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Effect of 12 hour-fasting promoted by breakfast omission on acute weight loss and physical performance of taekwondo athletes

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A Study Design
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Ronaldo AD Silva[1,2ABCD], **Leszek A Szmuchrowski**[2DE], **Paula Simonini**[2BD], **Cristiano AG Flôr**[1,2ABD], **Bruno VC da Silva**[3,4CD], **Marcos DM Drummond**[2ABCD]

[1] Estácio de Sá University Center of Belo Horizonte, Minas Gerais, Brazil
[2] School of Physical Education, Physiotherapy and Occupational Therapy, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil
[3] University of Itaúna, Minas Gerais, Brazil
[4] University Center of Belo Horizonte, Minas Gerais, Brazil

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Abstract

Background & Study Aim: Fasting is one of the most used nutritional strategies for weight loss by taekwondo athletes, but it could decrease sports performance. However, fasting promoted by breakfast omission may be an efficient alternative to rapid weight loss without negatively impair performance. This study aim was answer to question: whether 12-hour fasting promoted by breakfast omission promotes acute weight loss and interferes with the general and specific physical performance of taekwondo athletes.

Material & Methods: In a randomized, double-blind, crossover design, 10 black belts taekwondo athletes performed two experimental sessions of countermovement jump (CMJ) and three rounds of Frequency of Speed Kick Test multiple (FSKTmult) series. Physical performance was determined by the total kicks of the three rounds (TK) and of each round (TKR) performed after fasting, in two conditions: after ingesting a placebo drink or a liquid meal. Rate perception effort of the mean of the three rounds (RPEm), rate perception effort of each round (RPE), the total kicks decrement index (TKDI) and the kicks decrement index in each round (KDI) were measured.

Results: Total body mass decrease significantly between pre (64.68 ±7.11 kg) and post-fasting (64.03 ±7.03 kg) ($p = 0.001$; $d = 0.09$; $\Delta = 1\%$). CMJ, TK, RPEm and TKDI were not different between situations. KDI was not different between rounds in any condition. TKR decreased ($p<0.001$) between the three rounds but not between situations. RPE was not different between situations ($p = 0.27$) but increased between rounds ($p<0.05$).

Conclusions: A 12-hour fasting promoted by breakfast omission may be efficient to significantly decrease total body mass, without decrease the physical performance of taekwondo athletes.

Keywords: body weight changes • combat sports • dietary restrictions • energy balance • placebo

Conflict of interest: Authors have declared that no competing interest exists

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Author's address: Ronaldo AD Silva, Laboratory of Load Evaluation, Physical Education School, Universidade Federal de Minas Gerais, Antônio Carlos Luz Av. 6.627, Belo Horizonte, Brazil; e-mail: ronaldo.angelo@estacio.br

Energy balance – difference between total daily caloric ingestion and expenditure.

Dietary restrictions – reduced intake of kilocalories and/or nutrients.

Fasting – total or partial abstinence from food intake for a predetermined period of time.

Breakfast omission – skipping breakfast.

Placebo – *noun* a tablet that appears to be a drug but has no medicinal substance in it, used in tests and trials [39].

Performance – *noun* the level at which a player or athlete is carrying out their activity, either in relation to others or in relation to personal goals or standards [39].

Roundhouse kick – a type of kick executed to the chest that generally starts in the sagittal plane and finishes in the lateral plane.

INTRODUCTION

Taekwondo is an intermittent combat sport with moments of high and low intensity, and due to these characteristics, anaerobic and aerobic metabolism are important for athlete performance [1]. Furthermore, this sport requires high levels of specific capacities, such as flexibility, speed and power, especially in the lower limbs [2]. The kicks are the most important specific skills of the modality, being responsible for the majority of points obtained in competitions [3], and *bandal tchagui* (roundhouse kick) is considered the most used kick in simulated fights and competitions [4]. To monitor changes in athlete performance, there are several tests and tools reported in the literature on combat sports [5], such as the countermovement jump (CMJ) [6], rate of perceived effort (RPE) [7] and the multiple series test (FSKTmult), which is a specific test frequently used for monitoring training and studying performance in taekwondo [4].

During competitions, taekwondo athletes are divided into weight categories [8, 9]. Aiming to avoid disqualification in a specific category, obtain a competitive advantage or minimize anthropometric differences, athletes adopt several strategies to reduce their total body mass [8, 10, 11]. However, when it occurs abruptly, weight loss can cause harm to health [12] and decrease the physical and psychological performance of athletes [13, 14]. This reduction in performance is attributed to many factors, especially to reductions in energy substrate availability, muscle mass, RPE, and general and specific resistance [12, 15].

Although the majority of coaches (92%) recommend that their athletes adopt gradual weight loss methods [11], in combat sport modalities, 60% of athletes report using some rapid weight loss method [16] that promotes aggressive weight loss less than 7 days before competition [9]. Janiszewska and Przybyłowicz [17] identified that approximately 70% of taekwondo athletes adopted acute weight loss strategies and 80% adopted dietary restrictions. One of the nutritional strategies most used by athletes aiming for acute and chronic weight loss is caloric restriction by fasting [17]. Santos et al. [18] affirmed that elite Taekwondo athletes fasted or omitted one or two meals on the day of competition as a strategy to promote acute weight loss.

Some studies showed that fasting does not reduce physical performance in combat sports [19, 20], while others reported that it does [21, 22]. However, most studies have investigated this effect during Ramadan [19, 20, 23, 24], which involves more prolonged periods of fasting than those commonly used in combat sports culture [25]. Therefore, possible comparisons and extrapolations to other cultures and fasting protocols are difficult to perform. In addition, in these studies, only general tests were applied [21, 22] and therefore do not represent the specific physical demands of taekwondo [26, 1]. Thus, breakfast omission may be a better alternative for athletes to promote acute weight loss [27] without causing greater physical and psychological stress than other weight loss protocols [12], mainly because food restriction is adopted at night during sleep time [27]. However, we did not find studies that investigated the effect of breakfast omission on acute weight loss and physical performance in taekwondo athletes.

Therefore, the aim of the present study was answer to question: whether 12-hour fasting promoted by breakfast omission promotes acute weight loss and interferes with the general and specific physical performance of taekwondo athletes.

It was expected (hypothesis) that fasting promotes a reduction in total body mass without decreasing the physical performance of taekwondo athletes.

MATERIAL AND METHODS

Design

This study used a randomized, double-blind, crossover design. The volunteers randomly performed two experimental sessions of general and specific

physical tests after a 12-hour fasting promoted by breakfast omission, with the two experimental conditions being separated by an interval of one week: after ingesting a placebo drink (PLA) and after ingesting a liquid meal (LM). Subsequently, the volunteers performed the CMJ test and three rounds of the FSKTmult. The kicks performed and RPE reported by the athletes during each round were recorded. Additionally, the kick decrement index (KDI) was determined to analyse performance and the development of fatigue.

Subjects

This study included 10 male black-belt taekwondo athletes with a mean age of 18.2 ±4.5 years, a mean body mass of 64.68 ±7.11 kg and a mean height of 175.5 ±7.2 cm. The inclusion criteria were as follows: athletes with stable weight before the study; athletes with expertise at the national and international level but who did not participate in any championship during the period of study. The exclusion criteria were as follows: athletes who presented any type of injury in the lower limbs in the last 3 months; athletes with a prescribed or intentional hypocaloric diet in the last 30 days; positive answers to any alternative in the Physical Activity Readiness Questionnaire (PAR-Q); any other reason that would lead to participant withdrawal.

The volunteers were informed of the procedures of the study and signed a consent form for participation. This study was approved by the ethics and research committee of Universidade Federal de Minas Gerais (protocol number: 2.582.067).

Procedures

The volunteers were randomly allocated to the two experimental situations with an interval of one week between them: PLA and LM. The liquid meal consisted of 40 grams of nutritional supplement with a ratio of 4 grams of carbohydrate to 1 gram of protein (4:1) [28], and the PLA consisted of a drink with the same flavour and colour but without calories and nutrients. The volume of both drinks was 400 ml, and they were consumed in 10 minutes, 60 minutes before the tests. The last meal on the nights before the tests was one slice of white bread stuffed with two medium slices of lean ham and 220 ml of orange juice. The volunteers were instructed to omit breakfast on the test mornings while maintaining their diets and consuming other meals normally during the study period. To verify changes in the volunteers' total body mass after 12 hours of fasting, a portable digital scale (Digi-Health, Multilaser, Brasil) was used to measure their body mass 1 hour after the last meal and immediately before ingesting the placebo drink or liquid meal the following morning. The volunteers were instructed to not train in the 48 hours prior to the experimental sessions and to go to sleep at the same time and for the same amount of time on the nights before the tests.

As soon as the volunteers arrived at the test site, approximately 9 a.m., capillary blood glucose was measured to confirm their normal glycaemic status; this procedure was performed using a glucometer (FreeStyle, Abbott Labs of Brasil Ltda, Brasil). The volunteers' glycaemic levels before ingesting the PLA or LM were 82.20 ±4.89 mg/dl. Subsequently, respecting the crossed and double-blind design, they ingested the PLA or LM. After this procedure, the volunteers awaited 60 minutes to perform the countermovement jump (CMJ) [6] and Frequency Speed of Kick Test multiple series (FSKTmult) [4] and to respond to the RPE scale [7].

Prior to execution of the CMJ test, the volunteers performed five minutes of warm up that consisted of two minutes of general and special training activities (e.g., jogging and moving randomly forward, backwards and sideways, skipping) and three minutes of specific training activities (e.g., sequence of kicks moving freely without physical contact). This procedure was performed as described by Silva et al. [29]. After the warm-up, all volunteers performed five jumps with a one-minute interval rest between attempts, and the highest height was used for statistical analysis. The CMJ test protocol was the same as that reported by Goulart et al. [6]. This test was performed with a contact mat (Hidrofit Ltda, Belo Horizonte, Brazil) with 0.1 cm accuracy. All volunteers were previously familiarized with the CMJ test protocol. After the CMJ test, the volunteers rested two minutes before performing three rounds of the FSKTmult with a one-minute interval rest between rounds. At the end of each round, the volunteers reported their RPE. This adaptation was made to attempt to simulate fight demands, as was done in another study that used a specific test with judokas [30]. Performance was determined by the total number of kicks in three rounds of (TK) the FSKTmult and by the number of total kicks (TK) performed

during each round (TKR). The RPE scale was used as suggested by Slimani et al. [7], where 0 is rest and 10 is extreme effort, and its results were analysed round by round (RPE) and as the mean of three rounds (RPEm). Furthermore, the kicks decrement index (KDI) during each round was analysed according to Santos and Franchini [4] and the total kicks decrement index (TKDI) of the three rounds. To analyse the TKDI, the number of kicks executed in the last set of the third round was subtracted from the number of kicks performed in the first set of the first round, and this value was divided by the number of kicks performed in the first set of the first round and multiplied by one hundred. The first set of the first round was considered to have the best performance due to the absence of fatigue from previous rounds.

Statistics analysis

The normality of the data was verified by the Shapiro-Wilk test. To compare the means of total body mass before and after 12 hours of fasting, the CMJ jump height, the total number of kicks (TK), the TKDI and the RPE between situations (PLA x LM), Student's t test was used. Descriptive statistics (mean ± standard deviation and confidence intervals (95% CIs)) were used to summarize the data analysed for each situation. To compare the performance during different rounds and the outcomes of the kicks performed in the FSKTmult, the KDI and RPE means were analysed with two-way ANOVA (situations x rounds). When necessary, Bonferroni's post hoc test was employed to identify where these differences occurred. The effect size was calculated based on Cohen's d classification. The level of global significance of the experiment was kept fixed at $\alpha = 0.05$. Statistical tests were performed in Statistical Package for Social Sciences (SPSS Inc. version 20.0, Chicago, EUA).

RESULTS

The total body mass was significantly lower post-fasting (64.03 ±7.03 kg) than pre-fasting (64.68 ±7.11 kg) (Δ = 1%; p = 0.001; CI: 0.59, 0.69). The effect size was trivial (d = 0.09). The CMJ height, TK, RPEm and TKDI did not show statistically significant differences between the PLA and LM conditions (Table 1).

Two-way ANOVA showed no effect of the condition on TKR performance, but independent of the condition, the results showed a statistically significant difference between rounds [$F_{(2, 18)}$ = 73.48; p <0.001]. Thus, more kicks were performed in round 1 (PLA: 89.80 ±6.95; LM: 89.90 ±8.33) than in round 2 (PLA: 84.00 ±7.19; LM: 84.90 ±8.71) and round 3 (PLA: 81.50 ±7.10; LM: 82.40 ±8.65). Furthermore, the TK also showed a statistically significant difference: it was higher in round 2 than in round 3.

Regarding the RPE, two-way ANOVA did not show a significant difference between conditions (PLA x LM), but independent of the condition, the results showed a significant difference between rounds [$F_{(2, 18)}$ = 31.64; p = 0.001]. In the PLA condition, the RPE increased between round 1 (7.30 ±1.41) and round 2 (8.70 ±1.25) and between round 1 and round 3 (9.40 ±1.07) but not between round 2 and round 3. In the LM condition, there was a significant increase in the RPE between the three rounds (Round 1: 7.80 ±1.75; Round 2: 9.10 ±0.87; Round 3: 10.00 ±0.00).

In comparisons of the KDI among the three rounds, two-way ANOVA did not yield statistically significant differences between rounds, independent of condition (PLA x LM) [$F_{(1, 9)}$ = 0.004; p = 0.951]. The KDI in the PLA condition was 9.30 ±2.75% in the first round, 11.50 ±3.56% in the second round and 10.20 ±3.19% in the third round. For the LM

Table 1. Test results (mean and standard deviation) regarding the volunteers' performance.

Test	PLA	LM	p value	CI	Cohen's d
$CMJ_{(cm)}$	38.06 ±5.99	38.42 ±5.70	0.493	−1.50, 0.78	−0.06
TK	255.30 ±20.46	257.20 ±25.20	0.505	−8.08, 4.28	−0.08
RPEm	8.50 ±1.26	9.10 ±0.87	0.279	1.77, 0.57	−0.55
$TKDI_{(\%)}$	22.74 ±5.92	20.74 ±5.08	0.264	−1.80, 5.80	0.36

Note: **PLA** placebo; **LM** Liquid meal; **p** p value; **CI** Confidence Interval; **CMJ** countermovement jump; **TK** the sum the total kicks of three rounds; **RPEm** mean of rate perception effort the three rounds; **TKDI** total kick decrement index of three rounds.

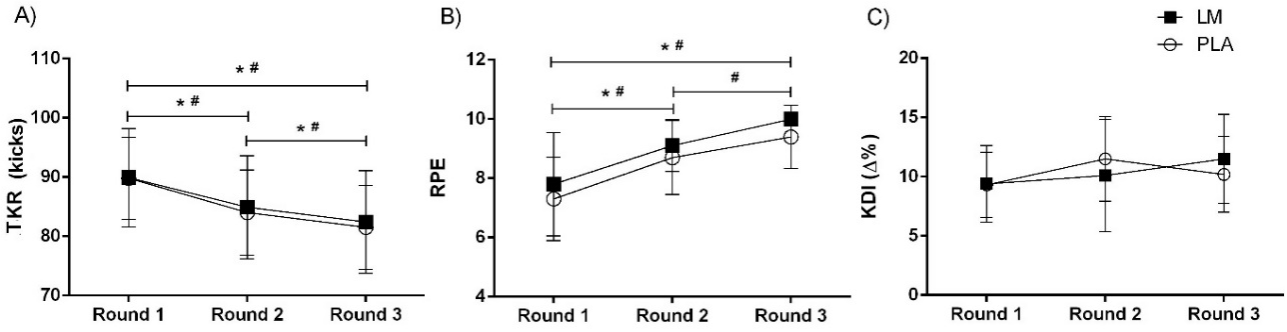

Figure 1. Mean and standard deviation of three rounds.

Note: TKR: total kicks performed in each round; RPE: rate perception effort round by round; KDI: kick decrement index in each round; *significant difference between rounds in PLA situation; #significant difference between rounds in LM situation. ($p<0.05$).

condition, the KDI was 9.40 ±3.23% in the first round, 10.10 ± 4.72% in the second round and 11.50 ± 3.77% in the third round (Figure 1).

DISCUSSION

In view of the main results, which showed a reduction in total body mass after 12 hours of overnight fasting without a decrease in performance on general or specific tests, the hypothesis that breakfast omission would promote acute weight loss without decreasing physical performance was proven.

A 12-hour fasting, restricted fiber diets and the use of laxative preparations and substances are the principal methods adopted by combat sports athletes aiming for acute weight loss through gastrointestinal manipulation [15]. According to Reale et al. [15], the principal benefits of this method are the loss of 1 to 2% of total body mass in a single day, which occurs due to the decrease in circulating food content in the gastrointestinal tract and a possible reduction in the glycogen and water stocks. Other possible benefits would be the minimal effect on acute nutritional status and performance [15]. Memari et al. [20] also investigated the effect of weight loss on physical performance in Taekwondo athletes. The results showed decreases in body mass of 1.19-1.63 kg between before, the middle and the end of the Ramadan period, without a significant change in the height of the CMJ. The results of the present study corroborate the results reported by this study. However, in another study conducted with judo athletes during Ramadan, the results showed a decrease in CMJ height [31]. Thus, although jumping tests are considered general tests for many sports [32], the choice of the test to be used must take into account the predominant energy metabolism and the specificity of the modality [26, 1], not just neuromuscular status.

Although we did not find studies where the FSKTmult was applied in three rounds with a 1-min rest interval with or without fasting, which makes this discussion difficult, our results for the TK performed during each round are near but not similar to those reported in other studies where the FSKTmult was applied in only one round with five 10-sec sets with a 10-sec rest interval without the athletes fasting [33, 4, 34]. The possible differences between the results of those studies and the results of our study may be partially explained by differences in the age and anthropometric characteristics of the volunteers because the mean age, height and body mass in the present study are lower than those in the studies previously cited. Another factor that must be taken into account in the present study was that the FSKTmult test was employed in the morning after 12 hours of fasting, which may be why no difference was detected in the FSKTtotal between the PLA and LM conditions. These results can be justified by the short time of fasting and muscle inactivity during the fasting period [27]. In these situations, during rest and sleep, the main substrates used by skeletal muscles are ketone bodies and fatty acids not the muscle glycogen stores [35], which are the main source of energy in training sessions and competitions [13].

The nutritional strategies adopted before or during a competition can increase the risk of fatigue during the sporting event [36]. Janiszewska and Przybyłowicz [17] identified a prevalence of fatigue in 47% of athletes who adopted strategies for acute weight loss. Hall and Lane [37] observed that combat sports athletes, who adopted strategies for acute weight loss for a period of one week, obtained a reduction of approximately 5.16% of their total body mass. In addition, associated with this loss, increased stress, tension, fatigue and reduced vigor during the period were reported by combat sports athletes [37]. Aloui et al. [24] affirmed that rapid weight loss can harm athletes' performance, especially due to severe dehydration, hyperthermia and reduced muscle glycogen stores. According to Koral and Dosseville [38], these harms can occur according to the time for which the weight loss strategy was applied, the composition of the lost body mass, the modality characteristics, and the magnitude of the dietary restriction to which the athlete was submitted. Yang et al. [14] observed a decrease in the physical performance of taekwondo athletes who lost approximately 5% of their total body mass in five days. Other studies have identified a decrease in sports performance in combat sports athletes who participated in acute weight loss strategies after an average minimum period of 10 days, extending to 19 days (16, 12, 18). These results suggest that after five days, these strategies may be sufficient to cause harm to sports performance, nutritional status and athletes' RPE. This may explain the maintenance of the physical performance observed in the present study after a single 12-hour fasting day, with breakfast omission. However, in the present study, no physiological measure was performed, which may limit the discussion of the results. Thus, other studies are necessary to investigate the effects of different fasting periods and protocols, such as breakfast omission, and the possible accumulated effects on the performance of taekwondo athletes submitted to general and specific test sessions.

However, in the present study, the results showed that there was no difference in RPEm between the PLA and LM conditions, but independently, the RPE increased throughout the rounds, similar to what occurs in simulated fights and official competitions [26, 1]. Furthermore, the TKDI and KDI showed no difference between conditions or rounds. These results demonstrate that regardless of the condition (PLA or LM), the athletes made the maximum possible effort during the tests, and they suggest that one day of 12-hour fasting promoted by breakfast omission does not influence psychological stress and fatigue in taekwondo. However, in other protocols and different tests applied in fasting, even small decrements in performance or an increase in the RPE should be monitored to ensure that mood and performance are not progressively deteriorating [21]. Thus, these results are specific to the breakfast omission, the fasting period adopted, and the study design.

CONCLUSIONS

A 12-hour fasting, promoted by breakfast omission, may be efficient to promote a significant decrease in total body mass without reducing the physical performance of taekwondo athletes, when performed for a single day. Thus, it can be an effective strategy to reduce weight acutely without negatively affecting sports performance.

HIGHLIGHTS

Fasting is one of the most used nutritional strategies by taekwondo athletes in pre-competitive period, especially on days before official weigh-in. However, without nutritional guidance and adequate monitoring of training load, this strategy can lead to a reduction in sports performance. Our findings demonstrate that a single day of fasting for 12 hours associated with breakfast omission, promoted a body mass reduction while the general and specific performance remained unchanged. However, further studies are needed to accompany longer periods of fasting and measure performance in simulated fights and official competitions.

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