

The Relationship between Weight Cutting and the Female Athlete Triad in Combat Sport Athletes

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ABSTRACT

Background: Females combat sport athletes are likely to partake in rapid weight reduction strategies prior to competitions. **Objective:** The purpose of this study was to investigate the relationship between weight cutting habits of female combat sport athletes and the risk of developing the female athlete triad. **Methods:** 102 female combat sport athletes (amateur=40; professional=62; 28.8±4.5y), competing in boxing (n=30), kickboxing (n=12), and mixed martial arts (n=60), completed two questionnaires. An adapted version of the Rapid Weight Loss Questionnaire (RWLQ) was used to determine the severity of athletes' weight cutting behaviors, and the Low Energy Availability in Females Questionnaire (LEAF-Q) was used to determine female athlete triad risk. Data was analyzed to determine correlations between LEAF-Q and RWLQ scores along with weight cutting behaviors. Scores were also compared between competition level and combat sports. **Results:** The results of this study showed that 38% of female combat sport athletes were at risk of developing the female athlete triad. Significant correlation between RWLQ and LEAF-Q scores ($p=0.013$; $r=0.244$, $r^2=0.060$) were noted. A significant difference ($p=0.006$) between the RWLQ scores of amateurs and professionals was also noted, with professionals engaging in more severe weight cutting behavior. Mixed martial artists reported the highest RWLQ and LEAF-Q scores, which were significantly greater than boxers. No other correlations between LEAF-Q and weight cutting behaviors were noted. **Conclusion:** Despite a small effect size ($r^2=0.060$), the findings of this study demonstrate that more severe weight cutting behaviors may increase the female athlete triad risk among female combat sport athletes.

Key words: Martial Arts, Boxing, Kickboxing, Female Athlete Triad Syndrome, Weight Loss

INTRODUCTION

Combat sports are a class of contact sports including, but not limited to, judo, boxing, kickboxing, and mixed-martial arts. To promote fair competition, weight classes exist in combat sports to ensure competition between athletes of a similar size (Barley et al., 2019). Athletes are required to weigh in anywhere from the day before a competition to an hour before, depending on the sport and level of competition. However, it is common practice for athletes to lose weight (referred to as weight cutting) in order to compete in a weight class lower than their natural weight (Artioli et al., 2010; Barley et al., 2018; Reale et al., 2017). The practice of weight cutting is very common in combat sports and even seen as necessary to achieve a competitive advantage (Pettersson et al., 2012). Combat sport athletes have reported achieving weight loss through a variety of methods including gradual dieting, skipping one or two meals, fasting, restricting fluids, increasing exercise, heated training rooms, saunas, training with rubber/plastic suits, spitting, laxatives, diuretics, diet pills, and vomiting (Artioli et al., 2010; Malliaropoulos et al., 2017;

Pettersson et al., 2012; Reed et al., 2015). Subsequently, athletes strive to rapidly regain the weight lost during the weight cut prior to the competition. This is seen as an advantage because by the time of competition, the athlete can gain back a substantial amount of the weight lost yielding a potential size advantage over his or her opponent (Pettersson et al., 2012). There have been several studies investigating the prevalence and potential repercussion of weight cutting in male combat sport athletes, however few have examined the implications of weight cutting on female combat sport athletes (Barley et al., 2019).

Similar to male combat athletes, females are likely to partake in rapid weight reduction strategies prior to competitions. Artioli et al. (2010) surveyed 822 adult judo competitors (607 males and 215 females) about their weight cutting habits and found that 85.8% of males and 85.9% of females participated in rapid weight loss prior to competition via methods including increased exercising, skipping meals, restricted fluid ingestion, and gradual dieting. Similarly, Malliaropoulos et al. (2017) surveyed 255 judo

competitors (189 males and 66 females) regarding their weight cutting practices and reported that 84.1% of male athletes and 84.8% of female athletes reported rapid weight loss practices. Notably, athletes in these studies reported cutting weight an average of five times per year, and no significant differences were found for rapid weight loss prevalence between the male and female athletes (Artioli et al., 2010; Malliaropoulos et al., 2017).

The low energy availability associated with weight cutting may be accompanied by disordered eating, menstrual dysfunction, and low bone mineral density (Mountjoy et al., 2018; Warrick et al., 2020). The combination of these risk factors, known as the female athlete triad, places athletes at higher risk for several dangerous health consequences (Mountjoy et al., 2018; Warrick et al., 2020). Prolonged or frequent episodes of the female athlete triad could be detrimental to the longevity of a combat sport athlete's career, negatively impact overall health, and increase the risk of bone stress fractures and infertility (Byrne & McLean, 2002; Kwiatkowska-Pamuła et al., 2017). Studying the relationship between the severity of weight cutting behaviors in female combat sport athletes and the risk of developing of the female athlete triad may have a positive impact on the athletes' health. A better understanding of this relationship may help minimize the potentially substantial health consequences of the female athlete triad in combat sport athletes. However, investigations have yet to document this relationship. Given the growing interest in combat sports among female athletes, the purpose of this study was to identify the prevalence of weight cutting and rapid weight loss behaviors among female combat sport athletes and to investigate if weight cutting habits of female combat sport athletes are associated with an increased risk of developing the female athlete triad. We hypothesized that combat sport athletes who have engaged in more severe weight cutting habits are at a greater risk of developing symptoms of the female athlete triad.

METHODS

Study Design

To explore the relationship between weight cutting and the female athlete triad, female combat sport athletes were asked to participate in a non-experimental survey study. Participants completed two questionnaires: an adapted version of The Rapid Weight Loss Questionnaire (RWLQ) and the Low Energy Availability in Females Questionnaire (LEAF-Q). The RWLQ was used to determine the severity of an athlete's weight cutting behavior and the LEAF-Q was used to determine whether or not an athlete was at risk of developing the female athlete triad. Data from both questionnaires were analyzed to explore the associations between weight cutting behavior and the risk of developing the female athlete triad. Independent variables were derived from data collected with the RWLQ and included the competition level (professional or amateur) of the athlete and the type of combat sport (boxing, kickboxing, or mixed martial arts) the athlete participates in. Dependent variables used during analysis were the LEAF-Q scores and the total RWLQ scores.

Participants

Female combat sport athletes (n=102) volunteered to complete this survey study. Participants included both professional (n=62; 29.4 ± 4.4y) and amateur (n=40; 27.9 ± 4.6y) athletes. The athletes included boxers (n=30; 29.3 ± 5.0y), kickboxers (N=12; 29.7 ± 4.0y), and mixed martial artists (n=60; 28.3 ± 4.4y). Inclusion criteria included cutting weight at least once and competing a minimum of two times in 2018 and two times in 2019. Athletes also had to be between the age of 18 to 39 years. Prior to completing the surveys, all participants agreed to an informed consent outlining the procedures, risks, and benefits present in this study. The research protocol was approved by the Hofstra University Institutional Review Board prior to participant recruitment. A post hoc power analysis was calculated for the total LEAF-Q and RWLQ scores for each one-way analysis of variance (ANOVA). For the LEAF-Q score, at the $\alpha=0.05$ significance level, a sample size of 102 female athletes detected a moderate effect size of $\eta_p^2=0.074$ and produced an actual power of 0.69. For the RWLQ score, a large effect size was detected $\eta_p^2=0.114$, producing an actual power of 0.89.

Procedures

Participants completed a survey consisting of two separate questionnaires: an adapted version of the RWLQ and the LEAF-Q. Artioli et al. (2010) created the RWLQ to evaluate weight loss patterns in competitive judo players. The adapted version of the RWLQ included adjustments to the questions to address combat sport athletes, rather than just judokas, without changing the content or meaning behind the questions. The RWLQ contained nine questions regarding personal history and nine questions regarding weight history and diet patterns. There were also eight Likert scale questions regarding the influence of other people on the weight patterns of the athletes and 14 Likert scale questions regarding specific weight cutting methods. Scores were summed to determine the level of harm and aggressiveness of the athlete's rapid weight loss patterns (Artioli et al., 2010). Content validity, convergent validity ($r=0.62$), and reliability ($r=0.98$) have been previously assessed, and it was determined that the questionnaire is both valid and reliable (Artioli et al., 2010). The LEAF-Q was created by Melin et al. (2014) as a screening tool to identify athletes at risk of the Female Athlete Triad. The LEAF-Q contains questions regarding personal history, weight/exercise history, and health. Each question was given a weighted value. The total value was used to determine if these athletes were at risk for developing the female athlete triad. A score of eight or higher indicates that an athlete is at risk. Test-retest reliability, discriminant validity, concurrent validity, and internal consistency reliability have been previously assessed, and it was determined that the questionnaire is both valid and reliable (Melin et al., 2014).

Statistical Analysis

Frequencies and descriptive information were determined to gain insight on specific demographic characteristics and

weight cutting characteristics of the sample of athletes who participated in the study. A Pearson’s correlation test was used to measure the correlation between the athletes’ LEAF-Q score and measures including: RWLQ, average amount of weight an athlete cut, most weight an athlete ever cut in their career, and age at which athletes began cutting weight an athlete began cutting. An independent t-test was used to determine if there was a significant difference in RWLQ and LEAF-Q scores for professionals and amateurs. A one-way ANOVA was used to determine if there was a significant difference in LEAF-Q scores for boxers, kickboxers, and mixed martial artists. A second one-way ANOVA was used to determine if there was a significant difference in RWLQ scores for boxers, kickboxers, and mixed martial artists. A Tukey post hoc tests were run for both ANOVAs. The frequency of athletes at risk for the female athlete triad was also determined. Frequencies were used to observe differences between professionals and amateurs as well as differences between boxers, kickboxers, and mixed martial artists. Data was analyzed using SPSS (Build 1.0.0.1347 64-bit edition). All data are presented as mean ± standard deviation, and significance was accepted at an alpha level of $p \leq 0.05$

RESULTS

Participant Characteristics

Participants were 28.8 ± 4.5 years old at the time of completing the survey. Participants, on average, began training in their sport at an age of 19.8 ± 6.0 years, with a range of 4 to 31 years. Participants, on average, began competing at an age of 21.7 ± 5.5 years, with a range from 4 to 34 years. The average win percentage was 74% in 2018 and 70% in 2019. 50% of participants changed their weight class in the past two years. The participants had an average “walk-around” weight of approximately 9.5% higher than their fight weight

(63.0 ± 7.2 vs. 57.5 ± 6.9 kg). The largest weight cut participants ever had before competition ranged from 1 to 18.2 kg (7.1 ± 3.5 kg). On average, participants cut 4.4 ± 2.6 kg approximately three times a year and typically regained 4.2 ± 2.5 kg within the week following competition. The mean age in which athletes began cutting weight was 22.9 ± 5.1 years. Participant characteristics for each combat sport (boxers, kickboxers, and mixed martial artists) are depicted in Table 1.

Weight Cutting Habits

The results showed that coaches had the biggest influence on the fighters’ weight cutting habits. Following coaches, in order from the most influential to the least influential were other fighters, physical trainers, dietician/nutritionists, parents, and physician/doctors. Weight cutting methods are shown in Figure 1. A majority of athletes in this study had participated in dehydration weight cutting methods such as restricting fluid (94%), sweating in the sauna (90%), training with rubber/plastic suits (86%), skipping 1 or 2 meals (71%), fasting (69%), spitting (52%), laxatives (49%), diuretics (40%), wearing winter/plastic suits all day (30%), using diet pills (20%), and vomiting (20%).

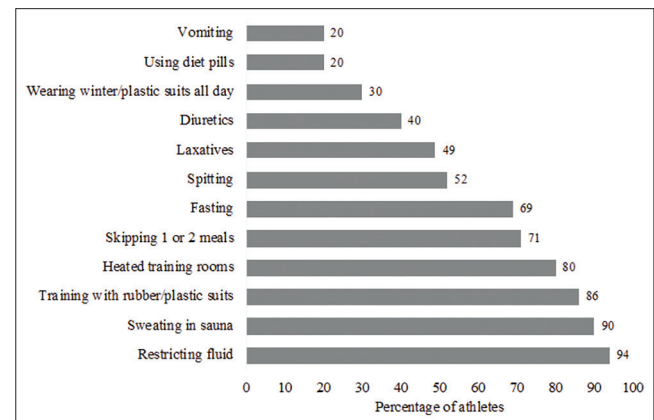


Figure 1. Percentage of athletes using weight cutting techniques.

Table 1. Participant characteristics

	Boxers	Kickboxers	MMA
n	30	12	60
Age (y)	29.3±5.0	29.8±4.0	28.4±4.4
Age began practicing sport (y)	21.4±5.8	17.0±7.3	19.6±5.4
Age began competing (y)	22.5±5.6	18.5±7.1	22.0±5.0
Current weight (kg)	62.9±7.0	61.2±6.0	62.4±7.9
Height (m)	1.66±0.08	1.67±0.05	1.64±0.08
Typical weight between fights (kg)	63.4±7.3	60.4±5.1	63.4±7.5
Largest weight cut (kg)	5.6±3.1	6.6±2.1	8.0±3.7
Number of weight cuts in 2019	4.1±3.8	3.8±2.6	2.8±1.5
Typical weight cut (kg)	2.8±1.5	3.9±2.6	5.3±2.7
Weight cut length (days)	16.3±15.4	19.0±19.1	14.7±17.3
Age began cutting (y)	24.4±6.1	21.0±4.5	22.6±4.6
Typical weight gained 1-week following competition (kg)	2.7±1.2	3.3±2.2	5.1±2.6
LEAF-Q Score	5.2±3.7	8.1±4.5	7.7±4.4*
RWLQ Score	31.2±10.6	33.7±12.1	39.7±11.0*

MMA = Mixed martial arts *Significantly greater than boxers

ber/plastic suits (86%), using heated training rooms (80%), and spitting (52%). A majority of the athletes in the study also had participated in food restriction techniques such as skipping one or two meals (71%) and fasting (69%). Several athletes also participated in extreme weight cutting behaviors such as using laxatives (49%), using diuretics (40%), wearing winter/plastic suits all day long (30%), using diet pills (20%), and vomiting (20%).

RWLQ and LEAF-Q Scores

There was a significant correlation between RWLQ scores and LEAF-Q scores ($p=0.013$; $r=0.244$; $r^2=0.06$). An independent t-test showed there was a significant difference ($p=0.006$) between the RWLQ scores of amateurs and professionals, with professionals engaging in more severe weight cutting behavior. No significant difference ($p=0.31$) was observed for LEAF-Q scores between amateurs and professionals. A one-way ANOVA showed a significant difference ($p=0.023$) in the LEAF-Q scores of boxers, kickboxers, and mixed martial artists, with a post-hoc test showing that mixed martial artists had significantly greater ($p=0.025$) LEAF-Q scores (7.7 ± 4.4) than boxers (5.2 ± 3.7). A one-way ANOVA also showed a significant difference ($p=0.002$) in the RWLQ scores of boxers, kickboxers, and mixed martial artists. Similarly, a post-hoc test showed that mixed martial artists had significantly greater ($p=0.002$) RWLQ scores (39.7 ± 11.0) than boxers (31.2 ± 10.6).

Weight Cutting and the Female Athlete Triad

The results of this study showed that 38% of the female combat sport athletes were at risk of developing the triad based upon LEAF-Q scores. There was no significant difference between the number of professionals (41%) and amateurs (32.5%) at risk for developing the triad. There was also no significant difference in the number of mixed martial artists (47%), boxers (20%), and kickboxers (41%) at risk for developing the female athlete triad. Pearson correlation tests showed no significant correlations between an athlete's LEAF-Q score and average weight cut ($p=0.27$), the most weight an athlete ever cut ($p=0.14$), or the age an athlete began weight cutting ($p=0.84$).

DISCUSSION

The purpose of the present study was to examine the relationship between weight cutting habits and the risk of developing the female athlete triad among female combat sport athletes. Collectively, 31% of the female athletes in this study were considered at risk of developing the female athlete triad. The results of this study supported the hypothesis and showed that there was a significant correlation between RWLQ scores and LEAF-Q scores. Namely, athletes with more severe weight cutting habits appear to be at elevated risk of developing symptoms of the female athlete triad. Compared to amateurs, professional athletes had greater RWLQ scores indicating that professionals engaged in more severe weight cutting behaviors. Between the different

combat sports, mixed martial artists reported the highest RWLQ and LEAF-Q scores, which were significantly greater than boxers.

Weight cutting in combat sports is very prominent and has shown to be potentially harmful to the athletes engaging in it (Barley et al., 2019). Rapid weight loss cycles have been associated with several issues including hormonal imbalances, bone loss, heightened mental stress, and suppressed immune function, along with an increased risk of developing type 2 diabetes mellitus and cardiovascular disease (Artioli et al., 2016; Barley et al., 2019; Montani et al., 2015). Regular weight cutting promotes a syndrome known as relative energy deficiency in sport (RED-S) which has been associated with elevated risk factors for the female athlete triad (i.e., menstrual function and bone health), along with other impairments of physiological functioning including metabolic rate, immunity, protein synthesis, and cardiovascular health (Mountjoy et al., 2018). While female combat sport athletes are likely to engage in more severe disordered eating practices than the average female athlete, few studies have included female participants when investigating combat sport athletes. For example, Kwiatkowska-Pamula et al. (2017) reported that a majority (93%) of female judokas engage in excessive body mass reduction consuming between 40-60% of their dietary needs. In the current study, our results demonstrate that more severe weight cutting behaviors may increase the female athlete triad risk among female combat sport athletes. These findings are in line with investigations in other female athletic populations. For example, female rowers who engaged in rapid weight loss cycles were found to have decreased progesterone secretion accompanied by a lengthening of the menstrual cycle (Morris et al., 1999). Additionally, male and female judoist who engaged in rapid weight loss were found to have an acute net increase in bone resorption (Prouteau et al., 2006). However, these concerns returned to normal in the off season with refeeding (Morris et al., 1999; Prouteau et al., 2006). Low energy availability has also been shown to be associated with the risk of developing amenorrhea (Reed et al., 2015) and lower estrogen levels (Nattiv et al., 2007) in exercising women, which elevates the risk of osteoporosis (Dimitriou et al., 2014). Estrogen deficiency and low energy availability have been associated with poor bone health in female athletes, with the combination of risk factors offering the most deleterious outcomes (Melin et al., 2015; Southmayd et al., 2017).

Research has shown that athletes have a limited understanding of the female athlete triad and professionals often lack a standard comprehensive screening approach (Warrick et al., 2020). In the current study, the athletes' weight cutting habits (depicted in Figure 1) were influenced by several individuals (coaches, other fighters, physical trainers, dietician/nutritionists, parents, and physician/doctors). These findings are similar to a previous report on rapid weight loss methods and sources of information among male and female combat athletes (Kurt & Sagiroglu, 2015). These findings could hopefully aid in the implementation of intervention programs to support the health of female athletes in combat sports. Early identification of female athlete triad symptoms

is important in protecting athletes from long-term damage due to the progression of the risk factors associated with the female athlete triad (De Souza et al., 2014). It would be beneficial to educate female combat sport athletes and the professionals involved in their careers on the dangers of the female athlete triad. Regular screening for potential risk factors associated with the female athlete triad could also prevent these athletes from developing a career-ending condition. Accurate diagnosis of the female athlete triad can be determined by a multidisciplinary health team including professionals such as a physician, sports dietician, mental health professional, exercise physiologist, and/or athletic trainer (De Souza et al., 2014).

There are several limitations to acknowledge in this study. First, it is assumed that the participants answered the survey questions honestly. If the athletes answered in a more socially desirable way, this could have resulted in participant bias. Another limitation involves the relatively small sample of participants. It may be difficult to determine the norm in such a sample, making it unclear whether or not the data can accurately depict the population. These athletes may have also chosen to participate in the study because of their past severe weight cutting behaviors, which makes it possible that information was gathered from a sample of athletes that knowingly engaged in more severe weight cutting behaviors than the average. Finally, markers of bone health (e.g., bone mineral density), dietary intake, and body composition were not directly assessed in this study. It is unknown if the participants reached a threshold of low energy availability to disturb menstrual dysfunction (Lieberman et al., 2018). Future research should strive to collect direct data on dietary habits, bone health, and menstrual dysfunction in female combat sport athletes.

CONCLUSION

The female athlete triad can lead to many health risks, physical performance declines, and psychological issues, making it important to identify athletes who are at risk of developing this condition. The objective of this study was to gain an understanding of the severity of the issues of both weight cutting and the female athlete triad among female combat sport athletes. This survey study sought to provide an understanding of the prevalence, magnitude, and methods of weight cutting among female combat sport athletes. Our findings showed that athletes with more severe weight cutting habits appear to be at elevated risk of developing symptoms of the female athlete triad.

Coaches, athletes, parents, dieticians, and physicians should all be aware of the dangers of the female athlete triad, as well as the warning signs. Early detection in female athletes is crucial to decrease the risk of developing the triad and decrease the severity of potential symptoms associated with the triad (De Souza et al., 2014). As a result of the high prevalence of weight cutting and elevated risk for developing symptoms of the female athlete triad, it is recommended that female combat sport athletes be screened for this condition as a part of a pre-participation evaluation.

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