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Weight loss strategies in combat sports and concerning habits in mixed martial arts

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Title: Weight Loss Strategies in Combat Sports and Concerning Habits in Mixed Martial Arts

Original Investigation

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**ABSTRACT**

**Purpose:** Combat sports are typically divided into weight classes and body mass manipulation to reach a weight class is commonplace. Previous research suggests that mixed martial arts (MMA) weight loss practices may be more extreme than other combat sports. We sought to investigate the magnitude of weight lost and prevalence of weight loss strategies in different combat sports. **Methods:** Competitors (n=637) from Brazilian jiu jitsu (BJJ), boxing, judo, MMA, muay Thai/kickboxing (MT/K), taekwondo (TKD) and wrestling completed an online questionnaire seeking information regarding their weight loss practices. **Results:** Body mass manipulation was commonly undertaken by all combat sports athletes, with a particularly high incidence of gradual dieting, increased exercise and fluid restriction. Skipping meals was higher in TKD and wrestling (84%) compared with the other combat sports (~58%), whilst training in heated rooms and forced oral fluid loss (spitting) was higher in wrestling (83% and 47%, respectively) compared with other combat sports (~45% and ~19%, respectively). MMA athletes reported the highest usage of sauna (76%) and water loading (67%) whilst also reporting the second highest use of training in rubber/plastic suits (63%). **Conclusions:** Body mass manipulation was present in all combat sports with the prevalence and magnitude of acute weight loss greater in MMA. The incidence of and practices reported will assist support staff to be fully aware of the variety of methods these athletes and coaches may use to achieve weight loss. Additionally, the results could aid regulatory bodies in the further development of policies on weight cutting.

**Keywords:** Weight cutting, Dehydration, Rehydration, Recovery, Diet
INTRODUCTION

Typically combat sports are divided into weight divisions in an effort to standardise competitors size and strength. Athletes are weighed prior to competition, with the time between weigh-in and competition varying (from less than 1 h up to 24 h).\textsuperscript{1,2} To gain a weight advantage over opponents, athletes will often aim to lose substantial weight over the days and weeks leading up to weigh-in, which is colloquially termed “weight cutting”. Following this, athletes aim to rapidly regain some of this weight and arrive at the competition heavier than their allocated weight class. This practice has been observed in many combat sports such as mixed martial arts (MMA), boxing, taekwondo (TKD), karate, wrestling, judo and kickboxing.\textsuperscript{3-7}

There are a large range of methods employed by combat sports athletes to lose weight, though the most common methods are body fluid manipulation and food (calorie) restriction.\textsuperscript{4,8,9} Whilst there is data on the methods and magnitude of weight loss for more traditional combat sports such as boxing, taekwondo, wrestling and judo there is a paucity of comprehensive data for other combat sports including MMA and Muay Thai/kickboxing (MT/K).\textsuperscript{4,6-10} Generally, these sports have a longer period between weigh-in and competition and a greater number of professional divisions, compared with more traditional combat sports. Research indicates that the magnitude of weight loss in MMA may be greater than traditional combat sports.\textsuperscript{6,11} Additionally, there is evidence to suggest that a method of weight loss called “water loading”, where athletes consume large volumes of fluid for several days before beginning severe fluid restriction with the aim of inducing hormonal responses to aid in weight loss is prevalent in combat sports.\textsuperscript{5,9} However, the prevalence of water loading in MMA and MT/K is unclear.

Developing a greater understanding of the various weight loss strategies used in combat sports and their prevalence is important as some strategies have been reported to negatively influence exercise performance \textsuperscript{12-15} and provides a potential risk to competitor’s health.\textsuperscript{6,16,17} Therefore, the present study sought to investigate the reported magnitude and strategies of weight loss and regain during competition preparation across different combat sports and sources of influence regarding these practices. The insights gained will have importance to support staff working with athletes in these sports by providing clear evidence for which practices may be being undertaken to achieve substantial weight loss.
METHODS

Overview

Combat sports athletes who had competed within the previous 12 months were recruited to complete an online survey investigating weight loss practices. Athletes were recruited from combat sports gyms, combat sport commissions, regulatory bodies and online forums from around the world. The study was approved by the Human Research Ethics Committee of the host institution in Australia and participants provided informed consent via electronic signature after reading an explanation of the study. A total of 1051 combat sports athletes were initially recruited, participants who did not complete the entire survey (n=353), gave answers in the wrong unit of measurement and did not provide sufficient information to allow for conversion (n=21), competed in divisions with no weight limit (n=6), were not competitively active (n=14) or competing in a combat sport in which there was not enough participants to give the group sufficient statistical power (<30) were excluded from final analysis (n=20). Resulting in a total of 637 combat sports athlete’s responses being included in the final analysis. Of these athletes 25% competed in Brazilian Jiu Jitsu (BJJ), 6% in boxing, 12% in Judo, 11% in Mixed Martial Arts (MMA), 12% Muay Thai/Kickboxing (MT/K), 6% Taekwondo (TKD) and 27% in wrestling.

Procedures

A previous survey developed and validated in judo by Artioli, Scagliusi, Kashiwagura, Franchini, Gualano, Junior 18 was modified and provided to the participants in a manner similar to previous studies investigating weight loss in multiple combat sports.8-10 The survey was modified by replacing the references to judo with generalised language referring to combat sports overall and the levels of competition were changed to reflect the different types of combat sports. Questions referring to weight loss directly before a weigh-in and weight regained before a competition were added to the survey. The survey contained 34 questions including personal de-identifying characteristics (age, time competing etc.), competitive level, weight, dietary history and weight loss behaviours (Table 1). The survey was conducted using online questionnaire software (Qualtrics, Qualtrics, USA).

Data analysis

Descriptive statistics (i.e. mean, SD and frequency) were used to display athlete responses to questions. Based on the sample size, data was not assessed for normality prior to analysis. This decision was based on previous research analysing the robustness of analysis of variance (ANOVA) when non-normally distributed data is used, indicating that provided the
sample is greater than 25, even in regards to the use of Likert scales assessment for normality is not required. One-way independent ANOVA testing was used to examine differences in weight loss and weight loss methods between combat sports prior to competition. The decision to use parametric testing on Likert-type measurements was based on previous research. When significant interactions were observed the Tukey-Kramer post-hoc test was conducted to determine where differences occurred, with this test chosen due to the uneven sample sizes. Differences in frequencies (i.e competitive level, gender and percentage of participants who have lost weight to compete) were assessed using the Chi-square test followed by the Bonferroni post-hoc correction. Statistical significance was accepted at $P<0.05$, with all statistical analyses performed using SPSS version 24 (SPAA Inc., Chicago IL, USA).
RESULTS

Stature differed significantly ($P<0.001$) between sports and a greater percentage of females competed in TKD than in other combat sports (Table 1). There were significant ($P<0.001$) differences in the average age of athletes between sports with boxing, judo, MMA and MT/K being of similar ages. However, wrestlers were significantly younger than boxing ($P=0.041$), judo ($P<0.001$), MMA ($P<0.001$) and MT/K athletes ($P<0.001$), whilst TKD was significantly younger than judo ($P=0.012$). The BJJ athletes were significantly older than wrestlers ($P<0.001$) TKD ($P<0.001$) and boxers ($P=0.008$) (Table 1). Other significant differences between sports were reported for the age at which athletes began competing ($P<0.001$), the frequency at which they competed ($P<0.001$), and rate of championship competition ($P<0.001$) (Table 1). Interestingly the country of origin most commonly reported by the recruited athletes was the United States of America (USA), Australia (AU) or the United Kingdom (UK).

The frequency of competition at regional/state and amateur level was similar between combat sports (Table 2). Exposure to national/international competition differed significantly ($P<0.001$) between sports with judo competing at this level more often than BJJ ($P=0.002$), boxing ($P=0.042$), MT/K ($P=0.002$) and wrestling ($P=0.002$), whilst the rate was higher in TKD than BJJ, boxing, MMA, MT/K and wrestling (for all comparisons, $P=0.002$) (Table 2). Amateur level competition differed significantly ($P=0.002$) between sports with more MMA athletes competing at the amateur level than BJJ and wrestling ($P=0.02$ and $P=0.002$, respectively). Additionally, more MT/K athletes reported competing at the amateur level than BJJ, judo and wrestling (for all comparisons, $P=0.002$). A smaller percentage of athletes reported competing at the semi-professional level. However, TKD athletes reported a greater percentage than BJJ and wrestling athletes (for both comparisons, $P=0.002$), whilst MMA and MT/K reported a higher percentage than BJJ (for both comparisons, $P=0.02$) and wrestling (for both comparisons, $P=0.02$). Under half of all athletes had competitive experience at the professional level, though higher rates of professional competition were reported in MMA compared with BJJ, boxing, judo, MT/K and wrestling (for all comparisons, $P=0.002$), whilst TKD reported a greater rate than BJJ ($P=0.02$) and wrestling ($P=0.002$) (Table 2).

The weight of athletes without an upcoming competition differed significantly ($P<0.001$) between sports (Table 3). The weight...
class in which respondents reported competing in varied significantly ($P<0.001$) between combat sports (Table 3). The majority ($\geq 85\%$) of all groups reported using a weight loss strategy prior to competition. Athletes reported beginning this weight reduction 14 to 28 days prior to weigh-in, except wrestling which reported a significantly shorter time period of 7 days when compared with BJJ ($P=0.001$), boxing ($P=0.001$), MMA ($P<0.001$), MT/K ($P=0.002$) and TKD ($P<0.001$) (Table 3). A significant interaction ($P<0.001$) was observed between sports for the most amount of weight athletes reported ever losing for a competition (~9.5% of body mass), with MMA reporting a significantly greater reduction (>12% body mass) compared with BJJ, MT/K, TKD and wrestling ($P<0.001$, $P=0.002$, $P=0.012$ and $P=0.001$, respectively) (Table 3). Likewise, typical weight lost for a competition was similar across the combat sports (~6% of body mass), except MMA which reported a significantly greater weight loss of approx. 11.5% body mass ($P<0.001$ when compared with BJJ, boxing, Judo, MT/K, TKD, wrestling). Compared with the other combat sports MMA reported losing a greater portion of weight within 14 days (~6.5% of body mass) of weigh-in compared with BJJ ($P<0.001$), judo ($P<0.001$) and MT/K ($P<0.001$). Additionally, MMA reported losing a greater portion of weight within 24 h of weigh-in (~4% of body mass, respectively) compared with all other combat sports ($P<0.001$), whilst wrestling reported a greater amount compared with BJJ ($P<0.001$) (Table 3). In most combat sports, it was reported that the majority of weight lost in the 24 h before weigh-in was recovered prior to competition and the majority of weight lost was typically regained 7 days following weigh-in (Table 3). The period of time between weigh-in and competition differed significantly ($P<0.001$) between combat sports with MMA, MT/K and TKD all reporting a longer time period when compared with BJJ ($P<0.001$ all comparisons), boxing ($P<0.001$, $P=0.004$ and $P<0.001$, respectively), judo ($P<0.001$, $P=0.041$ and $P=0.004$, respectively) and wrestling ($P<0.001$ all comparisons) (Table 3).

When examining how athletes ranked the influence of others on their weight loss, training partners, coaches and opponents were commonly ranked in the top 3 influences across all combat sports (Table 4). However, as an exception boxing, MMA and MT/K typically ranked the matchmaker higher in influence whilst parents were ranked higher in TKD and wrestling compared with MT/K and MMA (Table 4).

Gradual dieting, restricting fluid ingestion and increased exercise were among the most common methods of weight loss...
in all the combat sports (Table 5). Gradual dieting was less prevalent in wrestling than BJJ and MMA (for both comparisons $P<0.001$), whilst the rate was higher in MMA than judo ($P=0.016$). Restricting fluid intake was less prevalent in BJJ than wrestling ($P=0.001$). Skipping meals was more prevalent in TKD than BJJ ($P=0.018$), boxing ($P=0.001$) and MT/K ($P=0.005$), whilst wrestling had a higher prevalence than BJJ ($P<0.001$), boxing ($P<0.001$), MMA ($P=0.003$) and MT/K ($P<0.001$). Sauna use was prevalent in MMA athletes with over 75% of athletes reporting its use, which was significantly greater than BJJ ($P<0.001$) and judo ($P=0.04$). Additionally, wrestling reported a higher use of the sauna than BJJ ($P=0.024$). The use of plastic/rubber suits was significantly higher in MMA than BJJ ($P<0.001$), judo ($P<0.001$) and TKD ($P=0.014$), whilst wrestling was greater than BJJ ($P=0.001$) and MMA ($P=0.024$). Water loading was significantly more prevalent in MMA than BJJ ($P=0.046$), judo ($P=0.031$) and wrestling ($P<0.001$) (Table 5). Forced oral fluid loss or “spitting” was of low prevalence ($\leq 30\%$) in all combat sports except wrestling which reported a greater prevalence than BJJ ($P<0.001$), boxing ($P=0.001$), judo ($P<0.001$), MMA ($P=0.045$) and MT/K ($P<0.001$) (Table 5). The use of laxatives, diuretics, diet pills and vomiting were of low prevalence in all combat sports and no significant main effects were observed (Table 5).

*Insert table 5 about here*
The present study sought to investigate the strategies used for and the magnitude of weight loss prior to competition across different combat sports. The main observations were that: i) manipulation of body mass for competitions was reported in all combat sports, ii) whilst all combat sports engaged in weight loss prior to competition, MMA athletes lost a significantly greater magnitude of weight overall, within two weeks and 24 h of weigh-in, iii) increased exercise and fluid manipulation were the most common methods of weight loss in combat sports, particularly MMA. This work substantially increases the understanding and prevalence of the various weight loss strategies used by combat sports athletes and particularly the novel aspects as they pertain to MMA.

Athletes from all sports except TKD were predominantly males under the age of 30 y who had competed at a state and/or international level which is similar to previous studies of combat sports athletes. Over 85% of athletes in each combat sport examined, reported manipulating their body mass to make weight for competition. The magnitude of reported weight loss for a competition ranged from 4-12% of body mass overall, which included, 3.5-7% of body mass within two weeks of weigh-in and 1.5-4% of body mass within 24 h of weigh-in. Interestingly, the amount of body mass loss reported as real-world practice suggests that communication of well controlled scientific research is not impacting on the applied practice. As well controlled studies of acute loss of body mass (<5% body mass) in combat athletes have observed detrimental effects on performance in aerobic, anaerobic and strength-power tasks, or at least no increase in competitive success. We also provide further evidence that weight loss practices in MMA may be more extreme than other combat sports with MMA reporting significantly greater weight loss than other combat sports within two weeks and 24 h of weighing-in (Table 3). The greater magnitude of weight loss in MMA may be explained by the longer period allowed between weigh-in and competition which may encourage the athletes to attempt to lose more weight. However, MMA also lost greater weight prior to competition when compared with MT/K or TKD, despite no differences in time between the weigh-in and competition, which would contradict this explanation (Table 3). Alternatively, the larger magnitude of weight loss in MMA could be related to more athletes reporting to compete at the professional level however, this is not entirely supported by the data as a similar percentage of TKD athletes also reported competing at the professional level and the magnitude of weight loss in TKD was similar to other combat sports assessed (Table 2 and 3). Interestingly, most athletes reported that the weight lost within 24 h of competition was typically regained prior to competition.
These findings conflict with previous research indicating that even when provided with 24 h of ad libitum fluid/food intake athletes may not be adequately rehydrating.\textsuperscript{2,12} Clearly, further research is needed to assess the recovery strategies and their efficacy in combat sports following weigh-ins.

In the present study, a wide range of weight loss techniques were reported and several differences were observed between combat sports. Gradual dieting, restricting fluid ingestion and increased exercise were commonplace in all combat sports examined (Table 5). These results support previous research investigating weight loss in combat sports such as wrestling, boxing, judo, taekwondo and jujitsu.\textsuperscript{4,7-9,26} Skipping meals was especially high in TKD and wrestling (84\%) while training in heated rooms and spitting was higher in wrestling alone (Table 5). The high prevalence of skipping meals and spitting in wrestling could be due to the increased frequency of competitions (Table 1). Indeed, skipping meals would provide short term reductions in body weight due to the reduced weight of food within the gastrointestinal tract, as well as longer-term weight loss due to the likelihood of calorie restriction if used frequently. The high prevalence of spitting and fluid restriction may also be used in combat sports with regular competition in order to induce dehydration without the physiological strain possibly caused by thermal stress and/or increased exercise.\textsuperscript{27} The prevalence of water loading was over 60\% in MMA, MT/K and boxing, which is higher than previously reported (~20\%) in Australian boxers.\textsuperscript{9} MMA athletes also reported higher usage of thermal stress weight loss techniques (sauna and training in rubber/plastic suits) compared with other combat sports (Table 5). The high use of these weight loss methods, along with the greater magnitude of reported weight loss in MMA athletes highlights a concerning weight loss culture in MMA. Across all combat sports individuals with the most influence on weight loss habits were a training partner, coach or their opponent, indicating that weight loss culture differences between sports are not the result of sport specific individuals having a greater influence on the athlete (Table 4). These results indicate the individuals and groups most important to target for education on the positive and negative effects of various weight loss practices. However, it is also important to note that since competitive level, stature, body mass and gender distribution differ across each of the groups in the present study, caution should be taken when directly comparing combat sports. Instead, the results of the present study provide a descriptive analysis which improves our understanding of the reported weight loss practices currently used within combat sports and individuals perceived to influence such strategies.

Research has indicated that some of the aggressive weight loss habits observed in this study may negatively influence exercise performance over shorter recover periods (~3 h) and even up to
However, the effects of such weight loss on both short-term and long-term health requires further research. It is possible that the high magnitudes of weight loss could result in a number of health complications including cardiovascular problems and increased insulin sensitivity, alongside an increased risk of brain damage during competition. As such, there have been calls to ban the practice of weight cutting however, this is not likely to occur and the effectiveness of such a ban would be questionable. Furthermore, while it is plausible that the aggressive weight loss magnitude and strategies observed in this study may cause risk to the athletes and impair performance there is a paucity of systematic supporting evidence. Clearly further research is needed in this area. Regardless, the results of this study are important as they allow for a greater understanding of the reported weight loss practices currently used within combat sports and individuals perceived to influence such strategies. Such information will aid in better informing strategies aimed at maximising athlete safety and performance, as well as, informing research methodology aimed at examining the effects of such weight loss on performance and health.
Practical applications

The present study provides comprehensive data on the weight loss strategies employed in different combat sports. Whilst this relies on self-reported data, a sufficiently large total athlete sample was recruited and a highly validated combat sports survey was used in an attempt to mitigate this confounder. A wide range of weight loss methods were used throughout the combat sports assessed but the especially high magnitude of weight lost and the high prevalence of methods such as water loading, using a sauna and using rubber/plastic suits in MMA outlines a concerning weight loss culture in MMA. Understanding the strategies in different combat sports will allow more accurate best practice guidelines to be developed for each combat sport and improve regulations which attempt to reduce the negative influences of weight cutting. Alongside providing useful information for regulatory bodies the information in this study is also useful for coaches and competitors to better understand their practices in the context of other competitors and other combat sports.
Conclusions

Manipulating body mass to be within a prescribed limit is commonplace in most combat sports, ranging from striking to grappling or mixed style sports. Athletes will commonly use several strategies that serve as a risk to their personal wellbeing and a potential catalyst for impaired performance. Whilst similarities exist between combat sports, the results of this study indicate important differences regarding the magnitude of weight loss and strategies used. In particular, a greater magnitude of weight lost and prevalence of acute dehydration strategies was observed in MMA which was a novel finding of this study. Better understanding these practices is essential for developing meaningful regulations regarding weight loss in combat sports and informing coaches and competitors to make informed decisions for an athlete’s future and competitive success.
REFERENCES


Table 1. Descriptive statistics of athlete details and competitive history in the combat sports of Brazilian jiu jitsu (BJJ), boxing, judo, mixed martial arts (MMA), muay Thai/kickboxing (MT/K), taekwondo (TKD) and wrestling

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<th>Judo</th>
<th>MMA</th>
<th>MT/K</th>
<th>TKD</th>
<th>Wrestling</th>
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<td>28±8&lt;sup&gt;e&lt;/sup&gt;</td>
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<sup>a</sup> = $P<0.05$ when compared with BJJ. <sup>b</sup> = $P<0.05$ when compared with Boxing. <sup>c</sup> = $P<0.05$ when compared with Judo.

<sup>d</sup> = $P<0.05$ when compared with MMA. <sup>e</sup> = $P<0.05$ when compared with muay Thai/ Kickboxing. <sup>f</sup> = $P<0.05$ when compared with Taekwondo. <sup>g</sup> = $P<0.05$ when compared with Wrestling

N/A = Not applicable as no main effects were observed.
Table 2. Level of competitive experience of combat sport athletes competing in Brazilian jiu jitsu (BJJ), boxing, judo, mixed martial arts (MMA), muay Thai/kickboxing (MT/K), taekwondo (TKD) and wrestling

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<th>Judo</th>
<th>MMA</th>
<th>MT/K</th>
<th>TKD</th>
<th>Wrestling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional/State</td>
<td>81%&lt;sup&gt;e&lt;/sup&gt;</td>
<td>76%</td>
<td>89%&lt;sup&gt;e&lt;/sup&gt;</td>
<td>80%</td>
<td>60%&lt;sup&gt;a,c,f,g&lt;/sup&gt;</td>
<td>97%&lt;sup&gt;e&lt;/sup&gt;</td>
<td>92%&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>National/International</td>
<td>47%&lt;sup&gt;e,f,g&lt;/sup&gt;</td>
<td>41%&lt;sup&gt;e,f&lt;/sup&gt;</td>
<td>72%&lt;sup&gt;a,b,e,g&lt;/sup&gt;</td>
<td>51%&lt;sup&gt;f&lt;/sup&gt;</td>
<td>28%&lt;sup&gt;e,f&lt;/sup&gt;</td>
<td>90%&lt;sup&gt;a,b,d, e,g&lt;/sup&gt;</td>
<td>39%&lt;sup&gt;a,c,f&lt;/sup&gt;</td>
</tr>
<tr>
<td>Amateur</td>
<td>74%&lt;sup&gt;a,e&lt;/sup&gt;</td>
<td>95%&lt;sup&gt;g&lt;/sup&gt;</td>
<td>82%&lt;sup&gt;e&lt;/sup&gt;</td>
<td>93%&lt;sup&gt;a,g&lt;/sup&gt;</td>
<td>99%&lt;sup&gt;a,c,g&lt;/sup&gt;</td>
<td>85%</td>
<td>68%&lt;sup&gt;a,b,d,e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Semi-Professional</td>
<td>15%&lt;sup&gt;a,d,e,f&lt;/sup&gt;</td>
<td>19%&lt;sup&gt;e&lt;/sup&gt;</td>
<td>25%</td>
<td>34%&lt;sup&gt;a,g&lt;/sup&gt;</td>
<td>35%&lt;sup&gt;a,g&lt;/sup&gt;</td>
<td>41%&lt;sup&gt;a,g&lt;/sup&gt;</td>
<td>13%&lt;sup&gt;a,d,e,f&lt;/sup&gt;</td>
</tr>
<tr>
<td>Professional</td>
<td>10%&lt;sup&gt;a,f&lt;/sup&gt;</td>
<td>5%&lt;sup&gt;d&lt;/sup&gt;</td>
<td>10%&lt;sup&gt;d&lt;/sup&gt;</td>
<td>38%&lt;sup&gt;a,b,c,e,g&lt;/sup&gt;</td>
<td>12%&lt;sup&gt;d&lt;/sup&gt;</td>
<td>31%&lt;sup&gt;a,g&lt;/sup&gt;</td>
<td>5%&lt;sup&gt;a,f&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> = *P*<0.05 when compared with BJJ. <sup>b</sup> = *P*<0.05 when compared with Boxing. <sup>c</sup> = *P*<0.05 when compared with Judo.
<sup>d</sup> = *P*<0.05 when compared with MMA. <sup>e</sup> = *P*<0.05 when compared with muay Thai/ Kickboxing. <sup>f</sup> = *P*<0.05 when compared with Taekwondo. <sup>g</sup> = *P*<0.05 when compared with Wrestling

N/A = Not applicable as no main effects were observed
Table 3. Weight loss history and magnitude of weight loss in the combat sports of Brazilian jiu jitsu (BJJ), boxing, judo, mixed martial arts (MMA), muay Thai/kickboxing (MT/K), taekwondo (TKD) and wrestling

<table>
<thead>
<tr>
<th></th>
<th>BJJ</th>
<th>Boxing</th>
<th>Judo</th>
<th>MMA</th>
<th>MT/K</th>
<th>TKD</th>
<th>Wrestling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight without a</td>
<td>80.9±19.3&lt;sup&gt;de&lt;/sup&gt;</td>
<td>77.5±13.9&lt;sup&gt;f&lt;/sup&gt;</td>
<td>81.2±13.1&lt;sup&gt;de&lt;/sup&gt;</td>
<td>82.8±12.6&lt;sup&gt;de&lt;/sup&gt;</td>
<td>75.2±13.7&lt;sup&gt;d&lt;/sup&gt;</td>
<td>65.3±13&lt;sup&gt;abcde,g&lt;/sup&gt;</td>
<td>74.3±13.9&lt;sup&gt;abcd&lt;/sup&gt;f</td>
</tr>
<tr>
<td>competition coming up (kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current weight</td>
<td>76.6±13.9&lt;sup&gt;cdefg&lt;/sup&gt;</td>
<td>71.6±10.6&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80.2±14&lt;sup&gt;defg&lt;/sup&gt;</td>
<td>71.5±14.6&lt;sup&gt;ef&lt;/sup&gt;</td>
<td>70.6±12&lt;sup&gt;abcd&lt;/sup&gt;f</td>
<td>61.6±13.2&lt;sup&gt;abcde,g&lt;/sup&gt;</td>
<td>69.9±13.4&lt;sup&gt;cdef&lt;/sup&gt;</td>
</tr>
<tr>
<td>class (kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participants that</td>
<td>88%</td>
<td>93%</td>
<td>86%</td>
<td>95%</td>
<td>94%</td>
<td>85%</td>
<td>97%</td>
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<tr>
<td>have lost weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to compete (% yes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Most amount of</td>
<td>6.7±4.6&lt;sup&gt;d&lt;/sup&gt;</td>
<td>8.5±4.8</td>
<td>8.1±8.2</td>
<td>10.4±4.2&lt;sup&gt;abcdefg&lt;/sup&gt;</td>
<td>6.9±3.5&lt;sup&gt;d&lt;/sup&gt;</td>
<td>6.5±3.3&lt;sup&gt;d&lt;/sup&gt;</td>
<td>7.1±4.2&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>weight lost for a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>competition (kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much weight usually</td>
<td>4.2±2.6&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.3±2.9&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.8±2.1&lt;sup&gt;d&lt;/sup&gt;</td>
<td>9.8±7.9&lt;sup&gt;abcdefg&lt;/sup&gt;</td>
<td>5.9±3.5&lt;sup&gt;d&lt;/sup&gt;</td>
<td>4±3&lt;sup&gt;d&lt;/sup&gt;</td>
<td>4.4±3.7&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>lost for a competition (kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How many days</td>
<td>18±19&lt;sup&gt;f&lt;/sup&gt;</td>
<td>26±26&lt;sup&gt;f&lt;/sup&gt;</td>
<td>14±16&lt;sup&gt;f&lt;/sup&gt;</td>
<td>27±24&lt;sup&gt;f&lt;/sup&gt;</td>
<td>21±20&lt;sup&gt;f&lt;/sup&gt;</td>
<td>28±48&lt;sup&gt;f&lt;/sup&gt;</td>
<td>7±9&lt;sup&gt;abcede,f,g&lt;/sup&gt;</td>
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<tr>
<td>weight is usually</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>lost over</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Weight typically</td>
<td>3.1±2.3&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.7±2.7</td>
<td>2.4±2.1&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.6±3.1&lt;sup&gt;abcdefg&lt;/sup&gt;</td>
<td>2.6±1.7&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.4±3.2&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.4±3.2&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>lost within 2 weeks of</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>weigh-in</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight typically</td>
<td>1.4±1.4&lt;sup&gt;de&lt;/sup&gt;</td>
<td>1.8±2.1&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.5±1.1&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.4±1.9&lt;sup&gt;abcdefg&lt;/sup&gt;</td>
<td>2±1.2&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.6±1.4&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2.3±1.5&lt;sup&gt;ab&lt;/sup&gt;d</td>
</tr>
<tr>
<td>lost within 24 h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of weigh-in</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight typically</td>
<td>1.3±1.4&lt;sup&gt;de&lt;/sup&gt;</td>
<td>2±2.2&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2±1.3&lt;sup&gt;de&lt;/sup&gt;</td>
<td>5.3±2.9&lt;sup&gt;abcdefg&lt;/sup&gt;</td>
<td>3.5±3.7&lt;sup&gt;abcde&lt;/sup&gt;</td>
<td>2.2±1.3&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2.2±1.4&lt;sup&gt;ab&lt;/sup&gt;d</td>
</tr>
<tr>
<td>regained between</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>weigh-in and competition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time between</td>
<td>6±8&lt;sup&gt;de,f&lt;/sup&gt;</td>
<td>7±7&lt;sup&gt;de,f&lt;/sup&gt;</td>
<td>11±8&lt;sup&gt;de,f&lt;/sup&gt;</td>
<td>24±11&lt;sup&gt;abc&lt;/sup&gt;</td>
<td>18±9&lt;sup&gt;ab,c&lt;/sup&gt;</td>
<td>19±5&lt;sup&gt;abc&lt;/sup&gt;</td>
<td>7±15&lt;sup&gt;de,f&lt;/sup&gt;</td>
</tr>
<tr>
<td>weigh-in and competition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(h)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight regained</td>
<td>3.2±2.3&lt;sup&gt;de&lt;/sup&gt;</td>
<td>4±2.5&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.1±2&lt;sup&gt;d&lt;/sup&gt;</td>
<td>7.8±3.7&lt;sup&gt;abcdefg&lt;/sup&gt;</td>
<td>4.6±3.4&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.6±3&lt;sup&gt;d&lt;/sup&gt;</td>
<td>4.4±2.4&lt;sup&gt;abcd&lt;/sup&gt;</td>
</tr>
<tr>
<td>7 days following</td>
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<tr>
<td>competition</td>
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<td></td>
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</tr>
</tbody>
</table>

<sup>a</sup> = P<0.05 when compared with BJJ. <sup>b</sup> = P<0.05 when compared with Boxing. <sup>c</sup> = P<0.05 when compared with Judo. 
<sup>d</sup> = P<0.05 when compared with MMA. <sup>e</sup> = P<0.05 when compared with muay Thai/kickboxing. <sup>f</sup> = P<0.05 when compared with Taekwondo. <sup>g</sup> = P<0.05 when compared with Wrestling

N/A = Not applicable as no main effects were observed
Table 4. Ranking of the influence each individual had on weight loss practices followed by athletes competing in Brazilian jiu jitsu (BJJ), boxing, judo, mixed martial arts (MMA), muay Thai/kickboxing (MT/K), taekwondo (TKD) and wrestling

<table>
<thead>
<tr>
<th>Individual</th>
<th>BJJ</th>
<th>Boxing</th>
<th>Judo</th>
<th>MMA</th>
<th>MT/K</th>
<th>TKD</th>
<th>Wrestling</th>
<th>Average over all sports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training partner</td>
<td>2 (41%)</td>
<td>2 (36%)</td>
<td>2 (41%)</td>
<td>2 (33%)</td>
<td>2 (36%)</td>
<td>1 (36%)</td>
<td>2 (39%)</td>
<td>2±1</td>
</tr>
<tr>
<td></td>
<td>1 (36%)</td>
<td>4 (27%)</td>
<td>1 (23%)</td>
<td>4 (30%)</td>
<td>1 (20%)</td>
<td>3 (32%)</td>
<td>1 (25%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 (13%)</td>
<td>1,3 (14%)</td>
<td>3 (20%)</td>
<td>1,3 (17%)</td>
<td>3 (20%)</td>
<td>2,5,6 (8%)</td>
<td>3 (24%)</td>
<td></td>
</tr>
<tr>
<td>Coach</td>
<td>2 (35%)</td>
<td>1 (59%)</td>
<td>1 (43%)</td>
<td>1 (46%)</td>
<td>1 (56%)</td>
<td>2 (52%)</td>
<td>1 (47%)</td>
<td>2±1</td>
</tr>
<tr>
<td></td>
<td>1 (25%)</td>
<td>2 (27%)</td>
<td>2 (27%)</td>
<td>2 (28%)</td>
<td>2 (31%)</td>
<td>1 (36%)</td>
<td>2 (28%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 (24%)e</td>
<td>3 (14%)</td>
<td>3 (20%)</td>
<td>3 (11%)</td>
<td>3,4 (7%)f</td>
<td>4 (8%)</td>
<td>3 (18%)</td>
<td></td>
</tr>
<tr>
<td>Opponent</td>
<td>1 (31%)</td>
<td>3 (32%)</td>
<td>3 (25%)</td>
<td>1 (22%)</td>
<td>4 (22%)</td>
<td>3 (32%)</td>
<td>3 (28%)</td>
<td>3±2</td>
</tr>
<tr>
<td></td>
<td>3 (31%)</td>
<td>1 (23%)</td>
<td>1 (23%)</td>
<td>6 (20%)</td>
<td>3 (18%)</td>
<td>2 (16%)</td>
<td>1 (23%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2,4 (9%)</td>
<td>5 (14%)</td>
<td>2 (20%)</td>
<td>3 (17%)</td>
<td>2 (13%)</td>
<td>1,8 (12%)</td>
<td>2 (18%)</td>
<td></td>
</tr>
<tr>
<td>Parents</td>
<td>4 (28%)</td>
<td>8 (45%)</td>
<td>8 (36%)</td>
<td>8 (48%)</td>
<td>8 (49%)</td>
<td>4 (20%)</td>
<td>4 (29%)</td>
<td>6±2</td>
</tr>
<tr>
<td></td>
<td>8 (27%)</td>
<td>7 (14%)</td>
<td>4 (30%)</td>
<td>7 (24%)</td>
<td>7 (20%)</td>
<td>5 (16%)</td>
<td>8 (17%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 (17%)</td>
<td>4 (14%)</td>
<td>4 (9%)f</td>
<td>6 (11%)c</td>
<td>4 (18%)c</td>
<td>6,8 (16%)c</td>
<td>3 (13%)c</td>
<td></td>
</tr>
<tr>
<td>Physician/Doctor</td>
<td>5 (29%)</td>
<td>6 (32%)</td>
<td>5 (27%)</td>
<td>7 (41%)</td>
<td>7 (29%)</td>
<td>5 (32%)</td>
<td>5 (33%)</td>
<td>5±1</td>
</tr>
<tr>
<td>(N/A)</td>
<td>7 (27%)</td>
<td>7 (32%)</td>
<td>7 (27%)</td>
<td>5 (20%)</td>
<td>5 (22%)</td>
<td>7 (20%)</td>
<td>6 (24%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 (18%)</td>
<td>8 (18%)</td>
<td>6 (18%)</td>
<td>8 (15%)</td>
<td>6 (20%)</td>
<td>6 (16%)</td>
<td>8 (17%)</td>
<td></td>
</tr>
<tr>
<td>Dietician</td>
<td>6 (37%)</td>
<td>6 (32%)</td>
<td>6 (32%)</td>
<td>6 (30%)</td>
<td>6 (44%)</td>
<td>7 (32%)</td>
<td>6 (31%)</td>
<td>6±2</td>
</tr>
<tr>
<td></td>
<td>7 (19%)</td>
<td>7 (23%)</td>
<td>5 (16%)</td>
<td>4 (15%)</td>
<td>5 (22%)</td>
<td>5 (20%)</td>
<td>7 (31%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 (17%)e</td>
<td>8 (23%)d</td>
<td>7,8 (14%)</td>
<td>2 (13%)c</td>
<td>7 (11%)</td>
<td>6,8 (16%)d</td>
<td>8 (15%)d</td>
<td></td>
</tr>
<tr>
<td>Physical trainer</td>
<td>7 (21%)</td>
<td>3 (32%)</td>
<td>7 (30%)</td>
<td>5 (33%)</td>
<td>3 (24%)</td>
<td>4 (28%)</td>
<td>5 (25%)</td>
<td>5±2</td>
</tr>
<tr>
<td>(N/A)</td>
<td>5 (20%)</td>
<td>5 (27%)</td>
<td>6 (23%)</td>
<td>3 (20%)</td>
<td>5 (24%)</td>
<td>7 (20%)</td>
<td>7 (22%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 (17%)</td>
<td>7 (14%)</td>
<td>4 (18%)</td>
<td>4,5 (15%)</td>
<td>6 (18%)</td>
<td>2,3 (16%)</td>
<td>4 (19%)</td>
<td></td>
</tr>
<tr>
<td>Matchmaker</td>
<td>8 (41%)</td>
<td>4 (32%)</td>
<td>8 (32%)</td>
<td>5 (22%)</td>
<td>3 (22%)</td>
<td>8 (36%)</td>
<td>8 (40%)</td>
<td>6±2</td>
</tr>
<tr>
<td></td>
<td>7 (15%)</td>
<td>5 (23%)</td>
<td>7 (23%)</td>
<td>3 (15%)</td>
<td>7 (16%)</td>
<td>6 (24%)</td>
<td>4 (16%)</td>
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<tr>
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<td>4 (14%)b</td>
<td>2 (18%)abc</td>
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<td>7 (20%)abc</td>
<td>7 (13%)abc</td>
<td></td>
</tr>
</tbody>
</table>

Data shows the 3 most frequently occurring ranks chosen by athletes and is displayed as percentage of athletes in group who chose the rank.

* = P<0.05 when compared with BJJ.
* = P<0.05 when compared with Boxing.
* = P<0.05 when compared with Judo.
* = P<0.05 when compared with MMA.
* = P<0.05 when compared with muay Thai/ Kickboxing.
* = P<0.05 when compared with Taekwondo.
* = P<0.05 when compared with Wrestling

N/A = Not applicable as no main effects were observed
Table 5. Prevalence of weight loss practices in the combat sports of Brazilian jiu jitsu (BJJ), boxing, judo, mixed martial arts (MMA), muay Thai/kickboxing (MT/K), taekwondo (TKD) and wrestling

<table>
<thead>
<tr>
<th>Individual</th>
<th>BJJ</th>
<th>Boxing</th>
<th>Judo</th>
<th>MMA</th>
<th>MT/K</th>
<th>TKD</th>
<th>Wrestling</th>
<th>All sports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradual dieting</td>
<td>92%&lt;sup&gt;g&lt;/sup&gt;</td>
<td>86%</td>
<td>66%&lt;sup&gt;d&lt;/sup&gt;</td>
<td>93%&lt;sup&gt;c,g&lt;/sup&gt;</td>
<td>87%</td>
<td>92%</td>
<td>67%&lt;sup&gt;k,d&lt;/sup&gt;</td>
<td>83%</td>
</tr>
<tr>
<td>Skipping 1 or 2 meals</td>
<td>53%&lt;sup&gt;f,g&lt;/sup&gt;</td>
<td>36%&lt;sup&gt;f,g&lt;/sup&gt;</td>
<td>66%</td>
<td>57%&lt;sup&gt;c&lt;/sup&gt;</td>
<td>49%&lt;sup&gt;f,g&lt;/sup&gt;</td>
<td>84%&lt;sup&gt;a,b,e&lt;/sup&gt;</td>
<td>84%&lt;sup&gt;a,b,d,e&lt;/sup&gt;</td>
<td>61%</td>
</tr>
<tr>
<td>Fasting (not eating all day)</td>
<td>33%&lt;sup&gt;f,g&lt;/sup&gt;</td>
<td>36%</td>
<td>54%</td>
<td>48%</td>
<td>44%</td>
<td>68%&lt;sup&gt;a&lt;/sup&gt;</td>
<td>57%&lt;sup&gt;a&lt;/sup&gt;</td>
<td>49%</td>
</tr>
<tr>
<td>Restricting fluid ingestion</td>
<td>68%&lt;sup&gt;f&lt;/sup&gt;</td>
<td>68%</td>
<td>84%</td>
<td>76%</td>
<td>76%</td>
<td>84%</td>
<td>94%&lt;sup&gt;d&lt;/sup&gt;</td>
<td>79%</td>
</tr>
<tr>
<td>Increased exercise</td>
<td>86%</td>
<td>86%</td>
<td>82%</td>
<td>78%</td>
<td>82%</td>
<td>88%</td>
<td>95%</td>
<td>85%</td>
</tr>
<tr>
<td>Training in heated rooms</td>
<td>38%&lt;sup&gt;d,g&lt;/sup&gt;</td>
<td>45%</td>
<td>43%&lt;sup&gt;d&lt;/sup&gt;</td>
<td>63%&lt;sup&gt;a&lt;/sup&gt;</td>
<td>44%&lt;sup&gt;f&lt;/sup&gt;</td>
<td>40%&lt;sup&gt;f&lt;/sup&gt;</td>
<td>83%&lt;sup&gt;a,b,c,e,f&lt;/sup&gt;</td>
<td>51%</td>
</tr>
<tr>
<td>Sauna</td>
<td>36%&lt;sup&gt;d,g&lt;/sup&gt;</td>
<td>50%</td>
<td>43%&lt;sup&gt;d&lt;/sup&gt;</td>
<td>76%&lt;sup&gt;a,c&lt;/sup&gt;</td>
<td>51%</td>
<td>48%</td>
<td>50%&lt;sup&gt;a&lt;/sup&gt;</td>
<td>51%</td>
</tr>
<tr>
<td>Training in rubber/plastic suits</td>
<td>16%&lt;sup&gt;d,g&lt;/sup&gt;</td>
<td>50%</td>
<td>23%&lt;sup&gt;d&lt;/sup&gt;</td>
<td>63%&lt;sup&gt;a,c,f,g&lt;/sup&gt;</td>
<td>40%</td>
<td>28%&lt;sup&gt;d&lt;/sup&gt;</td>
<td>83%&lt;sup&gt;k,d&lt;/sup&gt;</td>
<td>43%</td>
</tr>
<tr>
<td>Use winter or plastic suits for the whole day (without exercising)</td>
<td>6%&lt;sup&gt;d,g&lt;/sup&gt;</td>
<td>18%</td>
<td>7%</td>
<td>20%&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4%</td>
<td>8%</td>
<td>17%&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11%</td>
</tr>
<tr>
<td>Spitting</td>
<td>4%&lt;sup&gt;g&lt;/sup&gt;</td>
<td>23%&lt;sup&gt;g&lt;/sup&gt;</td>
<td>18%&lt;sup&gt;g&lt;/sup&gt;</td>
<td>30%&lt;sup&gt;g&lt;/sup&gt;</td>
<td>20%&lt;sup&gt;g&lt;/sup&gt;</td>
<td>20%</td>
<td>47%&lt;sup&gt;a,b,c,d,e&lt;/sup&gt;</td>
<td>23%</td>
</tr>
<tr>
<td>Laxatives (N/A)</td>
<td>9%</td>
<td>9%</td>
<td>9%</td>
<td>0%</td>
<td>9%</td>
<td>16%</td>
<td>12%</td>
<td>9%</td>
</tr>
<tr>
<td>Diuretics (N/A)</td>
<td>8%</td>
<td>9%</td>
<td>5%</td>
<td>7%</td>
<td>9%</td>
<td>12%</td>
<td>12%</td>
<td>9%</td>
</tr>
<tr>
<td>Diet Pills (N/A)</td>
<td>1%</td>
<td>5%</td>
<td>2%</td>
<td>7%</td>
<td>7%</td>
<td>8%</td>
<td>6%</td>
<td>5%</td>
</tr>
<tr>
<td>Vomiting (N/A)</td>
<td>1%</td>
<td>0%</td>
<td>5%</td>
<td>2%</td>
<td>0%</td>
<td>4%</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>Excessive fluid consumption (water loading)</td>
<td>50%&lt;sup&gt;d&lt;/sup&gt;</td>
<td>64%</td>
<td>41%&lt;sup&gt;d&lt;/sup&gt;</td>
<td>67%&lt;sup&gt;a,c,e,g&lt;/sup&gt;</td>
<td>62%</td>
<td>48%</td>
<td>37%&lt;sup&gt;d&lt;/sup&gt;</td>
<td>53%</td>
</tr>
</tbody>
</table>

Data is presented as percentage of athletes that selected always or sometimes

<sup>a</sup> = P<0.05 when compared with BJJ.  
<sup>b</sup> = P<0.05 when compared with Boxing.  
<sup>c</sup> = P<0.05 when compared with Judo.  
<sup>d</sup> = P<0.05 when compared with MMA.  
<sup>e</sup> = P<0.05 when compared with muay Thai/ Kickboxing.  
<sup>f</sup> = P<0.05 when compared with Taekwondo.  
<sup>g</sup> = P<0.05 when compared with Wrestling  
N/A = Not applicable as no main effects were observed.