Rapid weight gain predicts fight success in mixed martial arts - evidence from 1,400 weigh-ins

Each pound matters: the influence of weight regain on fight success in mixed martial arts - an analysis of 1,474 weigh-in

Journal:	*European Journal of Sports Science*
Manuscript ID	TEJS-2020-1010
Manuscript Type:	Original Paper
Keywords:	Body composition, Competition, Performance, Recovery

Each pound matters: the influence of weight regain on fight success in mixed martial arts - an analysis of 1,474 weigh-in

Abstract:

We aimed to verify whether the weight regained (%WR) between the official weigh-in and the time of the fight is associated with fight success in MMA. A total of 1,474 MMA weigh-ins/fights from 21 MMA companies regulated by the California State Athletic Commission were analyzed. Logistic regression with the odds ratio (OR) performed using the %WR as the independent variable and the fight outcome (win and loss) was used as the dependent variable (controlled for sex, division, and weight difference from the opponent) with $p<0.05$. Bantamweight division presents the highest median of %WR (9.72%) and one athlete from the lightweight division presented the highest individual %WR (20.44%). The %WR was a significant predictor of fight outcome (ß=0.044; OR=1.045; 95%CI=1.014–1.077; p=0.004) so that for each 1%WR increased the chance of winning by 4.6%. The results suggest that the magnitude of weight regain is linked to the chance to win. Considering the regulatory commissions, confederations, and events' organizers should consider defining limits for weigh-regain, considering the potential advantage with high weight regain found. Otherwise, the athletes might invest in RWL and RWR after official weight-in, to increase their chance of winning.

Keywords: Martial arts; Weight loss; Weight gain.

INTRODUCTION

Mixed Martial Arts (MMA) is a combat sport that uses mixed techniques from different martial arts (12). The combats are divided into three rounds (five rounds for title fights) of five minutes with a one-minute interval. The fight might be interrupted if there is a submission or knockout (5). The victory in MMA is determined by actual or technical knockout (i.e. KO/TKO), submission, or by judges' decision (i.e., by points) (6). MMA gained popularity in the earlies 1990 when The Ultimate Fighting Championship (UFC) was created (7). The first events lacked weight-divisions, but after rules reformulation, divisions based on weight were created, similarly to others combat sports (6,12). This rule was created to equalize strength between opponents (1,6,11) so that the only difference between them would be their technical skills and/or strategy.

Despite the divisions by weight, most athletes choose to fight in a weight-division in which the weight limit is several pounds below their habitual weight (11). To ensure qualification, rapid weight loss (RWL) followed by rapid weight regain (RWR) strategies are adopted in order to get an advantage related to weight, size, and strength (5,11,17). The use of RWL strategies generally begins approximately seven days before the official weigh-in and has the characteristics to be acute and aggressive (7,14). The use of laxatives, diuretics, plastic or rubber clothing, and sauna are the most frequently reported method for RWL in combat sports (11). Specifically, in MMA, the most common strategies self-reported by the fighters are caloric and hydric restriction, sauna, diuretics, clothes that increases sweat production, high volume of low-intensity exercise, and water load (17,19). Moreover, some of these methods are used in combination (17,19). These results indicate that dehydration is the main strategy of RWL. Dehydration decreases blood volume, plasma volume, free testosterone, and blood creatine concentration (1,11,17). In this sense, Jetton et al. (12) compared the hydration status by urinary analysis

of 40 MMA fighters at 24h and two hours before the combat. The results showed that even after ~4.4% of weight regain (WR), 39% of fighters were still significantly dehydrated and 11% were seriously dehydrated two hours before the combat (12). Therefore, considering that the RWL strategy may impair performance and negatively impact the athletes' health, ways of avoiding it are warranted.

Despite the risk involved in the RWL, several athletes still opt to compete in divisions below their habitual weight, given that with RWR they may gain advantages over shorter and lighter fighters on the day of the fight. In this regard, Brechney et al. (3) investigated if the fight outcome was related to the weight loss magnitude in 75 MMA fighters and found that athletes who lost the fight lose more weight than the winners (10.6% vs 8.6%). However, most athletes included in their sample were amateurs (n = 59) (3). Considering that aggressive RWL is repeated throughout one's athletic career, there is a fear of the consequences of the athletes' health (1). Most importantly, there are reports of deaths that were caused as the consequence of RWL (7,14). On the other hand, the magnitude of WR has been suggested to be a decisive factor for fight success in MMA, more influential than the magnitude of weight loss (6,14). Thus, considering that the majority of events have the official weigh-in from 24h to 36h before the combat (4), the athletes consume high quantities of high energy macronutrients (i.e. carbohydrates) and use intravenous and oral rehydration methods, to recover as much as possible the weight lost (1,6,7,14).

MMA athletes lose ~10% of body weight in approximately seven days, with ~5% in the last 24h before the official weigh-in, to fit the division's weight limit (2,4,5,7,14,15). Hence, it has suggested that regulatory agencies create ways to inhibit the RWL process in combat sport for both athlete safety and fairness of sport. However, whether WR impacts on the outcome of combat is less discussed. Currently, there is no

formal consensus regarding the limit of weight loss or regain in MMA. However, some commissions have been monitoring the magnitudes of WR in order to create new rules in this regard. For instance, since 2016 the California State Athletic Commission (CSAC) recommends that athletes who exceed 10% of WR compete in the division above their current division (8). In 2019, CSAC approved the new rule stating that a fight must be canceled if one of the athletes regained >15% of WR (9). Although previous studies showed that the WR magnitude is a fundamental element for increasing the chances of winning, few studies verified this fact on a large scale. Thus, we aimed to verify whether the WR between the official weigh-in and the fight influences the chances of winning. We hypothesize that greater WR would positively associate with greater chances of winning.

METHODS

Study Design

To test whether the WR between the official weigh-in and the fight influence the chances of winning the present study analyzed the data of 1,474 weight-ins in professional MMA events from 20 MMA companies under the California State Athletic Commission regulation (CSAC). The CSAC regulates, licentiate, and supervise combat sports events in the California State, USA. The CSAC provided datasheets containing all information used in the present study. These data were acquired in 21 different locations, from national and international professional MMA events from January 2015 and August 2019 at the California state.

Subjects

The report from 1,550 fights was provided, involving both sexes. The events involved professionals MMA fighters divided into 11 weight divisions (Table 1). To be included, sufficient information regarding the study variables such as the fight outcome (win or lose, not draw), weight at weight-in day within the category limit should be reported. The data of 76 fighters were excluded: 31 did not present the weight at the fight day, 44 fight outcomes as a draw, one athlete exceeded his/her weight division limit. Therefore, the final analysis included the data on 1,474 fights (Female = 110; Males = 1,364).

The data were collected from the following MMA companies: BAMMA, Bellator MMA, Cage Fury Fighting Championship (CFFC), California Extreme Fight (CXF), California Fight Championship (CFC), California Fight League (CFL), Combat Americas, Dragon House MMA, Extreme Fighters, In Sync Promotions, Invicta MMA, King of the Cage (KOTC), Legacy Fighting Alliance (LFA), No Limit/Goodman, PR Promotions, Roy Englebrecht Events, Smash Global, Tachi Palace Fight, Titans Cage MMA, TS-1 Combate, and Ultimate Fight Championship (UFC).

The CSAC provided datasheet including the official weight-in date, event dates, official body weight at the weigh-in, at the fight day, and the difference between them (i.e., WR), and the difference in weight from the opponent (WD), sex, and divisions of the athletes. The official weigh-in (OW) was measured between 24-36h before the combat, while the re-weighing (RW) was performed ~3h before de fight. From these data was possible calculated the WR (WR = RW OW), and the percentage of WR: [%WR = (WR/OW)x100] (12).

Statistical Analyses

Descriptive data are presented as median and interquartile range as well as minimum and maximum values. Logistic regression was performed using as the independent variables all measures with a theoretical relationship with the dependent variable, namely %WR, sex, division, and WD from the opponent. The outcome of the fight (win and loss) was used as the dependent variable. The Odds Ratio (OR) with a 95% confidence interval (95%CI) was calculated for each independent variable. Accordingly, the probability of winning was calculated as the value exceeding OR of 1.00 multiplied by 100, only for variables that achieved a significant level of 5%.

RESULTS

Table 1 describes the information about weight categories (separated by sex) and %WR in each weight category. The highest %WR was found for the Bantamweight division and the highest individual %WR was from one athlete of the Lightweight division (20.4%). On the other hand, the heaviest categories (i.e. Heavy and Super Heavyweight divisions) presented the smallest median %WR.

Insert Table 1

Table 2 presents the results of the logistic regression analysis. Only the %WR was significantly associated with the fight outcome ($p = 0.004$). For each 1% of WR the probability of winning increased by 4.6%.

Insert Table 2

DISCUSSION

This study aimed to verify the influence of weight regain on fight success in MMA, analyzing 1,474 fights in events that occurred between 2015 and 2019 regulated by the CSAC. The main finding was that %WR was a predictor of fight success, independently of sex, division, and WD from the opponent. In fact, for each 1% of WR increased the probability of winning by 4.6%, which confirmed our hypothesis. Previous studies have suggested that the magnitude of WR, but not weight loss, was the main factor for fighters' performance (6,14). However, to the best of the authors' knowledge, this is the first study to investigate the influence of WR on fight success in an ecological and large-scale study with professional MMA athletes.

Our findings corroborate with Artioli et al. (1) statement that the RWL might be an indirect method to gain an advantage in the fight. These authors suggested that this method should be banned in combat sports and listed by World Anti-Doping Agency (WADA) as doping because it might enhance sports performance indirectly, and put athletes' health at risk and violating the spirit of the sport (1). One possible explanation for RWL to enhance sports performance is because it has small or no impact in physical capacities (1). This maintenance of performance has been associated with WR after the official weight-in, with reports that the weight of the athlete in the day of the fight corresponds to three weight divisions above the one he/she is fighting (14,15), which reinforce the idea of violation of the sports spirit. Indeed, the Coswig et al. (6) study concluded that WR was significantly higher in winners compared to losers. Interestingly, WR was positively correlated with time spent at high intensity during the fight, lower

limb blows, and ground and pound actions of the athletes. It is noteworthy that WR did not compensate for the weight loss (6), and only WR but not weight loss was correlated with measures of performance, which reinforce the idea that WR is more important than weight loss. Our study corroborates these findings, by showing that the magnitude of WR has high relevance for fight success in MMA.

In recent years, RWL has been highly criticized for the dangers it poses to the athletes. One fighter from Brazil and one from China died during the RWL process (7,14). Moreover, kidney injury (13) and rhabdomyolysis (16) cases were reported as a consequence of the RWL process. Despite that, few actions have taken to inhibit RWL methods. The Asian event ONE Championship banned since 2015 the weight loss by dehydration and has increased weight limits for each category compared to other events (14). On the other hand, UFC increased the time between official weigh-in and fight time to 24h to 36h in 2016, justifying as a protection for the athletes. However, it may have influenced the athletes to adopt even more aggressive methods for RWL, because the time window for regain is larger (14). In 2019, UFC together with U.S. Anti-doping Agency (USADA), prohibited the use of intravenous solutions for WR (20). This is important because athletes have been using this method to speed up the WR process (7). Whilst all these measures are important, the lack of control and limit about the magnitude of WR remains. In this sense, some researchers reported that superior values of WR comparing weight loss are influenced by the time available for WR (14,15). Thus, a decrease in the use of aggressive RWL methods could occur only when the time available for WR decreases considerably or if the official weigh-in is performed very close to the fight (4). In the “real-world”, athletes still use RWL methods because a high percentage of weight loss can be regained after the weight-in. In fact, seven out 11 divisions presented a median

%WR of >8%. Furthermore, one extreme example was the athlete from the lightweight division that showed 20.44% WR.

In order to restrict both RWL and high WR, some changes to the rules of MMA competitions should be made. First, the creation of intermediate weight division, between the existent categories, which would avoid severe RWL, as seen at the present (7). This is important because the difference of the limit of weight between some divisions reaches 20 pounds (i.e. between middle and light heavyweight divisions) and some athletes could achieve the weight to be characterized in 2-3 divisions above of the one they are competing in the fight day (15). Second, the official weigh-in should occur a few hours before the combat, as it occurs currently in Brazilian Jiu-Jitsu competitions (10), which prevents high weight loss and high WR. Some amateur events have adopted a similar approach, weighting the athletes in the morning of the fight day (4). Third, make the re-weighting official and put limits for the percentage of WR, under penalty of cancellation of the combat and/or punishment to the athlete. This rule was adopted in judo, where the extra weight-in has a limit of 5% of body weight (18). Fourth, events promoters/companies obligate a change of division if the athlete exceeds 5% of WR on the extra weight-in. This suggestion is limited because it depends on the voluntary adhesion of the companies. Finally, organizations such as USADA and WADA could consider high levels of WR as doping with its corresponding punishment, as it has been suggested by other authors (1,7).

Our findings should be interpreted with caution, considering the limitations of the present study. Considering the nature of data, it was not possible to include other variables in the regression analysis such as age, off-season weight, time of experience, and cartel, which could also influence the results. The data analyzed in our study came from only one athletic commission of the USA. This is important because the CSAC has a specific

orientation when the athletes exceed 10% of WR (8). Lastly, the time variability between official weight-in and re-weighing (i.e., between 24h and 36h) also is relevant and is was no specified in the datasheet. For instance, in the study by Coswig et al. (6) the weight loss (~6%) was not compensated by the WR, while in Matthews et al., (14) weight loss (~7%) were surpassed by WR. The main difference between the two studies was the measurement time of the re-weighing (24h vs 36, respectively).

Considering that the athletes regain ~8-10% of body weight and our findings conclude that a single 1% of regaining increase de probability of winning by 4,5%, the magnitude of WR is a strong variable linked to the chance to win. In this way, commissions, confederations, and events' organizers should consider changing the rules related to weigh-in, not only equalize the chances of athletes in the combat, mainly linked to body size and strength level, but also for safety reasons considering the risks involved in RWL. Until the rules are not changed, the athletes should invest in good ways to regain weight fast after official weight-in, to increase their chance of a win.

ACKNOWLEDGMENTS

The authors would like to appreciate to California State Athletic Commission for kindly providing us with the data used in the present study. We also would like to thank André Werneck for helping with data analysis

DECLARATIONS

The authors do not present any conflict of interest.

REFERENCES

1. Artioli, GG, Saunders, B, Iglesias, RT, and Franchini, E. It is Time to Ban Rapid Weight Loss from Combat Sports. *Sport Med* 46: 1579–1584, 2016.

2. Barley, OR, Chapman, DW, and Abbiss, CR. The Current State of Weight-Cutting in Combat Sports. *Sports* 7: 123, 2019.

3. Brechney, GC, Chia, E, and Moreland, AT. Weight-Cutting Implications for Competition Outcomes in Mixed Martial Arts Cage Fighting. *J Strength Cond Res* 1: 1, 2019.

4. Connor, J and Egan, B. Prevalence, Magnitude and Methods of Rapid Weight Loss Reported by Male Mixed Martial Arts Athletes in Ireland. *Sports* 7: 206, 2019.

5. Coswig, VS, Fukuda, DH, and Del Vecchio, FB. Rapid weight loss elicits harmful biochemical and hormonal responses in mixed martial arts athletes. *Int J Sport Nutr Exerc Metab* 25: 480–486, 2015.

6. Coswig, VS, Miarka, B, Pires, DA, Silva, LM da, Bartel, C, and Del Vecchio, FB. Weight Regain, But Not Weight Loss, Is Related to Competitive Success in Real-life Mixed Martial Arts Competition. *Int J Sport Nutr Exerc Metab* , 2018.

7. Crighton, B, Close, GL, and Morton, JP. Alarming weight cutting behaviours in mixed martial arts: A cause for concern and a call for action. *Br J Sports Med* 50: 446–447, 2016.

8. CSAC, CSAC. Commission Meeting materials - May 16, 2017. 2017. pp. 1–350

9. CSAC, CSAC. Commission Meeting Minutes - October 15, 2019. 2019. pp. 1–18

10. Faro, HKC, Tavares, MPM, Gantois, PMD, Pereira, DC, Lima, MNM De, Lima-junior, D De, et al. Comparison of competitive anxiety and self-confidence in Brazilian Jiu-Jitsu skills levels : a cross-sectional in-event study. *Ido Mov Cult* 20: 30–39, 2020.

11. Franchini, E, Brito, CJ, and Artioli, GG. Weight loss in combat sports: Physiological, psychological and performance effects. *J Int Soc Sports Nutr* 9: 2–7, 2012.

12. Jetton, A, Lawrence, M, Meucci, M, Haines, T, Collier, S, Morris, D, et al. Dehydration and acute weight gain in mixed martial arts fighters before competition. *J Strength Cond Res* 27: 1322–1326, 2013.

13. Kasper, Andreas, M, Crighton, B, Langan-Evans, C, Riley, P, Sharma, A, Close, GL, et al. Case Study: Extreme weight making causes relative energy deficiency, dehydration and acute kidney injury in a male mixed martial arts athlete. *Int J Sport Nutr Exerc Metab* 29: 331–338, 2019.

14. Matthews, JJ and Nicholas, C. Extreme rapid weight loss and rapid weight gain observed in UK mixed martial arts athletes preparing for competition. *Int J Sport Nutr Exerc Metab* 27: 122–129, 2017.

15. Matthews, JJ, Stanhope, EN, Godwin, MS, Holmes, MEJ, and Artioli, GG. The magnitude of rapid weight loss and rapid weight gain in combat sport athletes preparing for competition: A systematic review. *Int J Sport Nutr Exerc Metab* 29: 441–452, 2019.

16. Murugappan, KR, Cocchi, MN, Bose, S, Neves, SE, Cook, CH, Sarge, T, et al. Case Study: Fatal Exertional Rhabdomyolysis Possibly Related to Drastic Weight Cutting. *Int J Sport Nutr Exerc Exerc Metab* 11: 1–4, 2018.

17. Park, S, Alencar, M, Sassone, J, Madrigal, L, and Ede, A. Self-reported methods of weight cutting in professional mixed-martial artists: How much are they losing and who is advising them? *J Int Soc Sports Nutr* 16: 1–8, 2019.

18. Reale, R, Cox, RG, Slater, G, and Burke, LM. Regain in Body Mass After Weigh-In is Linked to Success in Real Life Judo Competition Authors: *Int J Sport Nutr Exerc Metab* 26: 525–530, 2016.

19. Santos-Junior, RB, Utter, AC, McAnulty, SR, Bernardi, BRB, Buzzachera, CF, Franchini, E, et al. Weight loss behaviors in Brazilian mixed martial arts athletes. *Sport Sci Health* , 2019.Available from: https://doi.org/10.1007/s11332-019-00581-x

20. UFC and USADA. Prohibited list and guide to the prohibited list. 2019.

Table 1. Distribution of athletes by division, sex, and percentage of weight regained by category.

Weight Class	% of the sample	Sex (n)			Percentage of WR (%)	
		M	F	All	Median (IQR)	Range (min-max)
Atomweight	1.00	-	15	15	9.35 (6.48 –11.12)	0.85 – 12.39
Strawweight	3.30	-	48	48	8.06 (5.23 – 11.04)	-2.51 – 15.96
Flyweight	6.80	83	17	100	9.42 (7.30 – 11.77)	1.13 – 16.86
Bantamweight	16.1	224	13	237	9.72 (7.83 – 12.45)	-0.23 – 17.78
Featherweight	20.9	291	17	308	8.95 (6.46 – 10.80)	-0.14 – 16.58
Lightweight	16.3	240	-	240	8.45 (6.02 – 10.60)	-2.61 – 20.44
Welterweight	16.4	242	-	242	8.24 (5.79 – 10.41)	-1.89 – 16.78
Middleweight	10.6	156	-	156	5.82 (4.24 – 8.45)	-6.15 – 14.27
Light Heavyweight	4.40	65	-	65	5.69 (4.19 – 7.67)	-1.09 – 13.19
Heavyweight	3.90	57	-	57	0.75 (0.08 – 1.88)	-6.93 – 8.56
Super Heavyweight	0.40	6	-	6	1.05 (-0.38 – 1.89)	-0.44 – 3.27
Overall	100	1,374	100	1,474	8.26 (5.48 – 10.62)	-6.93 – 20.44

Note: IQR; interquartile range; WR = weight regain

Table 2. Logistic regression of independent variables to predict fight outcome (win) (n=1,474).

Variable	Fight outcome		
	ß (95%CI)	**OR (95%CI)**	**p**
%WR	0.044 (0.014 – 0.074)	1.046 (1.015 – 1.078)	0.004
Sex	0.007 (-0.450 – 0.465)	1.007 (0.637 – 1.592)	0.974
Official weight	-0.000 (-0.013 – 0.012)	0.999 (0.986 – 1.012)	0.954
WD from de opponent	0.001 (-0.010 – 0.012)	1.000 (0.990 – 1.012)	0.874
Division	0.024 (-0.140 – 0.190)	1.025 (0.869 – 1.209)	0.767
Constant	-0.601 (-1.833 – 0.630)	0.547 (0.159 – 1.889)	0.339

Note: CI = confidence interval; OR = odds ratio; WD = weight difference; WR = weight regain.

Table 1. Distribution of athletes by division, sex, and percentage of weight regained by category.

Weight Class	% of the sample	Sex (n)			Percentage of WR (%)	
		M	F	All	Median (IQR)	Range (min-max)
Atomweight	1.00	-	15	15	9.35 (6.48 –11.12)	0.85 – 12.39
Strawweight	3.30	-	48	48	8.06 (5.23 – 11.04)	-2.51 – 15.96
Flyweight	6.80	83	17	100	9.42 (7.30 – 11.77)	1.13 – 16.86
Bantamweight	16.1	224	13	237	9.72 (7.83 – 12.45)	-0.23 – 17.78
Featherweight	20.9	291	17	308	8.95 (6.46 – 10.80)	-0.14 – 16.58
Lightweight	16.3	240	-	240	8.45 (6.02 – 10.60)	-2.61 – 20.44
Welterweight	16.4	242	-	242	8.24 (5.79 – 10.41)	-1.89 – 16.78
Middleweight	10.6	156	-	156	5.82 (4.24 – 8.45)	-6.15 – 14.27
Light Heavyweight	4.40	65	-	65	5.69 (4.19 – 7.67)	-1.09 – 13.19
Heavyweight	3.90	57	-	57	0.75 (0.08 – 1.88)	-6.93 – 8.56
Super Heavyweight	0.40	6	-	6	1.05 (-0.38 – 1.89)	-0.44 – 3.27
Overall	100	1,374	100	1,474	8.26 (5.48 – 10.62)	-6.93 – 20.44

Note: IQR; interquartile range; WR = weight regain

Table 2. Logistic regression of independent variables to predict fight outcome (win) (n=1,474).

Variable	Fight outcome		
	ß (95%CI)	**OR (95%CI)**	**p**
%WR	0.044 (0.014 – 0.074)	1.046 (1.015 – 1.078)	0.004
Sex	0.007 (-0.450 – 0.465)	1.007 (0.637 – 1.592)	0.974
Official weight	-0.000 (-0.013 – 0.012)	0.999 (0.986 – 1.012)	0.954
WD from de opponent	0.001 (-0.010 – 0.012)	1.000 (0.990 – 1.012)	0.874
Division	0.024 (-0.140 – 0.190)	1.025 (0.869 – 1.209)	0.767
Constant	-0.601 (-1.833 – 0.630)	0.547 (0.159 – 1.889)	0.339

Note: CI = confidence interval; OR = odds ratio; WD = weight difference; WR = weight regain.