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Rapid weight loss and athletic performance in combat sports

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Abstract

Competitions in combat sports are divided into certain weight classes in order to compete fairly among athletes of similar body weight. However, athletes lose weight compulsorily or tactically (to encounter weaker opponents, to be between two weights, to be faster and more agile, etc.). In many scientific studies, it is seen that the athletes lose their weight close to the competition scale, and generally they lose a lot of weight on the last day. In addition, it is stated that the rate of weight loss varies between 2-10% of the body weight of the athletes. Many methods are used to set weight before the competition scale. These; Reducing energy intake, reducing fluid consumption, not consuming anything especially the day before the competition scale, increasing the duration and intensity of exercise, loss of fluid with intense sweating, use of sauna, use of diuretic drugs. As the use of these harmful methods and the rate of weight loss increase, their negative effects on physical, physiological, psychological and performance increase at the same rate. In this study, studies in the literature on the effects of weight loss on strength, endurance, anaerobic performance, reaction and balance performance will be examined and the causes of possible effects will be determined.

Keywords: Dehydration, weight loss, combat sports, sports performance

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1. Introduction

Weight regulation is the practice of ensuring that competitions are held on equal terms (to confirm that characteristics such as body weight and strength are equal and reduce the risk of injury) among athletes competing in each weight category (Franchini et al., 2012; Artioli et al., 2013; Abadi et al., 2018). Body weight measurements of the athletes are taken the day before competition and shortly before the competition and this is called a weigh-in (Horswill, 1992). The time between weigh-in and competition may vary in weight-class sports but it is generally between 2-24 hours. Athletes lose weight and go into a lower weight class due to reasons such as having a body weight between two weight classes, the presence of strong opponents in their weight class, trainers needing athletes in a certain weight class when forming a team, wanting to be faster and more durable than their

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opponents and increase their mobility (Aydos & Konar, 1993; Artiolive et al., 2010), or thinking that athletes in the lower weight class may be weaker than themselves in terms of performance (Ersoy, 2010).

Studies examining the prevalence of weight cutting yielded the following results: Steen & Brownell (1990) reported that 89% of the university students participating in a wrestling tournament lost an average of 4.4 kg in 3 days, while 70% of the high school students lost an average of 3.3 kg in 4-5 days for the tournament. In another study, Artioli et al. (2010) found that while 89% of judo practitioners lost weight at least once during their competition careers, 82% lost weight regularly. Kordi et al. (2011) stated in their study that 62% of male wrestlers cut weight. A study conducted with kickboxers by Garthe & Borgen (2004) revealed that 76% of the athletes lost weight. In a similar vein, a study conducted by Brito et al. (2012) on karate practitioners showed that 70% of athletes lost weight. The data from the above studies show that the vast majority (60-90%) of the athletes practicing weight-class sports lose weight and this is quickly done a few days before competitions. Additionally, the studies revealed that the overall weight loss rate of the athletes was between 2-10% of their body weight (Artioli et al., 2016).

Athletes use many methods to lose weight before competitions. These methods can be listed as partial or complete fasting, restricting fluid intake, using sauna intense training, restricting fatty foods, running in sweat suits, taking various diuretics, and vomiting (Artioli et al., 2010). Reports indicate that it is quite common among athletes competing in branches such as wrestling, judo, taekwondo, karate, and jujutsu to use one or more of the above-mentioned weight loss methods simultaneously (Gann, Grant & Bounty, 2015; Brito et al., 2012).

Although combat sports are mainly performed as short bouts of high-intensity combats that utilize anaerobic glycolysis as an energy source, aerobic metabolism is also important (Roklicer et al., 2022). Deterioration in aerobic performance has been tied to dehydration, reduced plasma volume, increased heart rate, loss of electrolytes, impaired thermoregulation, and depletion of muscle glycogen (Woods, Wilson & Masland, 1988). Decline in anaerobic performance, on the other hand, has been attributed to reduced buffer capacity, depletion of glycogen stores and decrease in electrolytes (Woods, Wilson & Masland, 1988; Fogelholm et al., 1993).

Weight loss through fasting leads to a lack of energy, prompting the body to convert the amino acids in the body to glucose to produce the necessary energy (gluconeogenesis). This, in turn, leads to a decrease in muscle tissue, which results in loss of strength in athletes. Losing weight with this method also leads to issues such as low blood pressure, high levels of uric acid in the blood, dizziness, anemia, and mental disturbances (Ersoy, 2010).

Weight cutting methods such as using sauna, taking diuretics, intense training, restricting fluids employed for a few days prior to the weigh-in, cause rapid weight loss and this leads to a decrease in body fluids (Pehlivan, 2005). Use of methods that bring about rapid dehydration in a short time may potentially cause serious damage to the kidneys and cardiovascular system (Wilmore & Costill, 2004). As there is only a small amount of time between the weigh-in and the first match in most combat sports, it is not possible for athletes to consume the necessary nutrients and fluids and to begin the competition having fully recovered. In short, findings in the scientific literature sufficiently support that rapid weight loss affects mental well-being as well as physical health in athletes practicing in combat sports.

This study will examine other studies in the literature about the impact of weight loss on strength, endurance, anaerobic performance, reaction and balance performance and will determine the causes of any possible effects.

2. Method

The research study was designed in accordance with the specifications outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols, and the recommended elaboration and explanation document. The search was conducted on january 01, 2022 by systematically exploring PubMed (MEDLINE), Scopus, SPORTDiscus (EBSCO), Web of Science (via Thomas Reuters) and Sports Medicine and Education (PROQUEST) databases using the search terms ("Combat sport) and (Weight cut, Weight loss, Rapid weight loss). Obtained results were tabulated and interpreted.

3. Results

Table 1. Studies on weight loss and strength performance

Country	**Sports**	**Participant (n)**	**Weight loss ratio %**	**Strenght**	**Measurement**	**Alteration**	**Authors**
France	Judo	11	4.9	Explosive Power	Hand grip	↓	Filaire et al. (2001)
USA	Wrestling	12	6	Explosive Power Isokinetic power	Hand grip Knee and elbow extension	↓	Kraemer et al. (2001)
France	Judo	20	5	Explosive Power	Hand grip	↓	Degoutte et al. (2006)
India	Boxing	24	5	Explosive Power	Hand grip	↔	Gulati et al. (2006)
Estonia	Wrestling Karate	17	5,1	Peak Tork	Cybex	↓	Timpmann et al. (2008)
İranian	Wrestling	30	4	Maxsimal strenght	Chest press Squat	↓	Rashidlamir et al. (2009)
UK	Riding	8	1.8	Maxsimal strenght	Leg and chest press	↓	Wilson et al. (2014)

Turkey	Wrestling	12	5.6	Explosive Power	Hand grip	↔	Aydin, (2018)
Spain	Judo	38	>3	Isometric strenght	Hand grip	↔	Morales et al. (2018)
Belgium	Judo	22	4.1	Isometric strenght	Curl bar	↓	Clarys et al. (2010)

↓ : Decrease ↑ : Increase ↔ : no change

Strength is a very important motor ability in combat sports, as it is in every branch of sport. Extreme diets (starvation, dehydration) followed for short periods of time in addition to intense training and sauna use lead to rapid depletion of body fluids and carbohydrate stores. The rapid depletion of carbohydrate stores generates an increase in gluconeogenesis, eventually resulting in muscle breakdown. Additionally, the serious decrease in body fluids that occurs during weight loss also reduces the cross-sectional area of the muscles (Kukidome et al., 2008). Athletes experience decreases in strength and performance in this way.

Table 2. Studies on weight loss and endurance performance

	Country	**Sports**	**Participant (n)**	**Weight loss ratio %**	**Endurance**	**Measurement**	**Alteration**	**Authors**
Muscular endurance	France	College students	11	2.9	Isometric endurance	Knee extension	↓	Bigard et al., (2001)
	Australia	Rower	17	4	Muscular endurance	Rowing ergometer	↓	Slater et al., (2005)
	India	Boxing	24	5	Muscular endurance	Hand grip	↓	Gulati et al., (2006)
	Estonia	Wrestling Karate	17	5,1	Muscular endurance	Cybex	↓	Timpmann et al., (2008)
	Iranian	Wrestling	30	4	Muscular endurance	Squat test	↓	Rashidlamir et al., (2009)
	Iranian	Wrestling	30	4	Muscular endurance	Chest Press + Pull Up	↓	Rashidlamir et al., (2009)
	Turkey	Combat sports	12	5.6	Muscular endurance	Squat test	↓	Aydın, (2018)
	Tunusia	Karate	8	-	Isometric endurance	Scott Bench	↔	Zarrouk et al., (2016)
	Belgium	Judo	22	4.1	Anaerobic endurance	20 max jumps	↓	Clarys et al., (2010)
Cardiorespiratory endurance	USA	Wrestling	7	4,9	Anaerobic power	Treadmill	↓	Webster et al., (1990)
	Turkey	Wrestling	11	4	Anaerobic endurance	Shuttle run	↓	Eroğlu, (2002)
	Ireland	Riding	18	4	Anaerobic endurance	Bicycle ergometer	↓	Dolan , (2010)
	Azerbaijan	Wrestling	23	4-10.5	VO2max	Treadmill	↓	Rad et al., (2015)
	Turkey	Combat sports	12	5.2	VO2max	Treadmill	↓	Yarar, (2015)

↓: Decrease ↑ : Increase ↔ : no change

Endurance is defined as the ability to resist fatigue during long-lasting athletic activities (Sevim, 2007). There are two types of endurance, muscular and cardiorespiratory.

Muscular endurance is the ability of a muscle or group of muscles to perform repetitive contractions against resistance and at a certain rhythm and intensity for an extended period of time. It refers to the strength of the muscle group and its capacity to produce energy. While muscular endurance is related to individual muscles, cardiorespiratory endurance is encompasses the entire body and depends on the respiratory, circulatory and muscular systems (Wilmore & Costill, 2004). The circulatory system is required to transmit the oxygen, which is taken into the body by respiration, to the cells and tissues, and this cycle must continue.

Studies on this subject show that weight loss has a significant impact on endurance (Table 2). From 1996 to 2006, the American College of Sports Medicine recommended that "During exercise, athletes should consume fluids at a rate sufficient to replace all the water lost through sweating or consume the maximal amount that can be tolerated (Convertino et al., 2006). In 2007, they reported that aerobic exercise performance could be impaired when dehydration exceeds >2% of body weight, and that exercise in warm environments could lead to more water loss (Sawka et al., 2007). Generally, sudden changes of >2% of body weight result in a loss of body fluids, which in turn impairs endurance.

Resorting to methods that cause the body to lose excessive amounts of fluid in a short time (restriction of food and fluids, using saunas, and intense training) reduces blood volume, increases heart rate, decreases aerobic and anaerobic capacity, depletes energy stores, and potentially causes great harm to the kidneys and thermoregulation mechanisms (Wilmore & Costill, 2004). All these negative outcomes also affect the circulatory system which leads to the impairment of cardiorespiratory endurance.

Additionally, the decline in performance experienced after rapid weight loss results from a decrease in blood plasma volume and muscle glycogen stores (Hickner et al., 1991; Horswill et al., 1990; Choma et al., 1998; Bigard et al., 2001). Dehydration leads to a decrease in blood plasma volume, which in turn causes a decrease in ventricular filling pressure. As a result, the heart rate increases and stroke volume decreases by approximately 25-30%. In conclusion, decrease in cardiac output and arterial blood pressure, along with dehydration caused by rapid weight loss, lead to a decline in aerobic performance (Greenwood et al., 2008). During their research, Sinclair et al. (1983) observed a decrease in cardiac output and stroke volume and an increase in heart rate as a result of fluid loss. The data of this study indicate that the circulatory system disorders caused by reduced plasma volume and food restrictions that deplete muscle glycogen stores, lead to the deterioration of muscular endurance.

Table 3. Studies on weight loss and anaerobic performance

Country	Sports	Participant (n)	Weight loss ratio %	Anaerobic performance	Measurement	Alteration	Authors
Turkey	Wrestling	10	5.2	Peak power (w/kg)	Wingate	↑	Türkyılmaz, (2019)
Iranian	Wrestling	24	5.0	Peak power (w/kg)	Wingate	↑	Yadollahzadeh, (2015)
Iranian	Wrestling	16	5.2	Peak power (w/kg)	Rast test	↓	Almasi, (2013)
USA	Wrestling	16	4.0	Peak power (w/kg)	Wingate	↔	Marttinen, (2011)
Turkey	Wrestling	10	5.2	Anaerobic power(W)	Vertical jump	↔	Türkyılmaz, (2019)
France	Judo	11	4.9	Anaerobic power(W)	Vertical jump	↔	Filaire et al. (2001)
USA	Wrestling	12	6	Anaerobic power(W)	Vertical jump	↔	Kraemer et al. (2001)
Turkey	Wrestling	12	5.6	Anaerobic power(W)	Vertical jump	↔	Aydin, (2018)
UK	Recreational	12	3.9	Anaerobic power(W)	Squat jump	↔	Hayes & Morse (2010)
Greece	Wrestling	12	6.0	Anaerobic power(W)	Squat jump	↔	Barbas et al. (2010)
USA	Wrestling	7	4.9	Anaerobic power(W)	Treadmill	↓	Webster et al. (1990)
Spain	Individuals losing weight for the first time	12	1.8	Anaerobic power(W)	Squat jump	↓	Gutierrez et al. (2003)
Spain	Judo	20	3.9	Anaerobic power(W)	Squat jump (cm) Vertical jump (cm)	↔	Koral & Dosseville, (2009).
Germany	Taekwondo	10	5.0	Anaerobic power(W)	Squat jump (cm) Vertical jump (cm)	↑	Yang et al. (2014)

↓: Decrease ↑: Increase ↔ : no change

Studies on the effects of weight loss on anaerobic performance seem to yield different results (Table 3). The differences in the results may be due to the different tests used in the studies, different weight loss rates, weight loss times, weight loss methods and different recovery times after rapid weight loss.

Anaerobic power can be articulated in two separate ways as (W) and (W/kg). While Watt is an expression of absolute unit used without taking into account body weight, W/kg is an expression of relative unit, and since it is measured by taking into account the individual's body weight, it is more useful in revealing any possible differences between individuals. Therefore, the use of (W/kg) would be more accurate when comparing the maximum anaerobic power (MAG) in weight-class sports. For relative values (W/kg), if an athlete loses weight, his/her anaerobic power may appear to have increased or remained unchanged.

Studies with Wingate measure the MAG value (WAnT) over the highest five-second time frame within 30 seconds (Inbar et al., 1996; Kamar, 2003). Anaerobic performance may not be affected much during such short-term activities; the decrease in longer-term anaerobic performance, however, may be due to depleted muscle glycogen stores and an acid-base imbalance. Additionally, some suggest that the decrease in glycolysis rate resulting from the increase in free fatty acids negatively affects anaerobic performance (Filaire et al., 2001; Horswill et al., 1990). Houston et al. (1981) stated in their study that after weight loss achieved through 4 days of restricting food and fluids, glycogen stores were depleted. Therefore, a decrease in glycogen stores may have occurred. Similarly, Degoutte et al. (2006) observed an increase in glycerol levels after 1 week of weight loss.

Table 4. Studies on weight loss and reaction performance

Country	**Sports**	**Participant (n)**	**Weight loss ratio %**	**Reaction**	**Measurement**	**Alteration**	**Authors**
Turkey	Wrestling	10	5.2	Right hand Left hand Auditory	Newtest 1000	↔	Türkyılmaz, (2019)
UK	Riding	8	2.0	Visual reaction	-	↔	Wilson et al. (2014)
Turkey	Combat sports	16	3.6	Visual and Auditory reaction	Newtest 1000	↔	Yarar et al. (2020)
Tunisia	Karate	8	-	Visual reaction	Superlab 4.5	↔	Zarrouk et al. (2016)
Spain	Judo	38	≥3	Visual reaction	Contact platform	↑	Morales et al. (2018)
Belgium	Judo	22	4.1	Visual reaction	Opto jump	↓	Clarys et al. (2010)

↓ **: Decrease** ↑ **: Increase** ↔ **: no change**

Reaction time is the time that passes between the stimulus and the response to the stimulus (Bompa, 1998). The main factors that urge the individual to act are visual, auditory, tactile and kinesthetic stimuli. The stimuli in combat sports are predominantly visual and tactile, whereas in sports that require starting (swimming, athletics, running, etc.) auditory stimuli are more prominent (Şahin, 1995). Reaction time is a determining factor for performance in nearly all branches of sports and an essential component that must be improved with training (Saccuzzo & Michael, 1984). A review of the above-mentioned study results regarding weight loss and reaction time indicates that the reaction is generally unaffected or partially affected.

Along with stimulus, muscle activation is one of the most important factors affecting reaction time. The main electrolytes that enable muscle activation are sodium and potassium. Folgelholm et al. (1994) found no change in serum potassium levels following rapid weight loss. Reljic et al. (2013) also stated that there was no change in sodium and potassium levels after a 5.6% weight loss within 5 days. In a similar vein, Yang et al. (2014); Filaire et al. (2001), Judelson et al. (2008) observed no significant changes in serum potassium levels in their respective studies. These studies indicate that there is no significant difference in reaction time, as there is no change in the electrolytes responsible for muscle activation.

Table 5. Studies on weight loss and balance performance

Country	**Sports**	**Participant (n)**	**Weight loss ratio %**	**Balance**	**Measurement**	**Alteration**	**Authors**
Turkey	Combat sports	16	3.6	Dynamic balance	Biodex	↔	Yarar et al. (2020)
Ireland	Riding	12	4.2	Dynamic balance	-	↔	Cullen et al. (2015)
Spain	Judo	38	≥3	Dynamic balance	Wii Balance	↓	Morales et al. (2018)
Tunisia	Wrestling	10	-	Dynamic balance	Star balance test	↓	Jlid et al. (2013)

↓: Decrease ↑: Increase ↔ : no change

Balance is the postural stability maintained to keep the center of gravity on the base of support during movement of the body (Onat, Özişler, & Köklü, 2013). It is the ability to maintain the body's position in a stationary state and to remain stable in any position while in motion (Winter, Patla & Frank, 1990). Balance is maintained by vision, hearing, vestibular system, proprioception, reaction time, muscle strength, joint mobility, posture and sense of motion in legs and feet. Disorders and physiological loss that may impact the functions of these systems, lead to impairment of the ability to maintain balance (Onat, Özişler & Köklü, 2013). According to the results of the research, it is understood that income status is not related to nutritional information level. It was revealed that there was a difference between sex and nutrients and all ingredients (thought to be more common in men), there was no difference between liquids, refreshments, weight control, and food supplements. With training on nutrition, it was found that nutrients are not different from liquid ingredients, refreshment, weight control, food supplements, and not all ingredients (Gümüşdağ et al., 2020).

There are a limited number of studies on relation between weight loss and balance performance in the literature. Table 5 shows that there is a decline in balance performance. This decline may be due to dehydration that occurs during rapid weight loss. According to Lion et al. (2002), dehydration affects sensory organization through disorders of the vestibular system, and there is a connection between the level of dehydration and the use of loss of vestibular input. Additionally, rapid depletion of body fluids and carbohydrate stores following rapid weight loss increases gluconeogenesis and, as a result, leads to serious muscles breakdown. Breakdown of muscles leads to loss of strength, which causes a decline in balance performance (Kukidome et al., 2008).

4. Conclusions

Weight-cutting is quite common in weight-class sports for a variety of reasons, Athletes may think that competing in the lower weight class will prove to be an advantage or their current weight may be between the two weight classes. This study examined scientific studies on weight loss in the literature in terms of strength, endurance, anaerobic performance, reaction and balance performances of athletes, and presented the results in tables. To conclude, short-term weight loss causes physiological changes depending on the rate of weight lost, which affects athletic performance in almost all aspects and this does not present any advantages to athletes. Therefore, those responsible should be more careful about rapid weight loss to ensure the protection of athletic performances and health of the weight-class athletes.

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