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Weight Loss and Competition Weight Comparing Male and Female Mixed Martial Artists Competing in the Ultimate Fighting Championship's (UFC) Flyweight Division

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Abstract: Background: Although there is much literature demonstrating weight changes in professional mixed martial arts (MMA) athletes, there is minimal data comparing male and female MMA athletes. Therefore, the purpose of the current study was to compare weight changes between professional male and female MMA athletes leading up to competition. Methods: One hundred and three professional flyweight MMA athletes competing for the Ultimate Fighting Championship (UFC) were used for the study. Weight was obtained at multiple time points leading up to the competition. Two-way ANOVAs and post hoc t-tests were used, and significance was set at $p \leq 0.05$. Results: ANOVA revealed there was a significant main effect of condition for weight changes ($p < 0.001$) and a significant main effect of sex on weight changes ($p = 0.002$) prior to competition. Post hoc analysis revealed that males lost more weight prior to the official weigh-in and gained more weight prior to competition when compared to females ($p \leq 0.05$). Conclusion: MMA athletes lose weight prior to the official weigh-in and gain weight prior to competition. Moreover, male MMA athletes lose more weight prior to and gain more weight after when compared to female MMA athletes competing in the UFC's flyweight division.

Keywords: MMA; rapid weight loss; rapid weight gain; fighting

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1. Introduction

Modern mixed martial arts (MMA) has only recently become widely popularized, with the development of the Ultimate Fighting Championship (UFC) in 1993 [1]. Inspired by the Brazilian form of MMA, known as Vale Tudo, the UFC established a sanctioned MMA organization in the United States [1]. The first UFC event featured a roster of fighters with different martial arts backgrounds competing in a "no holds barred" tournament [2,3]. In the early onset of the UFC, the rules were limited, and the promotion of the sport relied heavily on the violent nature of the events, which led to calls for prohibition of the sport and legal barring in certain states [2,4]. Eventually, the sport would adopt new regulations to promote the safety of fighters while simultaneously allowing the sport to be sanctioned by various state athletic commissions [2]. The sport of MMA has grown dramatically over the years, with 100 times more MMA fights in 2021 since the beginning of the UFC in 1993 [5]. The UFC is now considered a mainstream sport with millions of fans and events all around the world [4]. As the UFC attempted to rebrand and establish itself as a safer and more regulated sport, they adopted the Unified Rules of Mixed Martial Arts [6]. The new rules outlawed headbutting, eye gouging, biting, spitting, fish-hooking, hair pulling, strikes to the groin, back of the head or spine, throat strikes, and

more [6]. UFC bouts take place in an octagonal cage, with fighters competing with 4 oz gloves in three 5 min rounds for non-title fights, and five 5 min rounds for title fights [4]. The Unified Rules of MMA developed the use of weight classes, including strawweight (115 lbs./52.2 kg), flyweight (125 lbs./56.7 kg), bantamweight (135 lbs./61.2 kg), featherweight, (145 lbs./65.8 kg), lightweight (155 lbs./70.3 kg), welterweight (170 lbs./77.1 kg), middleweight (185 lbs./83.9 kg), light–heavyweight (205 lbs./93.0 kg), and heavyweight (205–265 lbs./93.0–120.2 kg) [6]. The UFC currently holds four weight classes for female competitors in the strawweight (115 lbs./52.2 kg), flyweight (125 lbs./56.7 kg), bantamweight (135 lbs./61.2 kg), and featherweight (145 lbs./65.8 kg) divisions [6].

With the introduction of weight classes into MMA, similar to other combat sports, weight cutting practices have followed. While research into the performance effects of weight cutting is still uncertain, athletes continue to cut weight according to the belief that they may gain a competitive advantage over their opponent by cutting and regaining more weight [7–11]. Current research into weight cutting practices has found a high prevalence of rapid weight loss (RWL) prior to official weigh-in and a high prevalence of rapid weight gain (RWG) before competition in combat sports athletes [12–20]. From the inclusion of weight classes in MMA, most athletes have also adopted the practice of weight cutting in preparation for competitive bouts [10,12,13,16,20,21]. In comparison to other combat sports, mixed martial arts athletes have demonstrated an even greater prevalence of RWL practices [16,19]. Mixed martial arts athletes are allotted from 24 to 36 h after the official weigh-in to begin the process of rapid weight gain (RWG) [10]. Combat sports athletes have used weight cutting to gain a competitive advantage by entering competitions heavier than their opponent. [7–11]. MMA athletes resort to extreme dietary restrictions and dehydration to compete in a lower weight class [9,15,17,19,21–24]. Following a weigh-in, athletes attempt to regain as much body mass as possible before competition by rehydrating and utilizing various nutritional strategies [25].

The effects of RWL on physiological performance and fight outcome are still contested in the literature [25]. However, researchers agree that weight cutting can have serious short-term consequences on an athlete's health [9,16–21,26–32]. The dangers of weight cutting are evident from the multiple deaths of combat sports athletes partaking in RWL [33,34]. Our previous research into the magnitude of RWL seen in UFC athletes found an average of nearly 7% body mass lost before the official weigh-in, with variable magnitudes of weight loss depending upon the weight class [35]. Other research into the magnitude of RWL by MMA athletes found similar or greater percentages of body weight lost before official weigh-in [10,12,16,32,36]. Extreme measures of RWL, with 10% or greater body weight lost, have been reported in the current literature as well [10,21,28,37]. Cases of extreme RWL, are especially concerning for the safety of athletes, given the lack of regulation and supervision of weight cutting practices. A link between RWL and increased heart rate (HR) was observed in multiple studies attempting to determine the physiological effects of RWL [38–40]. Increased HR following RWL might indicate an increase in cardiovascular demand for combat sports athletes during competition, which could result in decreased aerobic capacity. Physiological performance was not impaired by RWL, following a recovery period of 1 h [41], 4 h [42,43], 12 h [44], and 16 h [45]. A meta-analysis from 2022, researching the current literature on RWL and physical performance, concluded that current evidence indicates RWL does not impact short-duration, high-intensity efforts; however, due to variability in study designs and approaches, more research needs to be performed to establish the effects of RWL and RWG [25]. Contrarily, other researchers found impairments of athletes' physical performances following RWL [46–49]. Notably, a negative psychological effect was also caused by RWL [9,46,50]. The differences in the identified impact of RWL seen among the current literature may depend upon the amount of body mass (BM) lost by the athlete because greater magnitudes of body percentage lost during RWL have shown increasing detriments to athlete performances [51]. Attempts have been made to determine the source of performance deficits seen in RWL. Immune and hormonal changes in response to RWL were measured in athletes, and greater increases in inflammatory cytokines and cortisol

were identified compared to controls, along with decreases in testosterone [38]. A common explanation of performance decreases following RWL is inadequate rehydration and replenishment of electrolytes and nutrients following RWL. Athletes at >/= 2% dehydration are known to have physical performance decreases [52–54]. Dehydration has been shown to decrease intermittent sprint performance [54], endurance performance [52], repeat muscular performances [39], and aerobic performance, with additive decreases in performance in the heat [40,54–59]. Decreased aerobic performance in the setting of dehydration is the result of increased cardiovascular strain from plasma volume reductions and increased temperatures [55]. The hypothesized cause of muscular performance defects from dehydration are believed to be a result of increased fatigue perception during exercise [53,54]. In an analysis of hydration levels in combat sports athletes, many athletes were still in a dehydrated state following recovery time for RWL, with one study finding nearly 40% of MMA fighters entering a competition dehydrated [60,61]. As evidenced by the lack of successful rehydration following recovery time, mixed martial artists should be particularly focused on rehydration strategies following RWL. Differences in weight cutting between men and women have not been frequently researched [5]. However, current research has identified similar prevalence of RWL and RWG in male and female athletes [36]. Athletes commonly regain greater amounts of body mass following the weigh-in than what they had lost through RWL [10,21,35]. A comparison between RWG in men and women competing in Judo also determined higher magnitudes of RWG in males [60]. While research is limited regarding female MMA athletes, there still exists substantial amounts of research regarding the physical differences between males and females. Research has established the average differences in body composition between men and women, with men having greater amounts of lean body mass and women having greater amounts of fat mass than men [62–64]. Interestingly, researchers have found smaller magnitudes of differences in body composition when comparing male and female athletes within the same sport [65,66]. Despite these findings, research regarding differences in body composition between male and female MMA fighters highlighted significant differences in body composition between sexes, with males having greater lean body masses than females, and females having greater fat masses and body fat percentages than males [67,68]. Given the differences in body fat mass and the implications of fat mass and lean muscle mass on total body water, male MMA athletes have greater total body water levels than female MMA athletes [68]. As dehydration is a common method of weight cutting in MMA fighters, there are likely differences between males and females regarding weight cutting. In support of this theory, a comparison between RWG in men and women competing in Judo determined higher magnitudes of RWG in males [60]. In a systematic review of the current research available for mixed martial arts, 112 studies were analyzed, and 94.9% of the 20,784 athletes studied were male [5]. This discrepancy between research for male and female athletes indicated a greater need for research into female MMA. While there is still utility in the current MMA research, identifying the differences between male and female athletes in the sport will help tailor training, nutrition, and sport-related strategies to the female fighters. Greater research for female MMA fighters on RWL, RWG, nutrition, psychology, and physiology are needed to narrow the gap in research for females competing in the sport [5]. Therefore, the purpose of this current study is to compare weight lost between male and female MMA athletes competing in the same weight division (Flyweight 125 lbs./56.7 kg) for the UFC. Based on previous body composition research, we hypothesize that both male MMA athletes and female MMA athletes competing in the UFC's flyweight division will perform RWL prior to the official weigh-in and RWG following the official weigh-in and prior to competition. Additionally, we hypothesize that male MMA athletes competing in the UFC's flyweight division will lose more weight prior to the official weigh-in when compared to female MMA athletes competing in the UFC's flyweight division. Furthermore, we hypothesize that male MMA athletes competing in the UFC's flyweight division will gain more weight prior to competition when compared to female MMA athletes competing in the UFC's flyweight division.

2. Results

2.1. Physical Characteristics

Physical characteristics, including age and height, were calculated for male and female flyweight fighters and summed for all fighters (Table 1). Weight was not calculated since it is provided as a dependent variable throughout.

Table 1. Age and height for all fighters by weight class.

	Males (n = 50)	**Females (n = 53)**	**All Fighters (n = 103)**
Age (years)	29.5 ± 2.7	30.7 ± 4.4	30.0 ± 3.7
Height (cm)	167.9 ± 3.9	165.0 ± 4.4	166.5 ± 4.4

Data are Means ± SD.

2.2. Weight Changes by Sex

The ANOVA revealed there was a significant main effect of condition for weight changes (F = 579.6, ηp2 = 0.867, $p < 0.001$) throughout the 72 h prior to the official weigh-in. There was also a significant sex by condition interaction (F = 11.8, ηp2 = 0.117, $p < 0.001$), as males and females lost weight differently across the different days leading up to and after the official weigh-in. There was a significant main effect of sex on weight changes (F = 10.15, ηp2 = 0.102, $p = 0.002$) throughout the 72 h prior to and then the 24-h period after the official weigh-in. Post hoc analysis revealed that there were significant differences between the two, as males lost more weight than females and regained more weight after the official weigh-in ($p \leq 0.45$ for all). There were no differences at weigh-in between the males and females ($p = 0.716$, Table 2).

Table 2. Weight changes by sex (male and female) and for flyweight fighters.

				95% CI	
	Males (n = 50)	**Females (n = 53)**	**All Fighters (n = 103)**	**Lower**	**Upper**
72 h pre-official weigh-in (lbs.)	136.5 ± 2.8 [a]	134.8 ± 4.0	135.6 ± 3.6 *	134.924	136.385
48 h pre-official weigh-in (lbs.)	135.0 ± 2.7 [b]	133.6 ± 3.4	134.2 ± 3.2 *	133.655	134.958
24 h pre-official weigh-in (lbs.)	132.9 ± 2.3 [c]	131.6 ± 3.0	132.2 ± 2.8 *	131.692	132.840
official weigh-in (lbs.)	125.6 ± 0.8 [d]	125.6 ± 0.8	125.6 ± 0.8 *	125.415	125.748
24 h regain fight weight (lbs.)	142.0 ± 3.5 [e]	137.9 ± 5.1	139.8 ± 4.8 *	139.037	140.881

Data are Means ± SD and 95% confidence intervals are shown for all variables. [a] Significant difference between males and females at 72 h, $p = 0.027$. [b] Significant difference between males and females at 48 h, $p = 0.045$. [c] Significant difference between males and females at 24 h, $p = 0.045$. [d] No differences between males and females at official weigh-in, $p = 0.716$. [e] Significant difference between males and females for fight regain weight, $p < 0.001$. * All days (72, 48, and 24) were significantly different from each day and the fight regain weight, $p < 0.001$ for all.

2.3. Percent Weight Changes by Sex

The ANOVA revealed there was a significant main effect of condition for percent weight changes (F = 1219.3, ηp2 = 0.932, $p < 0.001$) throughout the 72 h prior to the official weigh-in. These percentage changes were in comparison to the official weigh-in only. There was also a significant sex by condition interaction (F = 17.693, ηp2 = 0.166, and $p < 0.001$) as males and females lost percent weight differently across the different days leading up to the official weigh-in and regained a different percent after the official weigh-in. There was no significant main effect of sex on percent weight changes (F = 0.073, ηp2 = 0.001, $p = 0.788$) throughout the weight loss and the 24-h regain period after the official weigh-in. Post hoc analysis revealed there were significant differences in percent weight changes, as males lost a greater percent of weight than females at each weigh-in and for the regain after the official weigh-in, and the overall percent decreased from 72 to 24 h and then increased for the regain ($p \leq 0.27$ for all, Table 3).

Table 3. Percentage weight changes compared to official weigh-in by sex (male and female) and for all flyweight fighters.

	Males (n = 50)	Females (n = 53)	All Fighters (n = 103)	95% CI	
				Lower	Upper
72 h (%)	−7.9 ± 1.7 [a]	−6.8 ± 2.5	−7.4 ± 2.2 *	−7.9	−6.9
48 h (%)	−6.9 ± 1.7 [b]	−6.0 ± 2.2	−6.5 ± 2.0 *	−6.9	−6.0
24 h (%)	−5.5 ± 1.4 [c]	−4.6 ± 2.1	−5.0 ± 1.9 *	−5.4	−4.6
24 h Regain fight weight (%)	13.1 ± 3.0 [d]	9.8 ± 3.7	11.4 ± 3.6 *	10.8	12.1

Data are Means ± SD. [a] Significant difference between males and females at 72 h, $p = 0.017$. [b] Significant difference between males and females at 48 h, $p = 0.027$. [c] Significant difference between males and females at 24 h, $p = 0.03$. [d] Significant difference between males and females at 24 h weight regain, $p < 0.001$. * All percent changes (72, 48, and 24 h) were significantly different from each other day and the 24-h weight regain percent, $p \leq 0.005$ for all.

3. Discussion

As hypothesized, the data indicated RWL in both male athletes and female athletes competing in the UFC's flyweight division. The athletes lost approximately 9–11 lbs. (4–5 kg) 72 h prior to the official weigh-in, 8–10 lbs. (3.6–4.5 kg) 48 h prior to the official weigh-in, and 6–7 lbs. (2.7–3.5 kg) 24 h prior to the official weigh-in. Combat sports athletes have developed various strategies for weight cutting over the years, many of which have been researched. Common methods used by combat sports athletes include water loading, fluid restriction, dieting, increased exercise, sauna or hot bath, sauna suits, with rarer methods of spitting, laxatives, diuretics, diet pills, or vomiting [15,16,22–24,37,46,47,69–73]. While weight cutting practices have been shown to vary among combat sports [19,48], water loading, dieting, hot salt baths, and saunas were common strategies used among mixed martial arts athletes [12,16,21]. The weight loss observed through this study was likely achieved through the same strategies observed in the current literature. A study into the differences in RWL practices among males and females found both groups relied upon dieting, exercise, and saunas for RWL, but males were more likely to use a sauna suit than females [23]. As the data indicate, both males and females utilized a variety of strategies in order to perform RWL prior to officially weighing in. The most common source of weight cutting advice and practices listed among combat sports athletes were their coaches/mentors and fellow fighters, with health experts holding less influence for most fighters [12,16,23]. The dangerous weight cutting practices observed in current research, along with the lack of influence of health experts, has been a major cause of concern for researchers, who call for changes to weight cutting regulations amongst mixed martial arts organizations [7,9,16,18,22,23,28,30,32,49–51].

Similarly, as hypothesized, the data indicated RWG in both male athletes and female athletes competing in the UFC's flyweight division. The athletes gain approximately 12–17 lbs. (5.5–7.5 kg) following the official weigh-in and prior to competition. The data also indicate sex differences in percentage RWL prior to the official weigh-in. Male athletes competing in the UFC's flyweight division lose approximately 1% more weight each day prior to the official weigh-in when compared to female athletes competing in the UFC's flyweight division. The data also indicate sex differences in percentage RWG following the official weigh-in and prior to competition. Male athletes competing in the UFC's flyweight division gain approximately 3% more weight prior to competition when compared to female athletes competing in the UFC's flyweight division. With the evidence above, researchers have attempted to determine the best nutritional practices to prescribe to athletes undergoing RWL and RWG. Recovery methods have been hypothesized to play a significant role in an athlete's recovery of performance strength following rapid weight loss [43]. During RWL, athletes losing >3% BM diminish their body's stores of electrolytes and lose significant volumes of water [74]. One of the main strategies prescribed by researchers is the rapid rehydration of athletes as soon as possible, following their official

weigh-in [24]. Electrolyte supplementation during RWL is also shown to increase exercise capacity of athletes in the heat [59]. Athletes who underwent >3% BM RWL are advised to consume an electrolyte-containing fluid such as an oral rehydration solution designed for dehydration and electrolyte restoration [24,75]. In the setting of RWL, carbohydrate refeeding and glycerol supplementation were not found to positively affect athlete performance in comparison to water only [41,76]. However, with athletes weighing-in the day before competition, restoration of glycogen stores and even overloading carbohydrates at a rate of 5–10 g/kg/day are recommended to improve athlete performance following RWL [24]. Creatine supplementation with glucose consumption stimulated the regain of physical performance but not the recovery of body mass in wrestlers recovering from RWL [77]. While athletes are exercising before and during competition, fluid intake significantly improves continuous exercise performance, regardless of volume or timing of fluid consumption, especially in the heat [78]. Based on the current study, the results demonstrate that professional UFC athletes competing in the flyweight division rapidly lose weight prior to the official weigh-in. Moreover, these same athletes also gain weight rapidly and ultimately compete at a weight heavier than that of the official weigh-in. This is one of the first of studies to compare male and female professional UFC athletes competing in the flyweight division regarding RWL and RWG. Based on the results, it would be suggested to implement different weight loss scheduling between males and females to provide safe and effective weight loss strategies and to enhance weight regaining prior to competition. It may be worth noting that based on previous literature and practices of different organizations, it should be in the interest of performance scientists to improve or eliminate RWL/RWG. Other organizations practice methods of weigh-ins and hydration status testing to combat RWL/RWG. The NCAA requires wrestlers to limit weight loss in the week leading to competition. These ideas need to be explored to enhance safety and improve athlete performance. While the current study is one of the first to assess this data in UFC athletes competing in the flyweight division, it is not without limitation. First, the hydration status of the athletes was not assessed. Second, athletes' competition weigh-in time and instruments varied based on competition order and commission procedures scheduling. Third, attire was recommended but not controlled for. Athletes were instructed to strip down to minimal clothing while stepping on the scale. Lastly, the method of RWL/RWG was not investigated or reported. It is apparent based on the data that RWL/RWG practices were utilized, but the exact methods were not studied for this project. Further research is currently underway analyzing weight cutting strategies in male and female athletes competing in professional MMA.

4. Materials and Methods

One hundred and three professional MMA athletes (n = 53 female; n = 50 male) competing for the UFC's flyweight division (116–125 lbs.; 53–57 kg) between 2020 and 2022 were used for the study. The athletes reported to the designated competition hotel 72, 48, and 24 h prior to the official weigh-in. While in the hotel, the athletes were instructed to weigh in using the calibrated digital scale provided by the commission [35]. The athletes were told to wear the minimum clothing provided in the UFC athlete kit. These weights were obtained and reported immediately to UFC performance staff. Athletes reported to the hotel for the official weigh-in. Official weights were obtained utilizing the commission managed beam or digital scale during the official weigh-ins and were reported publicly [35]. The official weigh-ins took place one day prior to the official competition. On the day of competition, the UFC athletes reported to the arena for competition where weights were obtained using a commission calibrated digital scale and recorded by UFC performance staff [35]. These were the last weights obtained immediately before the competitions. Any of the athletes who missed weight, who were medically unfit for competition and/or failed to provide weight data at any time point through the week, were excluded from the data set. This study of de-identified data was approved by the University Institutional Review

Board (IRB). All UFC athletes provided consent to weigh-in and were deemed medically healthy and cleared for competition.

Statistical Analysis

Descriptive statistics (means and standard deviations) were calculated for age, height, obtained weights, and percent changes from official weigh-in for each sex (male and female) for the UFC athletes competing in the flyweight division. The flyweight athletes, regardless of sex, competed at 116–125 lbs. (53–57 kg), which was provided publicly in pounds. Due to this, the researchers also reported the obtained weights in pounds. Percent changes in weight reduction were calculated for each athlete at 72 h prior, 48 h prior, and 24 h prior to the official weigh-in (0 h). Then, a fighter's 24 h regain (competition) weight was measured, and the percent change was calculated from the official weigh-in. Two-way ANOVAs were used to assess the effect of sex (male and female) across the different conditions (weigh in days). The weigh-in conditions began 72 h prior to the official weigh-in. Then, weigh ins were conducted every 24 h period for a total of five weigh ins. Therefore, weigh ins occurred 72, 48, and 24 h prior to the official weigh in and then again 24 h after the official weigh in, which was the assumed competition weight of the UFC athlete. Post hoc analyses were complete with independent t-test for sex and pairwise comparisons for the weigh-in days prior to and after official weigh-in. All statistics were analyzed using IBM SPSS 28.0 (Version 28.0, IBM Inc., Armonk, NY, USA). The criterion for statistical significance was set a priori at $p \leq 0.05$

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