

# Weight loss practices in Taekwondo athletes of different competitive levels

Jonatas Ferreira da Silva Santos<sup>1,\*</sup>, Monica Yuri Takito<sup>1</sup>, Guilherme Giannini Artioli<sup>1,2</sup>, Emerson Franchini<sup>1</sup>

<sup>1</sup>Martial Arts and Combat Sports Research Group, Sport Department, School of Physical Education and Sport, University of São Paulo, São Paulo, Brazil

<sup>2</sup>Laboratory of Applied Nutrition and Metabolism, School of Physical Education and Sport, University of Sao Paulo, São Paulo, Brazil

This study investigated the prevalence, magnitude, and methods of rapid weight loss among male and female Taekwondo athletes from all competitive levels. A questionnaire was administered to 72 men (regional/state level,  $n=31$ ; national/international level,  $n=41$ ) and 44 women (regional/state level,  $n=9$ ; national/international,  $n=35$ ). Among the male athletes, 77.4% of the regional/state level and 75.6% of the national/international athletes declared to have reduced weight to compete in lighter weight categories. Among women, 88.9% of regional/state level and 88.6% of national/international level reported the use of rapid weight loss strategies. Athletes reported to usually lose ~3% of their body weight, with some athletes reaching ~7% of their body weight. The methods used to achieve weight loss are potentially dangerous to health and no difference between sexes was found. Four

methods were more frequently used by men athletes in higher competitive levels as compared to lower levels, as follows: skipping meals ( $Z=2.28$ ,  $P=0.023$ ,  $\eta^2=0.21$ ), fasting ( $Z=2.337$ ,  $P=0.019$ ,  $\eta^2=0.22$ ), restricting fluids ( $Z=2.633$ ,  $P=0.009$ ,  $\eta^2=0.24$ ) and spitting ( $Z=2.363$ ,  $P=0.018$ ,  $\eta^2=0.22$ ). Taekwondo athletes lost ~3% of their body mass, using methods potentially dangerous for their health. Although no difference was found between sexes, lower level athletes more frequently used methods such as skipping meals, fasting, restricting fluids and spitting. Considering that these health-threatening methods are more commonly used by lower level athletes, specific education programs should be directed to them.


**Keywords:** Combat sports, Weight-cyclers, Rapid weight loss

## INTRODUCTION

Taekwondo is an Olympic weight-categorized combat sport in which matches are typically organized in three 2-min rounds with 1-min rest interval between rounds (World Taekwondo Federation, 2015), imposing a high physiological demand to the athletes. The main goal of the Taekwondo athlete is to score points or to obtain a technical knockout (Bridge et al., 2014). In state-, national- and regional-level competitions, adult men (<54, <58, <63, <68, <74, <80, <87, and >87 kg) and women (<46, <49, <53, <57, <62, <67, <73, and >73 kg) compete in eight distinct weight divisions whereas in the Olympic Games there are four weight categories (men: <58, <68, <80, and >80 kg; women: <49, <57, <67, and >67 kg). The purpose of this classification is to equalize differences in strength, agility and

leverage among competitors (Artioli et al., 2010a). Many athletes, in order to qualify to lighter weight classes and obtain competitive advantage, use methods that may negatively affect health and performance. As athletes perform several competitions across a season, weight loss procedures are repeated many times over their competitive careers (Brito et al., 2012; Kazemi et al., 2011).

There is evidence indicating that exercise capacity in Taekwondo athletes is more affected by rapid (four days) than gradual (four weeks) body mass reduction, probably because gradual reduction preserves muscle mass while potentiating fat loss (Yang et al., 2014). Additionally, body mass reduction affects the water and imbalance in electrolyte (Yang et al., 2015). When rapid weight reduction (four days) and gradual weight reduction (four weeks) are realized, the basal parameters not are affected, but the rapid weight reduction negatively affect hemorheological parameters

\*Corresponding author: Jonatas Ferreira da Silva Santos  <http://orcid.org/0000-0002-3309-4731>  
Martial Arts and Combat Sports Research Group, Sport Department, School of Physical Education and Sport, University of São Paulo, Av. Prof. Mello Moraes, 66, Cidade Universitária—CEP: 05508-030—São Paulo, Brazil  
Tel: +55-11-5012-7947, Fax: +55-11-3091-3135, E-mail: jonatas\_contato@hotmail.com  
Received: April 6, 2016 / Accepted: May 6, 2016

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

and nitric oxide that is signaling in red blood cells (Yang et al., 2014; Yang et al., 2015) and the kick frequency of Taekwondo athletes is negatively affected (Yang et al., 2014), and these factors can affect the performance in Taekwondo athletes. However, although experts recommending gradual weight reduction (Oppliger et al., 1996) sport combat athletes of combat sports remain in practice rapid weight reduction (Franchini et al., 2012). This practice is applied because the athletes think that there will be advantage over weaker opponents. However, it was reported that though Taekwondo athletes reduce body weight in both rapid and gradual manner, the body fat was significantly reduced only with gradual weight reduction (Yang et al., 2014).

Recently, some studies have confirmed that Taekwondo athletes reduce body mass to compete (Brito et al., 2012; Drummond et al., 2014; Elsayy et al., 2014; Fleming and Costarelli, 2007; Franchini et al., 2012; Kazemi et al., 2011), but data on prevalence, magnitude and methods of rapid weight loss in this population remain scarce (Brito et al., 2012). In addition, it remains unknown how gender and competitive level influence weight management behaviors in Taekwondo athletes. It is possible that the competitive practices of more prominent level of Taekwondo athletes are more frequent and aggressive to health. Thus, the purpose of the present investigation is to examine the prevalence, magnitude and methods of weight reduction in Taekwondo athletes.

## MATERIALS AND METHODS

### Subjects

One hundred and sixteen black-belt Taekwondo athletes (men,  $n=72$ ; women,  $n=44$ ) who were actively competing at state-level

or more prominent competitions (regional/state medal winners,  $n=40$ ; national/international medal winners,  $n=76$ ) volunteered to participate in the study. Athletes were contacted in their training centers or in competition venues. Initially, athletes were provided with an explanation about the goals of the study; those who agreed to participate signed the consent form and then completed a questionnaire about diet and weight management. The procedures used in the study were approved by the Institutional Ethics Committee on Human Research. Participant's characteristics are presented in Table 1.

### Procedures

The questionnaire used in the present study was slightly adapted from a previously validated version for Judo athletes (Artioli et al., 2010b), which includes questions on sample characterization, prevalence and magnitude of weight loss, and methods for rapid weight loss. The questionnaire has a scoring system that allows for the assessment of the aggressiveness of weight management behaviors; the higher the score obtained by the athlete, the more aggressive his/her behaviors. The original version of the questionnaire has been previously validated for content, discriminant capacity and reliability (Artioli et al., 2010b).

### Statistics

A normality Shapiro-Wilk test was initially performed to check data distribution. When appropriate, a two-way (sex and competitive level) analysis of variance was used to compare groups. When significant differences were detected, the Fisher least significant difference *post hoc* test was used for multiple comparison purposes. For nonnormally distributed data the Mann-Whitney test was

**Table 1.** Characteristics and Taekwondo involvement in women and men Taekwondo athletes from regional to international level

Variable	Women		Men	
	Regional/state level ( $n=9$ )	National/international level ( $n=35$ )	Regional/state level ( $n=31$ )	National/international level ( $n=41$ )
Age (yr)	23.9±5.9	19.8±4.2 <sup>a)</sup>	21.6±5.8	22.3±5.5
Body mass (kg) <sup>b)</sup>	59.6±8.6	54.8±9.1	69.2±14.9	70.5±15.1
Height (cm) <sup>b)</sup>	162.7±7.9	163.3±6.9	176.6±8.3	176.6±8.3
Age began practicing Taekwondo (yr) <sup>c,d)</sup>	16.2±5.3 <sup>e)</sup>	11.1±4.3	11.3±3.7	10.9±4.6
Age began competing in Taekwondo (yr)	16.4±7.4	13.0±4.0	13.5±3.6	13.0±3.9
Competitions during the year (n) <sup>f)</sup>	4±1	9±1	5±1	7±1
Medals during the year (n) <sup>f)</sup>	4±1	8±1	4±1	6±1

Values are presented as mean ± standard deviation.

<sup>a)</sup>Interaction effect, younger than women regional/state level and men national/international level ( $P<0.05$ ). <sup>b)</sup>Sex effect, women < men ( $P<0.001$ ). <sup>c)</sup>Sex effect, men < women ( $P<0.01$ ). <sup>d)</sup>Competitive level effect, national/international level < regional/state ( $P<0.01$ ). <sup>e)</sup>Interaction effect, women at regional/state level differed from all other groups ( $P<0.01$ ). <sup>f)</sup>Competitive level effect, national/international level > regional/state ( $P<0.01$ ).

used. The Mantel–Haenzel test was used to determine the association between sexes and competitive levels. When appropriate, the effect size was calculated using the eta-squared ( $\eta^2$ ), which was classified according to Hopkins using the following scale: <0.1 (trivial); 0.1 to <0.3 (small); 0.3 to <0.5 (moderate); 0.5 to <0.7 (large); 0.7 to <0.9 (very large); 0.9 to 1 (perfect) (Hopkins, 2015). The alpha was set a priori at 5%.

## RESULTS

There was a sex and competitive level interaction effect on age ( $F = 4.14, P = 0.044, \eta^2 = 0.04$  [trivial]), with women from the national/international level group being younger than women from the regional/state level ( $P = 0.041$ ) and men from the national/international level groups ( $P = 0.044$ ). There was an effect of sex on body mass ( $F = 19.2, P < 0.001, \eta^2 = 0.15$  [small]) with higher values for men as compared to women ( $P < 0.001$ ). The Mann–Whitney test indicated no differences between competitive levels ( $Z = -1.5, P = 0.137, \eta^2 = 0.14$  [small]) concerning athletes' stature. However, a significant difference between sexes ( $Z = -7.0, P < 0.001, \eta^2 = 0.65$  [large]) was detected, with men being taller than women. The age the athletes began to practice Taekwondo differed between sexes ( $F = 7.1, P = 0.009, \eta^2 = 0.06$  [trivial]), with women starting at older ages in comparison to men ( $P = 0.009$ ). There was an effect of competitive level for age the athletes began to practice Taekwondo ( $F = 8.1, P = 0.005, \eta^2 = 0.07$  [trivial]), with earlier start

for state/international level athletes ( $P = 0.005$ ). There was also an interaction effect of sex and competitive level on the age they began to practice Taekwondo ( $F = 5.8, P = 0.018, \eta^2 = 0.05$  [trivial]), with regional/state level women athletes starting later than all other groups ( $P = 0.003$  for men at the same level,  $P = 0.001$  for men at the national/international level and  $P = 0.002$  for women at the national/international level). There was an effect of competitive level on the number of competitions during the year ( $F = 12.4, P = 0.001, \eta^2 = 0.10$  [small]), with higher number of competitions disputed by national/international level athletes ( $P = 0.001$ ). There was also an effect of competitive level for number of medals won during the year ( $F = 13.0, P < 0.001, \eta^2 = 0.10$  [small]), with higher number of medals conquered by national/international level athletes ( $P < 0.001$ ).

When considering the athletes who reported to have reduced body mass, 77.4% of regional/state level men, 75.6% of national/international level men, 88.9% of regional/state level women and 88.6% of national/international level women used procedures to compete in lower weight categories. When heavyweight athletes are excluded 79.3% of regional/state level men, 75% of national/international level men, 88.9% of regional/state level women and 91% of national/international level women used procedures to compete in lower weight categories. No differences were found between groups from different competitive levels ( $m-h = 0.0292; P = 0.8636$ ).

For the remaining questions, only the athletes who reported to

**Table 2.** Weight loss characteristics in women and men Taekwondo athletes from different competitive levels\*

Variable	Women		Men	
	Regional/state level (n=8)	National/international level (n=31)	Regional/state level (n=24)	National/international level (n=31)
Off-season body mass (kg) <sup>a)</sup>	61.2±9.4	54.8±9.1	70.3±16.7	73.0±17.7
Most weight lost (kg)	4.3±2.7	4.6±2.6	4.3±3.9	5.3±3.1
Most weight lost (%)	7.0±4.4	8.4±4.8	6.1±5.5	7.3±4.3
No. of weight reductions last year	2±1	4±4	2±4	3±3
Weight usually lost (kg)	2.2±1.9	1.8±1.1	1.6±1.4	2.2±1.7
Weight usually lost (%)	3.6±3.1	3.3±2.0	2.3±2.0	3.0±2.3
No. of days which weight is usually lost	19±19	12±12	10±8	10±7
Age began cutting weight (yr) <sup>b)</sup>	22.5±5.3 <sup>c)</sup>	16.2±2.3 <sup>d)</sup>	18.3±4.9	17.6±3.6
Weight usually regained in the week after competitions (kg)	1.3±0.8	1.6±1.1	1.2±1.0	2.0±1.5
RWLQ score	35.0±10.4	57.3±47.1	43.3±21.3	60.9±37.5

Values are presented as mean ± standard deviation.

RWLQ, Rapid Weight Loss Questionnaire.

<sup>a)</sup>Sex effect, men > women ( $P < 0.001$ ). <sup>b)</sup>Competitive level effect, national/international level < regional/state level ( $P < 0.001$ ). <sup>c)</sup>Sex and competitive level interaction effect, women regional/state level > than all other groups ( $P < 0.01$ ). <sup>d)</sup>Sex and competitive level interaction effect, women national/international level < men regional/state level ( $P < 0.05$ ). \*Only the athletes who reported to reduce body mass were included in the analysis.

reduce body mass were included in the analysis (Table 2).

Sexes differed concerning off-season body mass ( $Z = -5.3$ ,  $P < 0.001$ ,  $\eta^2 = 0.49$  [moderate]), with higher values for men as compared to women. Competitive level was not a factor influencing off-season body mass ( $Z = -1.4$ ,  $P = 0.170$ ,  $\eta^2 = 0.13$  [small]) (Table 2).

No effect of sex, competitive level or interaction were found for the following variables: most weight lost (both absolute and relative to body mass), number of weight reductions in the previous season, weight usually lost, number of days the weight was lost,

weight usually regained in the week after competitions, percentage of average weight lost and the Rapid Weight Loss Questionnaire score.

The age at which athletes began to cut weight differed between competitive levels ( $F = 15.2$ ,  $P < 0.001$ ,  $\eta^2 = 0.10$  [small]), with national/international level athletes starting earlier in their careers. There was also an interaction effect between sex and competitive level on the age at which athletes began to cut weight ( $F = 9.4$ ,  $P = 0.003$ ,  $\eta^2 = 0.10$  [small]). Women from the regional/state level group started to lose weight later than all other groups (vs men

**Table 3.** Weight loss methods in women Taekwondo athletes from different competitive levels

Method	Women state level (n=8)					Women international level (n=31)				
	Always (%)	Sometimes (%)	Almost never (%)	Never (%)	Do not use anymore (%)	Always (%)	Sometimes (%)	Almost never (%)	Never (%)	Do not use anymore (%)
Gradual dieting	37.5	37.5	12.5	12.5	0	29.0	32.3	22.6	9.7	6.5
Skipping one or two meals	50.0	37.5	12.5	0	0	16.1	48.4	12.9	12.9	9.7
Fasting	37.5	12.5	37.5	12.5	0	25.8	19.4	19.4	25.8	9.7
Restricting fluids	37.5	25.0	37.5	0	0	32.3	22.6	19.4	19.4	6.5
Increased exercise	62.5	25.0	12.5	0	0	45.2	38.7	6.5	9.7	0
Heated training rooms	12.5	12.5	25.0	50.0	0	29.0	22.6	12.9	29.0	6.5
Sauna	25.0	62.5	12.5	0	0	9.7	12.9	12.9	45.2	19.4
Training with rubber/plastic suits	25.0	12.5	12.5	37.5	12.5	38.7	29.0	12.9	16.1	3.2
Using winter or plastic suits	12.5	12.5	75.0	0	0	3.2	3.2	9.7	80.6	3.2
Spitting	12.5	87.5	0	0	0	6.5	22.6	19.4	41.9	9.7
Laxatives	25.0	75.0	0	0	0	9.7	16.1	58.1	16.1	0
Diuretics	12.5	75.0	12.5	0	0	16.1	6.5	58.1	19.4	0
Diet pills	75.0	25.0	0	0	0	9.7	3.2	80.6	6.5	0

**Table 4.** Weight loss methods in men Taekwondo athletes from different competitive levels

Method	Men state level (n=8)					Men international level (n=31)				
	Always (%)	Sometimes (%)	Almost never (%)	Never (%)	Do not use anymore (%)	Always (%)	Sometimes (%)	Almost never (%)	Never (%)	Do not use anymore (%)
Gradual dieting	28.0	36.0	20.0	16.0	0	19.4	35.5	22.6	16.1	6.5
Skipping one or two meals <sup>a)</sup>	8.0	16.0	36.0	32.0	8.0	19.4	38.7	16.1	19.4	6.5
Fasting <sup>a)</sup>	16.0	16.0	68.0	0	0	12.9	29.0	16.1	35.5	6.5
Restricting fluids <sup>a)</sup>	4.0	40.0	12.0	44.0	0	22.6	48.4	9.7	19.4	0
Increased exercise	48.0	40.0	4.0	8.0	0	35.5	41.9	9.7	9.7	3.2
Heated training rooms	28.0	40.0	28.0	4.0	0	22.6	29.0	19.4	25.8	3.2
Sauna	4.0	8.0	20.0	60.0	8.0	6.5	16.1	12.9	61.3	3.2
Training with rubber/plastic suits	36.0	24.0	4.0	24.0	12.0	25.8	32.3	16.1	19.4	6.5
Using winter or plastic suits	8.0	4.0	8.0	76.0	4.0	6.5	3.2	16.1	74.2	0
Spitting <sup>a)</sup>	4.0	8.0	12.0	76.0	0	9.7	32.3	12.9	45.2	0
Laxatives	8.0	4.0	88.0	0	0	3.2	19.4	71.0	6.5	0
Diuretics	4.0	96.0	0	0	0	9.7	9.7	77.4	3.2	0
Diet pills	4.0	96.0	0	0	0	9.7	83.9	6.5	0	0

<sup>a)</sup>Competitive level effect, national/international level < regional/state level ( $P < 0.05$ ).

from regional/state level:  $P = 0.008$ ; vs men from national/international level:  $P = 0.001$ ; vs women from national/international level:  $P < 0.001$ ). In addition, women from national/international level started early than men from regional/state level ( $P = 0.044$ ) (Tables 3, 4).

No differences ( $P > 0.05$ ) between sexes were found for the methods of weight reduction (Tables 3, 4). Four methods were more frequently used by men in the higher competitive levels as compared to lower competitive levels: skipping meals ( $Z = 2.28$ ,  $P = 0.023$ ,  $\eta^2 = 0.21$  [small]), fasting ( $Z = 2.34$ ,  $P = 0.019$ ,  $\eta^2 = 0.22$  [small]), restricting fluids ( $Z = 2.63$ ,  $P = 0.009$ ,  $\eta^2 = 0.24$  [small]) and spitting ( $Z = 2.36$ ,  $P = 0.018$ ,  $\eta^2 = 0.22$  [small]).

## DISCUSSION

The present study aimed to investigate the prevalence, magnitude, and methods of rapid weight loss among Taekwondo athletes. The main findings were as follows: (a) Taekwondo athletes usually lose  $\sim 2$  kg ( $\sim 3\%$  of body mass); (b) the most weight lost was 4–6 kg (6%–9% of body mass); (c) athletes usually reduce weight 2–4 times during the season; (d) athletes usually reduce weight in 10–20 days; (e) athletes use several inappropriate or prohibited methods such plastic clothing, laxatives, diuretics and other methods that can impose risks to health; (f) in men, the methods for weight reduction are more aggressive in less prominent competitive levels, although this does not hold true for women athletes; and (g) athletes competing at national/international levels begin to reduce weight to compete at younger ages.

Although women from regional level started to practice Taekwondo older than all other groups, the participation in competitions started when athletes were 13 to 16 yr of age, with no other statistical difference between genders or competitive levels. Generally, federations organize competitions for young Taekwondo athletes from 10–11 yr of age (Casolino et al., 2012), while the athletes of the present study began competing older, shortly after the beginning in the sport. Probably this behavior also happens with athletes who begin the practice of Taekwondo younger than the participants of this study; however, these young athletes participate in competitions whose rules are adapted to their age (Casolino et al., 2012). The Taekwondo athletes participate in many competitions during the year, and the national/international level athletes, regardless of sex, participate in more competitions than the regional/state level athletes. Probably, this pattern is related to the fact that many competitions are eliminatory and only more successful athletes can compete in the more advanced

phases, thus national/international level athletes take part in more competition due to their achievement in these competitions.

There is evidence that adolescent Taekwondo athletes (14–16 years) reduce body mass to compete, with difference of  $\sim 1.02$  to 1.09 kg between the weigh-in and the time prior to the competition (16–20 hr later) (Brito et al., 2012; Kazemi et al., 2011). The prevalence and magnitude of rapid weight loss among Taekwondo athletes in our study are similar to that reported previously (Brito et al., 2012). The magnitude of weight usually lost reported by athletes in our study was 2%–4% of body mass, while the most body mass lost was  $\sim 7\%$ . This result is similar to studies with Taekwondo (usually lost: 4%; Brito et al., 2012), Judo athletes (most weight lost:  $\sim 6\%$ ; usually lost: 2%–5%; Artioli et al., 2010a) and high school wrestlers (4.3%; Kiningham and Gorenflo, 2001). In accordance with previous investigations, we also found that rapid weight loss commonly starts when athletes are still adolescents (Kazemi et al., 2011).

In our study, the Taekwondo athletes reported to lose weight in 10–20 days, which is in line with other surveys with Taekwondo athletes ( $\sim 10$  days; Brito et al., 2012) and suggests that in other combat sports, such as Judo and Wrestling, athletes lose weight in shorter periods of time (Artioli et al., 2010a; Brito et al., 2012). Gradual weight loss (i.e., 4 weeks) has been shown to be a preferable method for adjusting body mass and body composition as opposed to rapid weight loss (i.e., 4 days), since it potentiates fat loss rather than lean mass loss, preserves anaerobic performance and reduces the rating of perceived exertion (Yang et al., 2014). Although Taekwondo athletes seem to prefer more gradual weight losses as compared to other combat sport athletes, the usual time frame to reduce weight (10–20 days) may be still too short to be considered as an appropriate strategy for weight management. This is reinforced by the aggressive methods for weight reduction reported in the present investigation.

One study reported that athletes from striking combat sports (Karate and Taekwondo: 13–14 yr, respectively) begin to lose weight to compete younger than grappling combat sports athletes (Judo and Jiu-Jitsu: 17–21 yr) (Brito et al., 2012). However, older ages were observed in the present study. The women athletes of national/international of this study began to lose weight earlier (16 yr) than the regional/state level athletes (22 yr) and then men athletes of regional/state (18 yr). Moreover, the age at which the Taekwondo athletes from our study began to lose weight is higher than that of Judo athletes (12 yr) (Artioli et al., 2010a). Athletes quickly regain the lost weight during the competition. The first week after competitions the athletes of the present study reported



a 1–2 kg increase in body mass, a similar regain as observed in Judo athletes (~1.6 kg) (Artioli et al., 2010a).

In the present study, 51.1% of athletes reported to have started to lose weight before 18 yr of age, which has been consistently reported in other rapid weight loss surveys (Artioli et al., 2010a; Brito et al., 2012). In our study, the youngest age at which an athlete started to cut weight was 12 yr. In the literature, more extreme cases have been reported, such as athletes younger than 10 (Artioli et al., 2010a) or even a 5-yr-old boy (Sansone and Sawyer, 2005). Our data confirm previous evidence that competing at higher levels is associated with worsened weight management behaviors (Artioli et al., 2010a), which can be evidenced by the younger ages at which international/national athletes started to lose weight. Children and adolescents reducing weight to compete can be exposed to additional health risks in comparison to their adult counterparts.

Evidence suggests that weight loss during adolescence adversely affect the hormonal balance, possibly interfering with growth and development (Brownell et al., 1987; Franchini et al., 2012; Roemmich and Sinning, 1997). Additionally, athletes who start losing weight very young may adopt more extreme weight management behaviors during adulthood (Artioli et al., 2010a) and develop several health-related problems (Roemmich and Sinning, 1997). In the study of Roemmich and Sinning (1997), increased growth hormone and decreased testosterone, insulin-like growth factor-I and growth hormone binding protein were reported during a competitive wrestling season as compared to the off-season period. Moreover, a partial resistance to growth hormone and changes in pituitary-gonads were observed, suggesting that weight cycling through a season may endanger normal growth. However, these changes returned to normal after the end of the season, when athletes usually normalize their food intake and reduce training volume.

The most commonly used weight loss methods are dehydration (obtained by the restriction of fluid intake, the use of plastic suits or clothing or by the use of saunas), and restriction of energy intake (skipping meals or not eating during the day) (Franchini et al., 2012). In addition to the common methods, extreme and more dangerous methods, such as laxatives, diuretics, diet pills or vomiting are often reported to be used by a considerable part of combat athletes (Franchini et al., 2012). Food restriction has also been a common practice among Taekwondo athletes on competition's eve with a negative energy balance in this period being reported (Drummond et al., 2014; Elsayy et al., 2014; Fleming and Costarelli, 2007). Although the proportion of ingested macronutrients have been appropriate, the absolute amounts of pro-

teins, carbohydrates and lipids were probably not sufficient to match their demands and below the current recommendations (Drummond et al., 2014).

In our study, the methods for weight loss used by women athletes of regional/state level were not different from those used by athletes to national/international level. However, national/international level men athletes more frequently skipped 1 or 2 meals, fasted, restricted fluids ingestion and spitted than regional/state level men athletes. These methods are used by Taekwondo, Karate, Judo and Jiu-Jitsu (Artioli et al., 2010a; Brito et al., 2012). This difference can be explained by the need to use more severe methods by athletes who practice weight-cycling (McCargar and Crawford, 1992) and who took part in more competitions during the season (resulting in less time to conduct gradual weight loss).

The results of the current study have shown that Taekwondo athletes use a variety of methods for weight loss. Although weight reduction in some athletes exceed 5% of body mass, most athletes lose less than 5% of body mass within 10–20 days. These indicate that, despite prevalent and achieved by similar methods used in other combat sports, weight loss in Taekwondo is more gradual and of lower magnitude. Even so, there is no evidence that this behavior is free of risks to health and performance, therefore athletes should be discouraged to reduce weight by any means leading to dehydration and starvation. Increasing the usual amount of exercise and adjusting diet in long-term appear to be the most appropriate procedures when performed throughout the competitive season. Thus, the professionals involved with the physical conditioning of Taekwondo athletes should include in their training programs plans setting weight and long-term body composition.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

## ACKNOWLEDGMENTS

The authors are glad to the athletes who participated in the study.

## REFERENCES

- Artioli GG, Gualano B, Franchini E, Scagliusi FB, Takesian M, Fuchs M, Lancha AH Jr. Prevalence, magnitude, and methods of rapid weight loss among judo competitors. *Med Sci Sports Exerc* 2010a;42:436-442.

- Artioli GG, Scagliusi F, Kashiwagura D, Franchini E, Gualano B, Junior AL. Development, validity and reliability of a questionnaire designed to evaluate rapid weight loss patterns in judo players. *Scand J Med Sci Sports* 2010b;20:e177-187.
- Bridge CA, Ferreira da Silva Santos J, Chaabène H, Pieter W, Franchini E. Physical and physiological profiles of Taekwondo athletes. *Sports Med* 2014;44:713-733.
- Brito CJ, Roas A FC, Brito I SS, Marins J CB, Córdova C, Franchini E. Methods of body mass reduction by combat sport athletes. *Int J Sport Nutr Exerc Metab* 2012;22:89-97.
- Brownell KD, Steen SN, Wilmore JH. Weight regulation practices in athletes: analysis of metabolic and health effects. *Med Sci Sports Exerc* 1987;19:546-556.
- Casolino E, Lupo C, Cortis C, Chiodo S, Minganti C, Capranica L, Tessitore A. Technical and tactical analysis of youth Taekwondo performance. *J Strength Cond Res* 2012;26:1489-1495.
- Drummond MD, Couto BP, Eufrásio RJ, Gonçalves R, Smuchrowski LA. Energy balance in Taekwondo athletes during pre-competition. *Arch Budo* 2014;10:195-199.
- Elsawy G, Abdelrahman O, Hamza A. Effect of choline supplementation on rapid weight loss and biochemical variables among female Taekwondo and judo athletes. *J Hum Kinet* 2014;40:77-82.
- Fleming S, Costarelli V. Nutrient intake and body composition in relation to making weight in young male Taekwondo players. *Nutr Food Sci* 2007;37:358-366.
- Franchini E, Brito CJ, Artioli GG. Weight loss in combat sports: physiological, psychological and performance effects. *J Int Soc Sports Nutr* 2012;9:52.
- Hopkins WG. A new view of statistics. a scale of magnitudes for effect statistics [Internet]. 2015 [cited 2013 Oct 7], Available from: <http://www.sportsci.org/resource/stats/effectmag.html>.
- Kazemi M, Rahman A, De Ciantis M. Weight cycling in adolescent Taekwondo athletes. *J Can Chiropr Assoc* 2011;55:318-324.
- Kinningham RB, Gorenflo DW. Weight loss methods of high school wrestlers. *Med Sci Sports Exerc* 2001;33:810-813.
- McCargar LJ, Crawford SM. Metabolic and anthropometric changes with weight cycling in wrestlers. *Med Sci Sports Exerc* 1992;24:1270-1275.
- Oppliger RA, Case HS, Horswill CA, Landry GL, Shelter AC. American College of Sports Medicine position stand. Weight loss in wrestlers. *Med Sci Sports Exerc* 1996;28:ix-xii.
- Roemmich JN, Sinning WE. Weight loss and wrestling training: effects on growth-related hormones. *J Appl Physiol* (1985) 1997;82:1760-1764.
- Sansone RA, Sawyer R. Weight loss pressure on a 5 year old wrestler. *Br J Sports Med* 2005;39:e2.
- World Taekwondo Federation [WTF]. Competition rules [internet]. Seoul: WTF; c2015 [cited 2015 Feb 05], Available from: [http://www.wtf.org/wtf\\_eng/site/rules/competition.html](http://www.wtf.org/wtf_eng/site/rules/competition.html).
- Yang WH, Grau M, Kim P, Schmitz A, Heine O, Bloch W, Mester J. Physiological and psychological performance of Taekwondo athletes is more affected by rapid than by gradual weight reduction. *Arch Budo* 2014;10:169-177.
- Yang WH, Heine O, Pauly S, Kim P, Bloch W, Mester J, Grau M. Rapid rather than gradual weight reduction impairs hemorheological parameters of Taekwondo athletes through reduction in RBC-NOS activation. *PLoS One* 2015;10:e0123767.