Worth the weight?: Post weigh-in rapid weight gain is not related to winning or losing in professional mixed martial arts

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Abstract

Body mass (BM) manipulation via rapid weight loss (RWL) and rapid weight gain (RWG) is common practice amongst mixed martial art (MMA) athletes to ensure qualification for the division in which the athlete wishes to compete in. Professional MMA competitors in California are required to weigh-in twice: 24 hours (h) prior to competition and immediately prior to the bout, after which they have typically engaged in RWG. In analysing data from 5 MMA events sanctioned by the Californian State Athletic Commission, we used Bayesian analyses to compare bout winners (n=31) and losers (n=31) in terms of in-competition BM (CompMass, kg) and the amount of BM regained between the two weigh-ins (MassDiff, kg). These data do not support the hypothesis that differences in CompMass (BF_{10}=0.667, d = 0.23) or MassDiff (BF_{10} = 0.821, d = .23) determines winning or losing. In addition, there was no statistical difference between bouts ending via strikes, submission or decision for either CompMass (BF_{10}=0.686, $\omega^2 < 0.01$) or MassDiff (BF_{10}=0.732, $\omega^2 = 0.054$). In conclusion, we report for the first time that the magnitude of RWG does not predict winning or losing in a professional cohort of MMA athletes. Additionally, we also report that MMA athletes typically compete at a BM that is at least 1-2 divisions higher than the division in which they officially weighed-in. These analyses may provide impetus for governing bodies and coaches to enact change at both professional and amateur levels to reduce negative health consequences associated with extreme RWL and RWG.

Key words:Body composition; body mass regulation; weight cutting

Word count = 2,210

Introduction

Mixed martial arts (MMA) is combat sport characterised by striking and grappling based actions, in which the participants compete in specified divisions (colloquially known as 'weight classes') according to their body mass (BM). There is a strong belief amongst participants and coaches that having a BM greater than the opponent provides a direct competitive advantage (Langan-Evans, Crighton, Martin, & Wilson, 2017), with evidence suggesting that this offers psychological support for performers (Pettersson, Ekström, & Berg, 2013). To achieve the BM required for their chosen division, MMA participants regularly engage in rapid weight loss (RWL) prior to their official weigh-in, followed by rapid weight gain (RWG) in the 24 hours (h) between the weigh-in and the bout itself (Gann, Tinsley, & La Bounty, 2015). Methods employed are a combination of diet restriction and activities designed to induce extreme hypohydration including: fluid restriction, training in plastic clothing, use of saunas and excessive fluid consumption (water loading). The magnitudes of RWL reported amongst MMA participants is typically greater than related sports such as boxing, wrestling and Brazilian jiu jitsu (Barley, Chapman, & Abbiss, 2017; Daniele, Weinstein, Wallace, Palmieri, & Bianco, 2016; Horswill, Scott, Dick, & Hayes, 1994). It is noteworthy that MMA athletes often partake in RWL and RWG practices on the basis of advice from coaches and training partners with little intervention from medical professionals or dieticians (Barley et al., 2017; Crighton, Close, & Morton, 2016; Hillier et al., 2019; Matthews & Nicholas, 2017; Santos-Junior et al., 2019).

There is emerging evidence that the magnitude of RWG may be an important factor for success in grappling sports such as judo (Reale, Cox, Slater, & Burke, 2016), though this effect is apparently absent in striking sports such as boxing (Reale, Cox, Slater, & Burke, 2017). In relation to MMA, Coswig et al. (2018) demonstrated that winners of competitive MMA bouts regained 3% more BM than bout losers after both groups lost 7-8% BM prior to weigh-in. Nonetheless, the small sample size of 8 winners and 7 losers precludes the conclusion that the

magnitude of RWL and subsequent RWG is an important determinant of success. Despite such limited data in this area, professional MMA athletes partake in large magnitudes of RWL and RWG, the result of which can be detrimental to health. For example, a recent case study (n=1) conducted by our laboratory reported that of the 18.1% (14.5 kg) BM lost by the participant during an 8 week period, 9.3% (7.3 kg) was due to severe hypohydration in the final 24 h before weigh-in. This led to reduced resting metabolic rate, hypogonadal endocrine profile and acute kidney injury (Kasper et al., 2018). The influences of severe hypohydration on brain trauma (Kempton et al., 2009) and hormonal changes (Coswig, Fukuda, & Del Vecchio, 2015) have been suggested as the main physiological causes of injury, sickness, kidney disease and in extreme situations, death (Crighton et al., 2016; Langan-Evans et al., 2017; Matthews & Nicholas, 2017; Murugappan et al., 2018).

To combat these issues, the California State Athletic Commission (CSAC) now conduct a second weigh-in on the day of competition to determine whether participants have regained more than 10% of their weigh-in BM (CSAC, 2017). Since the introduction of this process in 2017, CSAC have released the day of bout weigh-in results of five professional MMA events to the public domain. Through analysing these data, the aim of the present study was to test the hypothesis that the amount of RWG between the official weigh-in and the day of bout weigh-in would be predictive of who won the bout, and whether the bout ended due to strikes, submission or decision (Kirk, 2018). It was also hypothesised that different divisions would display different magnitudes of RWG.

Methods

The data used for this study were collected at five professional MMA events (four Ultimate Fighting Championship and one Bellator MMA) held in the state of California, USA by the

CSAC. As previously discussed, participants were required by the CSAC to weigh-in 24 h prior to their bout and again on the day of the bout. These data represent the occasions released to the public domain by the CSAC via the media. The following analyses were completed following institutional ethical approval, and approval from the CSAC. Data were recorded by the authors from various media outlets, cross referencing between each to ensure accuracy. The CSAC reported each of the following variables in lbs, converted by the authors into kg in keeping with SI units: participant's official BM as measured 24 h prior to the bout (OffMass); participant's BM after RWG on the day of the bout (CompMass). It is not known how or precisely when CompMass measurements were taken, other than they occurred on the day of the bout prior to competition. The amount of BM regained between these two points by each participant (MassDiff) was then calculated as follows:

$$\text{CompMass} - \text{OffMass} = \text{MassDiff}$$

The winner of each bout, the bout outcome (strikes, submission or decision (Kirk, 2018)), and the division in which the bout took place was also recorded. Draws, disqualifications and no contests were excluded from the sample, as were bouts where any participant's CompMass was not recorded/reported.

Statistical Analyses

Bout winners and losers were compared for statistically relevant differences in CompMass and MassDiff via two-tailed Bayesian t tests using a JZS Cauchy prior = 0.707. Cohen's d effect size was calculated using the standard deviation of the mean scores as the denominator. Bayesian one-way ANOVA with omega squared (ω^2) effect size was calculated for differences in CompMass and MassDiff between each bout outcome. Bayesian one-way ANOVA with ω^2 was calculated for MassDiff between divisions. ANOVA post-hoc comparisons were

calculated using a default t-test with a Cauchy prior. The data were also viewed to determine which division participants would, on average, be classed as based on their CompMass, regardless of the their OffMass.

The following Bayes factor (BF) thresholds were used for each Bayesian test: 1-2.9 = anecdotal; 3-9.9 = moderate; 10-29.9 = strong; 30=99.9 = very strong; ≥ 100 = decisive (Wetzels & Wagenmakers, 2012). Each BF was used to specify evidence in favor of either the hypothesis (BF_{10}) or the null hypothesis (BF_{01}). Due to a default prior being used BF robustness checks were also performed. Where a BF was found to cross a threshold using a wider prior, both thresholds are reported (Quintana & Williams, 2018). Cohen's d thresholds were set at: trivial $d \leq 0.1$; small $d \geq 0.2$; moderate $d \geq 0.6$; large $d \geq 1.2$. ω^2 thresholds were set at: small $\omega^2 \geq 0.01$; moderate $\omega^2 \geq 0.06$; large $\omega^2 \geq 0.14$. Each of the named statistical tests were completed using JASP 0.10.2.0 (JASP Team, Amsterdam, Netherlands).

Results

Effect of Rapid Weight Gain on Winning and Losing

Descriptive results are presented in Table 1. When comparing RWG between bout winners and losers, the difference between the in-bout mass of winners and losers was anecdotal (CompMass BF_{10} = 0.667, d = 0.23). The median [IQR] difference between winner's and loser's CompMass = 0.8 [-0.7:2.7] kg, with range = -9 – 14 kg. Importantly, the evidence in favour of bout winners regaining more mass than bout losers was also anecdotal (MassDiff BF_{10} = 0.821, d = .23). The median [IQR] difference between winner's and loser's MassDiff = 0.95 [-0.6:2.3] kg, with range = -8.5 – 13.4 kg.

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156 **Differences between Bout Outcomes**

157 Differences in CompMass (BF_{10} = 0.686, ω^2 < 0.01) and MassDiff (BF_{10} = 0.732, ω^2 = 0.054)
158 did not appear to have any effect on whether the bout ended via strikes, submission or decision.
159 Though there was a trend for winners to regain a greater %BM in bouts ending due to strikes
160 or submission, these differences were not found to be statistically relevant. When considering
161 bouts ending due to strikes, the data favoured the null hypothesis that CompMass did not affect
162 the outcome (BF_{01} = 2.129 – 3.761, d = 0.27), with the evidence for MassDiff having an effect
163 in these bouts being anecdotal (BF_{10} = 0.651, d = 0.33). Similarly, in terms of bouts that were
164 won by submission, there was only anecdotal evidence for either CompMass (BF_{10} = 1.1, d =
165 0.6) or MassDiff (BF_{10} = 1.8, d = 0.72) differentiating between winners and losers. For bouts
166 that ended in decision, the evidence favoured the null hypothesis of there being no effect on
167 the result for both CompMass (BF_{01} = 4.8, d = 0.05) and MassDiff (BF_{01} = 4.8, d = 0.06).

168 ***INSERT TABLE 1 HERE***

169

170 **Differences between Divisions**

171 When comparing MassDiff between divisions (Table 2), there was found to be anecdotal
172 evidence of each division regaining BM at different magnitudes (BF_{10} = 1.3, ω^2 = 0.05). Post
173 hoc testing did, however, find the following differences between individual divisions: light
174 heavyweight (LHW) and women's strawweight (WSW) BF_{10} = 5.4 (moderate); welterweight
175 (WW) and featherweight (FW) BF_{10} = 3.7 (moderate); WW and flyweight (FlW) BF_{10} = 7.5
176 (moderate); FW and WSW BF_{10} = 5.4 (moderate); FlW and women's featherweight (WFW)
177 BF_{10} = 4 (moderate); FlW and WSW BF_{10} = 25.9 (strong).

178 The mean CompMass of each division placed the participants in at least the division above
179 which they were competing in. Six divisions displayed a mean CompMass placing the
180 participants near to the upper limit of two divisions above their OffMass. It should be noted,
181 differences between heavyweight (HW) and other individual divisions were not calculated as
182 no HW participants reduced BM prior to official weigh-in.

183 ***INSERT TABLE 2 HERE***

184

185 **Discussion**

186 Despite widespread perceptions amongst athletes and coaches, we provide novel data
187 demonstrating that the amount of BM regained after official weigh-in appears to provide no
188 competitive advantage in professional MMA athletes. Indeed, these data suggest that the
189 magnitude of RWG does not predict success, regardless of whether the bout ends due to strikes,
190 submission or decision.

191 Similar to other grappling inclusive sports such as judo (Reale et al., 2016), previous
192 observations from Coswig et al. (2018) provided preliminary evidence to suggest that the
193 magnitude of RWG amongst MMA winners was significantly greater than losers. However,
194 using a larger sample size, the present data suggest this is not the case for those participants
195 studied here. Importantly, our data also extend recent research conducted on a mixed cohort of
196 amateur and professional MMA athletes (Brechney, Chia, & Moreland, 2019) which suggested
197 that bout losers engaged in a greater magnitude of RWL than bout winners. Furthermore, it is
198 noteworthy that MMA athletes in the present study were, on average, regaining an absolute
199 BM large enough to place them in a division that was 1-2 divisions above their OffMass,
200 regardless of winning or losing. Given the apparent lack of a competitive advantage and also
201 the dangers of engaging in extreme RWL and RWG (Kasper et al., 2018), these data therefore

suggest that athletes may be better served by reducing the magnitude of RWL and competing at least one division higher.

In contrast to judo (Reale et al., 2016) and the initial MMA findings by Coswig et al. (2018), any potential benefits of RWG appear to be absent in striking-based events (Reale, Cox, et al., 2017). A separate analysis of 71 boxing championship bouts found no effect of RWG on success (Daniele et al., 2016). Given that MMA is a sport where the technical requirements of successful performance can vary widely between grappling and striking movements (Kirk, 2018), the assumption that having a greater BM is a prerequisite for success does not seem to hold true. It appears more likely that a strategy of RWL/RWG that accommodates the middle of the striking-grappling spectrum would be more suitable. This may allow participants to achieve a BM applicable to both grappling and striking modes whilst reducing or potentially avoiding any negative health related outcomes.

The belief that RWG offers a competitive advantage appears to be most pronounced in the lighter mass divisions of FW, BW and FlW, where participants regained more relative BM than those in lightweight (LW) and above. This result also occurred in the three female divisions. Though these data cannot directly infer the magnitude of RWL, it would be reasonable to assume that this would be similar or greater to the amount of BM regained via RWG (Barley et al., 2017). Overall, the evidence presented here and by others (Brechney et al., 2019) represents emerging data that extreme RWL and RWG is not predictive of success. At present, there may be concerns amongst MMA athletes that those who do reduce RWL and change divisions would be at a disadvantage to those who do not. To that end, there should be a consistent, co-ordinated effort for researchers to work directly with athlete facing practitioners to induce cultural change within the sport. As this would take some time, competitors in the interim will need systems in place to ensure adequate health and safety alongside optimal performance. Such systems have been successfully utilised in Olympic combat sports (Reale,

Slater, & Burke, 2017) and should be developed within MMA. We suggest these analyses presented here are replicated periodically as more data become available.

Novelty Statement

In summary, we report for the first time that the magnitude of RWG does not predict winning or losing amongst professional MMA athletes. Additionally, we also report that MMA athletes typically compete at a BM that is at least 1-2 divisions higher than the division in which they officially weighed-in.

Practical Application

Given that our analyses do not support the notion that extreme RWL and RWG is required for success in MMA, the present data may provide impetus for governing bodies to enact legislative change at both professional and amateur levels to discourage extreme RWL and RWG. Our results should also be used to encourage athletes and coaches to make use of more sustainable RWL and RWG practices.

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Table 1 – Descriptive statistics of bout winners and bout losers (mean ± SD), as categorised according to the full cohort and bouts won by strikes, submission or decision.

	Bout Winner		Bout Loser	
	CompMass (kg)	**MassDiff (kg)**	**CompMass (kg)**	**MassDiff (kg)**
Full Cohort	77.3 ± 13.8	6.9 ± 2.9 [10.1 ± 0.04%]	76.4 ± 13.4	6 ± 2.8 [9.1 ± 0.05%]
Strikes	79.5 ± 14.2	6.9 ± 3.4 [10.4 ± 0.05%]	78.3 ± 15.3	5.7 ± 3.2 [8.5 ± 0.05%]
Submission	77.3 ± 11.2	5.7 ± 2.4 [8.3 ± 0.04%]	75.1 ± 2.4	4.2 ± 2.3 [6.2 ± 0.03%]
Decision	75.4 ± 13.8	7.2 ± 2.5 [10.6 ± 0.03%]	75.2 ± 12.5	8.6 ± 8.9 [10.5 ± 0.04%]

Nb. [%] = mean ± SD %BM regained in each group (MassDiff as a percentage of OffMass)

Table 2 – Mass variables by division (mean ± SD)

Division	Division Mass Limit (kg)	Full Divisional Cohort CompMass (kg)	Full Divisional Cohort MassDiff (kg)	Winners CompMass (kg)	Winners MassDiff (kg)	Losers CompMass (kg)	Losers MassDiff (kg)
Heavyweight	120.5	109.1 ± 5.6	1.1 ± 2.2 [1 ± 2.1%]	109.1 ± 6.9	1 ± 2.3 [0.9 ± 2.1%]	109 ± 5.7	1.1 ± 2.5 [1.1 ± 2.3%]
Light heavyweight	93.1	100.1 ± 1.4	7.2 ± 1.4 [7.8 ± 1.5%] [a]	100.9 ± 1.5	8.2 ± 1.1 [8.9 ± 1.2%]	99.3 ± 0.7	6.2 ± 0.6 [6.6 ± 0.7%]
Middleweight	84	92.2 ± 3.2 ◊	7.7 ± 3.4 [9.1 ± 4%]	94.1 ± 2.6	9.5 ± 3 [11.3 ± 3.5%]	90.2 ± 2.5	5.9 ± 2.9 [7 ± 3.5%]
Welterweight	77.2	82.1 ± 2.9 ◊	5.6 ± 1.5 [7.4 ± 1.8%] [b, c]	82.3 ± 3.2	5.8 ± 1.6 [7.6 ± 1.9%]	82 ± 2.6	5.4 ± 1.5 [7.1 ± 1.8%]
Lightweight	70.5	77 ± 4.8 ◊	5.6 ± 4.6 [8 ± 6.6%]	77.7 ± 5.5	7.2 ± 5.2 [10.2 ± 7.3%]	74.7 ± 4.2	4.1 ± 4.1 [5.8 ± 5.8%]
Featherweight	65.9	73.6 ± 3 #	7.8 ± 2.7 [11.8 ± 4%] [b, d]	73.6 ± 3.1	7.8 ± 2.4 [11.8 ± 3.6%]	73.6 ± 3	8.7 ± 3 [11.8 ± 4.6%]
Bantamweight	61.3	68.5 ± 2 #	6.9 ± 1.9 [11.1 ± 3.1%] [f]	69 ± 1.7	7.3 ± 1.5 [11.9 ± 2.5%]	68 ± 2.2	6.4 ± 2.2 [10.4 ± 3.5%]
Flyweight	56.8	65 ± 1.2 #	8.2 ± 0.8 [14.4 ± 1.3%] [c, e]	65.3 ± 1.8	8.4 ± 1.3 [14.8 ± 2.1%]	64.8 ± 0.4	8 ± 0.4 [14 ± 0.6%]

Women's featherweight	65.9	71.6 ± 1	◊	5.8 ± 1.2 [8.7 ± 1.9%] [e]	71.1 ± 0.4	5 ± 0 [7.6 ± 0%]	72 ± 1.5	6.5 ± 1.4 [9.9 ± 2.2%]
Women's bantamweight	61.3	68.5 ± 3.3	#	6.9 ± 3.4 [11.2 ± 5.5%]	66 ± 1.9	4.3 ± 1.8 [6.9 ± 2.7%]	71 ± 1.9	9.5 ± 2.1 [15.4 ± 3.3%]
Women's flyweight *	56.8	64 ± 3.1	#	7.1 ± 2.6 [12.4 ± 4.5%] [g]	66.2	8.9 [15.6%]	61.8	5.2 [9.2%]
Women's strawweight	52.3	57.5 ± 1.3	#	5 ± 1.3 [9.5 ± 2.4%] [a, d, f]	57.5 ± 1.4	5.2 ± 1.2 [9.9 ± 2.3%]	57.4 ± 1.3	4.9 ± 1.5 [9.2 ± 2.8%]

*Nb. ◊ = participants are on average near to the mass limit of the division above; # = participants are on average near to the mass limit of two divisions above; a/b/c/d/e/f = division displays moderate ANOVA post hoc differences in MassDiff to division with the same corresponding letter; g = division displays strong ANOVA post hoc differences in MassDiff to division with the same corresponding letter; * = one bout sampled in this division; [%] = mean ± SD %BM regained in each group (MassDiff as a percentage of OffMass)*

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