ORIGINAL ARTICLE

Effects of rapid weight loss on grip strength of national-level male judokas during simulated bout

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ABSTRACT

Rapid weight loss (RWL) is a common practice among combat sports athletes, particularly judokas, to compete within weight categories. This study examines the impact of RWL on isometric forearm strength and perceived exertion during a simulated bout among national-level male judokas. A total of 15 male judokas (age: 20.4 ± 2.0 y) participated in the study. Simulated judo bouts were conducted at three time points: baseline (before RWL), Phase 1 (72 hours after baseline, post 5% RWL), and Phase 2 (7 days after Phase 1). Handgrip strength (HGS) and rating of perceived exertion (RPE) were measured before and after bouts at each time point. Results demonstrated significant reductions in HGS post-bout across all phases (all $p < .001$). In addition, the pre-bout HGS of the right hand in Phase 1 was significantly lower compared to Phase 2. The RPE was higher in Phase 1 compared to Phase 2. These findings suggest that RWL negatively affects the HGS of the right arm and also increases perceived exertion after simulated bouts.
Keywords: Performance analysis, Body weight changes, Weight loss, Hand strength, Muscle strength, Athletic performance, Physical exertion, Physical fitness.

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INTRODUCTION

Rapid weight loss (RWL) is a common practice in combat sports, particularly among athletes competing in weight-classified disciplines (Martínez-Rodríguez et al. 2021). This practice is often employed to achieve a competitive edge by allowing athletes to compete in lower weight categories, which can enhance their performance against opponents who may be perceived as weaker due to size differences (Lakicevic et al. 2022; Lakicevic et al. 2020; Martínez-Aranda et al. 2023; Peacock et al. 2023). Research indicates that a significant proportion of judo athletes engage in RWL, with studies showing that approximately 40% of competitors have lost more than 5% of their body mass at least once, typically through methods that include dehydration and caloric restriction (Santos et al. 2024). The implications of such practices are multifaceted, affecting not only the athletes' physical capabilities but also their psychological and physiological states during competition (Lakicevic et al. 2022; Yu et al. 2024).

The forearm strength has also been shown to be affected by RWL strategies (Isacco et al. 2020). Assessing forearm strength is critical in judo as it serves as a key performance metric. Hand grip strength (HGS) is indicative of overall muscular strength and is essential for executing various techniques in judo, such as holds and throws. Studies have demonstrated that RWL can lead to a significant decrease in hand grip strength, which may impair an athlete's performance during high-intensity bouts (Lakicevic et al. 2020). This reduction in strength can be attributed to the physiological stress imposed by RWL, which often results in decreased muscle mass and compromised neuromuscular function (Lakicevic et al. 2020; Martínez-Aranda et al. 2023). Assessing forearm HGS is critical in judo, as it serves as a key performance metric (Demiral et al. 2024). HGS is essential for executing various techniques in judo, including holds and throws. Consequently, understanding the impact of RWL on HGS is vital for evaluating the overall performance and safety of judo athletes. Therefore, understanding the impact of RWL on HGS is vital for evaluating the overall performance and safety of judo athletes (Demiral et al. 2024). The purpose of this study was to find the effects of RWL on HGS and perceived exertion among national-level judoka during simulated bouts.

METHODOLOGY

Participants

This cross-over study involved a total of 15 male national-level judo players with an age of 20.4 ± 2.0 years, body weight of 60.6 ± 5.7 kgs, and height of 164.6 ± 3.3 cm. To qualify for inclusion in the experiment, participants were required to have a minimum of five years of competitive judo experience and to have utilized RWL methods within the preceding two years. All participants were required to be free from injury at the time of testing. Before the study, the benefits, risks, and procedures involved were thoroughly explained to each participant, who voluntarily consented by signing an informed consent form. Body composition parameters were assessed using a body composition analyser (Omron BF511, Omron Healthcare Ltd., Matsusaka, Japan). All study procedures adhered to the ethical guidelines outlined in the Declaration of Helsinki and received approval from the internal review board of the Rashtriya Raksha University.

Experimental approach to the problem

HGS and the rating of perceived exertion (RPE) were measured at three distinct time points: baseline (BL; before RWL), Phase 1 (P1; after RWL [i.e., 72 hours after BL), and Phase 2 (P2; 7 days after P1), as shown in Figure 1. The BL was conducted before any weight reduction. In Phase 1, participants were required to lose 5% of their body mass within three days before undergoing a simulated fight, which took place on the 3rd day. The second measurement, P1, was taken immediately after this simulated fight. P2 measurements were conducted seven days following P1. The methods employed for weight loss included dehydration, dietary restrictions, and increased training intensity without using laxatives and diuretics, as suggested by Isacco et al. (2020). RPE was measured using the Borg CR-10 scale, which provides a subjective assessment of exertion levels experienced by the athletes during the bouts.

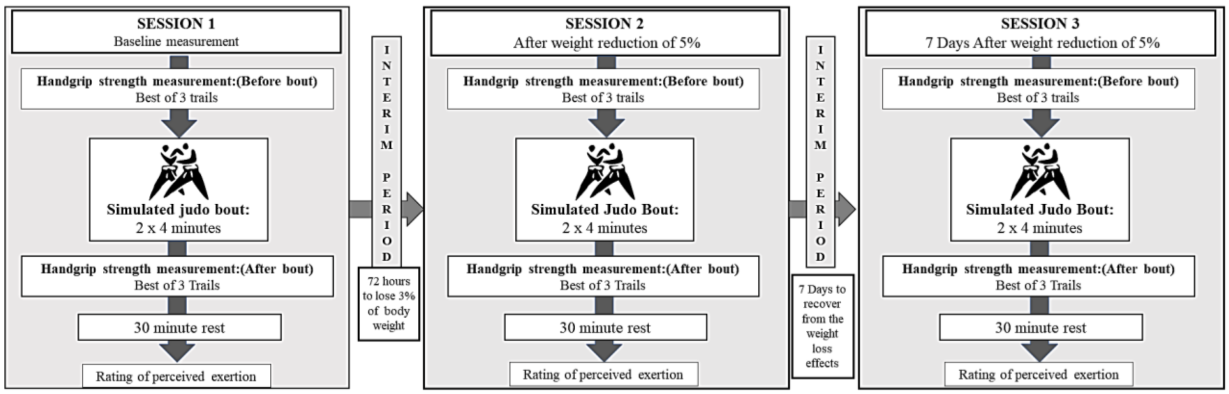

Figure 1. Graphical representation of the experimental study design: The figure illustrates the measurement timeline for handgrip strength and rating of perceived exertion at baseline (BL), phase 1 (P1), and phase 2 (P2).

The simulated judo bout

The simulated fight was designed with modifications to induce volitional exhaustion among the participants. This methodology aligns with the findings of the pilot study conducted by Del Vecchio et al. (2018), which demonstrated that varying the number of opponents in simulated judo combats influences technical-tactical actions, physiological demands, and neuromuscular responses. It consisted of two bouts lasting four minutes each, performed at full intensity to mimic a competitive situation, including a golden score period of four minutes and a regular bout scenario of four minutes. To maximize exertion, each participant faced two Uke (opponents), with each Uke engaging with the participant for a duration of four minutes. After the first four-minute bout concluded, the second Uke immediately replaced the first without any recovery interval, ensuring continuous exertion for the full eight-minute session. No winners were declared during these bouts, maintaining the focus on sustained effort and compliance with International Judo Federation (IJF) rules. Each Uke was matched to the participant based on similar weight categories to simulate realistic combat conditions.

Isometric handgrip strength

The assessment of isometric HGS was conducted using a hydraulic handgrip dynamometer (Carci®, SH 5001 model) (Venegas-Carro et al. 2022). Participants were instructed to sit comfortably in a chair, ensuring their feet were flat on the floor and their backs were supported for optimal posture. The arm was positioned at the end of the chair arm, maintaining a 90° flexion at the elbow.

Prior to the test, participants were guided to inhale through their noses and exhale through pursed lips while simultaneously flexing and squeezing their fingers around the dynamometer. Each subject performed a maximum voluntary contraction on the dynamometer for a duration of five seconds. To ensure reliability and accuracy, three trials were conducted for each hand, with the best performance from these trials selected for further analysis.

Statistical analysis

The normality of the data was verified using the Shapiro-Wilk test. Data are presented as mean and standard deviation. A two-way repeated measures analysis of variance (ANOVA) was applied to determine the main effects of bout and time on HGS, as well as the interaction effects. For the RPE data, Friedman's two-way analysis of variance by ranks was employed due to the ordinal nature of the scale. Post hoc pairwise comparisons with Bonferroni correction were conducted to identify specific differences between phases and time points. The analysis was conducted using SPSS software. For all the analyses, the level of significance was set at $p \leq .05$.

RESULT

Table 1 presents the statistical results. The post-hoc test revealed significant main effects of time on left and right HGS ($p < .001$). However, the interaction effects (time × bout) for HGS were not significant for both left and right hands ($p = .877$ and $p = .163$, respectively). Post hoc analysis demonstrated significant reductions in HGS post-bout across all phases, as well as differences between baseline and P1 and between P1 and P2.

Table 1. Statistical analysis.

Variables	**Baseline**		**After RWL**		**One week after RWL**	
	Pre-bout	Post-bout	Pre-bout	Post-bout	Pre-bout	Post-bout
Handgrip left (Kg)	105.7 ± 6.9	96.9 ± 11.5*	103.3 ± 10.2	95.1 ± 11.1*	105.2 ± 8.2	96.5 ± 10.9*
Handgrip right (Kg)	106.3 ± 9.5[ab]	97.9 ± 10.2*	102.1 ± 9.0[ac]	96.9 ± 11.4*	104.5 ± 9.0[bc]	98.2 ± 9.7*
RPE	7 ± 0.7		7.5 ± 1.1[c]		6.9 ± 0.7[c]	
Body mass (kg)	59.7 ± 6.4[ab]		57.4 ± 6.3[ac]		60.8 ± 6.4[bc]	

Variables	**Main effect Bout (*p*-value)**	**Time × bout (*p*-value)**
Handgrip left (Kg)	<.001	.877
Handgrip right (Kg)	<.001	.163
RPE	.008#	
Body mass (kg)	<.001	

***Note**: # - Friedman's two-way analysis of variance, * significant difference from pre-bout scores, a – significant difference between baseline and after weight loss, b – significant difference between baseline and one-week after weight loss, c – significant difference between after weight loss and one-week after weight loss, RWL – rapid weight loss.*

The result of the findings suggested that for left HGS, there was a significant reduction in post-bout scores compared to pre-bout scores across all phases (Table 1). At the baseline, the left HGS decreased from 105.7 ± 6.9 kg to 96.9 ± 11.5 kg after the bout ($p < .001$). In phase 1, the corresponding values were 103.3 ± 10.2 kg pre-bout and 95.1 ± 11.1 kg post-bout ($p < .001$). Similarly, in phase 2, the mean values decreased from 105.2 ± 8.2 kg pre-bout to 96.5 ± 10.9 kg post-bout ($p < .001$), as shown in Figure 2.

For right HGS, a significant reduction was also observed in post-bout scores compared to pre-bout scores across all phases. At the baseline, the mean right HGS decreased from 106.3 ± 9.5 kg to 97.9 ± 10.2 kg after the bout ($p < .001$). In phase 1, the values declined from 102.1 ± 9.0 kg pre-bout to 96.9 ± 11.4 kg post-bout (p < .001). In phase 2, the mean right HGS decreased from 104.5 ± 9.0 kg pre-bout to 98.2 ± 9.7 kg post-bout (p < .001). Additionally, significant differences were observed in right HGS between baseline and P1, as well as between P1 and P2, with recovery noted by the second phase.

For RPE, Friedman's two-way analysis indicated a significant difference between phases (p = .008). Post hoc analysis highlighted an increase in perceived exertion following weight loss (P1) compared to baseline and a reduction in perceived exertion from P1 to P2.

The RPE exhibited significant differences across phases. At baseline, the mean RPE score was 7.0 ± 0.7. Following rapid weight loss in phase 1, the RPE score increased to 7.5 ± 1.1. In phase 2, one week after weight loss, the RPE score decreased to 6.9 ± 0.7. Statistical analysis confirmed a significant difference in RPE values across phases (p = .008), with post hoc analysis indicating significant increases from baseline to P1 and significant decreases from P1 to P2.

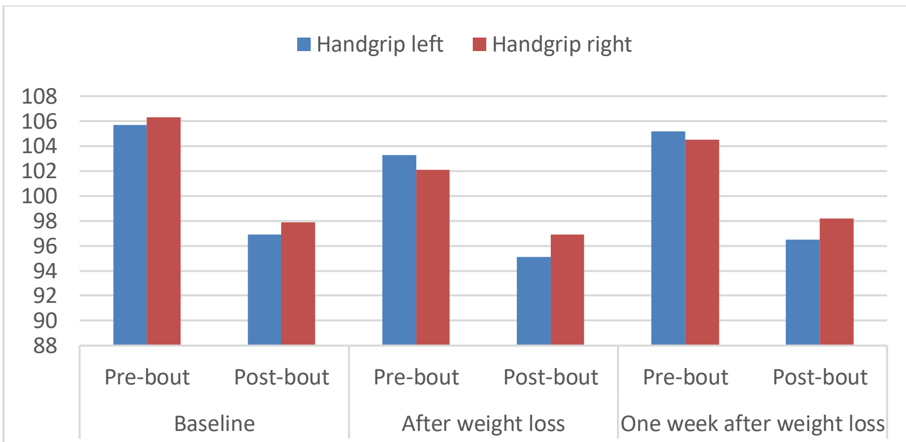

Figure 2. Changes in handgrip strength and rating of perceived exertion across phases.

DISCUSSION

The study aimed to examine the effects of RWL on isometric forearm strength and perceived exertion among national-level judoka after a simulated bout. The findings revealed significant changes in HGS after the simulated bout in all three phases. However, the pre-bout HGS of the right hand was significantly lower after RWL compared to the pre-bout HGS of baseline and one week after RWL. Higher RPE was reported by participants post bouts after RWL compared to one-week after RWL.

This reduction in HGS can be attributed to the physiological stress imposed by the RWL methods, including dehydration, caloric restriction, and increased training intensity. These methods are known to affect muscle functionality, particularly in small muscle groups such as those in the forearm, due to the depletion of glycogen stores and intracellular water content, which are critical for optimal muscle contraction (Lakicevic et al. 2020). Interestingly, HGS values partially recovered by P2, measured one-week post-weight loss. Although these values remained lower than baseline levels, the observed improvement suggests that the cessation of weight-loss practices and subsequent nutritional and hydration recovery may have contributed to the restoration of muscle function. However, the persistence of suboptimal strength levels highlights the potential long-term physiological effects of RWL, even after a short recovery period. This finding aligns with previous research suggesting that RWL can lead to prolonged impairments in performance and recovery (Brechney et al. 2022; Martínez-Aranda et al. 2023).

The RPE scores further corroborate the adverse effects of RWL on performance. Athletes reported a higher perceived exertion during bouts in P1 compared to BL and P2, emphasizing the heightened subjective difficulty of competing under conditions of weight loss-induced stress. The elevated RPE may be linked to the compounded effects of energy deficit, dehydration, and increased physical and mental strain experienced during RWL (Eston 2012; Martínez-Aranda et al. 2023). Notably, RPE scores in P2 returned closer to baseline levels, suggesting some degree of physiological adaptation or recovery. From a practical perspective, the findings of this study have important implications for judoka and their coaches. While RWL is a common practice in combat sports to meet weight-category requirements, its detrimental impact on muscle strength and perceived exertion raises concerns regarding performance and safety during competition. These results advocate for a more cautious and scientifically informed approach to weight management, prioritizing gradual weight loss strategies over rapid methods. Furthermore, the partial recovery observed in P2 underscores the need for extended recovery periods and structured rehydration and refeeding protocols post-competition to mitigate the adverse effects of RWL (Reale et al. 2017; Santos et al. 2024).

The physiological stress resulting from RWL has been documented in various studies, indicating that athletes often experience significant reductions in strength and endurance following RWL (Fortes et al. 2017; Mendes et al. 2013; Murugappan et al. 2022). This is particularly relevant in combat sports, where athletes frequently engage in weight-cutting practices to qualify for lower weight classes. The physiological mechanisms underlying these impairments includes dehydration, which can lead to reduced plasma volume and increased blood viscosity, ultimately affecting muscle performance (Mendes et al. 2013). Additionally, caloric restriction can result in decreased glycogen stores, which are essential for energy production during high-intensity exercise (McMurray et al. 1991; Ranisavljev et al. 2022). Moreover, the psychological impact of RWL cannot be overlooked. The increased RPE reported by athletes during P1 suggests that the mental strain associated with weight loss may further exacerbate feelings of fatigue and exertion during competition (Brito et al. 2012; Mendes et al. 2013). This aligns with findings from other studies that have shown a correlation between psychological stress and perceived exertion in athletes (Hanton et al. 2005; Pedersen 2000). The recovery observed in RPE scores during P2 may indicate a return to a more stable psychological state, allowing athletes to perform closer to their baseline capabilities (Brito et al. 2012).

There are a few limitations that should be acknowledged. Firstly, the samples included only male participants, and thus, the findings should not be extrapolated to females. Secondly, the participants were national-level judokas. The effects of RWL may differ between different participation levels. Thirdly, the inclusion of other variables, such as countermovement jump on force platforms before and after the bout, could provide a better understanding of the effects of RWL on lower extremity muscles.

CONCLUSION

In conclusion, this study demonstrates a significant reduction in pre-bout right HGS following RWL among national-level judokas. The findings indicate that while RWL leads to an acute decline in HGS, there are no additional effects on HGS post-bout, suggesting that the immediate impact of RWL is confined to the pre-bout phase. However, athletes reported higher RPE scores post-bout after RWL, indicating a negative effect on their perceived effort during competition.

AUTHOR CONTRIBUTIONS

Study Design: MH, RCY, and RKT; Data Collection: MH; Statistical Analysis: RKT; Data Interpretation: RKT; Manuscript Preparation: MH, RCY, and RKT wrote or revised the manuscript draft. All authors have read and agreed to the published version of the manuscript.

SUPPORTING AGENCIES

No funding agencies were reported by the authors.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

DATA AVAILABILITY

All data generated or analysed during this study are included in the published article as Table(s) and Figure(s). Any other data requirement can be directed to the corresponding author upon reasonable request.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of School of Physical Education and Sports, Rashtriya Raksha University (protocol code IRB/SPES/2023-24/05). All participants and their legal guardian were informed about the purpose, content, and potential benefits and risk associated with the study, and the legal guardian signed the informed consent forms and participants provided their verbal assent.

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