SHORT- AND LONG-TERM WEIGHT LOSS STRATEGIES ON MOOD STATE AND PERFORMANCE IN YOUNG JUDO FIGHTERS

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Abstract

Title: SHORT- AND LONG-TERM WEIGHT LOSS STRATEGIES ON MOOD STATE AND PERFORMANCE IN YOUNG JUDO FIGHTERS

Author: Vito Zocco

Weight loss in combat sports is a common practice to compete in a lower weight class. Athletes lose 5-10% of body mass through extreme strategies detrimental for health and performance. Our aim was to compare the effects of a rapid (RP) and gradual (GR) weight loss strategy on mood state and physical performance in young judo athletes. Sixteen athletes (6 males and 10 females, age 15-20 years) qualified for the Italian National Championship participated to the study. After three weeks of control, participants were divided into two groups, one adopting a gradual weight loss strategy for three weeks (GR) and the other a rapid weight loss (RP) of one week to lose 2-5% of body mass. Anthropometric measurements, hydration, mood states and performance were assessed six weeks (T0), three weeks (T1) and the day before the competition (T3). During control no significant differences were observed in body weight, %FM, and hydration while after intervention they decreased tension (P<0.04), depression (P<0.05) and grip strength (P<0.01) increased in both groups. The Iceberg Profile, characteristic of competitive athletes, was less pronounced in GR disappearing in RP after intervention. Independently to the weight loss strategy, three weeks of body weight loss negatively affected different aspects of the mood state in young athletes without compromising judo specific performance.

Key-words: judo, weight loss, Rapid weight loss, Gradual weight loss, young fighters.
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**Introduction**

Judo is an Olympic discipline that falls into the category of combat sports, which are the competitive contact version of the traditional oriental martial arts. Judo is a martial art discipline that groups certain practices and techniques codified and based on specific physical, cultural and philosophical principles.

Judo is classified as a situational sport because athletes are exposed to a huge range of variables that influence performance. This sport is characterized by dynamic, high-intensity, and short-duration intermittent activities with variable duration and where the matches are organized according to weight classes. As judo athletes have to repeat many explosive actions during each match, the physical demand of a single match is high. Typically, judo medalists perform four to six matches during international competitions, with each match having a 5-minute time limit.

The judoka therefore requires a preparation that can’t be separated by three fundamental aspects:

- Technical aspect
- Athletic aspect
- Psychological aspects

### 1.1 Technical aspect

In combat sports is expected to make a direct comparison between two athletes. This leads to a constant change of the situation due to the interaction between the two opponent’s behaviors, such as attacks, defenses, combinations or faint always aimed at achieving supremacy. Therefore, technique must be mastered by the athlete that, through a high number of repetitions, gradually acquires a certain skill, gaining fluency, accuracy and speed. Being judo a sport that presents variable and unpredictable situations, the coach should increase the variability of a technique requiring the athlete to perform it in a situation of attack, response or in their combination. Therefore, automated techniques in judo are often combined with the tactical components. The technical-tactical training is aimed to prepare the athlete to the different situations that they may find in the match. During training, tactics and technique in training must be combined with the physical components of strength speed and endurance as well as with cognitive and coordinative components.
Therefore, the technical-tactical training is very rich and variable, and it takes up a significant part of the time to develop the technical aspect.

The purpose of judo techniques is to unbalance the opponent to make him fall to the ground and possibly also immobilize using strangulation techniques and joint locks. The techniques of Kodokan Judo are divided into Nage Waza (throwing techniques or launch) and Katame Waza (techniques of control). These two groups in their turn are divided according to tables 1 and 2:

<table>
<thead>
<tr>
<th>Table 1: Techniques projection or launch provided by the Kodokan judo</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NAGE WAZA</strong></td>
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<tr>
<td><strong>TACHI WAZA</strong></td>
</tr>
<tr>
<td><strong>ASHI WAZA</strong> (leg or foot techniques)</td>
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<tr>
<td><strong>TE WAZA</strong> (hand or arm techniques)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2: Techniques required in the Kodokan judo</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>KATAME WAZA</strong></td>
</tr>
<tr>
<td><strong>OSAE WAZA</strong> (techniques of restraint)</td>
</tr>
<tr>
<td><strong>SHIME WAZA</strong> (techniques suffocation or strangulation)</td>
</tr>
<tr>
<td><strong>KANSETSU WAZA</strong> (techniques of joint lock)</td>
</tr>
</tbody>
</table>

**1.1.2 Regulation**

The current international regulation of judo includes a classification of athletes by age according to the following age classes: Cadets under 18 years (15-16-17 years), Junior under 21 years (18-19-20 years) Seniors under 35 years (21-35 years).
The aim of a judo match is to project the opponent to the ground on his back immobilizing it, or to force to surrender due to a choke, strangulation or arm bar.

1.1.2.1 Score in Nage Waza
Depending on how the opponent falls to the ground, or rather according to the body part that touches the ground, different scores can be assigned. In the regulation there are three levels of scoring, which in descending order are classified as: ippon, waza-ari, yuko.

- **Ippon**, is given in the projection if there are four basic assumptions such as: opponent completely falls on the back with control, strength and speed. The Ippon corresponds to the technical knockout and leads to the immediate interruption of the match;
- **Waza-ari**, is assigned when missing one of the four conditions for ippon. It corresponds to a high score, not sufficient to obtain immediate victory but useful at the end of regulation time to win the victory;
- **Yuko**, is assigned when there are two of the four conditions for the ippon and corresponds to a minimal advantage.

1.1.2.2 Score in Katame Waza
One advantage may be given in ground fighting, only as a result of immobilization. The immobilization can be performed when at least one of the opponent's shoulders touches the mat and control take place outside of the opponent's legs.

The benefits are awarded based on the duration of the immobilization:

- **Yuko**: from 10 seconds and up to 14 seconds
- **Waza-ari**: from 15 seconds to 19 seconds
- **Ippon**: 20 seconds

Victory is given at the stroke of 15 seconds even if the fighter who is immobilizing the opponent already has an advantage of a previous "waza-ari".

The victory by ippon is also given in response to a surrender of the opponent. In ground combat, the surrender is frequently caused by a choke or an arm bar at the elbow, the only authorized in judo. To indicate its surrender, the fighter hits two or more times the palm of your hand on the opponent's body or on the floor. If he cannot use his hands, he is allowed to ask the yield hitting his foot on the ground.

The regulations also provided penalties known as "Shido". Shido are given for errors such as: no combativeness (liabilities), rejection of the fight, excessively defensive posture,
outstretched arms, torso completely bent toward the front, gestures prohibited (fingers inside sleeve, hands on the face of the opponent, taking not permitted).

In addition, shido accumulates: four shido lead to a penalty called “hansoku” that leads to a disqualification of the fighter. The hansoku assigned after a gesture is also contrary to the spirit of judo, as disregard of the arbitrator or turning of the comments on this, and after an action that endangers the opponent or themselves.

In recent years the Arbitration Rules has undergone several modifications. A first major breakthrough came in 2010 with the abolition of the techniques directed to the opponent’s legs punished with a hansoku and thus the disqualification of the athlete. However, leg techniques can only be performed for defense or counterattack. On January 1, 2013 was introduced a total ban to techniques directed to the legs for both attack and defense for any situation where a fight on his feet, under penalty of disqualification. Finally, on January 1 2014 it was sanctioned with "Shido" also removed from combat and broken sockets with two hands (IJF, International Judo Federation, 2014).

1.2 Athletic aspect

From a physiological point of view, judo is classified as a sport that alternates aerobic and anaerobic activities with rest periods in between, mixing also extreme dexterity with considerable muscular effort.

It is an open-skill, acyclic sport because it is not characterized by the continuous repetition of the same movement, as it happens in running, cycling and swimming and because the opponents actions continuously vary depending on the relationship between space, time and the resistance of the opponent.

This sport induces also a strong neuro-psychic activity and requires excellent physical characteristics (strength, endurance, muscular flexibility, joint mobility and agility, coordination and motor skills, speed of reaction). The key issue is, of course, the timing at which the appropriate ability is chosen in different situations and in a short time with the more favorable methods to contrast the opponent and achieve success. (Dal Monte 1969, Silvy et al.1995, Doria et al. 2009).

Experts agree that over the entire combat the aerobic and anaerobic systems contribute in different proportions at different times as shown in Table (3).
In this sport it often happens that the judoka fights for the entire match bearing sometimes even six or seven fights in a day to complete the competition. Therefore, athletes require excellent aerobic and anaerobic endurance as well as high peak forces to maintain dynamic and isometric contractions during long periods, and a high explosive force to execute various techniques gestures such as projections.

### 1.2.1. Weight loss

Besides age divisions, athletes in judo are divided also in weight categories. In fact, two to six hours prior to a competition, athletes are weighted to be attributed to a specific weight class. Weight classes have been introduced to match athletes with similar size in order to create a balance between opponents’ strength, agility, and leverage and minimize the risk of injury. However, it is common practice to make athletes lose weight to take advantage from competing in a class 5–10% below their usual weight. For this purpose, typically they rapidly lose weight by a reduction in food and water intake for 4–5 days prior to competition. Fighters usually adopt acute rapid body water loss and dehydration strategies such as excessive exercise, sweat suits and extreme environments to attain the weight classes prior to official weigh-ins (Caldwell et al. 1994, Jetton et al. 2013).

Programmed weight reduction strategies to fit into a certain weight category is a widely practiced by judo athletes. We can classify these strategies as quick (up to seven days, mainly decreasing the percentage of water content in the body) and gradual (over seven days, mainly

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**Table 3: Contribution of aerobic and anaerobic energy system**

<table>
<thead>
<tr>
<th>Time (second)</th>
<th>Anaerobic (%)</th>
<th>Aerobic (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 30 s</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>0 - 60 s</td>
<td>70</td>
<td>30</td>
</tr>
<tr>
<td>0 - 120 s</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>0 - 240 s</td>
<td>40</td>
<td>60</td>
</tr>
</tbody>
</table>
at the expense of adipose tissue) weight reduction depending on the time used to obtain the desired weight (Maughan & Wilmore, 2000).

The gradual reduction in weight is achieved mainly at the expenses of adipose tissue, which is the result of a negative energy balance. On the other hand, in the case of rapid reductions of weight, the focus is on decreasing the percentage of water content in the body. However, this is a factor that often influence the training sessions in the period preceding the competition.

Many studies confirm that the appearance of physiological and psychological changes must not be neglected in combat sports. Athletes who compete in certain categories of weight commonly use rapid weight loss strategies (between 12 and 96 hours) by limiting fluid intake or food and even by using saunas, intensive training loads with rubber suits or sweaters during training (Degoutte et al. 2006). However, an important, rapid weight loss can lead to health risks also compromising performance.

However, Umeda et al. (2004) suggested that dietary restriction in addition to intense exercise training had an adverse effect on power during maximal cycling exercise and elevated serum creatine-kinase concentration, leading to an increased susceptibility of muscle tissue to injury. Studies have shown that the percentage of injured judokas during competitions or in the last days before the meeting is considerable (Birrer & Birrer 1983, Kujala et al. 1995).

A rapid decrease in weight can alter the psychological and physiological status of athletes greatly reducing performance (Horswill et al. 1990) and creating a high predisposition to accidents with body weight reductions of more than 5% in a few days (Green et al. 2006). In a study with wrestlers and judo athletes Fogelholm et al. (1993) observed that after two weight loss interventions (gradual and rapid), sprint performance (30-m run) and performance in a 1-min maximal cycling test were similar.

Other studies report that a rapid body mass loss (i.e. 3 to 4 days) can be detrimental to performance in terms of power, force, resistance, flexibility, and skillfulness reducing physiological and biochemical efficiency and leading to a decline of functional state and exercise ability as a consequence of dehydration, depleted glycogen stores, and a reduced lean muscle mass. Moreover, a rapid body weight loss may negatively affect also cognitive performance and mood. Koral & Dosseville observed higher levels of anger, fatigue, and tension and a lower vigor after rapid weight loss assessed by the Profile of Mood State (POMS) (Koral & Dosseville 2009).
A serious issue is that weight loss strategies are not only practiced in adults but also commonly and widely used in juvenile categories. However, there is a paucity of studies that show the effect of different weight loss strategies on mood state, cardio respiratory fitness, and health related parameters in young judo athletes. A study of athletes, who are subjected to a rapid weight loss, showed that a recovery of 4 hours was sufficient to not interfere with the performance, without neglecting the related health risks (Artioli et al. 2010). The real problem is represented by the time that elapses between the weight and the start of the competition that varies from two to five hours.

Filliare et al. (2001) have revealed that rapid weight loss strategies have a significant impact on the physiological and psychological functions, compromising physical performance. In fact, dehydration resulted in a decrease of plasma volume and an increase in blood viscosity with negative effects on stroke volume and cardiac output also affecting thermoregulation.

A rapid body weight loss due to limited food intake can induce also a significant reduction of glycogen stores in the skeletal muscle and liver, and may affect the buffer function of the blood and muscles. It has been shown that a diet with a lower percentage of carbohydrates during the period of weight reduction lead to a decrease of the alkaline reserves at rest (Timpmann S.et al. 1996). However, other studies, have reported no changes in specific aspects of performance and in particular on maximal oxygen consumption (VO2max). In fact, a study of Caldwell et al. (1984) reported that rapid weight loss affected VO2max based on the amount and percentage of weight reduction: a reduction of more than 3% obtained negative effects on VO2max on athletes from different disciplines, while losing less than 3% of body weight, no detrimental effects were observed (Caldwell E. 1984). In addition, they demonstrated that the method used to achieve the desired weight affects performance. In fact, athletes who prefer intense exercise with the use of the sauna were considered to have less negative effects on VO2max compared to those who use dietary restrictions are too rigid and diuretics. The physiological changes due to different strategies of weight loss are summarized in Figure 1.
1.3 Psychological aspect

From the psychological point of view a very important variable to consider is the mood. The POMS (McNair et al., 1971) is a questionnaire originally designed to assess changes prompted by psychotherapy but it is also widely used also in sport. It measure the dimensions of the subject that are defined as transient, that is closely related to the event that the athlete lives during a specific period of time as the pre-race period, the competition and the period following the competition.

The POMS was introduced in the sport in 1970 and in the eighties it was a point of reference for many research; its popularity in the sports world is mainly due to William Morgan, who...
has conducted numerous studies using the POMS. The mood states are assessed through a self-assessment questionnaire that consists of six different scales: Tension-Anxiety (T), depression-dejection (D), Anger-Aggression (A), Vigor-Activity (V), Fatigue-Indolence (S) and Confusion-Bewilderment (C), each one of them evaluated on a scale of five levels of intensity.

The factor T is defined by the adjectives that describe an increase in tension of skeletal muscles. The items relate to a somatic tension that may not be observable from the outside, as well as events psychomotor visible; other items relate to states of anxiety vague, diffuse.

The Q factor indicates a state of depression accompanied by a sense of personal inadequacy. This state is well defined by the stairs which indicate feelings of personal worthlessness and futility of efforts to adapt as well as a sense of emotional isolation and melancholy.

The A factor describes a mood of anger and antipathy towards others. The main stairs describe feelings of intense anger and open.

The factor V is defined by adjectives that give the idea of force, exuberance and energy, and is negative relationship with the other five factors of POMS.

The S factor is a mood characterized by boredom, laziness and lack of energy. Although there are particular item indicating an emotional state, most of them are geared toward a sense of physical fatigue.

The C factor is characterized by feelings of confusion and anxiety. It is not yet clear whether this represents a stretch factor of cognitive inefficiency, a state of mood or both of these conditions. It may represent the result of an evaluation about their cognitive efficiency, perhaps a consequence of anxiety or were connected to this.

Several studies on judokas of wrestlers have shown that the weight loss increases the negative mood characterized by tension, anger, confusion and fatigue which lead counterproductive effects both during training and during competition (Filaire E. e coll. 2001, Hall and Lane 2001).

A study (Choma et al., 1998) on a group of wrestlers showed that energy restriction and the consequent fall in blood glucose alters mood, perceived exertion during exercise and cognitive function. In particular the authors found a reduction in performance in several cognitive tests on short-term memory and worst scores were seen in five of the six scales of the POMS after weight loss, everything associated with a reduction in blood glucose and
plasma volume. However, these negative adaptations are reversible and physical and mental status returned to their initial values after 72 hours of rehydration and weight regain.

In summary, alterations in performance may depend on the amount and type of body mass loss and on the nature of the dietary restriction. However, the effect of dietary restriction on specific judo performance remains unclear (Fogelholm et al., 1993; Rankin, Ocel, & Craft, 1996; Umeda et al., 2004; Webster et al., 1990). In addition, no studies on young national athletes have been performed.

The aim of the present study was to compare the effects of two strategies for weight loss (rapid and gradual) on mood state and performance in young athletes prior to a national competition.

2 Materials and Methods

2.1 Subjects

- Sixteen young athletes, 6 males and 10 females
- Age between 15 and 19 years.
- Experience: all participants had qualified for the Italian Junior National Championship in all weight categories. On average, the participants had practiced judo for at least 8 years undertaking 8-12 hours of training per week. Their technical level ranged between first and third dan black belt.

After three weeks of control period, subjects were randomly divided into two groups:

- A gradual body weight loss group (GR), 3 weeks of intervention
- A rapid body weight loss group (RP), 1 weeks of intervention

2.2 Test Sessions

All participants took part to four test sessions (Figure 2).

- 1\textsuperscript{st}: 6 weeks before the competition, start of the control period (T0),
- 2\textsuperscript{nd}: 3 weeks before the competition, end of control period, group division (in GR and RP groups) and start of the gradual weight loss intervention GR group (T1),
• 3\textsuperscript{rd}: 1 week before, start of the rapid weight loss intervention in RP group (T2),
• 4\textsuperscript{th}: 1 day before the competition, post-test for both GR and RP groups (T3).

The measurements were made during the same day of the week, at the same time of day, with tests carried out in the following order: hydration analysis, anthropometric and body composition measurements, Profile of Mood State (POMS questionnaire) and performance evaluation.

2.2.1 POMS
Every athlete rated on a scale of 0 to 4 sixty-five different adjectives based on the perception of different feelings of the previous week. The score of each adjective was mapped back to six moods such as tension, anger, fatigue, depression, vigor, and confusion and a vector of six mood dimensions for each athlete were calculated. Thanks to the short time of analysis, the POMS was re-administered also prior to the competition to evaluate mood state of the RP group after rapid weight loss (7 days).

2.2.2 Hydration Status
Every athlete has provided a urine sample immediately preceding the body mass measurements. The urine was placed in a plastic container in which a small sample was immediately analyzed to measure its specific gravity urine (USG) using an optical refractometer. A value USG > 1.021 is commonly associated with a significant dehydration.
(Jetton et al. 2013). The urine samples were immediately deleted after being analyzed for USG.

2.2.3 Anthropometric measurements
Weight and height subjects were assessed on their arrival at the gym using a beam balance scale and a stadiometer (0.01 kg and 0.1 cm, respectively), with the athletes in t-shirt and pants uniform without shoes. Body composition was measured by bioelectrical impedance analysis (BIA) using the method tetra-polar electrode.

2.2.4 Performance testing:
- **Hand Grip test:** Grip strength was measured on both hands by means of a Jamar Hand Dynamometer (hydraulic), isometric grip force from 0 to 90Kg (0 to 200lbs) adjustable to five different grip positions, from 35 to 87mm in 13mm increments. Subject squeezed the dynamometer with the arm extended and distant from the body standing on the opposite leg. The measurement was repeated three times for each hand and the higher value was used for further analysis.

- **TW-5 test:** To test the maximal speed of the athlete in real conditions, the number of consecutive repetitions of a judo favorite technique during 5 seconds has been recorded (TW-5 = tokui waza in 5 second) for three times with 30 seconds break in between. The higher value was used for further analysis. All athletes were familiar with TW-5 test, because they routinely perform it before the competition.

- **Specific incremental test:** To test the aerobic-anaerobic exercise capacity during specific activities, a judo specific incremental test has been performed (Santos test, 2010). During the test, several technical skills have been consequently requested. These were the ones that the judoka uses more during competition, the ones that they perform better (in judo this is called tokui-waza or special techniques). The test was composed of a sequence of phases at growing workload. Each sequence was composed by two phases: The first one was active and the second one was passive. Active phase: the judoka had to consequently perform a specific technique without projecting the opponent to the floor for 40 seconds. The number of repetitions carried out by the subject increased by 1 every phase. This produced a progressive increase in the intensity of the process.
Passive phase: after the active phase, the judoka and his supporting partner, grabbing each other with their hands, had to move from one side of the tatami to the other. This activity tried to represent the movements that occur in real combats. It lasted 15 seconds. This second phase took place right after every active phase (40 seconds) and gave the test its intermittent characteristic, a key element in judo training and combat. During this phase, OMNI scale has been used to evaluate individual perceived exertion.

In summary, the progressiveness of the test was based on the increase of 1 repetition on each new 40-second series. The first active phase consisted of 7 repetitions, the second of 8, the third of 9, and so on, until exhaustion or until reaching a maximum of 18 repetitions. The test was interrupted at the 12th repetition or if the athlete was not able to raise his partner from the floor, throw him off balance and/or complete the correct number of repetitions in 40 seconds.

Heart rate (HR) was monitored through a HR monitor (POLAR RS400) and recorded in all athletes during the entire incremental test.

2.3 Experimental procedure

A month before the loss of body mass procedure, a judo coach and a nutritionist interviewed the participants about their eating habits. Three weeks before the competition the dietitian recommended to the subjects of GR an individualized diet plan that aimed to reduce the daily calorie intake of 300 - 400 Kcal/day for 21 days. RP group maintained their regular diet habits during the first two weeks and during the last week, subjects adopted a rapid weight loss strategy that dramatically reduced the intake of food and water together with additional intense training sessions to loose fluids and meet the their weight class.

The two groups performed for 3 weeks, ~10 h/wk of the same training protocol composed by three different types of training (session 1, 2 and 3) during the six weeks preceding the competition (figure 1). During the last week of training prior the competition the RP group performed four “special sessions” to rapidly lose weight by sweating through exercise with different methodologies such as exercising in plastic suits to increase water loss instead of the regular training: one on the Session 1 of day 4 and the other three on all Session 2 (day 1, 3 and 5).
• Session 1 lasted 90 min and was composed of 20 min of warm-up exercises with pre-athletics, followed by 1 hour of fighting divided into tachi-waza (all participants carried out 5 fights lasting 4 min, separated by two min of recovery) and ne-waza (all participants carried out 4 fights of 5 min with 2 min of recovery in between) and 10 min of cool-down.
• Session 2 lasted about 60 min and provided 10 min warm-up, 40 min of athletic and muscle training and 10 min of cool-down.
• Session 3 lasted about 60 min and provided 10 min warm up, 40 min of technical work and/or tactical situations (tachi waza or ne-waza) and 10 min of cool-down.
• The “special session” or “weight loss session” lasted about 50 min and provided 10 min warm up, 30 min of very high intensity exercise and 10 min of cool-down.

Table 4: Schematic representation of the training program of the week.

<table>
<thead>
<tr>
<th>Day</th>
<th>Session 1</th>
<th>Session 2</th>
<th>Session 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td></td>
<td><em>Morning</em></td>
<td><em>Afternoon or evening</em></td>
</tr>
<tr>
<td>Day 2</td>
<td></td>
<td><em>Evening</em></td>
<td></td>
</tr>
<tr>
<td>Day 3</td>
<td></td>
<td><em>Morning</em></td>
<td><em>Afternoon or evening</em></td>
</tr>
<tr>
<td>Day 4</td>
<td></td>
<td><em>Evening</em></td>
<td></td>
</tr>
<tr>
<td>Day 5</td>
<td></td>
<td><em>Morning</em></td>
<td><em>Afternoon or evening</em></td>
</tr>
<tr>
<td>Day 6</td>
<td></td>
<td></td>
<td><em>Morning</em></td>
</tr>
<tr>
<td>Day 7</td>
<td></td>
<td></td>
<td><em>RECOVERY</em></td>
</tr>
</tbody>
</table>
2.4 Data analysis

Data were analyzed by SPSS v21 (IBM® SPSS®). A paired-sample T-test was used to determine significant differences between T0 and T1 in weight, %BF, USG to check for weight fluctuations during the control period. No differences were found during the three weeks of control, therefore subjects were randomly assigned to the two intervention groups and a paired-sample T-test was performed to control for significant differences in weight, %BF, USG between GR and RP groups. No significant differences were found between groups, therefore the weight at T1 was used for the calculation of body weight loss as well as well as the pre-intervention session. Athletes were prescribed to lose a variable percentage of body weight (between 2 and 6%) in order fit into the lower weight category. After intervention, a $2 \times 2$ [mode (GR vs. RP) x time (T1 vs. T2)] repeated measures ANOVA with Bonferroni post-hoc test was carried out to determine between and within group differences. *A priori* significance was set at $\alpha < 0.05$.

3 Results

Table 5 reports the anthropometric data (age, height, weight, BMI, fat mass and USG) collected at T0 and T1. No significant differences were seen during this period confirming our hypothesis that the training alone was not enough to induce significant a weight loss in our athletes.

Table 6 reports the values of body weight, fat mass and USG before and after intervention. Body weight, fat percentage and hydration significantly decreased after weight loss intervention ($P<0.001$), and individual body weight was reduced by 2-6% as planned at T1 leading all athletes to fit in the lower weight class. Urine specific gravity was higher in both groups after intervention showing a high dehydrated prior to the competition (USG over 1.025). Figure 3 shows the changes in body weight measured at T1 and T3 in both groups.
Table 5: Anthropometric and hydration measurements and body composition of the RP and GR groups at the beginning (T0) and at the end (T1) of the control period.

<table>
<thead>
<tr>
<th></th>
<th>T0</th>
<th>T1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>17.6 ± 1.6</td>
<td>17.6 ± 1.6</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>167.1 ± 8.4</td>
<td>167.1 ± 8.4</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>68.2 ± 10.9</td>
<td>67.6 ± 10.7</td>
</tr>
<tr>
<td>Body Mass Index (Kg/m²)</td>
<td>24.3 ± 2.6</td>
<td>24.04 ± 2.5</td>
</tr>
<tr>
<td>Fat mass (%)</td>
<td>20.5 ± 8.1</td>
<td>20.8 ± 7.8</td>
</tr>
<tr>
<td>USG</td>
<td>1.024 ± 4.9</td>
<td>1.024 ± 4.5</td>
</tr>
</tbody>
</table>

Values are mean ± SD
USG urin specific gravity

Table 6: Hydration measurements and body composition of the RP and GR groups before (T1) and after (T3) three weeks of intervention.

<table>
<thead>
<tr>
<th></th>
<th>RP (n=8)</th>
<th>GR (n=8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>64.4 ± 9.5</td>
<td>70.7 ± 11.5</td>
</tr>
<tr>
<td>T3</td>
<td>62.7 ± 9.0†</td>
<td>68.7 ± 11.6†</td>
</tr>
<tr>
<td>Fat mass (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>19.3 ± 6.7</td>
<td>22.2 ± 8.8</td>
</tr>
<tr>
<td>T3</td>
<td>18.0 ± 8.1†</td>
<td>20.5 ± 8.7†</td>
</tr>
<tr>
<td>USG</td>
<td>1.023 ± 0.004</td>
<td>1.025 ± 0.004</td>
</tr>
<tr>
<td>T3</td>
<td>1.029 ± 0.006†</td>
<td>1.031 ± 0.004†</td>
</tr>
</tbody>
</table>

Values are mean ± SD
† P < 0.001 between T1 and T3
Fat mass SK (%) manual measurements

Figure 3: Body weight values in RP and GR groups before (T1) and After (T3) intervention.
Table 7 reports the fatigue, tension, depression, vigor, confusion and anger values reported by the athletes of FR and GR group after the analysis of mood state before and after the weight loss. Tension and depression increased significantly while, anger and fatigue slightly increased and vigor decreased in both FR and GR groups (figure 5.1 to 5.4). An interesting result was the reduced vigor in both groups. In fact, vigor is a very important item for athletes because it is related to performance and characterizing the "Iceberg Profile" (peak in correspondence to vigor) disappeared in the RP group after intervention (figure 4). It is important to note that the POMS graph of the RP group lost the Iceberg Profile after intervention even inverting the curve trend (figure 5.1).

Figure 4. Profile of Mood States. The 'iceberg' profile characteristic of elite athletes.

<table>
<thead>
<tr>
<th></th>
<th>RP (n=8)</th>
<th>GR (n=8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tension</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>45.5 ± 4.2</td>
<td>42.6 ± 6.9</td>
</tr>
<tr>
<td>T3</td>
<td>49.5 ± 5.7**</td>
<td>49.1 ± 9.5**</td>
</tr>
<tr>
<td>Depression</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>45.1 ± 4.4</td>
<td>43.8 ± 2.7</td>
</tr>
<tr>
<td>T3</td>
<td>47.5 ± 4.4*</td>
<td>46.4 ± 5.3*</td>
</tr>
<tr>
<td>Anger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>47.3 ± 6.1</td>
<td>45.5 ± 5.6</td>
</tr>
<tr>
<td>T3</td>
<td>49.3 ± 5.7</td>
<td>48.3 ± 6.7</td>
</tr>
<tr>
<td>Vigor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>50.5 ± 8.7</td>
<td>55.5 ± 7.0</td>
</tr>
<tr>
<td>T3</td>
<td>47.5 ± 10.8</td>
<td>51.1 ± 7.5</td>
</tr>
<tr>
<td>Fatigue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>48.5 ± 4.8</td>
<td>47.5 ± 6.2</td>
</tr>
<tr>
<td>T3</td>
<td>50.8 ± 6.0</td>
<td>48.8 ± 5.8</td>
</tr>
<tr>
<td>Confusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>49.3 ± 7.3</td>
<td>48.6 ± 8.7</td>
</tr>
<tr>
<td>T3</td>
<td>50.4 ± 10.4</td>
<td>45.6 ± 7.8</td>
</tr>
</tbody>
</table>

Values are mean ± SD
* P ≤ 0.05 between T1 and T3
** P ≤ 0.01 between T1 and T3
Figure 5.1. Profile of mood state in RP group before (T1) and after (T3) intervention: Only mean values have been reported.

Figure 5.2: Profile of mood state in GR group before (T1) and after (T3) intervention. Only mean values have been reported.
Figure 5.3: Profile of mood state of RP and GR groups before intervention (T1). Only mean values have been reported.

Figure 5.4: Profile of mood state of RP and GR groups after intervention (T3). Only mean values have been reported.
Table 8 shows the values of the grip strength and performance measured with TW-5 and the heart rate and perceived exertion detection at different stages of the incremental test. Data reported an increased strength in the right arm (the predominant hand in all 14 out of 16 athletes) in both groups after training (hand grip P<0.05). TW-5 did not show significant variations after intervention as well as HR and OMNI at different intervals. However, it is interesting to note that HR, had a downward trend in both groups (Figure 6.1 and 6.2) while the perceived exertion slightly increased in the RP group and decreased in the GR group (Figure 6.3 and 6.4).

Table 8: Results of performance testing of the RP and GR groups before (T1) and after (T3) three weeks of intervention.

<table>
<thead>
<tr>
<th></th>
<th>RP (n=8)</th>
<th>GR (n=8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand Grip Dy</td>
<td>T1 38.4 ± 6.7</td>
<td>41.8 ± 15.0</td>
</tr>
<tr>
<td></td>
<td>T3 40.0 ± 8.1*</td>
<td>46.1 ± 15.4*</td>
</tr>
<tr>
<td>Hand Grip Sx</td>
<td>T1 38.3 ± 7.2</td>
<td>39.5 ± 13.1</td>
</tr>
<tr>
<td></td>
<td>T3 37.8 ± 8.7</td>
<td>41.5 ± 14.0</td>
</tr>
<tr>
<td>TW-5</td>
<td>T1 6.7 ± 0.9</td>
<td>6.7 ± 0.6</td>
</tr>
<tr>
<td></td>
<td>T3 6.3 ± 0.5</td>
<td>6.6 ± 0.7</td>
</tr>
<tr>
<td>Incremental test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HR-1</td>
<td>T1 163 ± 19</td>
<td>158 ± 8</td>
</tr>
<tr>
<td></td>
<td>T3 158 ± 12</td>
<td>163 ± 12</td>
</tr>
<tr>
<td>HR-3</td>
<td>T1 163 ± 19</td>
<td>158 ± 8</td>
</tr>
<tr>
<td></td>
<td>T3 158 ± 12</td>
<td>163 ± 12</td>
</tr>
<tr>
<td>HR-6</td>
<td>T1 176 ± 21</td>
<td>171 ± 7</td>
</tr>
<tr>
<td></td>
<td>T3 171 ± 20</td>
<td>170 ± 11</td>
</tr>
<tr>
<td>HR-9</td>
<td>T1 183 ± 18</td>
<td>180 ± 7</td>
</tr>
<tr>
<td></td>
<td>T3 179 ± 18</td>
<td>177 ± 12</td>
</tr>
<tr>
<td>HR-12</td>
<td>T1 190 ± 15</td>
<td>188 ± 7</td>
</tr>
<tr>
<td></td>
<td>T3 185 ± 16</td>
<td>185 ± 11</td>
</tr>
<tr>
<td>OMNI-1</td>
<td>T1 0.6 ± 0.5</td>
<td>0.8 ± 0.9</td>
</tr>
<tr>
<td></td>
<td>T3 0.5 ± 0.5</td>
<td>0.5 ± 0.5</td>
</tr>
<tr>
<td>OMNI-3</td>
<td>T1 1.4 ± 0.5</td>
<td>1.6 ± 1.0</td>
</tr>
<tr>
<td></td>
<td>T3 1.1 ± 0.4</td>
<td>1.2 ± 0.5</td>
</tr>
<tr>
<td>OMNI-6</td>
<td>T1 2.8 ± 0.9</td>
<td>3.8 ± 1.7</td>
</tr>
<tr>
<td></td>
<td>T3 2.6 ± 0.7</td>
<td>2.8 ± 1.0</td>
</tr>
<tr>
<td>OMNI-9</td>
<td>T1 5.0 ± 1.1</td>
<td>5.6 ± 1.9</td>
</tr>
<tr>
<td></td>
<td>T3 4.6 ± 1.0</td>
<td>4.6 ± 1.0</td>
</tr>
<tr>
<td>OMNI-12</td>
<td>T1 6.6 ± 1.8</td>
<td>7.1 ± 2.4</td>
</tr>
<tr>
<td></td>
<td>T3 6.9 ± 2.1</td>
<td>6.6 ± 1.7</td>
</tr>
</tbody>
</table>

Values are mean ± SD
* P < 0.05 between T1 and T3
TW-5 repetition of 5 techniques, HR heart rate, OMNI scale of perceived exertion
Figure 6.1: Heart rate values in RP group before (T1) and after (T3) intervention at the end of interval 1, 3, 6, 9 and 12 of the incremental test. Only mean values have been reported.

Figure 6.2: Heart rate values in GR group before (T1) and after (T3) intervention at the end of interval 1, 3, 6, 9 and 12 of the incremental test. Only mean values have been reported.
Figure 6.3: Heart rate values of RP and GR groups before intervention (T1) at the end of interval 1, 3, 6, 9 and 12 of the incremental test. Only mean values have been reported.

Figure 6.4: Heart rate values of RP and GR groups after intervention (T3) at the end of interval 1, 3, 6, 9 and 12 of the incremental test. Only mean values have been reported.
4 Discussion

The aim of this investigation was to evaluate the effect of a rapid and gradual weight loss strategy on performance, physiological and psychological aspects before a judo competition. Two important findings emerged from this research: the first one is that weight loss negatively affected mood state in both groups without compromising performance; the second one is that weight loss could lead to noteworthy variations in mood state in those athletes with low levels of vigor.

In our study, a weight loss of 2 to 6% of body weight was the result of a reduction of both body fat and hydration in both groups. This suggested that three weeks of intense training had a “slimming” effect on athletes independently by the low caloric restriction that was not sufficient to significantly reduce fat mass in the GR group compared to the RP group. Likely, a longer intervention period would have obtained more evident differences. However, both groups resulted to be dehydrated even prior to the intervention (average USG <1.021) and highly dehydrated after weight loss period.

In agreement with other researches our results reported that weight loss induce negative modifications of the profile of mood state. Indeed, tension and depression significantly increased in both groups after the intervention while vigor lowered, even if not significantly after three weeks of training and weight loss. The higher somatic tension resulting from mood state analysis could have influenced the arm strength that increased after intervention since it describes also increments in tension of skeletal muscles producing psychomotor visible events. The higher depression was not coherent with the light lowering obtained on perceived exertion (OMI scale) during incremental test. The parameter depression, however, indicates also a sense of personal inadequacy and of emotional isolation and melancholy that could be less related to a single test and becoming more evident during a competition where the stress is higher and multiple fights are performed.

These data are of main importance when analyzing an athlete mood state because high and low levels of tension could be detrimental for performance and high levels of vigor characterize the "Iceberg Profile" that is proper of professional athletes (Morgan et al. 1980). Morgan’s Mental Health Model highlighted that positive emotional health and successful
athletic performance are correlated. Indeed, athletes who are less anxious, angry, depressed, confused and fatigued, and more vigorous are more successful than those who exhibit the opposite profile, as assessed by the Profile of Mood States. Previous researches demonstrated that the ability to produce appropriate emotional feeling before important competitions is recognized by coaches and athletes as one of the most important factors that contribute to athletic performance. Filliare and colleagues (2001) reported that that positive emotional health and successful athletic performance are related. Both groups in our study reported an Iceberg Profile in mood state, less pronounced in the RP group, but this was maintained only in the GR group after the intervention. In fact, an evident result was the reduction of the vigor score above 50 points in the RP group that lead to the disappearance of the Iceberg Profile while it was reduced but still preserved by the GR group that started with a higher peak in vigor. This specific profile has been identified by Pulkinnen et al. (1999) as a characteristic profile for success and, when assessed through a self-reference criterion, it is a more effective predictor of performance in sports of short duration when the sport involves open skills (Beedie et al. 2000). Moreover, all other items slightly increased in both groups after intervention highlighting a detrimental trend in mood state. It is interesting to note also that after weight loss, the RP group reported higher levels of confusion in respect to pre-conditions, while the GR group evidently lower as if the stress caused by losing weight in a short time could influence the mental state of a young athlete increasing confusion. Our data are in agreement with those of Newton and colleagues (1993) that observed a reduction in percentage of body fat together with an increased fatigue, depression, tension, confusion, and a reduced vigor after 12 weeks of caloric intake reduction in competitive bodybuilders. Moreover, Custer et al. (2000) showed that tension and depression decreased after low caloric diet, while well-being improved suggesting that pre-competition mood was an effective predictor of a single performance. However, despite the wide amount of evidences, more studies on this specific field are needed. In fact, there is a paucity of researches on the psychological effect of different weight loss strategies on young athletes where variability on mood state is higher.

The analysis of performance reported that grip strength significantly increased in both groups after training while TW-5 did not change. Our results are in contrast with those of Horswill at al. (1990) who did not find improvements in performance after weight loss due to a low
carbohydrate diet. Fogelholm and colleagues (1993) observed no group differences in sprint time (30-m run) and performance in a 1-min maximal cycling test after a gradual and a rapid weight loss intervention in wrestlers and judo athletes. On the other hand, Koral et al. (2009) reported group differences in performance parameters after two similar weight loss strategies. The improved arm strength in our athletes could be the result of a better physical condition occurred with training. Indeed, after intervention heart rate was slightly lower (more evident in RP group) at all stages of the incremental test as a sign of improved physical condition. Coherently, also perceived exertion during the incremental test was slightly lower prior to the competition. Another aspect to take under consideration is the variable weight loss obtained by our athletes. In fact, they lost from 2 to 5% of body weight while Degoutte et al. (2001) observed a significant decrease in strength after losing body weight of about 5%.

Another factor that could have prevented a loss of performance is the experience of athletes in using weight loss strategies. It could be possible that after eight years of training, our subjects were less sensitive to the detrimental effects of body weight fluctuations. It has been previously shown by Finn et al. (2004) and Buford and colleagues (2006) that continuous weight-cyclers can induce a chronic adaptation to weight loss preventing from performance decrements.

In conclusion our research reports that independently to the weight loss strategy, a 2 to 6% reduction of body weight in three weeks negatively affected different aspects of the mood state in young athletes without compromising judo specific performance and allowed upper limbs strength to increase.

This research presents some limitations that must be taken under consideration. The first one is the lack of control in the adherence to the dietary regimen of the GR group. We relied on parent’s ability to follow the suggestions of the nutritionist. In fact, they prepared the meals to the young athletes and supervised their diet habits. From the athletes’ side, we relied on their determination in reaching the target prior and during the competition. Another limitation is the small number of participants in relation to the wide variation of some of the analyzed parameters being the group composed by male and female athletes belonging to two age categories. These aspects could have been responsible of the no significant differences in some analyzed parameters.
This research could be useful for coaches who may want to adopt different weight loss strategies to induce a body weight in their athletes to fit into a certain weight category because important alterations of mood state could occur. Moreover, if a moderate weight loss (2 to 6% body weight) is obtained, athletes could maintain or even improve their performance if an appropriate exercise program is used.
5. REFERENCES


Santos et al. A new individual and specific test to determine the aerobic-anaerobic transition zone (Santos Test) in competitive judokas. Journal of Strength and Conditioning Research, 2010;24(9):2419-2428.


