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Physiology of wrestlers` dehydration

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Abstract

Rapid weight loss via dehydration has profound adverse effects on the wrestler's physiology and muscular endurance even with %1 of body weight loss. Additionally, there is a decline after 4% of weight loss in strength or anaerobic power performance. However, these adverse effects do not seem to impair muscle strength during high-power exertions lasting less than 30 seconds. In fact, for athletes participating in brief-duration, high- power sports, rapid weight loss may give them an advantage by increasing power on a pound for pound basis. But, as strenuous exercise is extended, environmental temperatures rise, and degree of dehydration increases performance will ultimately suffer. The negative effects of dehydration on cardiovascular fitness parameters seem to repair faster compared to strength and power values. Several studies indicated while weight cycling has acute effects on performance, augmentation in body weight and muscular performance of the wrestlers occurs subsequent to the wrestling season. Several studies also indicated some negative psychological effects of dehydration on wrestlers' performance: increased fatigue, anger, and anxiety, decrements in mood and motivation, and increased confusion. Still, more studies are needed in these areas. Weight loss due to the dehydration can potentially affect wrestlers' health negatively. However, it was found that there are no considerable health effects of dehydration on wrestling. However, more studies are needed to strengthen these results since there are not many studies about the long-term effects of dehydration on hormonal, psychological and health status of wrestlers.

Keywords: Dehydration, endurance, anxiety, strength, resting metabolic rate.

INTRODUCTION

Weight loss practices in wrestling have been a topic of study for well over 50 years. Wrestling events take place in tournament settings such as local tournaments, national, and international championships include multiple matches within 2 days. In wrestling there is a usually 12-18 hours period between the weighing and the first match of the tournament. Many wrestlers and their trainers believe that the wrestles should compete in a weight class lower than their pre-season weight to achieve a competitive frame. Typically, wrestlers attempt to lose weight quickly through a combination of vigorous exercise, fluid intake limitation and sweating during the days that precede a scheduled competition (42). The main goal of accelerated weight loss is to gain advantages of strength and power over the opponents who do not reduce weight in the same weight class.

Weight loss methods such as use of saunas, exercising in the heat wearing heavy clothing to stimulate sweating, water intake restrictions are inappropriate voluntary methods of weight loss that result in a loss of large volumes of water (26). A decrease in total body water by more than Dehydration is defined as e condition of lower than normal levels of body fluids is considered as "dehydration". Dehydration equal to or more than a loss of 2% euhydrated body mass is considered as a mild form of dehydration (e.g. a loss of 1.4 kg in a 70-kg athlete). In a normally active individual, drinking begins when fluids comprise 0.8% of one' body weight is lost. Voluntary dehydration may be defined as the delay in complete rehydration following water loss. When the delay in drinking is not cognitive, it is called involuntary dehydration (3). The level of dehydration is measured in multiple ways including the assessment of urinary density and body mass, ad various blood tests. While blood tests yield more accurate information they are not practical and/or feasible. According to Murray (26), the amount of fluid lost as sweat was strongly correlated with body weight (41). However, it is found that each method gives more or less the same approximation of hydration status

of athletes (18). When wrestlers voluntarily dehydrate, they expect to restore body fluids, electrolytes, and glycogen in a relatively short period of time (12 to 18) hours). However, restoring fluid homeostasis may take 24 to 48 hours if rehydrated voluntarily while the restoration of muscle glycogen levels may take as long as 72 hours. Restoration of the lean tissue may take even longer (3). The magnitude of decline in performance depends on the magnitude of dehydration, subject characteristics, environmental conditions, and the mode of exercise caused by impaired thermoregulations and physiological functions (2). Thus, the purpose of this comprehensive review is to summarize how dehydration affects physical performance specific in wrestling.

Methods for Selection of Studies

The studies for this review were identified by the keywords that included the effects of dehydration on wrestling performance, cardiovascular and thermoregulatory function, strength, power, oxygen consumption, muscle work, health, and psychological function. The databases included Medline, Physical Education Index, Psychology, Google Scholar, and Science database. Only English language articles were included. Books, articles, and other references available at California State University, Los-Angeles and Long Beach Libraries were used. References were grouped in different wrestling related topics including cardiovascular and thermoregulatory, endurance performance, strength and power, weight cycling, health effects, and psychological effects. These key words were also used during the data search.

Dehydration and Performance

In this section several sports-dehydration-related experiments were reviewed to investigate the effects of dehydration on the sports performance including: tests of sports-specific skills, muscular strength, muscular endurance, and anaerobic performance. This section mostly focuses on aerobic and anaerobic performances of wrestlers since wrestling requires highly anaerobic power and moderate aerobic power. The consistency of the results reflects the current agreement of scientific literature that dehydration incurred before or during continuous exercise often impairs physical performance (37).

In 2008, Ööpik et al. (43) published a study designed to evaluate acute effects of self-selected regimen of rapid body mass loss (RBML) in combative sports athletes. Seventeen (12 wrestlers and 5 karatekas) male athletes voluntarily dehydrated to reduced their body mass by 5.1 % in 3 days. They were used to dropping their body mass during the competitive season. They achieved the weight loss by an ongoing reduction of energy and fluid intake and mild sauna procedures. They performed a battery tests before (Test 1) and immediately after (Test 2) Rapid Body Mass Loss (RBML). The peak torque of knee extensors at three different speeds, and total work (Wtot.) were measured during a 3-min intermittent intensity knee extension exercise. As an end result of RBML, plasma urea concentration was significantly greater than before. The concentration of ammonia in a post-test tended to be higher. The plasma lactate and glucose responses to exercise were alike in pre-test and post-test. Overall the results demonstrated that the self-selected regimen of RBML impairs muscle performance in 3-min intermittent intensity exercise and induces a raise in blood urea concentration in trained male combat sports athletes. The decrease in Wtot is observed in this study is supported by the data published by other researchers (14). However, the Rankin & Hickner (33) studies engaged intensive ergometer tests of 6 and 5 minutes duration respectively. The total length of the muscle endurance test used in the present study was only 3 min. Therefore, it can be concluded that dehydration reduces physical performance capability even during short periods of high intensity exercise. Consequently, the recent changes of decline of the duration of a match, it is more likely that dehydration has a harmful impact of RBML on wrestlers` physical performance capacity. The results show that RBML of 5-8% may be accompanied by a significant decrease (36-54%) in muscle glycogen concentration (8,13,32).

The Norwegian Olympic Sports Centre and Confederation of Sports (31) also investigated the weight loss methods and nutritional routines in international level athletes in weight-category sports since they were concerned with possible negative effects of rapid weight loss (e.g. fasting, dehydration) on performance and health.

This report indicated that both genders' weight reduction regime affected performance factors such as strength and endurance. This study showed that the majority of the kick-boxing athletes loose bodyweight preceeding to competition to attain their competitive weight. Thus, weight reduction seems to be crucial matter among kick-boxing athletes as well as in wrestlers. The committee

recommended that rapid weight loss methods (based on dehydration) should not be more than 1% of the athletes total body weight.

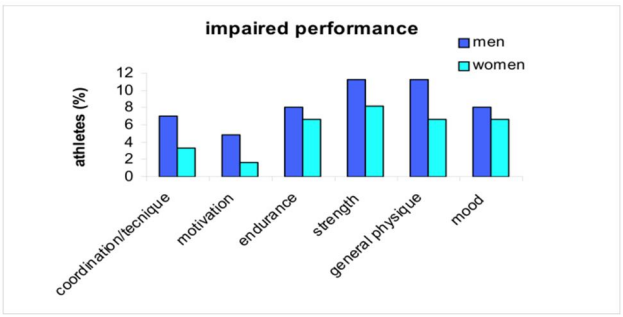

Figure 1. Self-reported impaired performance after weight loss. Presented in percent of the athletes who reported impaired performance (31).

Maughan (20) also investigated impact of mild dehydration on wellness and on exercise performance. In all, 15 healthy adults participated in two trials: fluid intake was limited for 37 hours in one trial and regular drinking was allowable in another trial. Body mass loss was 2.68% in the fluid restriction trial and 0.58% in the control trial. According to the results, self-ratings of alertness and ability to concentrate decline more and more when fluid intake is restricted to induce body mass deficits, even at levels as little as 1–2% of dehydration. At the same time, ratings of tiredness and headache increase.

Maughan (20) also reported several studies on effects of dehydration on muscle strength. These studies recommend that there is a modest effect of dehydration on muscle strength, but the methodology used to produce dehydration and the measures of strength varies between studies. Possible explanations to clarify diverse consequences between studies are; 1) different performance tests have been employed in different studies, 2) the length of the recovery period permitted between RBML and the measurement of performance was various, 3) in addition, the methods used for inducing RBML and the degree of the body mass loss achieved fluctuated.

According to Webster, Rutt & Weltman`s study (46), a total of 16 strength measures, involving both upper and lower limbs, were used and a statistically significant reduction in strength was seen in only two of these measures. However, there was a strong tendency towards a decrease in strength in all measures after dehydration. Similar findings are presented in a study by Dougherty et al. (11), which reported a significant impairment in basketball skill performance at dehydration of 2% body mass in adolescent subjects exercising in a moderate dehydration environment.

There seems to be relatively little effect of mild dehydration on muscle strength. There are, however, some difficulties in the analysis of these studies as the methods used to induce dehydration usually involve either heat exposure of exercise or restraining fluid intake, both of which will produce elevations of muscle temperature that will in it influence the contractile functions of the muscles. Where dehydration has been induced over a longer period by restriction of fluid intake, there is also generally a reduced food intake, leading to changes in muscle glycogen substance and in the acid–base level of the muscle (43).

Cardiovascular Fitness of Wrestlers and Dehydration

Muscular endurance is the ability of a muscle or group of muscles to sustain repeated contractions against a resistance for an extended period of time. Cardiovascular responses due to dehydration in wrestling are associated with declines in muscle endurance. As for performance, dehydration of as little as 1 to 2 percent of body weight has been shown to impair muscle endurance, likely due to the adverse changes in cardiac output. Several studies found unfavorable effects on wrestlers' muscle endurance because of dehydration before the competition (1,4,5,6,9,10,28,32,34).

For example, Allen et al. (5) investigated the hemodynamic responses to submaximal exercise after dehydration and rehydration in high school wrestlers, and results revealed several cardiovascular changes. Cardiac output, heart rate (HR), stroke volume (SV) and arteriovenous O2 difference (AVD) were measured in 16 high school wrestlers during submaximal work at normal weight (T1) and after a 4 or 5% weight loss (T2), and following 1 hour of rehydration (T3). Fluid and food restriction as well as intermittent exercise were the methods to achieve the weight loss in 48 hours. Noticeably higher HR and lower SV were observed during constant exercise. Following rehydration all dependent variables returned close to pre-test levels. In spite of a short rehydration period, the cardiovascular dynamics of these high school wrestlers quickly returned to normal during moderately heavy work because of the relatively small plasma changes that accompanied the 48-h weight loss.

Moreover, the most recent study done by

Aghaei et al. (1) focused on the effects of sauna induced-rapid weight loss on lactate response and stability of cardiovascular system in well-trained wrestlers. Eleven well-trained wrestlers performed an 11-min progressive running test on treadmill after rapid weight loss via sauna exposure and once in non-weight loss condition. Serum lactate, blood hemoglobin, hematocrit concentration, heart rate, systolic and diastolic blood pressure measurements were taken. Average body weight loss in subjects was 2.3 % of body mass. There were no significant changes in blood hemoglobin and hematocrit concentration and serum lactate between trials. These results indicate that weight loss via dehydration has negative effects on cardiovascular stability. Such effects may interrupt recovery of wrestler in the rest interval during competition; as a result, athlete's performance is declined. Mechanism behind how dehydration impairs performance is that sympathetic NS activity is increased in order to maintain CV function and body fluid balance in dehydration and during exercise, which increases blood concentration of catecholamine such as epinephrine and norepinephrine. These hormones stimulate glycolysis and glycogenesis and increase availability and utilization of glucose in muscle activities. However, if the blood flow to muscles is reduced then low oxygen delivery in the mitochondria may have been disrupting energy supply via oxidative phosphorylation. Dehydration leads to a shift in energy source and eventually a greater use of carbohydrate leading to increased lactate production. Thus, the athlete will be exhausted earlier and athletic performance is disrupted. Early lactate production cause impairment in the performance. However, according to Aghaei (1), there was no difference between the measures of lactate. The lower rate of body weight loss might be the factor affecting the lactate level in the study.

Contradicting to the findings of Aghaei et al. study (1), Tarnopolsky et al. (32) study revealed an increase in lactate concentration subsequent to dehydration when they examined the effect of energy restriction and wrestling on muscle glycogen content in highly- trained male wrestlers. This contradiction might result from different rates of body weight loss in these experiments, 2.3% in Aghaei et al. (1) and 5% Tarnopolsky et al. (32). In the later study, twelve highly trained male wrestlers volunteered as subjects and were randomly assigned to one of two groups (Group A, n = 6; Group B, n = 6) and all had performed rapid weight loss at least three times/year. Group A test includes four 5-min wrestling bouts following a 5% body weight loss in 7 hours and 17 hour repletion period; Group B test included a 5% of weight loss through dehydration methods over 72 h. Weight loss caused a decrease in muscle glycogen concentration and increase in lactate level for treatment group as below.

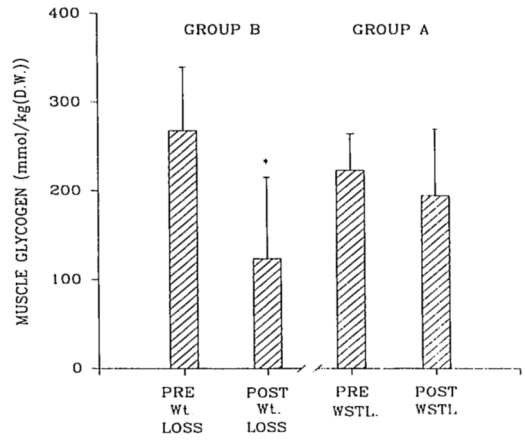

Figure 2. Muscle glycogen concentrations for Group B (pre-weight loss + postweight loss) and Group A (prewrestling tournament + postwrestling tournament). *, significant (p=0.018) reduction in muscle glycogen concentration. There was no other between or within group differences that were significant (32).

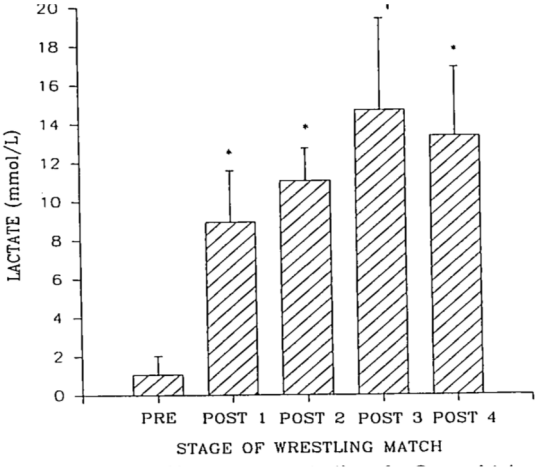

Figure 3. Whole blood lactate concentrations for Group A taken before (PRE) and 4 min after each 5-min wrestling bout (POST1, etc.). *, significantly (p<0.001) different from PRE concentrations. Significantly (p<0.05) different from POST 1 and POST 2 (32).

Researchers concluded that the weight loss methods universally performed by wrestlers resulted in large decreases in muscle glycogen concentration and increases in lactate concentrations implying that there is decrement in performance that were mostly reversed with rehydration between weigh-in and the start of the competition.

These studies and other studies clearly state that dehydration has unfavorable effects on cardiovascular endurance, muscle glycogen concentration, and lactate production which can

effect wrestlers' performance. However, studies also found that the time elapsed between weight loss through dehydration and the beginning of the competitions may repair these values to the levels prior to weight loss.

Dehydration & Muscle Strength and Power of Wrestlers

Muscular Strength is defined by the ability of the body's muscle to generate force in a short period of time. Power is the explosive nature of force production. Maximal power has been marked as being synonymous with explosive strength. While strength is related to power, strength is maximal force production. Brief muscle actions and high movement velocities characterize high power output effort by muscle (24).

During high-power exertions in short time, muscle strength does not seem to be affected by negative impacts of dehydration. Eventually, rapid weight loss may cause power increase benefit by escalating power on a pound for pound basis. However, as vigorous exercise is lengthened, environmental temperatures rise, and extent of dehydration increases, performance will eventually decline. In addition, electrolyte losses may take place with large fluid losses or diuretic use and it could furthermore disturb muscle function, resulting in decreased coordination or increased muscle cramping. Many studies revealed decrements in anaerobic muscle work associated with strength and power (11,16,20,23,34,36,44,46,47).

For example, Ööpik (44) investigated the effect of rapid weight loss on metabolism and isokinetic performance of quadriceps femoris muscle in two well-trained wrestlers. Weight cut was 5.1-5.8% during 3 days. The quadriceps femoris muscle was impaired during single maximal contraction after the weight loss. Moreover, muscle-working ability measured during 5-min isokinetic performance assessment was impaired as a result of weight drop. Even after a 16.5-hrs recovery period of rehydration and food supplementation period following weight loss, body weight of the subjects, plasma volume, blood urea concentration and muscle isokinetic performance characteristics did not return to the initial levels. These findings suggest that rapid weight loss by 5-6% may hinder wrestlers' metabolism and impair the quadriceps femoris muscle function. Support to this study comes from a study by Kraemer (16) and his colleagues' paper that investigated the physiological and performance responses to a simulated freestyle-wrestling tournament after typical weight loss techniques used by amateur wrestlers. Twelve Division I collegiate wrestlers lost 6% of total body weight during the week prior to a simulated 2-days of freestyle wrestling tournament. The test battery included measurement for body composition, reaction/movement time, lower and upper body power and isokinetic strength, and a venous blood sample at baseline as well as before and immediately after each individual match of the tournament. Results indicated that lower body power and upper body isometric strength were significantly reduced as the tournament progressed. Large increases in testosterone, cortisol, and lactate levels were observed subsequent to each match. On the other hand, significant reductions in resting testosterone were observed in the later matches. Norepinephrine, epinephrine and plasma osmolality was steadily higher than normal values at all times including baseline with substantial increases observed after each match. This study and other studies clearly indicate that tournament wrestling causes physiological and performance decrements because of weight loss through dehydration and its influence is progressive in excess of 2 days of competition (16)

Weight Cycling in Wrestling and Dehydration

Weight cycling is the continued loss of body weight practiced by wrestlers to compete in a lower weight class. Weight cycling is a common practice for the majority of wrestlers. Several studies investigated the effects of weight cycling in various age and skill levels in wrestling. In a study that investigated the effects of weight cycling on muscular strength of 19 wrestlers during a collegiate season, large muscle groups changed little in muscular strength and endurance whereas the smaller shoulder abductors and adductors and also hamstring muscles were differentially affected at times of testing. However, ratings of perceived exertion declined after the 4.5-months of wrestling season of weight cycling but not at times of acute dehydration (47)

In addition, McCargar & Crawford (23) investigated the metabolic and anthropometric changes that occur with rapid weight loss/regain cycles in competitive wrestlers. The purpose of study was to investigate the anthropometric changes, resting energy expenditure and thyroid hormone that plays role in regulating metabolic rate. Collegiate wrestlers were divided into two groups: cyclers and noncyclers. Results indicated no

differences on resting energy expenditure between and within groups; however, there was a decrease in thyroid hormone values in the treatment group. Due to short-term dehydration, even some physiological changes were observed; however, a training effect may have overridden any metabolic influence of weight cycling. These findings are in line with the Melby et al. (22) study, which studied the resting metabolic rate differences between cyclers and noncyclers. They found no difference in RMR between pre and post seasons. Conversely, Buford et al. (7) found weight and muscular performance increases of the wrestlers following the collegiate wrestling season after assessing 12 Division I collegiate wrestlers in testing sessions, during midseason, and 3 weeks following the season.

Subsequent to the wrestling season, augmentation in body weight and muscular performance of the wrestlers occurs. The cardiovascular dynamics of these wrestlers rapidly returned to normal during moderately heavy work (5,17,23,32,47). This is because of restoration of body fluids, electrolytes, and glycogen in a short time. Training effect is also an important indicator for getting rid of any negative metabolic consequences of weight cycling.

Weight Cycling in Wrestling and Health problems

Weight loss due to the dehydration can potentially have negative effects on wrestlers' health. Moderate dehydration (up to 3–4 percent of body weight lost) can usually be tolerated without severe health problems as it was previously reviewed in many studies throughout this paper. On the contrary, in strict dehydration (over 5 percent of body weight lost), physiologic systems are gradually compromised (3). Excessive dehydration may cause serious problems including death because of the cardiovascular and thermoregulatory strain of the body. According to ACSM report(3), three cases of dehydration- and hyperthermia-related deaths involving collegiate wrestlers, who had lost about 15 percent of their total body weight trying to compete at 25 to 37 pounds less than their preseason mass, were reported (9).

Reduction in resting metabolic rate is another concerns related to weight cycling. Reduction in resting metabolic rate causes development of obesity. Thus, making rapid regain of weight is more likely for wrestlers since their resting metabolic rate may decline after the weight loss and termination of wrestling. Resting metabolic rate was investigated in several settings. For example, McCargar & Crawford (23) found no difference on resting energy expenditure between and within groups before and after the wrestling season; however, there was a decrease in thyroid hormone values. Similarly, Melby et al. (22) found no difference when they assessed the resting metabolic rates of weight cycling collegiate wrestlers compared to physically active noncyclers. RMR of 14 wrestlers were measured before, during and 6 months after wrestling season. After weight loss wrestlers had lower RMR compared to pre-season; however, after the 6 months there was no difference between the preseason vs. post-season RMR values.

In another weight cycling study, Nitzke et al (30) investigated weight cycling practices and long-term health conditions in a sample of collegiate and former professional wrestlers. They were concerned that rapid weight loss would decrease the resting metabolic rate and cause weight gain in wrestlers after the season and also in the long run. 60 ex-wrestlers and 104 nonwrestlers filled questionnaires. However, no significant differences were found between two groups regarding the weight gain and other health problems.

In addition, hormonal status has an important role in development and growth of athletes. The effect of weight cycling on body composition, blood chemistry and hormonal parameters were investigated on eighteen elite wrestlers before and after two to three weeks weight reduction program (15). In order to determine the degree of dehydration and hormonal status, blood samples were collected to obtain blood chemistry, electrolytes and endocrinological parameters. Significant dehydration because of rapid weight reduction increased blood hemoglobin, hematocrit, and serum creatinine. There was a considerable reduction in serum testosterone and luteinizing hormone concentrations. A reduced body weight is associated with decreased serum testosterone concentration. The results suggest that even short-term weight decline may have noticeable effect on body composition, blood chemistry and hormonal parameters. It may cause a possible health threat at least in a developing youth wrestler.

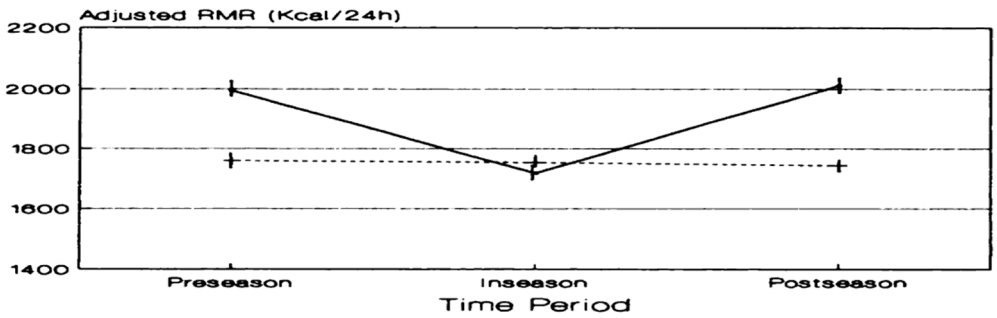

Figure 4. Adjusted RMR (Mean±SEM) in weight-cycling wrestlers (—) and in control subjects (----) before, during, and after a single wrestling season (22).

Psychological Effects of Dehydration on Wrestling

In additional to physiological effects of dehydration on wrestlers' performance, its psychological effects have been an area of concern. For example, Morgan (29) studied anxiety levels of eleven college wrestlers over a one-week period as they tried to lose 5% of their body weight through fasting dehydration. There were nine control subjects who did not lose weight. The subjects filled questionnaires during 5 days of weight loss. From day 1 to day 5, there were fluctuations in their anxiety levels. However, the trial group had a reduction on their anxiety levels at the last day compared to the baseline measurements. Although was a significant decrease in anxiety level between baseline and day five of the weight loss, it was concluded that it was not practically important because there were high levels of fluctuation during these days causing inconsistency in the levels of anxiety.

Table 1. Health problems reported by wrestlers and non-wrestlers, by age (30).

Condition	Wrestlers (n=60)		Nonwrestlers (n=92)	
	under 40	40 and older	under 40	40 and older
High cholesterol	0	4	3	12
Hypertension	0	4	0	10
Hemorrhoids	0	6	0	7
Arthritis	0	4	0	5
High triglycerides	0	2	1	4
Gout	0	3	0	3
Digestive disorders	0	1	1	3
Kidney disease	0	1	0	3
Heart attack	0	0	0	3
Gall stones	0	0	0	3
Depression	0	1	0	1
Heart disease	0	1	0	1
Angina	0	0	0	1
Cancer	0	0	0	1
Respiratory problems	0	0	0	1
Diabetes	0	0	0	1
Stroke	0	0	0	0
Other	0	1 (joint problems)	0	1 (multiple sclerosis)

In parallel to this study, Steen et al. (42) assessed current weight loss practices in wrestlers, 63 college wrestlers and 368 high school wrestlers completed a questionnaire that examined emotions associated with weight loss. The questionnaires were given to the 38 subjects at the beginning of the tournament and collected after completion of the 2 day of tournament. College wrestlers reported frequency of psychological problems that they experienced fatigue (75%), anger (66%), and anxiety (33%). High school wrestlers also experienced frequency of fatigue (35%), anger (45%), and anxiety (24%). Both groups reported depression (24) and low self-esteem (12%). In addition to negative effects of weight loss reported in this study, Risto et al (35) concluded that wrestlers who lost four percent or more of their body mass had significantly higher levels of confusion on the day of the match. Test battery was made in four different occasions of weight loss. First one was 10 days, 6 days, and 2 days before the competition and 2 hours before the competition. Subjects completed a battery of tests on four occasions during weight loss. The results of the subjects who lost 4% or more weight indicated significant increase in confusion from day 10 to day 0. These results also support findings of Maughan (20) that reported decrements self-ratings of alertness and ability to concentrate.

Overall, these studies seem to indicate that dehydration have negative psychological effects on wrestlers' performance, however, according to Morgan's study(20), anxiety level is declined on the last day of the weight loss even there were serious fluctuations in the anxiety levels among these days. These fluctuations cause confusion to make clear judgments on the result of the study. Lower anxiety levels seem to be helpful in sports performance, but there are no conclusive studies in the optimum levels of anxiety required for wrestling events. In addition, in studies trying to measure anxiety levels of wrestlers, different types of the questionnaires were used; thus, this may be major limitation to

make clear judgments in the anxiety levels of the wrestlers due to weight loss. Further studies are needed to investigate the long-term psychological effects on wrestling performance since there are not many in this area.

In conclusion; when rapid weight loss techniques are used, primarily water and lean body mass is lost, not fat. Muscle carbohydrate stores (glycogen) and muscle water are decreased. This impairs temperature regulation and cardiovascular function. However, effects of dehydration on cardiovascular fitness, muscle strength, power and strength seem to be only short term effects of dehydration on performance according to weight cycling studies. The cardiovascular dynamics and muscular performance of these wrestlers rapidly returned to normal following to competition. This happens because of restoration of body fluids, electrolytes, and glycogen in a short time. Training effect is also another important indicator for getting rid of any negative metabolic consequences of weight cycling. Even some studies indicated that weight loss has some negative psychological effects of dehydration on wrestlers' performance: increased fatigue, anger, and anxiety (40), decrements in mood and motivation, and increased confusion (35), nevertheless more studies are needed in these areas. Moderate dehydration (up to 3–4 percent of body weight lost) can usually be tolerated without severe health problems as it was reviewed in this paper. Three colligate wrestlers died because of excessive weight loss of 15 % of body weight (9). It was because of uncompensated fluid loss that affected the cardiovascular and thermoregulatory functions of the wrestlers causing the death. Weight loss may also change hormonal status (15) and inhibit normal growth as well as development. However, it does not cause reduction in resting metabolic rate after the competitive season compared to pre-competition levels even though there was a reduction in RMR during the wrestling season.

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