Methods of Body-Mass Reduction by Combat Sport Athletes

Ciro José Brito, Aendria Fernanda Castro Martins Roas, Igor Surian Souza Brito, João Carlos Bouzas Marins, Claudio Córdova, and Emerson Franchini

The aim of this study was to investigate the methods adopted to reduce body mass (BM) in competitive athletes from the grappling (judo, jujitsu) and striking (karate and tae kwon do) combat sports in the state of Minas Gerais, Brazil. An exploratory methodology was employed through descriptive research, using a standardized questionnaire with objective questions self-administered to 580 athletes (25.0 ± 3.7 yr, 74.5 ± 9.7 kg, and 16.4% ± 5.1% body fat). Regardless of the sport, 60% of the athletes reported using a method of rapid weight loss (RWL) through increased energy expenditure. Strikers tend to begin reducing BM during adolescence. Furthermore, 50% of the sample used saunas and plastic clothing, and only 26.1% received advice from a nutritionist. The authors conclude that a high percentage of athletes uses RWL methods. In addition, a high percentage of athletes uses unapproved or prohibited methods such as diuretics, saunas, and plastic clothing. The age at which combat sport athletes reduce BM for the first time is also worrying, especially among strikers.

Keywords: martial arts, weight loss, athletic performance, diuretics

Combat sport athletes are categorized using body mass as a criterion. Because of this categorization, many athletes choose rapid-weight-loss (more than 5% body-mass reduction in less than 1 week) procedures with the objective of competing against smaller and weaker athletes (Artioli, Gualano, et al., 2010; Artioli, Iglesias, et al., 2010; Perriello, 2001). However, one must be cautious when undergoing rapid weight loss because there is evidence of associated impairment of athletic performance, in addition to the risk of death (Centers for Disease Control and Prevention, 1998; Forte, Precomano, Neto, Maia, & Faria-Neto, 2006).

The loss of large amounts of body mass in a short time (as shown previously) is extremely harmful to the body; it can reduce muscle strength (Flaiti, Grélot, Coudreuse, & Nicol, 2001), performance time in aerobic activities, plasma and blood volume (Stöhr et al., in press), myocardial efficiency, and maximum oxygen consumption (American Dietetic Association et al., 2009). In addition, reductions in renal blood fluid and the volume of liquid filtered by the kidneys (Melin et al., 1997) and glycogen stores (American Dietetic Association et al., 2009) have been reported. Rapid weight loss also compromises the thermoregulatory process and electrolyte equilibrium (Oppliiger, Case, Horswill, Landry, & Shelter, 1996).

In addition to physiological damage, rapid weight loss can affect mental function through deficits in concentration, memory, and cognitive processing speed, as well as increase the risk of developing eating disorders (Choma, Sforzo, & Keller, 1998; Landers, Arent, & Lutz, 2001; Rouveix, Bouget, Pannafieux, Champely, & Filaire, 2007). Considering that winners can be defined by a perfect technique, difficulty to concentrate and to conduct a correct decision-making process may improve their adversaries’ chance of winning. Moreover, dehydration exceeding 2% of body mass can negatively affect posture maintenance (Lion et al., 2010), which is important to both grappling and striking actions.

Induced dehydration has been described as the most significant adverse factor leading to a decline in performance. The loss of body fluids from exercise in hot environments and the use of plastic clothing, laxatives, and diuretics can affect the body’s electrolyte balance, especially for calcium, which can result in lower bone mineralization and cause stress fractures (Leydon & Wall, 2002). Green, Petrou, Fogarty-Hover, and Rolf (2007) reported that the risk of athlete injury during judo competitions increased in those who had lost more than 5% of their body mass before the competition. Often, diuretics produce hypokalemia in athletes, which could pose a health risk because the reduction of body potassium alters the activity of the sodium-potassium pump, which in turn may lead to death (Cadwallader, de la Torre, C. Brito is with the Physical Education Dept., Federal University of Sergipe, Aracaju, Brazil. Roas is with the School of Physical Education, Izabela Hendrix Methodist University, Belo Horizonte, Brazil. I. Brito and Marins are with the Physical Education Dept., Federal University of Viçosa, Viçosa, Brazil. Córdova is with the Physical Education Dept., Brasilia Catholic University, Brasilia, Brazil. Franchini is with the School of Physical Education and Sport, University of São Paulo, São Paulo, Brazil.
In fact, this process led to the death of three Olympic wrestlers in 1997 (Centers for Disease Control and Prevention, 1998).

Although an extensive body of evidence points out that the rapid-weight-loss process is widely addressed in Olympic wrestling (Oppliger et al., 1996; Landers et al., 2001; Oppliger, Nelson Steen, & Scott, 2003; Oppliger, Utter, Scott, Dick, & Klossner, 2006; Perriello, 2001) and judo (Artioli, Gualano, et al. 2010; Artioli, Iglesias, et al. 2010; Artioli, Franchini, et al., 2010; Koral & Dosseville, 2009), its prevalence has not yet been investigated in jujitsu, karate, and tae kwon do athletes. Our objective was to survey and discuss rapid-weight-loss practices adopted by judo, jujitsu, karate, and tae kwon do athletes—two grappling and two striking combat sports.

**Methods**

This was an observational cross-sectional study, approved by the Federal University of Viçosa Ethics in Human Research Committee, in accordance with the Helsinki Convention.

**Participants**

Initially, contact was made with the following associations in Minas Gerais (the second most populous state in Brazil) to survey registered sports gyms and clubs (N = 351): the Judo Federation, the Judo League, the Jujitsu Federation, the Jujitsu League, the Karate Federation, and two Minas Gerais tae kwon do federations. Subsequently, we adopted a simple-random-sample technique to select the sports gyms and clubs to be included in the study (n = 96)—a draw was conducted to determine a representative sample of the gyms and clubs from the city (without area division), although all zones were included in our sample. After contact with these institutions, the athlete selection was again accomplished by simple random sample. Of the population (N = 1,650), 1,200 athletes met the inclusion criteria (302 in judo, 337 in jujitsu, 297 in karate, and 264 in tae kwon do), of whom 28.3% declined to participate in the study, mostly because they did not have time to complete all the procedures, and 23.3% were not present at training sessions or competitions when we conducted the research. We included male athletes who had been registered for at least 1 year and excluded those younger than 18 years old and who did not participate in competitions throughout the year. The final sample consisted of 580 athletes: 12.5% jujitsu, 13.1% judo, 11.9% karate, and 15.5% tae kwon do from the total registered athletes from the state of Minas Gerais. Table 1 includes data on the sample distribution in relation to the competitive level and frequency of weight loss among these athletes.

**Procedures**

The athletes were informed of the importance of the study and were randomly interviewed after giving their consent. Exploratory methodology was employed, using a standardized questionnaire with self-administered objective questions. This questionnaire had some of the questions previously validated to investigate weight-loss practices in judokas (Artioli, Scagliusi, et al., 2010) and also could be used with other combat sport athletes. Despite that, the instrument had undergone content validity by three researchers before the final draft (Figure 1), two of whom work with nutrition and have extensive experience in dietetics and body-mass manipulation. The third was from the sport sciences area and has expertise in combat sports and sport nutrition. The evaluators made minor comments to improve the questionnaire’s clarity before the final version.

After this phase, the questionnaire was applied with 30 judokas (16 below and 14 above their category weight limits) to determine the instrument’s discriminant validity. It was expected that the athletes above their weight limits would have a greater prevalence of rapid-weight-loss strategies. As for discriminant validity, a higher prevalence of adoption of rapid-weight-loss strategies was observed in the athletes above their weight limit (85.7%).

**Table 1 Competitive Level and Rapid Weight Loss of Athletes in Absolute and Relative Values**

<table>
<thead>
<tr>
<th></th>
<th>Judo</th>
<th>Jujitsu</th>
<th>Karate</th>
<th>Tae kwon do</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Competitive level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>regional</td>
<td>87 (60.0%)</td>
<td>72 (46.5%)</td>
<td>79 (60.8%)</td>
<td>84 (56.0%)</td>
<td>324 (55.9%)</td>
</tr>
<tr>
<td>national</td>
<td>48 (33.0%)</td>
<td>53 (34.2%)</td>
<td>39 (30.0%)</td>
<td>51 (34.0%)</td>
<td>190 (32.8%)</td>
</tr>
<tr>
<td>international</td>
<td>10 (6.9%)</td>
<td>30 (19.4%)</td>
<td>12 (9.2%)</td>
<td>15 (10.0%)</td>
<td>66 (11.3%)</td>
</tr>
<tr>
<td><strong>Weight loss</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>regional</td>
<td>52 (59.8%)</td>
<td>45 (62.5%)</td>
<td>56 (70.9%)</td>
<td>54 (64.3%)</td>
<td>207 (63.9%)</td>
</tr>
<tr>
<td>national</td>
<td>35 (72.9%)</td>
<td>28 (52.8%)</td>
<td>28 (71.8%)</td>
<td>35 (68.6%)</td>
<td>126 (66.3%)</td>
</tr>
<tr>
<td>international</td>
<td>4 (40.0%)</td>
<td>15 (50.0%)</td>
<td>8 (66.7%)</td>
<td>6 (40.0%)</td>
<td>33 (50.0%)</td>
</tr>
</tbody>
</table>

*p < .05 between regional vs. national and international levels for judo, karate, tae kwon do, and all athletes grouped. **p < .05 between national vs. international levels for judo, karate, tae kwon do, and all athletes grouped. ***p < .05 between regional vs. international levels for jujitsu athletes.
Rapid Weight Loss in Combat Sports

Reliability was ascertained in 35 jujitsu athletes who answered the questionnaire twice at a 2-week interval. The correlation between the two measures was higher than 92% on all instrument’s items. After these procedures, the questionnaire was administered to the current study sample.

Subsequent to the questionnaire, anthropometric measures were taken. Height and body-mass measurements were made on scales with attached stadiometers (0.5-cm range and 100-g resolution, respectively). Percentage body fat was estimated indirectly by the skinfold technique (Thorland et al., 1991). We used this equation because it was previously validated for college and high school wrestlers (Roberts, 1998; Thorland et al., 1991) and is still used to determine body fat in wrestlers (Kordi, Ziae, Rostami, & Wallace, 2011).

Statistical Analysis

A normality test (Shapiro–Wilk) was initially performed to investigate the data distribution. When appropriate, analysis of variance (one-way ANOVA) was used to investigate differences between groups. Scheffé’s test (post hoc) was adopted for multiple comparisons of the dependent variables (judo vs. jujitsu vs. karate vs. taekwondo vs. total). The Kruskal–Wallis test was used to detect differences in variables that violated the normality assumption. The chi-square test was used to determine the association between the following variables: rapid weight loss, weight before and after training, guidance received on the handling of body mass, and rapid-weight-loss procedures. The significance level was $p < .05$.

Results

Competitive level was not associated with weight-loss practices (Table 1). According to Table 2, the jujitsu athletes were significantly older than karate athletes; however, they did not differ from the other groups. Among combat sports, karate athletes were shorter and had practiced their sport for less time. Judo and jujitsu athletes...
were significantly heavier than karate and tae kwon do athletes. Finally, judokas had a higher fat percentage than the other combat sport athletes.

Table 3 shows the prevalence of participants engaged in different rapid-weight-loss strategies in the competitive periods. The jujitsu athletes began to reduce their body mass at significantly later ages; the strikers performed this process during adolescence. Strikers significantly adopted such procedures a few years after starting in the sport. On average, tae kwon do athletes lose body mass within 10 days of a competition. Judokas showed a significantly higher absolute and relative precompetitive body-mass loss than the other combat sport athletes. The largest reductions in body mass were 10, 8, 5, and 6 kg in the precompetition week for judo, jujitsu, karate, and tae kwon do, respectively.

Table 4 presents the procedures used by the athletes tested for body-mass restriction. Judokas significantly restricted fluid and carbohydrate intake the most, compared with the strikers. Compared with the others, judokas were least likely to use diuretics or laxatives. Judo and karate athletes restricted fat the most before competitions. All the alternatives presented in Tables 4 and 5 were employed more than once.

Table 5 presents the main sources of information for body-mass-control methods reported by these athletes. Judo and tae kwon do athletes received significantly more advice from fitness instructors and coaches than

### Table 2  Athletes' Age, Experience, and Anthropometric Characteristics (M ± SD)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Judo</th>
<th>Jujitsu</th>
<th>Karate</th>
<th>Tae kwon do</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>145</td>
<td>155</td>
<td>130</td>
<td>150</td>
<td>580</td>
</tr>
<tr>
<td>Age (years)</td>
<td>24.9 ± 3.4</td>
<td>26.4 ± 4.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>23.9 ± 4.3</td>
<td>24.6 ± 2.9</td>
<td>25.0 ± 3.7</td>
</tr>
<tr>
<td>Experience (years)</td>
<td>8.7 ± 2.0</td>
<td>7.9 ± 5.7</td>
<td>7.1 ± 4.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>9.1 ± 6.0</td>
<td>8.2 ± 4.5</td>
</tr>
<tr>
<td>body mass (kg)</td>
<td>80.0 ± 9.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>78.2 ± 8.5&lt;sup&gt;c&lt;/sup&gt;</td>
<td>69.8 ± 12.0</td>
<td>70.1 ± 9.3</td>
<td>74.5 ± 9.7&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.8 ± 0.1</td>
<td>1.7 ± 0.2</td>
<td>1.7 ± 0.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.8 ± 0.3</td>
<td>1.8 ± 0.2</td>
</tr>
<tr>
<td>Body-mass index (kg/m²)</td>
<td>24.7 ± 2.5</td>
<td>25.2 ± 2.7</td>
<td>25.0 ± 2.9</td>
<td>22.4 ± 3.1&lt;sup&gt;e&lt;/sup&gt;</td>
<td>24.3 ± 2.8</td>
</tr>
<tr>
<td>% Body fat</td>
<td>17.2 ± 3.5&lt;sup&gt;c&lt;/sup&gt;</td>
<td>15.9 ± 6.1</td>
<td>15.5 ± 4.2</td>
<td>16.8 ± 6.5</td>
<td>16.4 ± 5.1</td>
</tr>
</tbody>
</table>

<sup>a</sup>p < .05 between jujitsu vs. karate. <sup>b</sup>p < .05 between karate vs. judo, tae kwon do, and total. <sup>c</sup>p < .01 between judo and jujitsu vs. karate, tae kwon do, and total. <sup>d</sup>p < .01 between total vs. judo, jujitsu, karate, and tae kwon do. <sup>e</sup>p < .05 between tae kwon do vs. judo, jujitsu, karate, and total. <sup>f</sup>p < .05 between judo vs. jujitsu, karate, tae kwon do, and total.

### Table 3  Weight Control, Age at Which Body Mass Was Reduced, Precompetition Timetable When Reduction Started, Absolute Weight Loss, and Guidance in Relation to the Loss, Absolute Values and Percentages

<table>
<thead>
<tr>
<th></th>
<th>Judo</th>
<th>Jujitsu</th>
<th>Karate</th>
<th>Tae kwon do</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loses weight</td>
<td>62.8%</td>
<td>56.8%</td>
<td>70.8%</td>
<td>63.3%</td>
<td>63.1%</td>
</tr>
<tr>
<td>Loses &gt;5% of body mass</td>
<td>43.4%&lt;sup&gt;c&lt;/sup&gt;</td>
<td>27.1%</td>
<td>29.2%</td>
<td>28.7%</td>
<td>31.7%</td>
</tr>
<tr>
<td>Weighs before and after training</td>
<td>57.2%</td>
<td>41.9%</td>
<td>50.0%</td>
<td>46.7%</td>
<td>49.0%</td>
</tr>
<tr>
<td>Age body mass was reduced for the first time (years)</td>
<td>17.0 ± 2.5</td>
<td>21.1 ± 5.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.6 ± 1.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>14.2 ± 2.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>16.5 ± 2.8</td>
</tr>
<tr>
<td>How long in the sport when lost weight for the first time (years)</td>
<td>5.3 ± 0.5</td>
<td>7.2 ± 1.1</td>
<td>2.4 ± 3.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.5 ± 3.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.5 ± 1.8</td>
</tr>
<tr>
<td>Number of days before competition that weight loss starts</td>
<td>14.5 ± 6.0</td>
<td>21.5 ± 14.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>14.8 ± 7.0</td>
<td>9.7 ± 5.2&lt;sup&gt;d&lt;/sup&gt;</td>
<td>15.1 ± 8.1</td>
</tr>
<tr>
<td>Loss during competitive week (kg)</td>
<td>5.6 ± 2.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.9 ± 1.5</td>
<td>2.5 ± 1.1</td>
<td>3.2 ± 1.2</td>
<td>3.6 ± 1.5</td>
</tr>
<tr>
<td>Loss during competitive week in relation to % body mass</td>
<td>8.5 ± 4.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.1 ± 2.0</td>
<td>3.6 ± 2.2</td>
<td>4.3 ± 3.2</td>
<td>5.3 ± 3.5</td>
</tr>
<tr>
<td>Receives guidance in relation to handling weight</td>
<td>65.5%</td>
<td>63.2%</td>
<td>80.8%</td>
<td>80.0%</td>
<td>72.1%</td>
</tr>
</tbody>
</table>

<sup>a</sup>p < .05 between jujitsu vs. judo, karate, tae kwon do, and total. <sup>b</sup>p < .05 between karate and tae kwon do vs. judo, jujitsu, and total. <sup>c</sup>p < .01 between jujitsu vs. judo, karate, tae kwon do, and total. <sup>d</sup>p < .001 between judo and jujitsu vs. karate, tae kwon do, and total. <sup>e</sup>p < .001 between tae kwon do vs. judo, jujitsu, karate, and total. <sup>f</sup>p < .05 between judo vs. jujitsu, karate, tae kwon do, and total.
the jujitsu athletes. Jujitsu athletes were the least likely to consult doctors compared with the strikers. Judo and tae kwon do athletes received most of their information through magazines, parents, and friends. Strikers sought their instructor’s guidance significantly more than did the grapplers.

**Discussion**

This study found that over 60% of combat sport athletes, regardless of modality, reported using a rapid-weight-loss procedure in the competitive period through increased energy expenditure. A disturbing factor is the age at which these athletes started to use a sudden reduction of body mass for the first time, particularly in the strikers. The current study found a prevalence of athletes involved in rapid weight loss slightly lower than that reported by Artioli, Gualano, et al. (2010) in Brazilian judokas (89%) and that reported by Steen and Brownell (1990) in Olympic wrestlers in the United States (89%) but similar to those presented by Kiningham and Gorenflo (2001) in high school Olympic wrestlers (60–70%) and by Kordi et al. (2011) in Iranian wrestlers.

This prevalence is of concern because the Centers for Disease Control and Prevention (1998) have reported deaths of young athletes in the competitive stages of Olympic wrestling. In Brazil, Forte et al. (2006) described a case of myocardial infarct in a mixed-martial-arts fighter attempting to rapidly lose weight.

Despite studies that consistently warn of the adverse effects of rapid weight loss (Artioli, Gualano, et al., 2010; Landers et al., 2001; Oppliger et al., 2003), there is still a high percentage of athletes whose body mass is above the limit for their category. Most believe that rapid weight loss will facilitate migration to lower weight categories with smaller, lower performing opponents (Artioli, Iglésias, et al., 2010). Artioli, Gualano, et al. (2010) found that approximately 89% of judokas (n = 822) underwent rapid weight loss up to the day before competition. In our study, 63.1% reported this type of practice. Therefore, according to scientific criteria, monitoring and weight
control during the preparation period would contribute positively to maintaining homeostasis with fewer adverse effects (Morton, Robertson, Sutton, & Maclaren, 2010).

Another aspect of concern is the age at which athletes are involved in rapid-weight-loss strategies (during adolescence). At this life stage, this type of practice can affect body development through changes in endocrine mechanisms such as testosterone release and growth factor linked to insulin-1 (Roemmich & Sinning, 1997). Based on this information, it is likely that strikers are the most affected by using rapid weight loss (Table 3). The age range for these groups was similar to those reported by Artioli, Gualano, et al. (2010) for judokas (<15 years) and by Kordi et al. (2011) for wrestlers (15.5 ± 2.4 years). In addition, strikers use inappropriate rapid-weight-loss methods after 2 years of practice, thereby indicating a cultural bias in these sports that steers fighters toward such procedures.

Among rapid-weight-loss strategies, increased physical activity and a low-calorie diet intensify in the last 2 days before competition. If adopted during the preparation period, these strategies can benefit the athlete by preserving muscle mass, strength, and body fluids. Near the competition these strategies affect performance because muscle protein turnover requires approximately 72 hr (Oppiliger et al., 1996). Moreover, in judokas, 24 hr was not sufficient for complete rehydration after a 6% body-mass reduction (Fogelholm, Koskinen, Laakso, Rakinen, & Ruokonen, 1993). According to the American Dietetic Association et al. (2009), loss of body mass should not exceed 2% per week.

Recent follow-up in boxers showed that it was possible to reduce body mass considerably (9.4 kg) without a sharp reduction in lean body mass and the use of dehydration procedures over a 12-week period (Morton et al., 2010). Thus, for the athletes analyzed in this study, mean reduction in body mass (7.45 kg) should not have exceeded 1.5 kg in absolute terms. Instead, we found that grapplingers reported a reduction of more than 8.0 kg precontest. However, it is important to consider some aspects involved with weight-loss practices in combat sport athletes. Recent studies (Artioli, Franchini, et al., 2010; Buford, Rossi, Smith, O’Brien, & Pickering, 2006; Finn, Dolgener, & Williams, 2004) indicated that athletes highly experienced with these procedures seem to not be affected by them, but more investigation is needed to better understand which physiological or psychological mechanisms can explain this phenomenon. Kordi et al. (2011) found that many wrestlers (72%) think weight loss can help them achieve better performance, although a similar percentage (77%) believed that rapid weight loss has negative side effects.

In addition, studies that analyzed weight loss and competitive performance reported inconsistent results. Wroble and Moxley (1998) observed that a higher percentage of placers (58%) had not followed the minimum wrestling weight recommendation than had followed such recommendation (33%). Moreover, Horswill, Scott, Dick, and Hayes (1994) analyzed body-mass recovery after weigh-in and competition in wrestlers (266 winners and 269 defeated athletes in their first match during a national-level competition). They found no difference between winners and defeated athletes concerning absolute weight gain (winners 3.5 ± 1.2 kg, defeated 3.5 ± 1.5 kg), relative weight gain (winners 5.3% ± 2.0%, defeated 5.3% ± 2.4%), and weight difference between an athlete and his opponent (winners 0.1 ± 2.0 kg, defeated –0.1 ± 2.0 kg). On the other hand, Alderman, Landers, Carlson, and Scott (2004) reported that winners had lost a higher amount of body mass (mean reduction 3.78 kg, range 2.95–4.77 kg) than defeated athletes (mean reduction 3.05 kg, range 1.91–3.95 kg). Taken together, these results indicate that for some athletes rapid weight loss resulted in better competitive performance, although it was not consistent for all athletes and most of them reported negative side effects. In our sample, no association was found between competitive level and the amount of weight loss.

Approximately 50% of the athletes also reported using sauna or plastic clothing and restricting carbohydrates. Wearing plastic clothing affects the dissipation of body heat and increases internal temperature, causing cramps, generalized weakness, fatigue, nausea, and diarrhea (Bigard et al., 2001). Moreover, use of a sauna decreases bodily water stores and maximum strength (Schoffstall, Branch, Leutholtz, & Swain, 2001).

In a sport in which muscle power is critical, such as the four combat sports studied here, carbohydrates are the main fuel (Artioli, Iglesias, et al., 2010). For this reason, strikers would be significantly more affected than grappling athletes. Carbohydrate restriction leaves a fighter unprepared to compete because his ability to apply fast and efficient technique is essential for good performance (Artioli, Iglesias, et al., 2010). According to Kowatari et al. (2001), rapid weight loss in judokas, associated with carbohydrate restriction, resulted in decreased immune-system activity, increasing the propensity for infection. In addition, it was reported that athletes engaged in rapid weight loss are more prone to injury (Green et al., 2007). During high-intensity exercise, Carter, Pringle, Boobis, Jones, and Doust (2004) observed that glycogen depletion affects endurance time by altering the kinetics of oxygen consumption. It is suggested that low carbohydrate availability results in decreased activity of Type II fibers, demanding greater energy production from aerobic fibers. In turn, carbohydrate consumption can mitigate loss of strength and the onset of fatigue (Nybo, 2003). It is important to realize that continuous caloric restriction (<1,500 kcal) is related to inadequate intake of vitamins and proteins (Rossi, Goya, Matayoshi, Pereira, & Silva, 2009), which can affect athletic performance. In addition, vitamins attenuate oxidative stress, as well as performing metabolic functions (Mastaloudis, Morrow, Hopkins, Devaraj, & Traber, 2004). A smaller percentage (approximately one third) of those who reduced their body mass made use of fluid restriction, diuretics, or laxatives. This type of strategy is worrisome because diuretics can affect calcium electrolyte balance, thus increasing the propensity for stress frac-
tutes (Leydon & Wall, 2002). Concomitantly, diuretics lead to hypokalemia (decreased potassium concentration in the blood), which alters sodium-potassium-pump activity and can lead to death (Shivkumar & Narins, 1995). In addition, diuretics are included on doping lists for their ability to mask the detection of other banned substances and have been identified as a concern regarding positive test results in combat sports (Halabchi, 2009). Fluid restriction will also result in forced dehydration, which can negatively affect performance during competition (Oppliger et al., 1996). Reducing fat intake is an important strategy for reducing body mass without affecting lean body mass; however, eating less fat does not seem to have an effect in the few days before competition. In addition, a diettian must plan for fat restriction because there are essential fatty acids that should not be removed from the diet (American Dietetic Association et al., 2009; Morton et al., 2010).

Much of the misconduct regarding rapid weight loss may be avoided by proper guidance. It is important that professionals use caution when prescribing strategies for body-mass reduction in athletes. For example, Zinn, Schofield, and Wall (2006) found that rugby coaches had little knowledge and improperly instructed their athletes in this regard. In Brazil, Juzwiak and Ancona-Lopez (2004) also found errors in the nutritional guidance coaches provided young athletes. Another issue that contributes to mistakes in guidance is the small demand for dietitians (26.1%), the professionals most qualified to guide athletes in body-mass manipulation. Table 2 shows the percentage of fat that allows body-mass reduction. Long-term planning and gradual reduction are recommended for male athletes, who should have at least 7% body fat to avoid harming their health (Perriello, 2001). For the athletes in our sample it would be reasonable to try reducing body-fat percentage, because this value was higher than that previously reported in high-level combat sport athletes (Franchini, Del Vecchio, Matsushigue, & Artioli, 2011; Yoon, 2002). However, it seems that when large samples of combat sport athletes are analyzed, their body-fat percentage is higher than those in these high-level groups. A recent publication (Kordi et al., 2011) reported that a large sample (n = 436) of Iranian wrestlers presented values (95% confidence interval of 15.2–16.7% of body fat) similar to those from our study.

This was the first study to simultaneously examine four styles of popular combat sports in Brazil. We observed a similarity between the sports when dealing with inappropriate behaviors to reduce body mass. It seems obvious that in the culture of combat sports there is a belief in the benefits of these strategies for competition. In an attempt to better educate coaches and athletes, it would be interesting to establish guidance campaigns through conferences and seminars. Another factor that would certainly contribute to reducing the prevalence of inadequate strategies would be to create a regulation that prohibits such actions, similar to the one implemented by the National Collegiate Athletic Association (Oppliger et al., 2006) or as recently proposed by Artioli, Franchini, et al. (2010). According to Oppliger et al. (2006), 40% of athletes stated that these new rules make rapid weight loss difficult, especially the adoption of the minimum fat percentage (5%).

Among the limitations of this study are the exclusion of the females, because the number of female athletes is minimal, and the use of a doubly indirect method to estimate body composition. Future studies should directly measure the loss of fluids and body mass.

**Conclusion**

Considering the established goals and results, we concluded that a high percentage of athletes are involved in rapid-weight-loss methods. Furthermore, a high percentage of athletes used nonrecommended or prohibited methods such as diuretics, saunas, and plastic clothing. The age at which the athletes reduced body mass for the first time is worrisome, especially among strikers. The results obtained here can be used to better educate athletes to avoid poor health, and even death.

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