



Self-confidence and Disordered Eating amongst Martial Artists: A Cross-sectional Study

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Abstract

Background: Extreme dieting is a well-known phenomenon in combat sports, and still, little research has explored the link between extreme dieting and confidence levels among martial artists.

Methods: In this cross-sectional study, extreme dieting and sport-specific self-confidence among 111 Swedish athletes practicing mixed martial arts (MMA) or Brazilian jiu-jitsu (BJJ) were examined. Athletes completed an online survey containing the Eating Disorder Examination questionnaire (EDE-Q) and the Trait Sport-Confidence inventory (TSCI).

Results: The results showed that MMA athletes dieted in more extreme ways than BJJ athletes, primarily via restricted eating. They also had higher sport-specific self-confidence, which was positively correlated with weight loss. BJJ athletes used less restrictive eating than MMA athletes, but those who did diet in extreme ways experienced lower self-confidence compared to MMA athletes.

Conclusions: The results are consistent with previous studies showing rapid weight loss in MMA athletes and suggest that some martial artists are at a particular risk of extreme dieting and possible sequelae. There is a link between self-confidence and weight loss, but it seems to allude to a comprehensive explanation and is in need of further research.

Keywords: Dieting, Self-Reliance, Brazilian Jiu-Jitsu, Mixed Martial Arts

1. Background

Extreme dieting in sports is not a new phenomenon; it has been previously observed in many classic Olympic sports such as boxing, wrestling, taekwondo, and judo (1-3). However, there is an information gap concerning the detrimental effects of extreme dieting for certain newer sports. Mixed martial arts (MMA) and Brazilian jiu-jitsu (BJJ) have recently increased in popularity (4, 5) and the expansion has led to media exposure and debate on unhealthy weight loss among especially MMA athletes (6-8). For this reason, martial arts organizations need informed practices to keep their athletes in good health.

MMA and BJJ both are martial arts where participants compete in specific weight categories, which often leads to "adjustment" of body weight before a competition in order to maximize chances of winning. This form of weight loss is nowadays seen as rather "normal" and is to some a compulsory aspect of competition (2, 3). Professional MMA athletes weigh in twenty-four to thirty-six hours before competition, and amateurs circa five hours before. This practice is considered to be the greatest contributing factor to the fast and extreme weight loss among martial artists (9)

who generally seek to weigh in at the lowest weight possible and afterwards attempt to regain weight rapidly before the competition (10). In comparison, the majority of BJJ organizations allow competitors to weigh in just before competition in order to avoid engagement in extreme dieting. However, this practice may also lead to persistent problems with food and eating that can be either physically, psychologically, and/or psychosocially harmful.

In certain sports, the concept of athletic anorexia has been introduced to explain unhealthy weight loss (11). Athletic anorexia is a continuous stage of dieting and therefore differs from the more volatile extreme dieting used by mixed martial artists. The figure skater always strives to be thin whilst the martial artist needs to lose weight before weighing in and then gain it again before competition.

Extreme dieting is manifested in many different forms, such as restrictive nutritional intake and/or excessive use of laxatives. Another common proceeding is to use a hot sauna in order to lose weight in water (12) or hot water immersion (13). While martial arts are very physically demanding, it is not uncommon for athletes to compete in a dehydrated state as a result of their attempts at weight loss (2, 14, 15). However, acute dehydration can lead to struc-

tural changes in the brain, such as reductions in white as well as grey brain mass, thus exposing dehydrated participants to more severe consequences if enough damage is applied to the head (16, 17). This is alarming since recent research reported that 12.7 % of all fights end in a knockout, and microstructural changes in the brain have been linked to the number of knockouts suffered (18).

Extreme dieting can lead to decreased cognitive functions such as impaired short-term memory and concentration, as well as a lack of self-confidence, confusion, and depression, all of which can influence the competitive performance of athletes (19, 20). Despite the obvious hazards, many martial arts athletes consider themselves forced to use these methods to cope with the weight limit of their desired sports (10), and this dramatic weight decrease is often the result of the desire to face physically weaker opponents (21). Athletes, compared to non-athletes, suffer more from extreme dieting, especially in sports where weight is considered an “edge” such as judo, weightlifting, and wrestling (22-24). Some studies of the relationship between weight loss and success show that weight loss may at least partially contribute to enhanced competitive outcomes (25, 26), but these results have not been consistent (26, 27). In 1997, three college wrestlers in the United States died due to heat stroke and dehydration caused by extreme weight drops (25). The deaths forced the National Collegiate Athletic Association to update its rules and requirements concerning dieting to prevent further deaths (25). Various martial arts federations have begun to apply methods of weight regulation, but no consensus prevails and the dietary culture in MMA has already resulted in deaths (10).

Eating disorders in athletes have been researched (12, 23) but there is comparatively less research on the connection between dieting and sport-specific self-confidence in athletes. Competitively successful martial artists are characterized by high mental resilience, self-confidence, and positive attitudes (28-30). Thus, a well-grounded assumption would be that martial artists that do well in the competition also have greater self-confidence than martial artists who are not as successful. In relation to extreme dieting, Pettersson and Berg (15) explored the importance of weight loss for the athletes’ perceived self-confidence and found that athletes seemed to gain confidence by cutting weight. Considering the vast literature that points to the cognitive detrimental effects of weight loss, such as low self-confidence, these findings seem contradictory and in need of more research.

2. Objectives

The present study aimed to compare MMA and BJJ, which differ in weighing in before competitions, to assess which athletes are most at risk for extreme weight loss. As it is not clear how self-confidence may affect weight loss amongst martial artists, the relationship between participants’ weight loss and sport-specific self-confidence will also be explored through the following hypotheses:

1) MMA athletes lose more weight and exhibit more disordered eating than BJJ athletes due to their volatile dieting (23, 31).

2) Athletes who diet in extreme ways show less sport-specific self-confidence than other athletes.

3. Methods

3.1. Data Collection and Participants

Initially, 137 participants were recruited by mailing surveys to local MMA and BJJ clubs. Twenty-six of the willing participants were eliminated because they gave incomplete answers or did not meet the criteria for inclusion, leaving 111 participants eligible for the study (MMA: n = 47; BJJ: n = 64). As the study needed to make a distinction between the groups, participants had to state that they practiced MMA or BJJ.

Since there are no established guidelines dictating when MMA and BJJ athletes are considered “elite”, we created our own division of athletes based on prior literature (32, 33). In order to qualify as a serious practitioner, participants had to have practiced for at least four years and exercise a minimum of six hours per week. Consequently, the current sample may be considered elite- or at least semi-elite. Furthermore, BJJ athletes had to have a blue belt, and to participate in a minimum of four tournaments a year, while MMA athletes had to have completed at least four fights in total. Note that the heavyweight and plus classes in MMA (≥ 100.5 kg) and BJJ (≥ 120 kilograms [kg]) also were excluded based on the unlikelihood that these participants diet in the same way as the others. Overall, the participants’ weight ranged from 52 kg to 93 kg. Exclusion criteria for both groups were thus experience below four years and/or less than six hours a week training on a regular basis. BJJ athletes were excluded if they did not have a blue belt (i.e., they were only white belts) and/or if they did not compete in at least four tournaments per year. MMA athletes were excluded if they had below four fights in total.

3.2. Measurements

Besides demographic data such as age, gender, and sporting occurrences, we asked for data on athletes’ current weight, intended weight class for competition, total weight loss (in kg), time of weight loss, number of

years trained, and training hours per week. All these items used an open-answer format. The questionnaires were distributed online.

Extreme weight loss. We measured extreme dieting by determining the actual amount (in kg) of weight lost and the relative weight loss (i.e., weight loss in proportion to body weight). For example, an athlete who weighs 93 kg and whose weight loss results in a weight of 90 kg would not be classified as having lost an extreme amount of weight, whereas an athlete with a body weight of 60 kg who loses the same amount-3 kg-might be considered to have engaged in extreme weight loss. The human body can tolerate a short term weight loss of less than 4 percent by practicing dehydration (34), but this notion has been criticized by Burke et al. (35), who suggest a maximum weight reduction of 2 to 3 percent of the total body weight if it is made with sufficient nutritional and hydrational management. However, there are no established guidelines for what could be considered an extreme weight loss; and therefore, our classification is arbitrary.

The participants also completed the Eating Disorder Examination questionnaire (EDE-Q) (35), which is based on a 28-day interval and this interval was modified to focus on the 28 days prior to the participant's most recent competition, in order to capture the eating behavior related to their athletic context. The EDE-Q has four subscales: restrictive eating, eating concern, shape concern, and weight concern. Each item is answered on a 7-point Likert scale ranging from 0 ("no days") to 6 ("every day"). The item scores for each subscale are averaged to provide subscale scores, and a global score can be calculated by averaging the subscale scores. Higher scores are indicative of more severe eating disorder psychopathology.

Traditionally, based on the theoretically derived subscales of the EDE, a mean global score of 4.0 has been used as a threshold for ED psychopathology in community studies of the EDE-Q. However, evidence from clinical settings has shown that nearly half of the patients diagnosed with an ED obtain a global score of less than 4.0 (36). It is therefore probable that a cut-off of 4.0 has limited clinical utility, and if utilized for screening purposes, may yield an underestimate of the prevalence of ED (37).

All subscales reported adequate reliability in subsequent analyses (restrictive eating: $\alpha = 0.84$; eating concern: $\alpha = 0.77$; shape concern: $\alpha = 0.89$; weight concern: $\alpha = 0.73$).

Sport-specific confidence. The participants also completed the Trait Sport-Confidence inventory (TSCI) (38) to determine their sport-specific self-confidence. TSCI total score ranges from 13 to 117, with scores of 13 - 39 indicating low sport-specific self-confidence, 40 - 90 indicating average self-confidence, and 91 - 117 indicating high self-confidence. TSCI reported adequate reliability ($\alpha = 0.86$).

3.3. Statistics

All analyses were conducted using IBM SPSS statistics 23, and all visualizations were conducted in R Studio. In the initial phase, assumptions and normality were assessed. Descriptive statistics were established, and a correlation analysis of all experimental variables was performed using Pearson's r . To explore the potential differences between groups, a MANOVA was performed in which all experimental variables were included (i.e., the dieting, disordered eating and self-confidence variables). Based on an a priori power analysis using G*power, 64 participants were required for an effect size of .4, an error probability of .05, and a power of 0.95. This was based on the MANOVA option calculation, utilizing two groups (and eight outcome variables (total EDE-Q, its four subscales, weight loss, sport-specific self-confidence and relative weight loss)).

3.4. Ethics

To ensure that the study complied with the ethical principles of the declaration of Helsinki, the survey was presented as a study on martial arts practice and behavior related to mental health and food. An effort was made to avoid stating the exact content of the study to decrease participant bias, like for example social desirability. The study was anonymous, and participation was voluntary. Participants could refrain from participation whenever necessary, as stated by the ethical principles. All collected information was used only in this study, as per the utility requirement.

4. Results

Table 1 shows the descriptive data for all athletes divided by their chosen martial art. Initially, age, gender, and competitive level was controlled for and found not to affect the results. All variables were normally distributed, except for weight loss and relative weight loss. See descriptive data in Table 1 below.

As can be seen in Table 1 MMA athletes reported an overall higher score on the Eating Disorders Examination questionnaire than did BJJ athletes. Specifically, MMA athletes were found to use more restrictive methods of dieting, according to the EDE-Q, than were BJJ athletes. In addition, MMA athletes ($Mdn = 0.03$) showed greater relative weight loss than did the BJJ athletes ($Mdn = 0.01$; $U = 568$, $n_1 = 47$, $n_2 = 64$, $P < 0.001$).

The results of the correlation analyses regarding sport-specific confidence, weight loss, relative weight loss, EDE-Q total, and EDE-Q restrictive eating are shown in Table 2 below.

Table 1. Descriptive Data of the Participants According to Chosen Martial Art^a

	MMA	BJJ
Age	31.49 ± 6.3	32.63 ± 6.2
Hours training per week	12.87 ± 4.13	9.64 ± 3.78
Years practiced	8.85 ± 4.09	8.48 ± 3.83
Weight	71.05 ± 10.11	76.11 ± 9.49
Weight loss, kg	2.03 ± 1	1.25 ± 1.1
Relative weight loss, kg	0.03 ± 0.01	0.01 ± 0.01
Sport-specific self-confidence	80.06 ± 21.27	67.84 ± 25.58
MMA competitions/BJJ tournaments	11.01 ± 6.02	3.94 ± 2.04
EDE-Q total	2.6 ± 3.8	1.46 ± 1.04
EDE-Q restrictive eating	2.78 ± 1.52	2.04 ± 1.43
EDE-Q eating concern	1.02 ± 1.11	0.85 ± 1.08
EDE-Q shape concern	1.59 ± 1.35	1.3 ± 1.29
EDE-Q weight concern	1.87 ± 1.31	1.56 ± 1.24

Abbreviations: BJJ, Brazilian jiu-jitsu; EDE-Q, Eating Disorder Examination questionnaire; MMA, mixed martial arts.

^aValues are expressed as mean ± SD.

All of the statistical assumptions for utilizing a MANOVA were met, except for the homogeneity of covariance matrices (Box's test significant at $P < 0.001$). Thus, we used Pillai's trace which is robust to this violation when sample sizes are roughly equal (39).

The total MANOVA model was significant, $F(5, 105) = 4.75$, $P < 0.001$, $\eta^2 = 0.18$. Specifically, MMA athletes lost more weight in total, $F(1, 109) = 12.55$, $P < 0.001$, $\eta^2 = 0.1$, more relative weight in total, $F(1, 109) = 14.15$, $P < 0.001$, $\eta^2 = 0.12$, displayed higher total EDE-Q score, $F(1, 109) = 5.06$, $P = 0.03$, $\eta^2 = 0.04$, displayed more restrictive eating, $F(1, 109) = 6.86$, $P = 0.01$, $\eta^2 = 0.06$. and reported higher sport-specific self-confidence than BJJ athletes, $F(1, 109) = 7.1$, $P < 0.001$, $\eta^2 = 0.06$. The results are displayed in Figure 1 and Figure 2 below.

5. Discussion

Two martial art sports with two different systems of weighing in before competition were compared to assess whether and which athletes were at risk of extreme dieting and lack of sport-specific confidence. The results showed that MMA athletes exhibited more extreme relative weight loss and extreme dieting than the BJJ athletes as the first hypothesis stated.

However, in opposition to the second hypothesis, the results showed that MMA athletes, despite exhibiting more extreme dieting, also reported higher sport-specific self-confidence than did the BJJ athletes.

The differences in weight loss activities accords with previous research suggesting that weight loss in MMA generally is more extreme than in other combat sports (6, 10) MMA athletes, as noted, have more time than BJJ athletes to tamper with their weight before competition. As previously reported by Pettersson and Berg (15), hydration levels might not be fully restored because of the weight loss, and this may affect the athletes' health in the long run.

While more excessive dieting was associated with higher sport-specific confidence in MMA athletes, there was no significant link to explicit eating disorders. Although extreme dieting might influence performance negatively due to issues related to physical well-being as well as cognitive functions (1, 20), there is also evidence that athletes perform well in competition in spite of their extreme weight loss (2, 3). The findings in the present study indicated that athletes who reported much-lost weight also possessed high sport-specific self-confidence in line with Pettersson et al.'s study (3) regarding the "mental advantages" of weight loss. Several explanations are plausible such as the fact that the reported high sport-specific confidence might be a protective factor against psychopathology, to be compared with the study by (40) who measured self-esteem and weight loss. Another possible explanation could be that the path towards a restrictive eating disorder only had been initiated, and follow-up studies on athletes with high sport-specific confidence and extreme weight-loss would be informative to determine whether they would continue to possess the high self-confidence despite the weight tampering or if psychopathology might arise over time.

Despite the differences in eating disordered behavior and actual weight loss as measured by the EDE-Q, there were no significant correlations for either group between EDE-Q and sport-specific self-confidence. However, self-confidence was significantly correlated to the actual weight loss measured in kilos for MMA athletes. The correlational results thus suggest that the process of losing weight amongst MMA athletes may be positively associated with higher self-confidence and mental advantages, but that eating disordered behavior has a less clear relationship to self-confidence. In other words, the weight loss itself may be mentally beneficial, but once this process turns into eating disordered behavior, it becomes vague whether it still provides the same mental advantage. On the contrary, no significant correlations between eating disordered behavior, weight loss, and self-confidence was found for BJJ athletes; thus, the relationship between dieting, disordered eating, and the construct of self-confidence seems less important for BJJ athletes who are regulated by stricter timeframes.

Although unfortunate, it is difficult to compare stud-

Table 2. Correlations Between Dieting, Relative Weight Loss^a, EDE-Q Total, EDE-Q Restrictive Eating, and Sport-Specific Self-confidence Among MMA and BJJ Athletes (In Parenthesis)

	Weight Loss	Relative Weight Loss	EDE-Q Total	EDE-Q Restrictive Eating
Weight loss	0	0	0	0
Relative weight loss	0.95 ^b (0.98 ^b)	0	0	0
EDE-Q total	0.53 ^b (0.58 ^b)	0.21 (0.54 ^b)	0	0
EDE-Q restrictive eating	0.42 ^b (0.51 ^b)	0.29 ^b (0.54 ^b)	0.71 ^b (0.70 ^b)	0
Sport-specific self-confidence	0.39 ^b (-0.1)	0.49 ^b (0.06)	0.3 (-0.04)	0.18 (0.07)

Abbreviations: BJJ, Brazilian jiu-jitsu; EDE-Q, Eating Disorder Examination questionnaire; MMA, mixed martial arts.

^aSee methods section for a description of the term "relative weight loss".

^bp < 0.01.

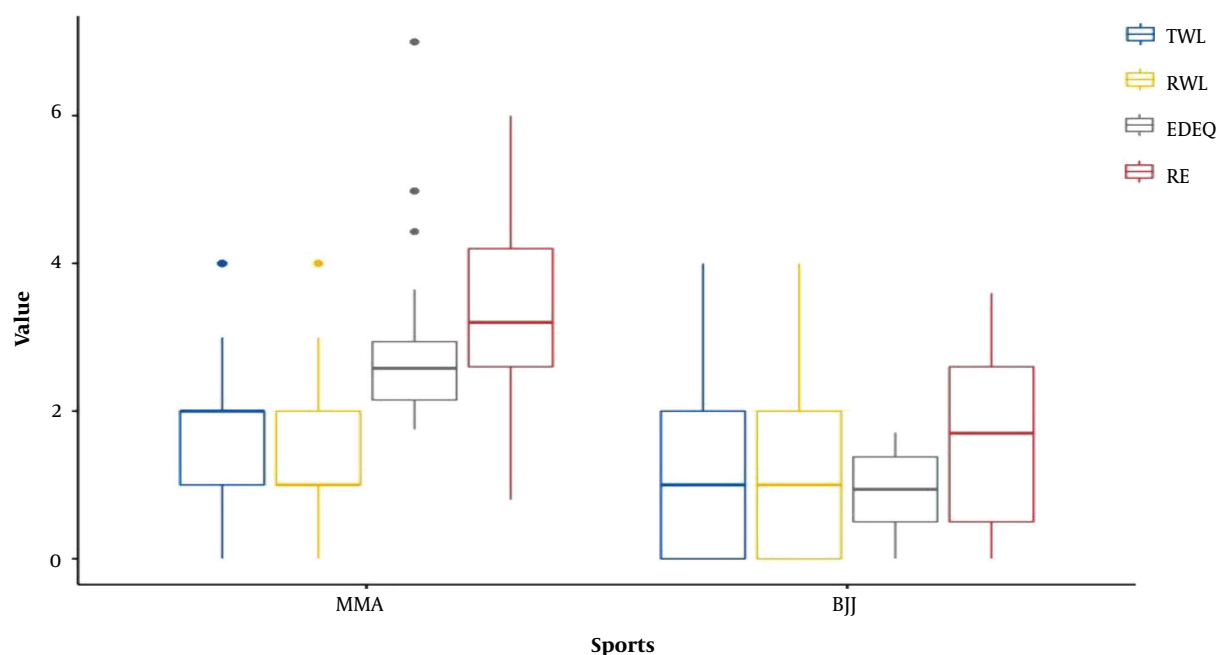


Figure 1. MANOVA with relative- and total weight loss, EDE-Q and restrained eating as dependent variable and sport as independent variable. Note. TWL, total weight loss; RWL, relative weight loss; EDEQ, Eating Disorder Examination questionnaire; RE, restricted eating.

ies regarding weight loss in martial arts or other sports divided into weight classes, as the methods differ, and the outcomes are mixed. According to Reale et al. (27) there are few studies overall related to weight loss and weight gain in competition performance. Therefore more research is needed (but, see (41)). Additionally, the cited studies do not report self-confidence; thus, the current study was conducted under the assumption that being successful in competition is highly linked to being self-confident.

In accordance with the prerequisites of the EDE-Q, the athletes' eating behavior was measured 28 days before the competition, and therefore, no conclusions about athletes' relation to food beyond this time frame could be drawn. It is possible for athletes showing indications of extreme

dieting had a healthy attitude to food in their everyday life beyond the competition period. Finally, cross-sectional studies provide only an indication of athletes' current weight-related issues. To fully rule out participants' use of weight loss as merely a tool to reach their desired weight class, longitudinal studies would be required. This is a salient limitation, as it would be beneficial to explore if weight loss generates self-confidence and to what extent.

The time frame MMA athletes can regain weight differs from the one BJJ athletes are given. This regulation may indirectly contribute to enhance extreme dieting (and weight gain). However, greater weight loss was also associated with better self-confidence for MMA athletes and not for BJJ athletes. This indicates that the weight loss may give

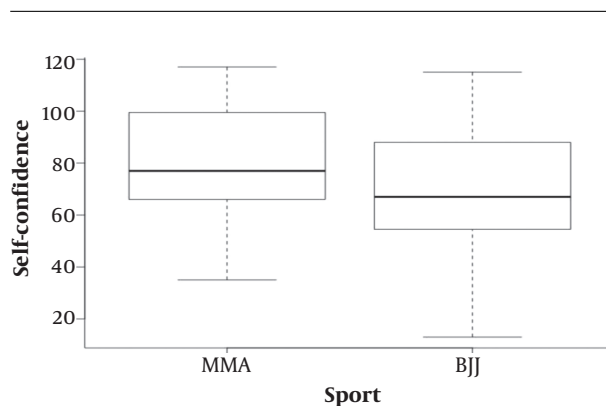


Figure 2. Differences in sport-specific confidence amongst MMA- and BJJ athletes

a mental “edge” to MMA competitors, who could gain a physical advantage through this practice; however, a correlational analysis cannot account for the causal relationship.

5.1. Conclusions

The results show that MMA athletes lose more weight than BJJ athletes due to their volatile dieting, but they also show higher sport-specific confidence than BJJ athletes in spite of their extreme dieting and possible eating disorders.

As the ruleset regarding weight management in MMA may stimulate more extreme dieting than the short time-frame in BJJ, there is a need to discuss and approach these problems as no one is likely to benefit from sports if they do not also engage in a healthy lifestyle. One suggestion would be to only allow a certain percentage of the participants’ body mass to be dieted ahead of the competition. Other suggestions would include pre-measuring of athletes’ usual weight and locate them into a “natural weight” class or for MMA organizations to adopt the weigh in rules of BJJ.

Footnotes

Authors’ Contribution: The study concept and design and acquisition of data were made by TMB and MT. The analysis and interpretation of data were made by the authors together. Statistical analyses were made by TBM. The manuscript was preliminary drafted by TBM and MT. The final draft was written by EH. The critical revision was made by a colleague along with the authors.

Conflict of Interests: The authors declare no conflict of interest.

Ethical Approval: To ensure that the study complied with the ethical principles of the declaration of Helsinki, the survey was presented as a study on martial arts practice and behavior related to mental health and food. An effort was made to avoid stating the exact content of the study to decrease participant bias, like for example, social desirability. All collected information was used only in this study, as per the utility requirement (Forsman, 2002).

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Informed Consent: The study was anonymous, and participation was voluntary. Participants could refrain from participation whenever necessary, as stated by the ethical principles and told upon the initiation of the study.

References

1. Degoutte F, Jouanel P, Begue RJ, Colombier M, Lac G, Pequignot JM, et al. Food restriction, performance, biochemical, psychological, and endocrine changes in judo athletes. *Int J Sports Med.* 2006;27(1):9–18. doi: [10.1055/s-2005-837505](https://doi.org/10.1055/s-2005-837505). [PubMed: 16388436].
2. Franchini E, Brito CJ, Artioli GG. Weight loss in combat sports: physiological, psychological and performance effects. *J Int Soc Sports Nutr.* 2012;9(1):52. doi: [10.1186/1550-2783-9-52](https://doi.org/10.1186/1550-2783-9-52). [PubMed: 23237303]. [PubMed Central: PMC3607973].
3. Pettersson S, Ekstrom MP, Berg CM. Practices of weight regulation among elite athletes in combat sports: a matter of mental advantage? *J Athl Train.* 2013;48(1):99–108. doi: [10.4085/1062-6050-48.1.04](https://doi.org/10.4085/1062-6050-48.1.04). [PubMed: 23672331]. [PubMed Central: PMC3554040].
4. Blue S. Ongoing change in the rhythms of mixed martial arts practice. *Int J Sports Soc.* 2013;3(3):161–70. doi: [10.18848/2152-7857/CGP/v03i03/53911](https://doi.org/10.18848/2152-7857/CGP/v03i03/53911).
5. Blomqvist Mickelsson T. Modern unexplored martial arts - what can mixed martial arts and Brazilian Jiu-Jitsu do for youth development? *Eur J Sport Sci.* 2020;20(3):386–93. doi: [10.1080/17461391.2019.1629180](https://doi.org/10.1080/17461391.2019.1629180). [PubMed: 31167632].
6. Barley OR, Chapman DW, Abbiss CR. Weight loss strategies in combat sports and concerning habits in mixed martial arts. *Int J Sports Physiol Perform.* 2018;13(7):933–9. doi: [10.1123/ijsspp.2017-0715](https://doi.org/10.1123/ijsspp.2017-0715). [PubMed: 29283792].
7. Matthews JJ, 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.* 2017;27(2):122–9. doi: [10.1123/ijsnem.2016-0174](https://doi.org/10.1123/ijsnem.2016-0174). [PubMed: 27710145].
8. Santos-Junior RB, Utter AC, McAnulty SR, Bittencourt Bernardi BR, Buzzachera CF, Franchini E, et al. Weight loss behaviors in Brazilian mixed martial arts athletes. *Sport Sci Health.* 2019;16(1):117–22. doi: [10.1007/s11332-019-00581-x](https://doi.org/10.1007/s11332-019-00581-x).
9. Matthews JJ, Stanhope EN, Godwin MS, Holmes MEJ, 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.* 2019;29(4):441–52. doi: [10.1123/ijsnem.2018-0165](https://doi.org/10.1123/ijsnem.2018-0165). [PubMed: 30299200].
10. Crighton B, Close GL, Morton JP. Alarming weight cutting behaviours in mixed martial arts: a cause for concern and a call for action. *Br J Sports Med.* 2016;50(8):446–7. doi: [10.1136/bjsports-2015-094732](https://doi.org/10.1136/bjsports-2015-094732). [PubMed: 26459278].
11. Sundgot-Borgen J. Prevalence of eating disorders in elite female athletes. *Int J Sport Nutr.* 1993;3(1):29–40. doi: [10.1123/ijsn.3.1.29](https://doi.org/10.1123/ijsn.3.1.29). [PubMed: 8499936].

12. Torstveit MK, Rosenvinge JH, Sundgot-Borgen J. Prevalence of eating disorders and the predictive power of risk models in female elite athletes: a controlled study. *Scand J Med Sci Sports*. 2008;**18**(1):108–18. doi: [10.1111/j.1600-0838.2007.00657.x](https://doi.org/10.1111/j.1600-0838.2007.00657.x). [PubMed: [17490455](https://pubmed.ncbi.nlm.nih.gov/17490455/)].
13. Connor J, Shelley A, Egan B. Comparison of hot water immersion at 37.8 degrees C with or without salt for rapid weight loss in mixed martial arts athletes. *J Sports Sci*. 2020;**38**(6):607–11. doi: [10.1080/02640414.2020.1721231](https://doi.org/10.1080/02640414.2020.1721231). [PubMed: [31997718](https://pubmed.ncbi.nlm.nih.gov/31997718/)].
14. Jetton AM, Lawrence MM, Meucci M, Haines TL, Collier SR, Morris DM, et al. Dehydration and acute weight gain in mixed martial arts fighters before competition. *J Strength Cond Res*. 2013;**27**(5):1322–6. doi: [10.1519/JSC.0b013e31828a1e91](https://doi.org/10.1519/JSC.0b013e31828a1e91). [PubMed: [23439336](https://pubmed.ncbi.nlm.nih.gov/23439336/)].
15. Pettersson S, Berg CM. Hydration status in elite wrestlers, judokas, boxers, and taekwondo athletes on competition day. *Int J Sport Nutr Exerc Metab*. 2014;**24**(3):267–75. doi: [10.1123/ijnsnem.2013-0100](https://doi.org/10.1123/ijnsnem.2013-0100). [PubMed: [24280038](https://pubmed.ncbi.nlm.nih.gov/24280038/)].
16. Kempton MJ, Ettinger U, Schmechtig A, Winter EM, Smith L, McMorris T, et al. Effects of acute dehydration on brain morphology in healthy humans. *Hum Brain Mapp*. 2009;**30**(1):291–8. doi: [10.1002/hbm.20500](https://doi.org/10.1002/hbm.20500). [PubMed: [18064587](https://pubmed.ncbi.nlm.nih.gov/18064587/)]. [PubMed Central: [PMC6871128](https://pubmed.ncbi.nlm.nih.gov/PMC6871128/)].
17. Streitburger DP, Moller HE, Tittgemeyer M, Hund-Georgiadis M, Schroeter ML, Mueller K. Investigating structural brain changes of dehydration using voxel-based morphometry. *Plos One*. 2012;**7**(8):e44195. doi: [10.1371/journal.pone.0044195](https://doi.org/10.1371/journal.pone.0044195). [PubMed: [22952926](https://pubmed.ncbi.nlm.nih.gov/22952926/)]. [PubMed Central: [PMC3430653](https://pubmed.ncbi.nlm.nih.gov/PMC3430653/)].
18. Hutchison MG, Lawrence DW, Cusimano MD, Schweizer TA. Head trauma in mixed martial arts. *Am J Sports Med*. 2014;**42**(6):1352–8. doi: [10.1177/0363546514526151](https://doi.org/10.1177/0363546514526151). [PubMed: [24658345](https://pubmed.ncbi.nlm.nih.gov/24658345/)].
19. Filaire E, Maso F, Degoutte F, Jouanel P, Lac G. Food restriction, performance, psychological state and lipid values in judo athletes. *Int J Sports Med*. 2001;**22**(6):454–9. doi: [10.1055/s-2001-16244](https://doi.org/10.1055/s-2001-16244). [PubMed: [11531040](https://pubmed.ncbi.nlm.nih.gov/11531040/)].
20. Steen SN, Brownell KD. Patterns of weight loss and regain in wrestlers: has the tradition changed? *Med Sci Sports Exerc*. 1990;**22**(6):762–8. doi: [10.1249/00005768-199012000-00005](https://doi.org/10.1249/00005768-199012000-00005). [PubMed: [2287253](https://pubmed.ncbi.nlm.nih.gov/2287253/)].
21. Samadi M, Bagheri A, Pasdar Y, Hozoori M, Moradi S, Karimi S, et al. A review of high-risk rapid weight loss behaviors with assessment of food intake and anthropometric measurements in combat sport athletes. *Asian J Sports Med*. 2019;**In Press**(In Press). doi: [10.5812/asjasm.85697](https://doi.org/10.5812/asjasm.85697).
22. Currie A. Sport and eating disorders - understanding and managing the risks. *Asian J Sports Med*. 2010;**1**(2):63–8. doi: [10.5812/asjasm.34864](https://doi.org/10.5812/asjasm.34864). [PubMed: [22375193](https://pubmed.ncbi.nlm.nih.gov/22375193/)]. [PubMed Central: [PMC3289170](https://pubmed.ncbi.nlm.nih.gov/PMC3289170/)].
23. Giel KE, Hermann-Werner A, Mayer J, Diehl K, Schneider S, Thiel A, et al. Eating disorder pathology in elite adolescent athletes. *Int J Eat Disord*. 2016;**49**(6):553–62. doi: [10.1002/eat.22511](https://doi.org/10.1002/eat.22511). [PubMed: [26876906](https://pubmed.ncbi.nlm.nih.gov/26876906/)].
24. Kordi R, Nourian R, Rostami M, Wallace WA. Percentage of body fat and weight gain in participants in the tehran high school wrestling championship. *Asian J Sports Med*. 2012;**3**(2):119–25. doi: [10.5812/asjasm.34711](https://doi.org/10.5812/asjasm.34711). [PubMed: [22942998](https://pubmed.ncbi.nlm.nih.gov/22942998/)]. [PubMed Central: [PMC3426731](https://pubmed.ncbi.nlm.nih.gov/PMC3426731/)].
25. Alderman B, Landers DM, Carlson J, Scott JR. Factors related to rapid weight loss practices among international style wrestlers. *Med Sci Sports Exerc*. 2004;**36**(2):249–52. doi: [10.1249/01.MSS.0000113668.03443.66](https://doi.org/10.1249/01.MSS.0000113668.03443.66). [PubMed: [14767247](https://pubmed.ncbi.nlm.nih.gov/14767247/)].
26. Daniele G, Weinstein RN, Wallace PW, Palmieri V, Bianco M. Rapid weight gain in professional boxing and correlation with fight decisions: analysis from 71 title fights. *Phys Sportsmed*. 2016;**44**(4):349–54. doi: [10.1080/00913847.2016.1228421](https://doi.org/10.1080/00913847.2016.1228421). [PubMed: [27564844](https://pubmed.ncbi.nlm.nih.gov/27564844/)].
27. Reale R, Slater G, Burke LM. Acute-weight-loss strategies for combat sports and applications to olympic success. *Int J Sports Physiol Perform*. 2017;**12**(2):142–51. doi: [10.1123/ijpspp.2016-0211](https://doi.org/10.1123/ijpspp.2016-0211). [PubMed: [27347784](https://pubmed.ncbi.nlm.nih.gov/27347784/)].
28. Bagherpour T, Hashim HA, Saha S, Ghosh AK. Exploratory factor trait sports confidence inventory (TSCI) scale among adolescent taekwondo players. *Middle East J Sci Res*. 2012;**11**(1):106–12.
29. Kuan G, Roy J. Goal profiles, mental toughness and its influence on performance outcomes among Wushu athletes. *J Sport Sci Med*. 2007;**6**(CSSI-2):28.
30. Vealey RS. Mental skills training in sport. In: Tenenbaum G, Eklund R, editors. *Sport psychology*. 3th ed. 2012. p. 285–309. doi: [10.1002/9781118270011.ch13](https://doi.org/10.1002/9781118270011.ch13).
31. Papatthomas A, Petrie T. Editorial: Towards a more sophisticated approach to eating disorders in sport research. *Psychol Sport Exerc*. 2014;**15**(6):675–9. doi: [10.1016/j.psychsport.2014.06.006](https://doi.org/10.1016/j.psychsport.2014.06.006).
32. Amtmann JA. Self-reported training methods of mixed martial artists at a regional reality fighting event. *J Strength Cond Res*. 2004;**18**(1):194–6. doi: [10.1519/1533-4287\(2004\)018<0194:stmomm>2.0.co;2](https://doi.org/10.1519/1533-4287(2004)018<0194:stmomm>2.0.co;2). [PubMed: [14971990](https://pubmed.ncbi.nlm.nih.gov/14971990/)].
33. Bounty PL, Campbell BI, Galvan E, Cooke M, Antonio J. Strength and conditioning considerations for mixed martial arts. *Strength Cond J*. 2011;**33**(1):56–67. doi: [10.1519/SSC.0b013e3182044304](https://doi.org/10.1519/SSC.0b013e3182044304).
34. Williams JG, Maughan R, editor. *Nutrition in sport*. 201. 7th ed. Oxford: Blackwell Science; 1968. p. 324–9.
35. Burke L. Weight-making sports. *Practical sports nutrition*. Human kinetics; 2007. 289–312 p.
36. Welch E, Birgegard A, Parling T, Ghaderi A. Eating disorder examination questionnaire and clinical impairment assessment questionnaire: general population and clinical norms for young adult women in Sweden. *Behav Res Ther*. 2011;**49**(2):85–91. doi: [10.1016/j.brat.2010.10.010](https://doi.org/10.1016/j.brat.2010.10.010). [PubMed: [21185552](https://pubmed.ncbi.nlm.nih.gov/21185552/)].
37. Ro O, Reas DL, Stedal K. Eating disorder examination questionnaire (EDE-Q) in Norwegian adults: Discrimination between female controls and eating disorder patients. *Eur Eat Disord Rev*. 2015;**23**(5):408–12. doi: [10.1002/erv.2372](https://doi.org/10.1002/erv.2372). [PubMed: [26094887](https://pubmed.ncbi.nlm.nih.gov/26094887/)].
38. Vealey RS. Conceptualization of sport-confidence and competitive orientation: Preliminary investigation and instrument development. *J Sport Psychol*. 1986;**8**(3):221–46. doi: [10.1123/jsp.8.3.221](https://doi.org/10.1123/jsp.8.3.221).
39. Unwin A. Discovering statistics using R by Andy Field, Jeremy Miles, Zoë Field. *Int Stat Rev*. 2013;**81**(1):151–73. doi: [10.1111/insr.12011_21](https://doi.org/10.1111/insr.12011_21).
40. Croll J, Neumarkstainer D, Story M, Ireland M. Prevalence and risk and protective factors related to disordered eating behaviors among adolescents: relationship to gender and ethnicity. *J Adolesc Health*. 2002;**31**(2):166–75. doi: [10.1016/s1054-139x\(02\)00368-3](https://doi.org/10.1016/s1054-139x(02)00368-3).
41. Coswig VS, Miarka B, Pires DA, da Silva LM, Bartel C, 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;**1-8**. doi: [10.1123/ijnsnem.2018-0034](https://doi.org/10.1123/ijnsnem.2018-0034). [PubMed: [29757051](https://pubmed.ncbi.nlm.nih.gov/29757051/)].