Rapid Weight Loss in Sports with Weight Classes

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Abstract
Weight-sensitive sports are popular among elite and nonelite athletes. Rapid weight loss (RWL) practice has been an essential part of many of these sports for many decades. Due to the limited epidemiological studies on the prevalence of RWL, its true prevalence is unknown. It is estimated that more than half of athletes in weight-class sports have practiced RWL during the competitive periods. As RWL can have significant physical, physiological, and psychological negative effects on athletes, its practice has been discouraged for many years. It seems that appropriate rule changes have had the biggest impact on the practice of RWL in sports like wrestling. An individualized and well-planned gradual and safe weight loss program under the supervision of a team of coaching staff, athletic trainers, sports nutritionists, and sports physicians is recommended.

Introduction
Body weight and body composition are important aspects of many sports (54). In general, weight-sensitive sports can be divided into three main categories, as follows: 1) weight-class sports, which consist of combat sports, weight lifting, lightweight rowing, horse racing (jockeys), and sprint football, 2) gravitational sports, in which light weight is an advantage as moving the body against gravity is essential (sports with components of running, skiing, skating, jumping, and cycling are among this group), and 3) aesthetic sports, in which body shape is important and also judged (e.g., gymnastics, diving, synchronized swimming, figure skating, and cheerleading).

Rapid weight loss (RWL) has been a part of numerous sports for many decades. RWL is characterized by transitory weight loss of at least 5% of body weight in less than a week. Other than the obvious reason of dropping weight into a class where one would have advantage over lighter and weaker opponents, RWL is perceived by some as a mental toughness practice that gives them a psychological advantage over their opponents (41). RWL can have significant health risks for athletes. In wake of the tragic death of three collegiate wrestlers in 1997, the National Collegiate Athletic Association (NCAA) made significant changes in its rules to prevent RWL practice (12). The purpose of this article was to review RWL practices among athletes, their potential health risks, and measures to prevent these risks.

Epidemiology
Weight-sensitive sports are among the most popular Olympic and non-Olympic sports worldwide. Most studies rely on athletes' self-report, which may not represent the true prevalence of RWL. It seems that this practice is less common among athletes in the highest weight classes of combat sports (3,6,23). The exact prevalence of RWL in sport is unknown. Due to many rule changes in a variety of these sports in recent years, the prevalence of RWL appears to be diminishing. Current rules of sports with weight classes are summarized (Table). Wrestling is the most commonly studied sport for RWL (3,13,23,39,40). Prevalence of RWL among high school, collegiate, and international style wrestlers has been reported as 40% to 90% (3,19,23,39,57). RWL practice is quite prevalent among other combat sports, although the accurate prevalence is unknown (6,10,19,36,41). RWL is also a common practice among jockeys (59). Multiple studies have shown that the practice of RWL starts early, often during adolescence (10,19,23).

Methods of RWL
As previously discussed, the majority of athletes in weight-class sports aim to compete at the lightest weight possible in the belief that it will provide a competitive edge over their smaller and less powerful opponents. Based on sport, level of competition, weight class, age, gender, and amount of excessive weight, athletes use different active (e.g., increased exercise) and passive (e.g., low-calorie diet and heat exposure) strategies and methods to “cut” their weight rapidly. RWL is typically in the range of 5% to 10% of the...
<table>
<thead>
<tr>
<th>Sports</th>
<th>Categories</th>
<th>Weigh-in Procedure</th>
<th>Minimum Body Fat Percentage Allowed, M:F (%)</th>
<th>Hydration Status (Urine-Specific Gravity)</th>
<th>Weekly Weight Loss Percentage Allowed (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrestling</td>
<td>High school</td>
<td>2 to 4 h before the beginning of the competition in each category</td>
<td>7:12</td>
<td>&lt;1.020</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>Collegiate</td>
<td>≤2 h before the first matches begin on the first day</td>
<td>5:12</td>
<td>&lt;1.020</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>Non-Olympic</td>
<td>The day before the beginning of the competition in each category</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Olympic</td>
<td>The day before the beginning of the competition in each category</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Boxing</td>
<td>Collegiate</td>
<td>Daily weigh-in during the competition</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Olympic</td>
<td>Daily weigh-in during the competition</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Non-Olympic</td>
<td>The day before the competition</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Judo</td>
<td>Olympic</td>
<td>In the morning of the competition; there are at least 2 h between the weigh-in and the start of the competition</td>
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<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Non-Olympic</td>
<td>The day before the competition or on the morning of the competition</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Taekwondo</td>
<td>Olympic</td>
<td>The day before competition</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Non-Olympic</td>
<td>Weigh-in in the evening before competition; one weigh-in at the start of competition</td>
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<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Lightweight rowing</td>
<td>Collegiate</td>
<td>1:1 (&lt;73 kg:&lt;59 kg) Once a day, 1 to 2 h before the scheduled time of the first race during the competition (weekly during the season)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Olympic</td>
<td>1:1 (&lt;73 kg:&lt;59 kg) Once a day, 1 to 2 h before the scheduled time of the first race during the competition</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Weight lifting</td>
<td>Youth</td>
<td>2 h before the start of the competition</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Olympic</td>
<td>2 h before the start of the competition</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Non-Olympic</td>
<td>2 h before the start of the competition</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
athlete’s body weight in a week prior to the competition (19). The core strategies for RWL include the following: 1) reducing food and fluid intake, 2) increasing body secretions, and 3) rising body metabolic rate to burn fat tissues (6, 23, 56, 59). Athletes use one or several of these methods at the same time. Reducing food and fluid intake is the main strategy in RWL. Most weight-class athletes start to cut their diet and reduce drinking fluids in the week preceding their weigh-in and gradually intensify restrictions as they get closer to the weigh-in date. In the last day before weigh-in, many athletes fast and some are so dehydrated they suck on ice cubes to prevent their mouths from excessive drying (6). Taking diet pills is another method for losing weight by blocking appetite and burning body fat mass (23).

In general, athletes are interested in losing weight by maximizing fat loss while minimizing glycogen and muscle loss to benefit from lower weights while achieving a higher “strength to mass ratio” and preserving their anaerobic energy source (55). However, in extreme conditions, some athletes may even choose to sacrifice muscle mass by restricting protein and carbohydrate intake. Cessation of restrictive diets after weigh-in usually results in rapid weight gain due to intensified accumulation of fat mass in a mechanism known as poststarvation obesity (58). Repeated cycles of RWL and weight regain are associated with overall weight gain in the long term (50).

Reducing body weight by increasing body secretions, sweating, and dehydration is another strategy of RWL that is generally used a couple of days before weigh-in.

About 65% of the human body is made of water, which makes it a good source for significant and temporary RWL by increased sweating and dehydration. This method of cutting weight is so popular among athletes that is well-known as “drying out” (36). Reduced body water can be easily and rapidly regained by hydrating after weigh-in. Different methods for severe dehydration including use of wet or dry saunas, training in heated rooms, and training with plastic or rubberized suits (sweat suits) in addition to restricting fluid intake are commonly practiced by athletes in the last hours before weigh-in (2, 37, 39). It is important to note that rapid dehydration by more than 5% of the total body weight can result in serious health conditions such as muscle injuries, heat stroke, and even death and is therefore not recommended. Laxative use and intentional vomiting are other aggressive methods that are used mostly at the last day before weigh-in to minimize body weight (8, 18). Although dangerous and banned by World Anti-Doping Agency, using diuretic agents is another method for RWL in the last hours before the weigh-in (11). Using diuretic agents is the most common anti-doping rule violation in combat sports (21). There are a few unusual techniques that are being used by some athletes to reduce body weight before weigh-in including enemas, chewing gum to increase salivation and then spitting out the saliva, and even shaving hairs (8, 23).

Conducting strenuous exercise in the few days before weigh-in is another strategy for RWL. The overall aim of excessive exercise is to reduce body weight by utilizing body fat and even glycogen resources as well as increasing dehydration and sweating. The most common types of exercise used to achieve RWL include running, jogging, cycling, and swimming, with prolonged running or jogging at aerobic intensity in heated rooms or while wearing vapor-impermeable suits as the most common practice (3). Some athletes choose high-intensity intermittent exercise programs to reduce subcutaneous and abdominal body fat (9).

**Physiological Effects**

Due to the small and methodologically weak nature of existing studies, there are conflicting results on the physiological effects of RWL. It appears that RWL causes little or no increase in muscle strength and possibly can reduce it. In a study of 17 elite male boxers, Reljic et al. (45) did not find any alterations in the vitamin and glutathione status in the RWL group compared with those in the control group. In another study, Coswig et al. reported that mixed martial art athletes who practiced RWL (n = 5) were more likely to have abnormally high lactate dehydrogenase and aspartate

### TABLE.

(Continued)

<table>
<thead>
<tr>
<th>Number of Weight Categories, M:F</th>
<th>Weigh-in Procedure</th>
<th>Minimum Body Fat Percentage Allowed, M:F (%)</th>
<th>Hydration Status (Urine-Specific Gravity)</th>
<th>Weekly Weight Loss Percentage Allowed (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed martial arts*</td>
<td>9:2</td>
<td>The day before or within 8 h of the starting time of the event</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Horse racing (jockeys)*</td>
<td>1 (no gender distinction; &gt;50 kg and &gt;57 kg)</td>
<td>Target minimum riding weight will be determined based on body fat percentage and hydration status</td>
<td>6:12</td>
<td>≤1.020</td>
</tr>
<tr>
<td>Sprint football (NCAA)</td>
<td>1: N/A (&lt;78 kg)</td>
<td>Twice a week during the seven-game season</td>
<td>5: N/A</td>
<td>&lt;1.020</td>
</tr>
</tbody>
</table>

* Rules vary by state, country, league, and college organization (e.g., NCAA).

b Freestyle and Greco-Roman.

c Except under 20 years or non-International Judo Federation tournaments.
aminotransferase compared with the control group \( (n = 12) \) in a regional competition in Brazil \( (14) \). Both groups showed increase in lactate, glucose, and cortisol levels. Degoutte et al. \( (17) \) reported significant endocrine parameter changes (decrease in testosterone, insulin, and T3/T4 ratio and increase in adrenocorticotropic hormone (ACTH); dehydroepiandrosterone sulfate (DHEA-S) levels) in dietary restriction group \( (n = 10) \) compared with those in the control group \( (n = 10) \) after the competition.

**Cognitive Function and Psychological Effects**

Research on the psychological effects of RWL is not clear. A survey reported that 60% of college wrestlers and 45% of high school wrestlers felt angry while losing weight \( (53) \). These mood and mental performance changes could potentially impact a wrestler’s school and athletic performance, although this has not been directly studied. Athletes overall are known to have more of an “iceberg” profile on their psychological scores on the validated Profile of Moods States questionnaire, with lower scores for tension, depression, and anger, high scores for vigor, and lower scores for fatigue and confusion \( (34) \). In the short term, athletes who cut weight can see an increase in their levels of confusion after dropping weight for competition with insignificant increases in depression and anger \( (28) \) but another study found that decreases in weight before competition affected tension, fatigue, and anger without increasing confusion or depression \( (17) \). A literature review from 2012 reports decreases in memory, concentration, and self-esteem with increases in confusion, depression, rage, and fatigue after RWL \( (19) \). However, Choma et al. \( (13) \) found that the effect of weight cutting on mood is not sustained after weight is regained. While Koral and Dosseville \( (24) \) noted increases in tension and confusion with decreases in vigor after weight cutting, they posit that increases in anger and tension may result in increased performance, a theory also suggested by others.

Choma et al. \( (13) \) also found an association between decreased mood, digit span, and story recall with hypoglycemia associated with RWL, but no changes in other cognitive tests. Other research shows no differences in cognitive testing after RWL in jockeys \( (15) \). It is worth mentioning that none of these studies reported improvements in psychological or cognitive parameters associated with RWL and most had control groups to offset the effect of pre-performance stress on testing.

While there is concern that RWL could lead to development of eating disorders, this has not been shown. It has been reported that 10% to 15% of boys who participate in weight-sensitive sports practice unhealthy weight loss behaviors, with disordered eating the highest in weight-class sports \( (58) \). Surveys of in-season wrestlers have reported the use of cyclic vomiting consistent with bulimia in 1.4% to 5% of wrestlers \( (16,24,39) \). However, Davis et al. \( (16) \) conducted interviews with wrestlers identified as “at risk” on the Eating Disorder Inventory Survey and concluded that the athletes’ weight concerns were due entirely to the demands of wrestling and did not meet the criteria for the diagnosis of bulimia nervosa. Rouveix et al. \( (49) \) found that athletes who participate in weight cutting are at increased risk for developing eating disorders based on predictive test scores but not on observed development of eating disorders. A large survey of judoka found no differences in weight cutting behavior between men and women and no reports of risky dieting behaviors in the off season \( (6) \).

**Effect of RWL on Performance**

Experts believe that RWL compromises sports-related aerobic and anaerobic performance \( (19) \). However, there is only a handful of studies in this area. In general, most studies on the effects of RWL on performance are small and have methodological weaknesses.

One of the effects of RWL is on hydration status as many RWL methods target fluid loss. Moderate dehydration (3% to 4% of body weight) impairs muscular endurance during high-intensity exercise \( (26,32) \). However, it seems that moderate dehydration does not impair maximal muscular strength or power \( (26,32) \). In a study of 28 well-trained combat athletes (wrestling, boxing, judo, taekwondo, and karate athletes), Reljic et al. \( (44) \) reported no significant change in aerobic performance capacity in RWL group compared with that in the control group despite a significant decrease in hemoglobin caused by impaired erythropoiesis and increased hemolysis.

Mendez et al. \( (31) \) reported no significant changes in performance from before weight loss to after weight loss in the RWL group \( (n = 10) \) compared with the non-weight cycler group \( (n = 10) \) in a group of combat sport athletes. In another small study of 14 athletes, Artioli et al. \( (7) \) did not find any judo-related performance deficit among experienced weight cyclers compared with that in the control group. In a study of 20 athletes, Degoutte et al. \( (17) \) reported significant judo-related performance deficit in the RWL group compared with that in the control group. Wroble and Moxley \( (61) \) reported in their study that high school wrestlers who practiced aggressive RWL performed better and received more medals compared with those who followed the recommended weight loss protocols. Marttinen et al. \( (28) \) found that the self-selected RWL did not have any effect on grip strength or lower-body power among 16 male collegiate wrestlers. Studying 20 national and international judo athletes, Koral and Dosseville \( (24) \) reported a significant decrease in judo movement repetitions over 30 s but not over 5 s in the weight loss group \( (n = 10) \) compared with that in the control group \( (n = 10) \) in France.

Wilson et al. \( (60) \) reported significant impairment of maximum pushing frequency among eight jockeys (randomized crossover design) who rapidly lost 2% of body weight in a simulated race.

**Health Consequences**

Multiple medical associations and authors have warned of the potential acute and long-term medical consequences of RWL and weight cycling by athletes \( (37,54,56) \). Concerns about the acute health risks of weight cycling have centered primarily upon RWL of greater than 5% of body mass through extreme dehydration in the 1 to 2 days prior to weighing in. Extreme dehydration can cause decreased plasma volume, resulting in decreased stroke volume, increased heart rate, and reduced arteriovenous oxygen difference during submaximal exercise. These changes can reduce renal flow and electrolyte abnormalities and make
athletes possibly more susceptible to heat injury and muscle cramps (43). However, these changes are quickly reversed within an hour of ad libitum fluid rehydration (4). The debate over the risks of RWL was indubitably altered in the fall of 1997 when three collegiate wrestlers died within a 5-wk period from complications of RWL (12). All three wrestlers were attempting to rapidly lose significant weight by induction of severe dehydration using traditional techniques (exercise and heat-induced sweating and fluid deprivation). The practices of RWL among wrestlers could no longer be considered a harmless exercise in discipline and self-control.

Other potential health consequences of RWL and weight cycling that have been postulated include hormonal changes, growth impairment, decreased bone formation, decreased basal metabolic rate, and loss in fat-free mass with negative protein balance (5,37,43). However, the physiological changes observed with cyclic RWL appear to be transient and not associated with negative health consequences. Perturbations in the hypothalamic-pituitary-adrenal and growth hormone insulin-like growth factor axes were found in wrestlers during the competitive season but rapidly returned to normal after the season (47). Similarly, lightweight female rowers who engaged in RWL cycles were found to have decreased progesterone secretion associated with weight loss and lengthening of their menstrual cycles that returned to normal in the off season (35). Male and female judoist who engaged in RWL were found to have an acute net increase in bone resorption relative to formation, but this effect reversed with refeeding, and their bone mineral density was actually higher than active age-matched controls (42). Studies looking at the impact of weight cycling on basal metabolic rate and fat-free mass have been mixed (29,52).

A longitudinal study of wrestlers found that their basal metabolic rate decreased during the wrestling season but returned to preseason values after the season and was higher than that of physically active nonwrestling controls (30).

There has been concern that repetitive weight loss cycling negatively affects the immune systems and reparative abilities of athletes, making them more susceptible to illness and injuries. Immune function at baseline, just prior to and, after a national championship was measured in college judoists who were classified into three groups depending on the amount of weight they lost immediately prior to the competition. Blood leukocyte, neutrophil, and lymphocyte counts were unchanged in all groups. However, the group that lost the most weight had significantly decreased phagocytic activity. Actual illness incidence was not reported for the three groups (25). There have been few studies looking at injury risk associated with RWL. A study done at a judo championship found that participants who lost greater than 5% of their body weight prior to the competition had a significantly greater risk of injury (36.8%) compared with athletes who did not lose weight (14.6% injury rate) (20).

Proposed long-term consequences of frequent weight cycling include impaired growth, eating disorders, obesity, and increased cardiovascular disease risk. Two studies that monitored the growth and maturation of adolescent male wrestlers concluded that the dietary restrictions and weight cycling patterns typical of wrestlers did not adversely affect normal anthropometric growth patterns or maturation (22,48).

Large epidemiological studies have found that weight cycling in the general population is associated with an increased risk of developing type 2 diabetes mellitus and cardiovascular disease (33), raising concerns that athletes who engage in habitual weight cycling also could be at increased risk. Saarni et al. (50) followed a cohort of elite Finnish athletes for 45 years. They found that former athletes from sports with weight classes gained more body mass index (BMI) units and were more likely to be obese than athletes in other sports and nonathletic controls. The enhanced weight gain was not accounted for by current health habits or baseline weight at age 20 (50). In contrast, retired elite French athletes in weight-class sports had lower BMI and were more physically active than the age-matched general population after an average follow-up of 22 years. In addition, there was no statistical differences in weight gain between athletes who habitually weight-cycled in their careers and athletes who did not (27). The different findings of the studies could be at least partially due to the different periods that the athletes were active. The Finnish study looked at athletes who were active between 1920 and 1963, while the French study involved athletes active between 1978 and 2003. Guidelines for nutrition and physical activity were certainly different in the two eras represented in the studies and could have influenced the retired athletes’ behavior.

**Strategies to Prevent RWL Practices**

The most successful way to prevent RWL methods is to implement rules that make RWL impractical. Voluntary programs that emphasized education from 1960 to 1997 did not reduce RWL (51). The deaths of the college wrestlers in 1997 prompted the NCAA to institute a mandatory weight monitoring program for wrestlers (12). The NCAA implemented five rule changes for the 1998 to 1999 season, including a minimum wrestling weight based on 5% body fat, moving weigh-ins to at most 1 h prior to competition, and a prohibition of using saunas, steam rooms, and impermeable suits to lose weight (Table). The National Federation of State High School Associations made similar recommendations with the exception of setting the minimum at 7% body fat for boys and 12% for girls. Several studies have reported that these programs have been successful in decreasing the frequency and magnitude of RWL by wrestlers (16,38,40). Other weight-class sports have not implemented mandatory weight monitoring programs, although there has been a proposal for the International Judo Federation to institute a program similar to the NCAA wrestling weight certification program (5). At the youth level, methods of matching combat sport opponents not strictly based on weight have been successfully implemented and should be encouraged.

A study by Alderman et al. (3) in 2004 emphasized the importance of having a rule-based weight monitoring program to effectively change athletes’ behavior. The study found that high school and college wrestlers reverted to RWL methods and patterns when competing in an international tournament, which had no minimum weight rules.
and a longer period between the weigh-in and the competition (3).

Educational programs are important, in conjunction with rule changes, to change the attitude of athletes and coaches toward weight loss. RWL is ingrained in the culture of weight-class sports, particularly combat sports (41). For any weight management program to be successful, the athletes and coaches must believe that the medical professionals involved (physicians, athletic trainers) understand the demands of their sport. Education must focus on how healthy weight control and nutrition will make the athletes better competitors. Examples of successful wrestlers such as Kyle Dake who went up a weight class each year in college and won four NCAA championships have a greater impact on wrestlers and coaches than a discussion of possible medical risks. The American College of Sports Medicine (37), National Athletic Trainers Association (56), and International Olympic Committee Medical Commission (53) have all published guidelines on safe weight loss and weight maintenance in athletes. These guidelines stress the importance of close working relationships between coaches, athlete trainers, physicians, and athletes to set realistic goals based on an accurate assessment of percentage of body fat. Athletes who are competing at an appropriate body composition achieved with scientifically sound training and nutrition principles will maximize their performance without needing to engage in RWL prior to the competition.

Conclusions

No matter which RWL strategy is being used, there are potential negative health and performance effects of rapid and aggressive weight loss that occur in less than 7 d. Therefore, RWL practice is discouraged by many organizations (1,46,53,54,56). RWL is still a common practice among athletes in several weight-sensitive sports. We recommend an individualized and well-planned gradual weight loss program for athletes who desire to lose weight. Coaching staff, athletic trainers, sports nutritionists, and sports physicians should be consulted and should supervise athletes during the program. We also believe that better education and appropriate rule changes (e.g., 1997 NCAA wrestling weight management rule changes) will have the largest impact on reducing the practice of RWL worldwide. Further large-scale prospective studies are required to investigate the true prevalence of RWL practice and its physiological and psychological effects on athletes.

The authors declare no conflicts of interest and do not have any financial disclosures.

References
