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Original article

Rapid weight loss and mood states in judo athletes: A systematic review

Nemanja Lakicevic[a], Ewan Thomas[a], Laurie Isacco[b], Antonina Tcymbal[c], Stefan Pettersson[d,e,*], Roberto Roklicer[f], Tatjana Tubic[f], Antonio Paoli[f], Antonino Bianco[a], Patrik Drid[g]

[a] *Sport and Exercise Sciences Research Unit, University of Palermo, 90133 Palermo, Italy*
[b] *Clermont Auvergne University, UPR 3533, Laboratory of the Metabolic Adaptations to Exercise under Physiological and Pathological Conditions (AME2P), CRNH Auvergne, Clermont-Ferrand, France*
[c] *Department of Sport Science and Sport, Friedrich-Alexander-University Erlangen-Nuremberg, Erlangen, Germany*
[d] *Department of Food and Nutrition, and Sport Science, Centre for Health and Performance, University of Gothenburg, Gothenburg, Sweden*
[e] *Swedish Olympic Committee, Sofiatornet, Olympiastadion, 114 33 Stockholm, Sweden*
[f] *Faculty of Sport and Physical Education, University of Novi Sad, Novi Sad, Serbia*
[g] *Department of Biomedical Sciences, University of Padova, 35122 Padua, Italy*

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ABSTRACT

Objective. – Rapid weight loss (RWL) has been traditionally practiced in judo. While the effects of it on performance and health have been extensively studied, less attention is dedicated to psychological ramifications of RWL. We sought to investigate the effects of RWL on mood states in judo athletes.
Method. – PubMed and Web of Science were systematically searched for the relevant literature. Only original studies investigating the magnitude of RWL in judo athletes while jointly using Profile of Mood States questionnaire were eligible.
Results. – Six studies met the inclusion criteria and were included in the analysis. Studies varied vastly in their design (time allocated to RWL and the degree of RWL), but the common trait in virtually all studies was a significant increase in tension and significant drop in vigor following RWL. It appears that when ≥ 5% RWL per week is prompted, mood states greatly exacerbate in judo athletes.
Conclusion. – Overall, data showed that mood states in judo athletes are aggravated after ≥ 5% RWL with no significant difference between males and females. Future studies should explore the long-term effects of weight cycling on the mental health of judo athletes and other athletes participating in weight-classified sports.

RÉSUMÉ

Objectif. – La perte de poids rapide (PPR) est traditionnellement utilisée dans la pratique du judo. Alors que les effets de cette pratique, aussi bien au niveau de la performance que de la santé, ont été amplement considérés, peu d'études concernent spécifiquement les effets psychologiques de la PPR chez les judokas. Aussi, l'objectif de cette revue est de déterminer les effets de la PPR sur l'humeur des judokas.
Méthode. – Une recherche systématique de la littérature correspondante a été effectuée sur PubMed et Web of Science. Seules les études originales s'intéressant à l'importance de la PPR chez les judokas et utilisant le questionnaire de Profil d'Humeur étaient éligibles.
Résultats. – Six études remplissaient les critères d'inclusion et ont donc été considérées dans l'analyse. Les études divergeaient en termes de protocole (durée et degré de PPR), mais toutes les études ont observé une augmentation significative de la tension et une diminution significative de la vigueur à la suite de la PPR. Il semblerait qu'une PPR ≥ 5 % par semaine exacerbe particulièrement l'humeur des judokas.

* Corresponding author at: Department of Food and Nutrition, and Sport Science, Centre for Health and Performance, University of Gothenburg, Gothenburg, Sweden.
Adresse e-mail : stefan.pettersson@ped.gu.se (S. Pettersson).

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Tension
Fatigue
Confusion
Dépression

Conclusion. – De manière générale, les données montrent que l'humeur des judokas est aggravée lors d'une PPR ≥ 5 %, sans dimorphisme sexuel. De nouvelles études devront s'intéresser aux effets à long terme des variations de poids sur la santé mentale des judokas et, en général, des sportifs pratiquant des sports à catégorie de poids.

1. Introduction

Judo is a physically demanding combat sport consisting of intermittent activities requiring outstanding physical fitness, mental preparation and fine-tuned tactical skills. Due to its intermittent nature, judo athletes utilize various energy systems and must maintain excellent shape year-round to compete at an elite-level(Franchini et al., 2013). Beyond maintaining superb conditioning, judo athletes need to be conscious of their weight, given that judo is a weight-classified sport (Lakicevic et al., 2020). To "make weight" and compete in a desired weight category, judo athletes regularly engage in rapid weight loss (RWL) and rely on a number of methods of active and passive dehydration, glycogen depletion and gut content manipulation (Brito et al., 2012; Franchini et al., 2012; Lakicevic et al., 2020). The most aggressive RWL methods are applied by male elite-level judo athletes and those that began RWL at a younger age (Malliaropoulos et al., 2018). They regularly adopt this approach to drop one or two weight classes to compete against lighter and potentially weaker opponents (Artioli et al., 2016). Although RWL can provide competitive edge to judo athletes in some instances (Reale et al., 2016), it is often argued that its acute and long-term health consequences outweigh temporary performance benefits (Crighton et al., 2016).

Large-scale studies have shown that nearly 90% of judo athletes undergo RWL up to 10 times per year (Giannini Artioli et al., 2010), with prevalence being even greater (96%) in top-level judo athletes (Štangar et al., 2022). Prevalence and magnitude of RWL are greater in senior judo athletes compared to their younger counterparts, juniors and cadets (Escobar-Molina et al., 2015). Previously published studies have eloquently described the acute effects of RWL in judo athletes, both in terms of health and performance (Lakicevic et al., 2020), while long-term effects of weight cycling in judo and other weight-classified sports on health are gaining increasing attention in recent years (Krstulović et al., 2022; Miles-Chan & Isacco, 2020).

Knowing that physiological and psychological responses to a given stimuli are intertwined, some researchers have investigated the mood states during and immediately after RWL in combat sports athletes. The term "mood" refers to a "relatively enduring affective states that arise when negative or positive experience in one context or time period alters the individual's threshold for responding to potentially negative or positive events in subsequent contexts or time periods." (Nettle & Bateson, 2012, p. 1). A substantial body of work suggests that RWL can have negative effects on various aspects of psychological wellbeing including increased levels of tension, anger, and fatigue coupled with a significant decrease in vigor (Barley et al., 2019; Lakicevic et al., 2020). Contrary, some authors have suggested that RWL mediates a self-image of being a "real athlete" and can provide a sense of focus and commitment, evoking mental advantage that extends beyond purely gaining physical edge (Pettersson et al., 2013). Given the high prevalence of RWL in judo and the opposing perspectives on this issue, the aim of this study was to systematically screen the existing evidence and provide objective, data-driven stance on RWL and mood states in judo athletes.

2. Method

The preferred reporting items for systematic reviews and meta-analysis (PRISMA 2020) guidelines were used to ensure transparent and complete report (Page et al., 2021).

2.1. Inclusion and exclusion criteria

This review focused solely on judo athletes when they were assessed via Profile of Mood States (POMS) (McNair et al., 1971) questionnaire during RWL as preliminary search showed that the majority of studies on this matter are performed in this combat sport. Studies had to be conducted in professional judo athletes and had to report on changes in bodyweight (kg, lbs, or %) during the RWL and subsequent mood state alterations assessed via POMS before and after RWL. Studies had to include control groups (weight stable group) in their experimental design. Both sexes were eligible to be included and there was no age limit. Only original studies published in English in peer-reviewed journals were considered; other types of publication such as reviews, meta-analyses, conference abstracts, and books, were excluded.

2.2. Information sources, search strategy and selection process

EndNote software (Clarivate Analytics, Jersey, UK, ver. 9.1.) was used for the study search and organization of content acquired by the literature search. PubMed and Web of Science were databases used to obtain necessary literature. Systematically searched of the literature was performed from the earliest data possible to 15th of November, 2022, using the following keywords: "judo AND profile of mood states"; "judo AND poms" and "judo AND rapid weight loss". Reference lists and citations of included studies were searched for additional eligible publications. The study screening involved a three-step process: examining the titles, reviewing the abstracts, and reading the full texts. Whenever discrepancies arose between the two investigators (NL & RR), a third investigator (PD & AB) conducted an independent evaluation and held discussions with the other investigators to reach a consensus. It's important to note that the investigators were not kept unaware of the study manuscripts, including their titles, authors, or affiliated institutions, throughout the selection process. The screening process's outcomes were summarized using the PRISMA 2020 flow diagram, as illustrated in Fig. 1.

2.3. Data extraction and data synthesis

We collected data using a standardized form based on the guidelines provided by the Centre for Reviews and Dissemination. The data encompassed the following elements, where available: Sample size and participant characteristics, including age, height, combat sport, competitive level, and nationality. Measurements of body mass at different stages: baseline, weigh-in, and pre-competition. Detailed information on RWL methods, such as types, natural frequencies, and percentages employed. For continuous outcomes, such as body mass, all studies utilized a uniform measurement scale, either kilograms or pounds. The results were

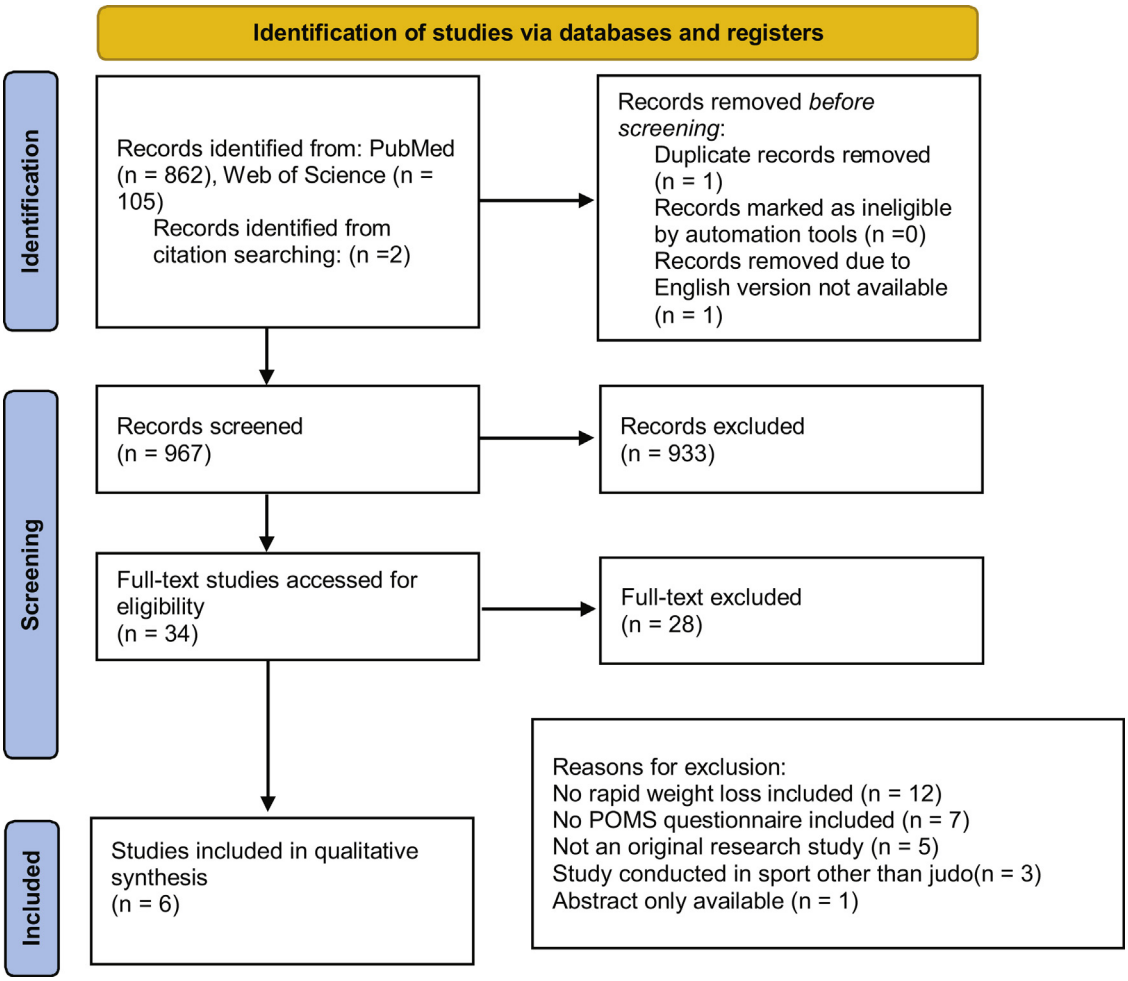

Fig. 1. PRISMA flow diagram.

presented in terms of mean difference values. The findings were synthesized into a comprehensive narrative summary, supported by tables of evidence. All domains of mood (anger, confusion, depression, fatigue, tension, vigor) assessed via POMS were extracted in a separate table. Study authors were contacted if any data of interest was missing.

2.4. Risk of bias assessment

The Newcastle–Ottawa Scale, a validated tool (Wells et al., 2014), was employed to evaluate the potential bias in nonrandomized studies. This scale assesses study quality across three key dimensions: the selection of study groups, the comparability of these groups, and the ascertainment of exposure or outcome, depending on whether it's a case–control or cohort study, respectively.

3. Results

Fig. 1 shows the screening process according to the PRISMA 2020 protocol. After applying eligibility criteria, six studies were included in the review (Degoutte et al., 2006; Fortes et al., 2018; Hiraoka et al., 2019; Isacco et al., 2020; Koral & Dosseville, 2009; Yoshioka et al., 2006) and were analyzed in detail. The included studies were published between 2006 and 2020 and had a total of 172 participants (138 males; 34 females) coming from three different countries (France, Japan, Brazil). Studies were of fair to good quality according to the risk of bias scale (Table 1).

Included studies varied vastly in terms of time dedicated to RWL and the magnitude of weight loss in a given time. French judo athletes lost 2–6% in 28 days (Koral & Dosseville, 2009), 3% in 7 days (Isacco et al., 2020), and 5% in 7 days (Degoutte et al., 2006). Japanese judo athletes lost ~4% in 20 days (Yoshioka et al., 2006) and ~5% in 21 days (Hiraoka et al., 2019). Brazilian judo athletes lost 10% of their body weight in 14 days (Fortes et al., 2018). RWL methods used were similar to what is found in previously published studies on RWL in combat sports (Burke et al., 2021). Food and fluid restriction were the most commonly reported methods utilized to prompt RWL, followed by plastic suit training, increased levels of exercise, sauna use and laxative consumption, respectively (Table 2).

Two studies had athletes engaging in a weeklong RWL in either of 3 (Isacco et al., 2020) or 5% RWL (Degoutte et al., 2006) (Table 3). There was no difference in pre-post mood states in both experimental (EG) and control group (CG) following 3% RWL, whereas when 5% RWL was prompted, EG showed significant increases in tension ($p < 0.05$), anger ($p < 0.01$), fatigue ($p < 0.01$), and a significant drop in vigor ($p < 0.01$). No changes were seen in depression and confusion levels in EG, while all values remained unchanged in CG.

One study obliged athletes to engage in 10% RWL in 14 days (Fortes et al., 2018). Both EG and CG had significantly elevated tension levels after two weeks ($p < 0.05$), while EG experienced a significant drop in vigor ($p < 0.05$); contrary CG showed significant increase in vigor ($p<0.05$). In addition, EG showed significant increases in anger ($p < 0.05$), depression ($p < 0.05$) and fatigue ($p < 0.05$). At the same time, none of these values changed in CG. Confusion levels remained unchanged in both groups.

Table 1
Risk of bias.

	Selection				Comparability[b]	Outcome			Total (9/9)
Study	A	B	C	D	E	F	G	H	
Degoutte et al. (2006)	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	8
Yoshioka et al. (2006)	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	8
Koral & Dosseville (2009)	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	8
Fortes et al. (2018)	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	8
Hiraoka et al. (2019)	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	8
Isacco et al. (2019)	[a]	[a]	[a]	0	0	[a]	[a]	[a]	6

A: representativeness of the exposed cohort; B: selection of the non-exposed cohort; C: ascertainment of the exposure; D: demonstration that outcome of interest was not present at start of study; E: comparability of cohorts on the basis of the design or analysis; F: assessment of outcome; G: was follow-up long enough for outcomes to occur; H: adequacy of follow-up of cohorts.

[a] A single point allocated to a particular study.

[b] A maximum of two stars (points) can be given for comparability.

Table 2
Study characteristics.

Reference	Sample	Age	RWL period	EG baseline (kg)	EG follow-up (kg)	Weight loss	RWL methods
Degoutte et al. (2006)	EG – 10 CG – 10	NA	7 days	75.9 ± 3.1	72.1 ± 1.4	5%	Food and fluid restriction
Yoshioka et al. (2006)	EG – 30 CG – 13	19.1 ± 08	20 days	72.5 ± 12.5	71.1 ± 12.2	Males – 3.4% Females – 4.9%	Food and fluid restriction; increased exercise; plastic suits training
Koral & Dosseville (2009)	EG – 10 CG – 10	17 ± 1	28 days	72.4 ± 13.5	69.6 ± 13.1	2–6%	Food restriction; increased exercise; plastic suit training
Fortes et al. (2018)	EG – 20 CG – 19	22.1 ± 1.7	14 days	72.5 ± 3.6	64.8 ± 4	10%	NA (self-selected methods)
Hiraoka et al. (2019)	EG1 – 10 EG2 – 10 CG – 10	20.1 ± 0.3	21 days	78.1 ± 5.3	NA	EG1 – < 5% EG2 – □ 5%	Food and fluid restriction; increased exercise; plastic suit training; sauna use
Isacco et al. (2019)	EG – 10 CG – 10	24 ± 5	7 days	75.5 ± 7.7	NA	3%	Food and fluid restriction

EG: experimental group; CG: control group; NA: not available.

Three studies had athletes engaging in various levels of RWL in ≥ 20 days (Hiraoka et al., 2019; Koral & Dosseville, 2009; Yoshioka et al., 2006). In a study where athletes engaged in 3.4–4.9% in 20 days, no changes in mood states were seen in either EG or CG (Yoshioka et al., 2006). In another study athletes had to undergo either < 5% or > 5% RWL in 21 days (Hiraoka et al., 2019). The group that had < 5% RWL had no changes in mood states, whereas > 5% RWL EG showed no changes in tension, depression, anger and confusion, along with significant drop in vigor ($p < 0.05$) and significant increase in fatigue ($p < 0.05$). No changes were seen in the CG.

The most extended timeframe dedicated to RWL was 28 days where athletes lost 2–6% of their bodyweight (Koral & Dosseville, 2009). Both EG and CG groups showed significant increases in tension ($p < 0.05$) and confusion ($p < 0.05$) and no changes in depression, anger and fatigue. Only EG experienced a significant drop in vigor ($p < 0.05$), while CG showed no changes compared to baseline values.

4. Discussion

The aim of the present review was to determine the effects of RWL on mood states in judo athletes. Although studies varied vastly in their design, certain patterns could be identified. First, the greater the magnitude of weight loss in a given timeframe, the worse the outcomes of the psychological values measured. This is particularly reflected in the significant increase of tension and significant drop in vigor that was detected in multiple studies (Degoutte et al., 2006; Fortes et al., 2018; Hiraoka et al., 2019; Koral & Dosseville, 2009). Moreover, more than 5% RWL per week seems to greatly exacerbate mood states in judo athletes (Degoutte et al., 2006; Fortes et al., 2018; Hiraoka et al., 2019). Notably, total mood disturbance (TMD) was increased in EGs coming from all studies included in this review. This margin of 5% seems to also be relevant for physical performance as recent meta-analysis showed that RWL of ≤ 5% prompted over 7 days does not influence performance outcomes in the official weight-classified Olympic combat athletes (including judo), especially in strength and power measurements (Mauricio et al., 2022). There is no universally accepted definition of RWL (regarding the magnitude and time dedicated to it), but on a broader scale, available data suggest that RWL in combat athletes does not alter short-duration, repeated high-intensity-effort performance; however, there is evidence to suggest that some exercise performance outcomes may decline due to RWL (Brechney et al., 2022).

Several studies that have also investigated the effects of RWL on mood states, but did not meet our inclusion criteria due to lack of control group are worthy of mentioning. Namely, in a sample of French judo athletes who underwent significant RWL within a week, confusion, anger, fatigue and tension were significantly higher compared to baseline, with vigor being significantly decreased following RWL (Filaire, Maso, Degoutte, et al., 2001; Filaire, Maso, Sagnol, et al., 2001). In a study on Japanese judo athletes somewhat divergent results were found (Umeda et al., 1999). Following RWL, overall POMS results were significantly lower in males when compared to baseline. However, vigor was significantly lower both in males and females, while confusion increased significantly only in females. Also, anxiety level accessed via the State-Trait Anxiety Inventory was increased in females only. It is important to interpret anxiety level changes with caution as increased anxiety is associated with elevated hormonal responses in anticipation of a judo combat regardless of RWL (Filaire et al., 2001a, b). In a large-scale cross-sectional study on Brazilian judo athletes, findings have shown that senior athletes seem to develop more effective strategies to cope with RWL-caused mood perturbations. In contrast, cadet and junior female judo athletes are more likely to suffer from the psychological-related states

Table 3
Effects of rapid weight loss on mood states in judo athletes.

Authors	POMS questionnaire	Results		
		EG Pre vs. Post		CG Pre vs. Post
Degoutte et al. (2006)	Tension	↑*		↔
	Depression	↔		↔
	Anger	↑**		↔
	Vigor	↓**		↔
	Fatigue	↑**		↔
	Confusion	↔		↔
Koral & Dosseville (2009)	Tension	↑*		↑*
	Depression	↔		↔
	Anger	↔		↔
	Vigor	↓*		↔
	Fatigue	↔		↔
	Confusion	↑*		↑*
Yoshioka et al. (2006)	Tension	↔		↔
	Depression	↔		↔
	Anger	↔		↔
	Vigor	↔		↔
	Fatigue	↔		↔
	Confusion	↔		↔
Fortes et al. (2018)	Tension	↑*		↑*
	Depression	↑*		↔
	Anger	↑*		↔
	Vigor	↓*		↑*
	Fatigue	↑*		↔
	Confusion	↔		↔
Isacco et al. (2019)	Tension	↔		↔
	Depression	↔		↔
	Anger	↔		↔
	Vigor	↔		↔
	Fatigue	↔		↔
	Confusion	↔		↔
		EG1	EG2	
Hiraoka et al. (2019)	Tension	↔	↔	↔
	Depression	↔	↔	↔
	Anger	↔	↔	↔
	Vigor	↔	↓*	↔
	Fatigue	↔	↑*	↔
	Confusion	↔	↔	↔

CG: control group; EG: experimental group; EG1: experimental group that underwent less than 5% of weight loss; EG2: experimental group that underwent more than 5% of weight loss; POMS: Profile of Mood States; Post: post weight loss; Pre: pre weight loss; ↔: no change; ↑: significant increase; ↓: significant decrease.
* $p < 0.05$.
** $p < 0.01$

associated with RWL (Escobar-Molina et al., 2015). Indeed, females were more concerned about their diets, showed higher anxiety, scored higher in the emotion scale, and more eating disorders symptoms, although RWL was of lower magnitude.

Analogous investigations have been conducted in other combat sports. In a unique qualitative study on Swedish combat sports athletes (wrestling, judo, taekwondo), the emphasis was placed on athletes' own experiences and opinions (Pettersson et al., 2013). Hereby, the athletes reported that RWL enhances their sense of belonging, self-esteem and commitment to sport which ultimate makes them "a real athlete." In another questionnaire-based study conducted in Mexico, wrestlers and taekwondo athletes reported altered mood states such as tiredness, sadness, increased fatigue and vigor after undergoing RWL (Castor-Praga et al., 2021).

In the sample of British mixed-martial arts athletes, RWL prompted elevated levels of confusion and TMD and a significantly increased levels of anger at the official weigh in (Brandt et al., 2018). Similarly, in a sample of UK amateur boxers RWL was associated with elevated levels of anger, fatigue and tension, and reduced vigor (Hall & Lane, 2001).

Even though male and female data was merged in our study for a better inter study comparison, it is important to outline potential differences in responses to RWL between male and female judo athletes. Three studies have included female athletes in their study design. In a sample of French judo athletes (Koral & Dosseville, 2009), the mood states of confusion in male judo athletes, and tension and confusion in female judo athletes, increased significantly from the pre-post ($p < 0.05$). Also, vigor decreased significantly in both male and female athletes in the EG ($p < 0.05$). In contrast, quite unforeseen results were found in Japanese judo athletes (Yoshioka et al., 2006). Namely, within EG, males showed significantly higher scores in tension ($p < 0.05$), fatigue ($p < 0.01$), vigor ($p < 0.05$) and TMD ($p < 0.05$) following RWL. However, female EG actually showed a marked decrease in anger, confusion, depression, tension, and TMD when compared to baseline, although the changes were not significant. Though, females had the higher values in all mood states prior to the study when compared to males. In another survey of Japanese judo athletes, no differences in mood states following RWL were identified (Hiraoka et al., 2019). This data offers a valuable input, as POMS scores can predict athletic performance across a wide variety of sports (Lochbaum et al., 2021).

Findings from the present review corroborate with the results of a recent study on top tier judo athletes where nearly all participants (91%) reported negative consequences of RWL such as feeling lethargic, confused, unmotivated, depressed, sleep deprived, while gastrointestinal symptoms and even faint/collapse were also documented (Štangar et al., 2022). However, the same study showed that a significant portion of participants perceived RWL as beneficial for improved concentration/determination, increased self-confidence, and better focus, while increased aggression/anger was the second

most reported consequence (71%) of RWL. These findings are in alignment with a previously mentioned qualitative study on Swedish combat athletes who reported that RWL amplifies their feeling belonging and a sense of commitment to the sport (Pettersson et al., 2013).

Multiple studies on the prevalence of weight cycling in judo have indicated that many judo athletes first engage in RWL as young as four (Berkovich et al., 2016), but more commonly when nine (Giannini Artioli et al., 2010) or twelve years old (Štangar et al., 2022). This notion is particularly worrisome knowing that during this period, children and adolescents normally undergo intense growth and development (both physically and psychologically), but unfortunately this trend is something that is seen in other youth combat sports as well (Lakicevic et al., 2022). Considering that nearly identical patterns of weight cycling between youth and adult combat sports were found (Burke et al., 2021), it can be postulated that RWL/RWG is a heritage that younger combat sport athletes inevitably inherit from their older counterparts who already have adverse effects of RWL such as distorted self-image, negative mood profile, impaired short-term memory, high susceptibility for eating disorders and menstrual dysfunction (Brandt et al., 2018; Choma et al., 1998; Dick, 1991; Hall & Lane, 2001; Oppliger et al., 1993; Rouveix et al., 2007; Thiel et al., 1993). Indeed, there is a pervasive belief in the combat sports community that RWL or achieving the least weight possible ahead of the weigh-in and then engaging in RWG by replenishing necessary foods and fluids following the weigh-in and prior to the competition, enhances one's chance to win against lighter and presumably weaker opponent (Pettersson et al., 2012). Such reductionist viewpoints whereby weight is viewed as the only variable that matters leads to false conclusions and can potentially lead to drawing too much attention to weight cycling in preparatory phase and potentially neglecting other key aspects of optimal physical and mental preparation. In practice, success in judo (and other combat sports) is multifactorial and includes factors such as overall nutrition, adequate training design (periodization and skill development) proper recovery, previous experience in sport, and mental preparation (Lakicevic et al., 2021; Rossi et al., 2022; Ziv & Lidor, 2013). In laboratory-based studies, RWL induces muscle damage (Roklicer et al., 2020), which can further lead to performance decrements in dynamic and isometric strength in upper limbs and in judo-specific performance (Ceylan et al., 2022; Filaire et al., 2001a, b).

Nonetheless, RWL can affect career trajectories of combat sports athletes. Chronic weight cycling does not protect athletes from the negative impact of RWL on performance given that the timeframe from weigh ins to competition is too short for adequate fluid and food ingestion (Mendes et al., 2013). In the case of judo athletes, rapid weight loss of $\geq$ 5% placed the athlete at a higher risk of injury (Green et al., 2007). Moreover, a recent study on American collegiate wrestlers showed that RWL was associated with a higher risk of in-competition injuries where for every percent in body weight lost, wrestlers had an 11% increased hazard of injury during competition (Hammer et al., 2022).

This review is certainly not without limitations. A preliminary search of the literature showed that the majority of studies on RWL and mood state effects in combat athletes (that also control group in their experimental design) were conducted in judo athletes, so we only included RWL/POMS studies conducted in judo athletes and excluded those from other sports. Thus, we ended up with a very small number of studies having less than 200 participants. Also, as less than 20% of the overall sample was female, thus male/female data was merged for a better inter study comparison, potentially skewing the independent outcome if presented separately. However, a detailed review of the literature was performed whereby stringent eligibility criteria was followed, offering the most concise evidence on RWL and mood states in judo athletes to date. Prior to crafting this study, we wanted to perform a meta-analysis but this was precluded due to different versions of POMS and different scoring systems associated with it.

Our study indicates that more high-quality studies in this field are needed. Namely, even though there is a substantial data on RWL and mood states in judo athletes, other combat sports are not well represented in the existing literature. Psychological wellbeing in combat athletes should not be secondary to performance studies, especially since it has been shown repeatedly that RWL in combat sports starts at a very young age (Lakicevic et al., 2022).

5. Conclusion

Rapid weight loss can lead to adverse mood states in judo athletes when > 5% weight loss is prompted. This is particularly reflected in the elevated tension levels and a significant drop in vigor that was noticeable in both males and females. Studies on potential long-term psychological consequences of repeated weight cycling are needed.

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Disclosure of interest

The authors declare that they have no competing interest.

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