr>
</tbody>
</table>

At the beginning of the study, a briefing session was conducted to explain the research program to participants. Participants signed forms of consent agreeing to participate in the study, as well as a medical questionnaire to confirm their health. After selecting qualified participants, data was collected on age, height, body mass index, and V̇O₂max to determine their aerobic capacity and fat percentage. In the current study, the sample was chosen in a selective and non-random way, and participants were divided either the experimental group or the control group (each group consisting of ten people). After conducting all tests in the pretest stage (the stage before weight loss), the participants lost their weight by the use of the methods that will be explained later during 60 hours and did the tests once again.

**The manner of data collection**

Weight: in order to measure the participants’ weight, they were placed on a scale having the minimum clothes, distributing their weight equally between the two heels, and putting their arms along their sides. This measurement was performed with the accuracy of 0.1 Kg. Height: In order to measure participants’ height, a meter strip which was fixed to a wall in addition to a set square. Participants were supposed to stand still without having shoes on, distribute body weight equally between the two legs, and their head and eye view in line with the horizon. Later, at the end of normal expiration, their height was measured from metatarsus up to their head based on centimeters. Test of anaerobic power (Wingate test: The instrument used in this test was an ergometer bicycle. The participants were supposed to warm up for ten minutes and then start pedaling with the speed as much as possible having the resistance of 0.075 Kg for each kilogram of body mass (7.5 percent of the net weight of participants). The participants continued this exercise with their utmost power for 30 seconds. The electrical or mechanical numerator on the ergometer measured the rotation of pedals every 5 seconds. Then, the anaerobic power of every participant was calculated using the formula below: The formula for the measurement of the highest power output (Kg): Power Output (kpm•min-1) = [revs x resistance (kg) x distance (m) x 60 (sec)] / time (sec). Aerobic power (Bruce test): In the current study, maximal aerobic power as the maximum amount of oxygen an athlete can take in within an exhaustive exercise (which involves large muscle groups and continues up to the point of exhaustion) is estimated by the application of Bruce maximal test based on millimeter per kilogram per minute. The test is done under the conditions of 22 degrees centigrade temperature of the environment (which is within the range of suggested temperature). In addition, the humidity was 48 percent (according to the 50-percent suggested rate of humidity). Participants were asked to perform a brief warm up, and then to mount on a treadmill to walk on a 10-percent slope for three minutes having the speed of 1.7 miles per hour. Every three minutes, the activity was intensified by increasing the slope by two percent and the speed of the treadmill (according to the figure below) until the athlete was not able to continue the activity.

![Figure 1. Bruce maximal test](image)

The formula for this test is as follows:

\[
V_{O_2\text{max}} = 14.8 - (1.379 \text{(time)}) + (0.451 \text{(time)}^2) - (0.012 \text{(time)}^3)
\]
**Data analysis**

With regards to inferential statistics and before the analysis of data, Kolmogorov-Smirnov test was applied in order to ensure normality of data distribution (table 2).

<table>
<thead>
<tr>
<th>Factors</th>
<th>Z</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobic power</td>
<td>0.82</td>
<td>0.63</td>
</tr>
<tr>
<td>Anaerobic power</td>
<td>0.98</td>
<td>0.46</td>
</tr>
<tr>
<td>Fat percentage</td>
<td>0.28</td>
<td>1.07</td>
</tr>
<tr>
<td>Body composition</td>
<td>0.63</td>
<td>0.73</td>
</tr>
</tbody>
</table>

Table 2. Kolmogorov-Smirnov test results

As it can be seen from table 2, the distribution of data is normal. Therefore, parametric tests were applied in the analysis of data. In addition, with regards to the normality of data distribution and the quantification of the variables, t-test for correlated samples was performed to investigate within-group differences and independent samples t-test was performed for measuring the inter-group differences. Rapid weight loss was not correlated significantly with athletes’ aerobic power (especially athletes of weight-sensitive sports). In order to obtain indices of aerobic power, Bruce maximal test was performed on a treadmill and participants’ VO2max was calculated based on activity time up to the point of exhaustion. The values of pretest and posttest are shown in the table below. In order to test the above hypothesis, t-test for correlated samples was conducted to compare both groups’ pretest and posttest (Sig. <0.05). The reduction of VO2max resulting from rapid weight loss (0.56 milliliter per kilogram per minute) is statistically significant and the null hypothesis is rejected. Therefore, it can be concluded that rapid weight loss has a negative effect on athletes’ aerobic power. Rapid weight loss is not significantly correlated with athletes’ anaerobic power in weight-sensitive sports. In order to obtain indices of anaerobic power, a thirty-second Wingate test was performed on a Monark ergometer. Values for pretest and posttest are shown in the table below. In order to test the above hypothesis, t-test for correlated samples was performed to compare both groups’ pretest and posttest (Sig. <0.05).

<table>
<thead>
<tr>
<th>Groups</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Observed t</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>51.28±2.53</td>
<td>48.72±1.45</td>
<td>2.41</td>
<td>0.04 *</td>
</tr>
<tr>
<td>Control</td>
<td>51.56±1.85</td>
<td>51.39±1.72</td>
<td>0.32</td>
<td>0.76</td>
</tr>
</tbody>
</table>

Table 3. Results of pretest and posttest of VO2max for the two groups

**Conclusion**

Our research showed that rapid weight loss leads to a significant reduction in the participant’s aerobic power (VO2max). A five-percent reduction was observed in subjects’ aerobic power within experimental group, which is statistically significant (039/OP<). The findings in the current study are not in line with findings of Koutedakis et al. (1997), who found subjects with similar VO2 max showing no reduction as a result of weight loss. Two differences can be observed between the two studies: First, different methodologies were used, and second, maximal aerobic power was defined differently. In the current study, maximal aerobic power has been defined relatively based on milliliter per kilogram per minute. However, maximal aerobic power is defined in an absolute way in Koutedakis et al.’s research. Maximal aerobic power is generally a valid indicator and a method to estimate changes and condition of cardio-respiratory fitness, hematological components of oxygen delivery, and oxidative mechanisms of active muscles. Nevertheless, some points have to be made in this regard: 1) Weight is an important factor in weight-sensitive sports, and the athletes’ performances are measured based on their weight. In this regard, it was found that rapid weight loss led to the reduction of relative maximal aerobic power; 2) Among other performance indicators that had been measured by Koutedakis et al. was the maximal oxygen consumed at respiratory threshold that has reduced significantly as a result of weight loss; 3) One of the units by which maximal aerobic power is defined is milliliter per a kilogram of weight (without fat) per minute. Statistical procedures show that rapid weight loss has not been able to change this factor significantly. Overall, it can be concluded that rapid weight loss has a significant impact on indices of aerobic power and leads to the reduction of aerobic power among athletes. Among other findings that were observed because of rapid weight loss were the significant difference between the values of anaerobic power for the participants in the control group on pretest and posttest. With respect to statistical analysis, a 32-percent increase was observed in participants’ anaerobic power that is statistically significant (009/OP<), while no such difference was observed for the control group. Therefore, one may conclude that the significant increase in anaerobic power of the participants in the experimental group originates because of their rapid weight loss. These findings are in line with findings of Fogelhom et al., though they are in contrast with findings of Houston et al. (1991), Horshil et al. (1990), Horshill (2003) and Websters et al. (1990). The reasons for such discrepancies in these findings can be traced to the participants, type of methodology, and manner of measurement. The power output in the study done by Hickner et al. decreased after the rapid weight loss. However, Han Park argued that anaerobic power didn't significantly change during the training season, and that it wasn't negatively affected during the season (while no tendency was observed in their study for the
reduction of absolute and relative power). The possible reasons of increase in aerobic power can be explained in the following way: with the assumption that the relative capability for the creation of power by neuromuscular system is kept constant after weight loss, the relative expression of this capability (creation of power per each kilogram of the weight) increases, and can show itself as the higher rate of work done per unit of weight on ergometer test.

References


UČINCI BRZOG MRŠAVLJENJA NA AEROBNU I ANAEROBNU MOĆ KOD SPORTAŠA U SPORTOVIMA OSJETLJIVIM NA TEŽINU

Sažetak

Svrha ovog rada bila je istražiti utjecaj brzog mršavljenja na aerobnu i anaerobnu snagu sportaša koji sudjeluju u sportovima osjetljivim na težinu. Dvadeset i četiri hrvača je izabrano prema standardnim kriterijima. Oni su informirani o svim postupcima u projektu. Sudionici su grupirani slučajno u eksperimentalnu ili kontrolnu skupinu. Prije početka protokola mršavljenja, za svakog sudionika je izračunata aerobna i anaerobna moć. Eksperimentalna skupina je pokazala razinu od 5 posto brzog mršavljenja uz intervencije koje su uključivale teške vježbe, korištenje plastične odjeće i ograničenu potrošnju vode i hrane. T-testom za korelirani uzorak izvršena je usporedba nezavisnih uzoraka radi dobivanja inter-grupnih razluka. Nakon izračuna mršavljenja intervencija je uvedena na istraživačkim varijablam na baza post-test. Kako bi se odredila razlika između pre-test i post-test za eksperimentalne i kontrolne skupine, t-test je izveden pomoću SPSS programa. Sljedeći rezultati su dobiveni: Značajno smanjenje od 5 posto za aerobnu snagu opaženo je u eksperimentalnoj skupini (P <0,039), a značajan porast (32 posto) u njihovoj anaerobnoj snazi (P <0,009) u usporedbi s kontrolnom skupinom. Držimo kako bi bilo bolje čitati kako slijedi: Eksperimentalna skupina doživjela je pad od 5% u aerobnoj snazi (P <0,039); Međutim, povećana je anaerobna snaga za 32% (p <0,009) u usporedbi s kontrolnom skupinom.

Ključne riječi: gubitak težine, aerobna snaga, anaerobna snaga

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