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The Magnitude of Rapid Weight Loss Affects Subjective Stress and Recovery in Elite Powerlifters at the World Championships: An Exploratory Analysis

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ABSTRACT
Rapid weight loss is common in weight category sports, and large magnitudes of it can affect performance. This study explored relationships between changes in the Short Recovery and Stress Scale (SRSS) items and the magnitude of rapid weight loss in elite powerlifters competing at the World Championships. A total of 53 powerlifters (27 males, 26 females) who competed in either the 2019 or 2022 International Powerlifting Federation World Championships participated. At 7, 2, and 0 days out from competition, the participants completed the SRSS and recorded their body mass. Cumulative link mixed models were used to explore the relationship between SRSS score and proximity to competition, competitive caliber (good lift points [GLP]), sex, and magnitude of relative weight change. On average, the participants lost −2.5% (1.83 kg) of body mass from day 7 to day 0. The results suggest that (a) elite powerlifters can decrease subjective stress and promote recovery leading into competition, (b) powerlifters with higher GLP at competition are more likely to report better recovery and negative emotional state scores, (c) higher relative magnitude of weight loss is associated with worse subjective stress and recovery scores, and (d) female powerlifters experience worse negative emotional state responses with higher relative weight loss. These findings highlight that the magnitude of rapid weight loss can affect subjective stress and recovery and provide data to inform future hypothesis testing.

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Athlete monitoring; mental performance; powerlifting; world class powerlifters

Rapid weight loss (RWL), characterized by a body mass reduction of 2% to 5% (although more occurs in some sports, as to be discussed) in a short period, often within 5–7 days of competition (Brito et al., 2012), is a common practice of powerlifters regardless of lifting experience (Campbell et al., 2023). Despite the lack of specific research in RWL for powerlifters, more than 80% of powerlifters utilize some form of RWL strategy to achieve the weight required for their weight class (Campbell et al., 2023; Kwan & Helms, 2022; Nolan et al., 2020). The method of RWL varies from lifter to lifter, and this variance in approach can lead to different amounts of weight lost and may negatively influence performance due to dehydration or fatigue from a reduced energy intake (Campbell et al., 2023; Schoffstall et al., 2001). As demonstrated primarily from research in combat sports (Oliver R. Barley, Chapman, et al., 2018; Viveiros et al., 2015), the greater the magnitude of weight lost through RWL, the greater the potential for a negative impact on athlete performance, psychology, and physiology. Further, negative psychological impacts from RWL have been recorded in powerlifters (Kwan & Helms, 2022).

A notable difference between the two sports is the magnitude of weight loss. Combat sport athletes tend to lose greater relative amounts, often up to 5–8% () of weight compared to powerlifters, on average losing ~2–6% of body mass (Campbell et al., 2023; Kwan & Helms, 2022; Nolan et al., 2020). This is partly because powerlifters in the International Powerlifting Federation (IPF; the largest powerlifting sports body) have only two hours post-weigh-in to refuel and rehydrate (IPF, 2023) compared to combat sport athletes who have a wide range from 30 minutes to three hours and even up to 30 hours depending on their specific sport (Daniele et al., 2016). Notably, the more time available to an athlete to rehydrate and refuel post weigh-in, the athletes attempt larger magnitudes of body mass loss during (Lakicevic et al., 2021). This distinction is important because the negative impact of RWL on physical and mental performance is exacerbated with greater losses of body mass, given the same amount of time to refuel and rehydrate (Campbell et al., 2023; Coswig et al., 2019). Moreover, a longer post-weigh-in refueling period may help mitigate the negative effects of RWL on an athlete's physical and mental performance (Artioli et al., 2010).

There are several RWL strategies that powerlifters utilize. The first involves reducing body weight by manipulating residual food weight in the gut, achieved by omitting fiber and consuming foods that are more energy dense (Kwan & Helms, 2022). The second strategy is dehydration through fluid manipulation, commonly done by increasing water consumption followed by a steep reduction prior to competition, known as water loading, which increases acute body water reduction to a greater degree compared to fluid reduction alone (Reale, Slater, Cox, et al., 2018). In addition, RWL via dehydration can also be induced through heat exposure, leading to sweating. These methods are like those used by combat athletes, but the

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magnitude of body weight loss tends to differ (Kwan & Helms, 2022). Therefore, current research on the negative impacts of RWL in combat sport athletes cannot be directly extrapolated to IPF powerlifters with a shorter post-weigh-in window.

Powerlifting performance can be influenced by body mass manipulation (Coker et al., 2018) and attempt selection (van den Hoek et al., 2023); i.e., the load selection strategy athletes choose for each lift attempt. Additionally, one paper suggested that the opening squat may be the most important lift of the competition (Howells et al., 2022), as its success changes the probability of a successful competition overall. Since the first attempt squat is the performance most proximal to the weight cut, a greater magnitude of body weight induced through RWL makes it harder for the lifter to rehydrate and refuel within the two hours after the weigh-ins, which may impact first-squat performance.

Given the potential relationship between RWL and powerlifting success, more research is warranted to investigate how RWL strategies impact an athlete's readiness and performance. These factors and the gaps in the existing research led us to conduct an exploratory in-person survey to determine the relationship of weight change with subjective well-being at two IPF World Championships. The outcomes of this survey may be important, as psychological pressure can negatively impact performance (Yang et al., 2014). Further, a more positive mental state—achieved by reducing competitive anxiety and improving mood through better emotional control and the ability to maintain confidence—has led to greater athletic success in other weight class-based athletes (Durguerian et al., 2016; Yang et al., 2014). To explore the potential relationship between perceived stress, recovery, and performance in powerlifters, we utilized the Short Recovery and Stress Scale (SRSS), an easy-to-use, previously validated scale (Perkins et al., 2022). We hypothesized that there may be a relationship between SRSS category scores and certain descriptive factors, such as body weight loss, time, and the competitive level of the powerlifter.

Methods

Data collection for this study was completed at the 2019 IPF Classic World Championship in Helsingborg, Sweden, and the 2022 IPF Classic World Championship in Sun City, South Africa. A convenience sample of potential participants was recruited via social media and/or e-mail, and the only inclusion criteria were that they were competitors at the World Championship and had the availability and willingness to participate. The aim of the current study was twofold. First, the study aimed to explore subjective well-being, readiness, and weight change over seven days in IPF powerlifters competing at the 2019 and 2022 World Championships, using the SRSS. The SRSS was used to determine how predictors such as competitive caliber (reflected in a strength relative to body mass coefficient score, scored in the IPF as Good Lift Points; [GLP]), sex, and magnitude of RWL affect SRSS scores. In addition, we tested whether competition performance was affected by the magnitude of RWL. We then evaluated the interaction of the readiness score of the participants across multiple categories, including day, body weight, competitive division, biological sex, and GLP. The relative Δ body weight (using day 2 to day 0 as an example) is calculated as [(body weight on day 0 − body weight on day 2)/body weight on day 2] × 100. The rest of the formulas can be found on OSF.

Participants were informed that they would need to complete the SRSS, an eight-question questionnaire using a 7-point Likert scale at three different time points: the day before they began any form of acute RWL (day 7, 6–7 days before the meet), 2 days before the meet (day 2), and immediately after weigh-ins (day 0). The SRSS was chosen for its ease of use and its validity when compared with biomarkers such as cortisol and creatine kinase in weightlifters, a strength-power sport that also utilizes a 2-hour weigh-in period (Perkins et al., 2022). Participants were familiarized with the SRSS questionnaire during the first meeting (day 7) in detail, and each participant received instructions on how to answer each item. The SRSS consists of eight items that measure physical, mental, emotional, and overall aspects of both recovery and stress (Perkins et al., 2022). The four items measuring recovery include Physical Performance Capability (PPC), Mental Performance Capability (MPC), Emotional Balance (EB), and Overall Recovery (OVR). The subsequent four items measuring stress include Muscular Stress (MS), Lack of Activation (LOA), Negative Emotional State (NES), and Overall Stress (OS). Each item is described with a list of adjectives, and participants rank them on a scale from 0 to 6, with 0 being "does not apply at all" and 6 being "fully applies." The eight subscales of the SRSS are structured such that better perceived recovery is characterized by higher responses, and improved stress by lower responses (stress items are scored inversely, with lower values indicating less stress), on the 0 to 6 scale. In addition to completing the questionnaire, participants' body weight was recorded at three time points on their personal scale that was calibrated to the scales of the competition (morning body weight on day 7 and day 2, and official weigh-in weight on day 0). Participants' overall competition placements were recorded. Informed consent was obtained prior to participation. This study was approved by the university's ethics committee, ethics application number 18/161. The SRSS questionnaire can be found in Supplementary File 1.

Statistical analysis

These statistical analyses are exploratory and aim to identify patterns and associations between variables of interest (i.e., how proximity to competition, sex, competitive caliber, and magnitude of acute weight loss, and the interaction of these variables, affect recovery and stress ratings) in our dataset (Ditroilo et al., 2024). We employ an estimation-based approach (Gardner & Altman, 1986) to report model estimates (and their uncertainty) that are of interest when identifying patterns or associations in the dataset. *P*-values are reported for completeness but are not interpreted in their traditional manner due to the exploratory nature of our analysis.

All statistical analysis was performed in the R statistical language (version 4.4.1; R Core Team 2021). The dataset and analysis code are available on the Open Science Framework (URL: https://osf.io/cf954/). To explore the effect of weight change on GLP at competition, a linear model with fixed effects (with interaction terms) for day 7 to 2 weight change, day 2 to day 0 weight change, and sex was performed using the *lme4* package (Bates et al., 2015). Linear model assumptions were checked using the *performance* (Lüdecke et al., 2021) package.

Given the ordinal data structure obtained from the SRSS, cumulative link mixed models (CLMM) were performed in R using the *ordinal* package (Christensen, 2015). Maximum likelihood estimation within the logit model was used. The number of adaptive Hauss-Hermite quadrature points was set at 5 for all CLMMs. A full model was constructed on the grounds of data availability and potential theoretical interest. The full model included fixed effects with interaction for day (3 levels: day 7, day 2, and day 0), weight change from day 7 to 2 (continuous), weight change from day 2 to 0 (continuous), competitive division (2 levels: male or female), and GLP (continuous). Participant identification number was included as a random effect to model inter-individual responses and account for the non-independence of observations in the repeated measures design of the study. Where interactions of interest were identified, post-hoc analyses were completed using the *emmeans* package (Lenth et al., 2018).

To balance model parsimony and goodness of fit, the full model's effect estimates, standard errors, and *p*-values were inspected, and the model was simplified by first removing interaction terms (and retaining the variable as a main effect) of fixed effects with weak associations. Weak evidence was assessed by a combination of factors: odds ratios close to 1 (interpreted relative to the scale of the predictor), the width of the confidence intervals, and the highest *p*-values. This backward stepdown variable selection approach was used, given the convenience-based sample size, and that previous SRSS data on a similar participant cohort are not available to inform what relative likelihood to expect (Heinze et al., 2018). After model simplification by removing interaction terms, main effects that did not contribute to the model were removed from the model (Chowdhury & Turin, 2020). Simpler models were compared to the more complex model via AIC, BIC, and likelihood ratio test (Harrell, 2001). If model fit improved with the simpler model, the simpler model was selected, and the process of model simplification continued until model fit did not improve. If the model fit did not improve with the simpler model, the more complex model was retained and reported. Day (7, 2, or 0) was always retained as a fixed effect in the final model due to conceptual importance.

After determining the final model, the proportional odds assumption was evaluated through visual inspection of empirical logits for cumulative probabilities at each threshold of the ordinal response (0–6) (Harrell, 2001). Where visual inspection indicated violations of the proportional odds assumption, the proportional odds model was retained to provide a unified, averaged estimate of the predictor's effect across all response levels. In these cases, results are interpreted as reflecting an average effect rather than threshold-specific associations. Multicollinearity was assessed by calculating the variance inflation factor between predictors. Linearity of continuous variables was assessed by adding quantile natural splines (0.05, 0.35, 0.65, and 0.95) to continuous variables (body weight and/or GLP) in the final model separately and then performing a likelihood ratio test comparing the final CLMM model with the spline model (Harrell, 2001).

One participant did not register a total at the competition due to failure to make weight, and the mean cohort GLP (97.8) was imputed for this participant to enable analysis of all participants who completed the SRSS. Odds ratios were derived and reported by exponentiating the log odds coefficient produced from the CLMM model.

Results

The final sample included 53 participants (females = 26, males = 27) from seven weight classes, respectively, with an average GLP score of 97.8. GLP scores of total medalists and non-medalists were 104.5 and 95.4, respectively. There were seven participants who placed first and 11 participants who placed second or third in their respective weight class, and the average placing for all participants was 7.5 out of 17.1 total places. All 53 participants from 2019 and 2022 were distinct and were not repeated. The figures below display overall responses (Figure 1), male responses (Figure 2), and female responses (Figure 3), respectively.

On average, participants decreased body weight by 0.39 kg between day 7 and day 2, and 1.44 kg between day 2 and day 0. Total body weight loss from day 7 to day 0 was 1.83 kg (2.5% of total body weight). The association between GLP score at competition and the magnitude of weight change between day 7 and day 2 was $\beta = 0.66$ (95% CI [−3.03, 4.36], $p = .72$). The interaction between day 2 to day 0 weight change and sex was positively associated ($\beta = 3.38$, 95% CI [−0.22, 7.00], $p = .07$). Post-hoc analysis suggested a positive association of GLP with weight loss between day 2 and day 0 for females ($\beta = 3.31$, 95% CI [0.36, 6.25], $p = .02$) but not males ($\beta = -0.08$, 95% CI [−2.51, 2.35] $p = .94$).

Q1

The odds of reporting a higher PPC response were lower on day 2 (OR = 0.54, 95% CI [0.26, 1.13], $p = .10$) and on day 7 (OR = 0.91, 95% CI [0.43, 1.92], $p = .80$) relative to day 0, respectively. The odds of reporting a higher PPC response were higher on day 7 relative to day 2 (OR = 1.67, (95% CI [0.81, 3.44], $p = .17$). The odds of reporting a higher PPC response increased as GLP increased (OR = 1.04, 95% CI [0.99, 1.09], $p = .07$). The odds of reporting a higher PPC response were lower as day 2 to 0 as relative body weight loss increased (OR = 0.74, 95% CI [0.58, 0.95], $p = .02$).

Q2

The odds of reporting a higher MPC response were lower on day 2 (OR = 0.35 (95% CI [0.16, 0.75], $p = .007$) and on day 7 (OR = 0.99 (95% CI [0.47, 2.08], $p = .97$) relative to day 0, respectively. The odds of reporting a higher MPC response were higher on day 7 relative to day 2 (OR = 2.76 (95% CI [1.32, 5.79], $p = .007$). The odds of reporting a higher MPC response increased as GLP increased (OR = 1.04, 95% CI [0.99, 1.09], $p = .10$). The odds of reporting a higher MPC response were lower as day 2 to 0 relative body weight loss increased (OR = 0.71, 95% CI [0.53, 0.96], $p = .03$).

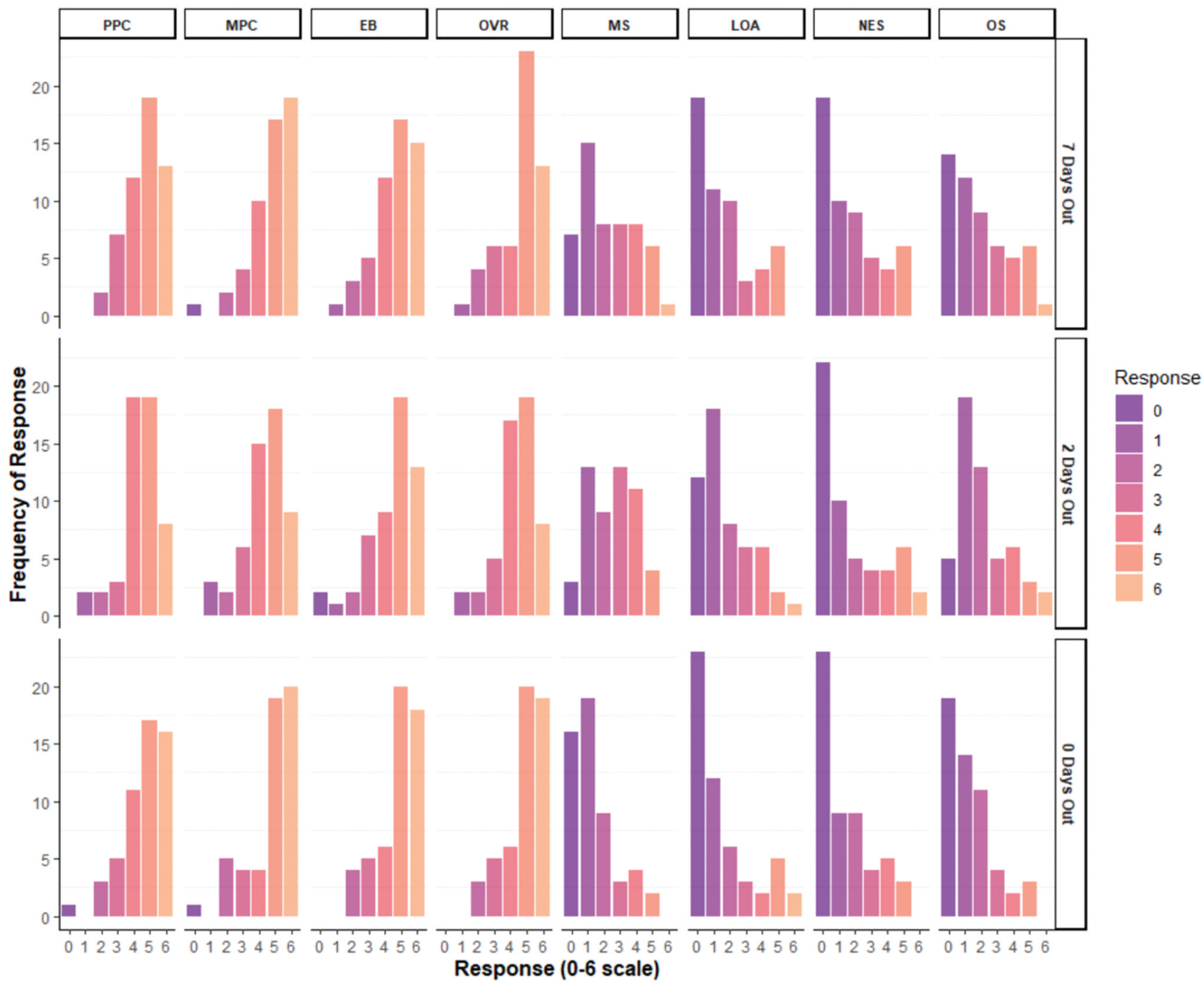

Figure 1. Overall response.

Q3

The odds of reporting a higher EB response were lower on day 2 (OR = 0.55, 95% CI [0.26, 1.16], $p = .11$) and on day 7 (OR = 0.69, 95% CI [0.33, 1.43], $p = .32$) relative to day 0, respectively. The odds of reporting a higher EB response were higher on day 7 relative to day 2 (OR = 1.24 (95% CI [0.61, 2.55], $p = .54$).

Q4

The odds of reporting a higher OVR response were lower on day 2 (OR = 0.35, 95% CI [0.17, 0.73], $p = .001$) and on day 7 (OR = 0.60, 95% CI [0.29, 1.25], $p = .17$) relative to day 0, respectively. The odds of reporting a higher OVR response were higher on day 7 relative to day 2 (OR = 1.96, 95% CI [0.91, 4.22], $p = .08$). The odds of reporting a higher OVR response increased as GLP increased (OR = 1.03, 95% CI [0.99, 1.07], $p = .12$). The odds of reporting a higher OVR response were lower as day 2 to 0 as relative body weight loss increased (OR = 0.85, 95% CI [0.69, 1.03], $p = .10$).

Q5

The odds of reporting a higher MS response were higher on day 2 (OR = 4.66, 95% CI [2.26, 9.59], $p = .0001$) and on day 7 (OR = 3.40, 95% CI [1.65, 7.04], $p = .001$) relative to day 0, respectively. The odds of reporting a higher MS response were lower on day 7 relative to day 2 (OR = 0.73, 95% CI [0.37, 1.45], $p = .37$). The odds of reporting a higher MS response were higher as day 2 to 0 as relative body weight loss increased (OR = 1.19, 95% CI [1.01, 1.40], $p = .03$).

Q6

The odds of reporting a higher LOA response were higher on day 2 (OR = 3.37, 95% CI [1.21, 9.37], $p = .02$) and on day 7 (OR = 2.30, 95% CI [0.79, 6.67], $p = .13$) relative to day 0, respectively. The odds of reporting a higher LOA response were lower on day 7 relative to day 2 (OR = 0.68, 95% CI [0.26, 1.79], $p = .44$). There was a positive association between day 2 (relative to day 0) LOA responses and day 2 to 0 weight change (OR = 1.36, 95% CI [0.97, 1.93], $p = .07$). Post-hoc analysis suggested that as the magnitude of relative weight loss increased from day 2 to day 0, the odds of a higher LOA

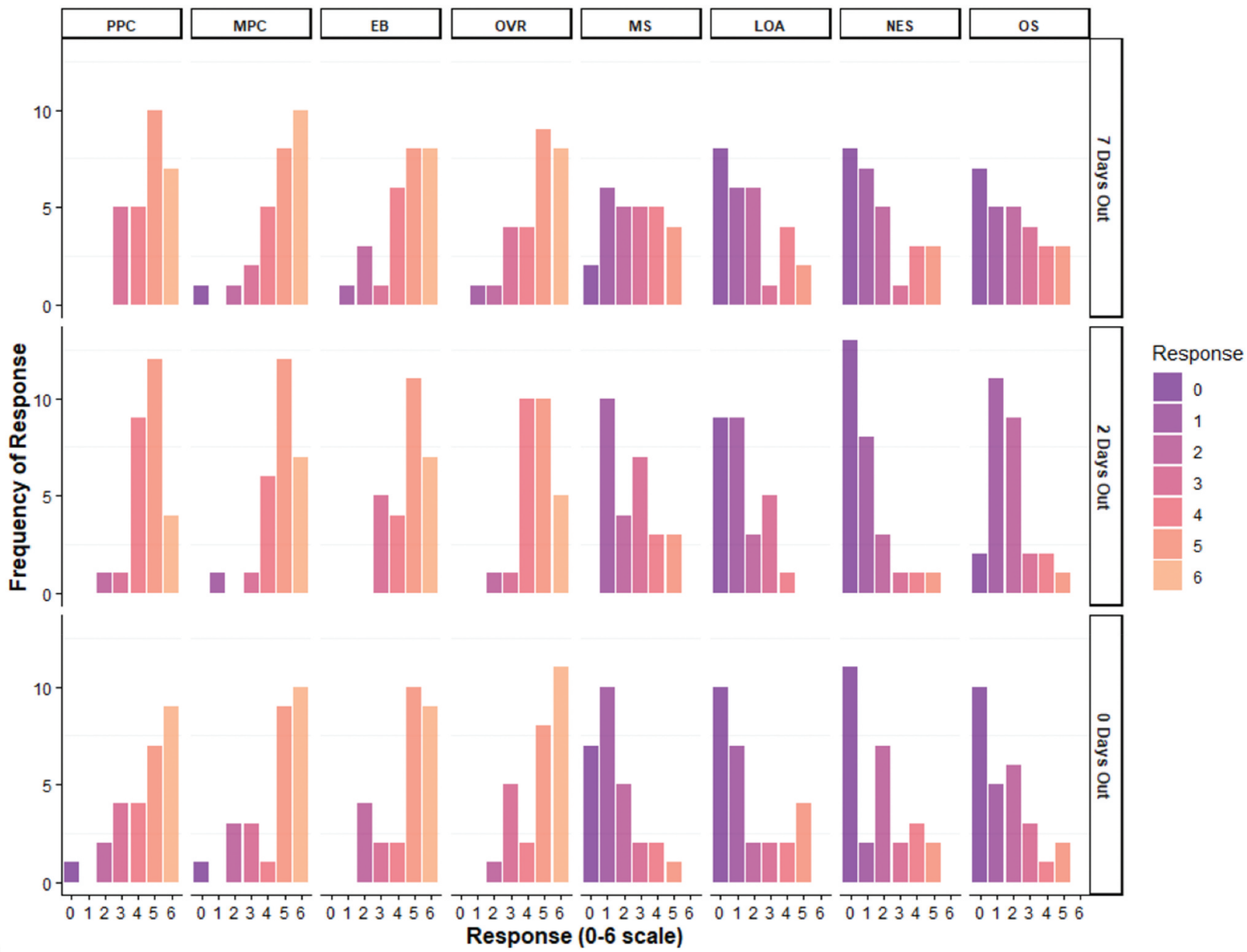

Figure 2. Male responses.

response increased on day 0 (OR = 1.48, 95% CI [1.10, 1.99], p = .008) but not day 2 (OR = 1.08, 95% CI [0.82. 1.43], p = .40).

Q7

The odds of reporting a higher NES response were higher on day 2 (OR = 1.23, 95% CI [0.59, 2.57], p = .58) and on day 7 (OR = 1.36, 95% CI [0.67, 2.79], p = .39) relative to day 0, respectively. The odds of reporting a higher NES response were higher on day 7 relative to day 2 (OR = 1.11, 95% CI [0.54, 2.27], p = .78). The odds of reporting a higher NES response decreased as GLP increased (OR = 0.96, 95% CI [0.92, 1.00], p = .06). There was a positive association between sex and day 2 to day 0 body weight change (OR = 1.52, 95% CI [1.01, 2.30], p = .04). Follow-up analysis revealed a positive slope for females (OR = 1.52, 95% CI [1.01, 2.29], p = .04), indicating that for every additional percentage point of relative body weight loss, the odds of a higher NES response increased 52%.

Q8

The odds of reporting a higher OS response were higher on day 2 (OR = 4.71, 95% CI: [1.71, 13.00], p = .002) and on day 7 (OR = 3.65, 95% CI: [1.26, 10.53], p = .01) relative to day 0, respectively. The odds of reporting a higher OS response were lower on day 7 relative to day 2 (OR = 0.78, 95% CI [0.29, 2.06], p = .61). The odds of reporting a higher OS response were higher on day 0 as day 2 to day 0 relative body weight loss increased (OR = 1.33, 95% CI [1.01, 1.74], p = .04).

Discussion

We explored the relationship between SRSS scores and the magnitude of body weight loss, sex, proximity to competition, and GLP in powerlifters competing at two World Championships. We report that (a) elite powerlifters can decrease subjective stress and promote recovery leading into competition; (b) powerlifters with higher GLP at competition are more likely to report better stress and negative emotional state scores; (c) higher relative magnitude of weight loss is associated with worse subjective stress and recovery scores; and (d) female powerlifters experience worse negative emotional state responses with higher relative weight loss. On average, participants lost 2.5% (slightly lower than previous reported values, with both Nolan et al. and Kwan & Helms both reporting ~3% lost) of total body weight from day 7 to day 0, with most weight loss occurring in the final two

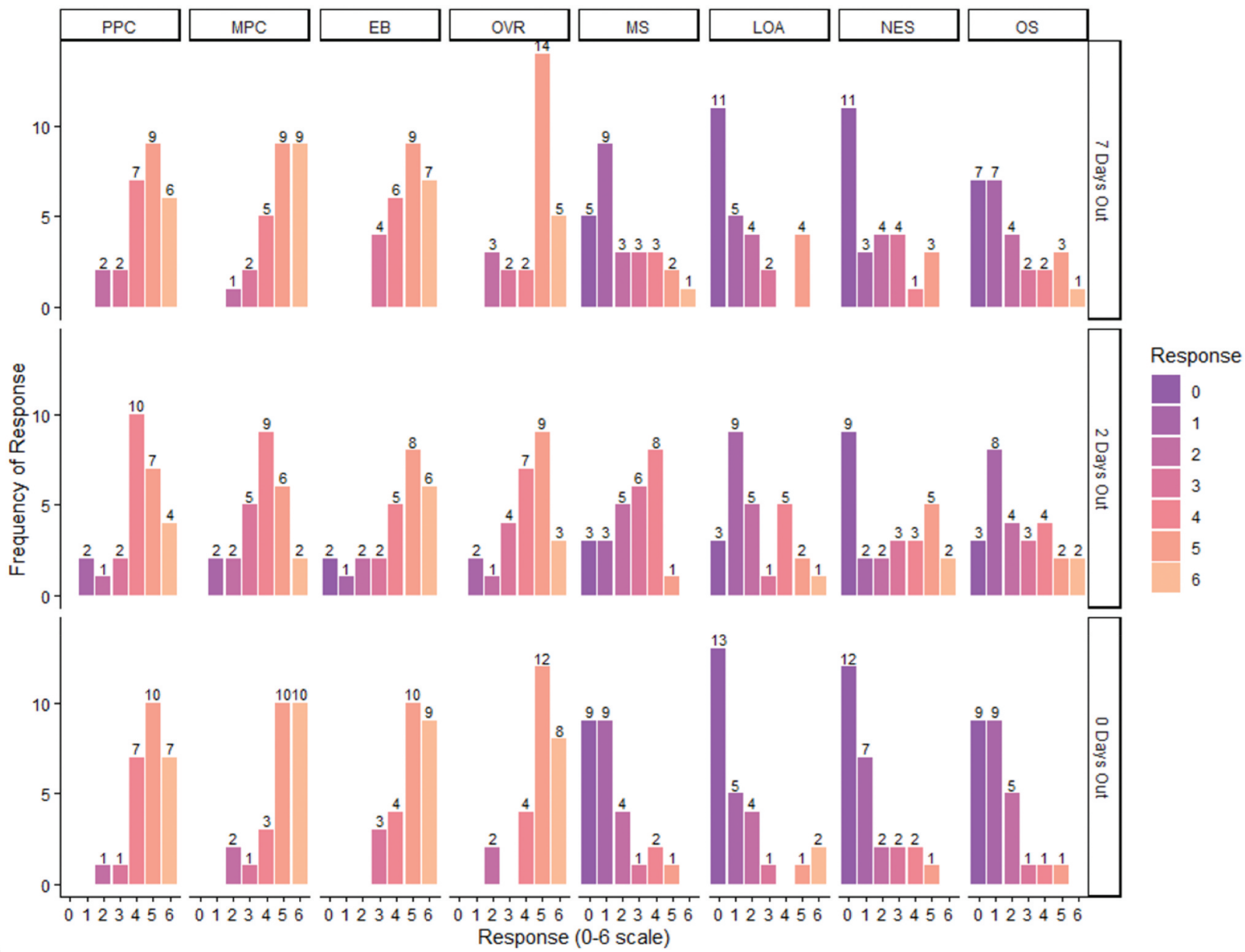

Figure 3. Female responses. Abbreviations: Physical Performance Capability (PPC), Mental Performance Capability (MPC), Emotional Balance (EB), and Overall Recovery (OVR). The subsequent four items measuring stress include Muscular Stress (MS), Lack of Activation (LOA), Negative Emotional State (NES), and Overall Stress (OS).

days before competition (2%). Since most RWL methods induce body weight loss in the final days leading to competition, this pattern was expected. While we did not ask participants about their RWL methods, previous surveys on powerlifters (Nolan et al., 2020) indicate that a combination of fluid manipulation and gut volume manipulation—methods commonly used and averaging ~3% body weight loss—is likely in the present sample. However, less common methods such as dehydration via heat exposure cannot be ruled out.

We explored the relationship between SRSS scores and relative body weight loss, proximity to competition, sex, and GLP. These categories were based on assumptions and observations from previous research in other weight class sports (Artioli et al., 2009; Reale, Slater, & Burke, 2018) and the authors' powerlifting coaching experiences. Indeed, we observed associations between PPC, MPC, OVR, MS, LOA, and NES, with relative body weight loss. In this study, higher scores indicate that a specific measure fully applies; this means that the higher the score, the higher the perceived state.

The present sample of elite powerlifters competing at the World Championships was more likely to experience higher recovery as their proximity to competition increased. The odds of reporting higher PPC, MPC, EB, and OVR scores were lower on day 2 relative to day 0. On these four recovery items, powerlifters were 45%–65% less likely to report a higher score for recovery on day 2 (relative to day 0), suggesting that the powerlifters perceived their physical capacity, mental capacity, emotional balance, and overall recovery to be lower on day 2 compared to immediately before competition. Similar trends were also observed in stress-related measures, as MS, LOA, and OS were more likely to be lower (lower scores indicate lower perceived stress), suggesting that perceived stress levels declined closer to competition. The lower odds of recovery and higher odds of stress on day 2 compared to the day of competition align with existing research on pre-competition anxiety and subjective well-being peaking and diminishing after competition (Carrasco Páez & Martínez-Díaz, 2021; Hanton et al., 2004). Therefore, it is unsurprising that as an athlete approaches competition, subjective well-being and recovery decrease, while stress increases, and these feelings are largely diminished after the athlete successfully weighs in (day 0).

Relative body weight change in the two days before competition affected responses on five of eight subscales within the SRSS, generally indicating worse subjective recovery and stress as relative weight loss increased. The odds of scoring higher on

PPC, MPC, and OVR were lower, as more relative weight loss occurred between day 2 and on competition day, indicating worse recovery, as acute relative weight loss in the two days before competition increased. Similarly, the powerlifters had higher odds of reporting higher MS and LOA (i.e., worse scores) with each additional percentage point of weight loss on competition day. Further, our data align with other research showing that with greater body weight loss, negative impacts on performance can be felt to a greater degree (Barley, Iredale, et al., 2018; Fortes et al., 2017). Logically, lifters with only 2 hours to refuel could experience an even greater negative impact on PPC, scaling with lost relative body weight. In support of this contention, and in alignment with our findings, the impact of RWL on cognitive function and mental performance is well established (Landers et al., 2001), with some studies indicating a greater decrease in outcomes related to MPC as body weight loss increases (Choma et al., 1998; Franchini et al., 2012). A second explanation for our findings could be that a lifter's mental state is impacted to a greater extent when they realize they must lose a large amount of body weight closer to competition from day 2 to day 0, despite having lost weight from day 7 to day 2. In the current study, higher subjective MS was more likely among powerlifters who lost more weight from day 2 to day 0. Further, the odds of higher LOA scores were greatest on day 0 rather than day 2, indicating that greater weight loss by day 0 likely contributes to more feelings of less motivation, energy, and enthusiasm on the day of competition. Body weight loss can lead to significant changes in biomechanics, such as altered joint angles and leverages, which may affect neuromuscular coordination (Viitasalo et al., 1987; Zubac et al., 2020), possibly impacting the subjective experience of the final training sessions before competition, which happens two to three days before competition, leading to greater perceived LOA. Collectively, our data indicate that with more relative weight loss in the two days before competition, the participants were more likely to feel less recovered and more stressed on day 2 compared to day 0.

Powerlifters' subjective stress and recovery ratings were associated with competitive caliber, measured by GLP. Within this cohort, GLP meaningfully differentiated competitive caliber, with medalists demonstrating approximately 10-point higher GLP values than non-medalists, supporting its use as a descriptive proxy of competitive caliber. Higher-caliber lifters perceived that they were more recovered and less stressed (NES), irrespective of the proximity to competition. The likelihood of higher responses for PPC, MPC, and OVR (indicating better recovery) increased with each additional unit of competitive caliber (1 GLP). Lifters with higher GLP scores had 5%, 4%, and 3% greater odds of reporting higher recovery PPC, MPC, and OVR scores, respectively. A similar trend was observed with NES, where higher GLP scores were associated with a 4% decrease in the odds of experiencing NES. Thus, collectively, as GLP increases (and competitors become more experienced), they may be better able to mitigate stress and manage bodyweight loss, resulting in greater perceived recovery. Elite powerlifters, either due to inherent traits, confidence in better-established RWL methods, or simply due to repeated exposure, may be resilient to the negative perceptual impacts of RWL. It is also possible that the relationship between GLP and SRSS scores is bidirectional. While speculative, novice powerlifters may use less effective RWL strategies—and have less experience with the strategies—subsequently resulting in the RWL process negatively impacting performance, and thus, their GLP scores. Additionally, previous research measuring competitiveness through medal achievements found that powerlifters who competed more frequently (approximately three times per year) were more likely to win medals while performing RWL (Kwan et al., 2022), aligning with research showing a greater increase in total with competition frequency, but a rate of diminishing returns occurs as lifters approach four competitions per year (Pearson et al., 2020). The increased odds of winning while using RWL further support the hypothesis that familiarity with RWL may mitigate its potential negative effects. In support of this contention, higher level Judokas exhibit greater psychological resilience than their less competitive counterparts (Correia & Rosado, 2019). Finally, elite athletes in other sports also exhibit higher confidence levels than their novice counterparts; building self-confidence is a strategy that can be used to reduce pre-competition anxiety (Craft et al., 2003), which may explain the lower NES reported by the powerlifters of higher caliber.

Interestingly, we observed sex-specific associations with SRSS scores, body weight loss, and GLP. In female participants, each additional percentage of relative weight loss increased the odds of reporting higher NES scores by 52%, a pattern that was not observed in the male lifters. Similarly, some research reports female fighters tend to experience higher anxiety compared to their male counterparts (Correia & Rosado, 2019; Piepiora et al., 2017; Viveiros et al., 2015; Woodman & Hardy, 2003). Further, there was a small interaction effect between GLP registered at competition, relative body weight loss between day 2 and day 0, and sex, such that greater weight loss was associated with a higher GLP score at competition in female lifters. Specifically, as weight loss increased, GLP at competition increased for female powerlifters in our cohort but not males. This might be because, on average, the female lifters in our cohort had lower GLP scores compared to the males (95 ± 12.9 and 100 ± 6.1 GLP at competition, respectively). Therefore, it is unclear whether we observed a true sex difference *per se* or whether the difference in GLP between male and female powerlifters in our sample influenced these observations.

A strength of our study is that all the participants were elite powerlifters competing at World Championships, offering valuable insights into the real-world practices of top-level athletes. Importantly, the effects of RWL in elite lifters may differ from those observed in lower-level powerlifters, as noted in previous research. Additionally, as opposed to a retrospective online survey, the data were collected in-person, in real-time, with the researcher at the event. These conditions allowed clarification of potential misunderstandings, likely reducing recall bias (te Braak et al., 2022), and captured the lifters' immediate emotional responses, potentially increasing data accuracy (Heerwegh & Loosveldt, 2008). Finally, rather than collecting data across multiple events of different levels, we believe the homogeneity of the competition environment reduced potential variability in the participants' emotional reactions (Jekauc et al., 2021). Therefore, by focusing on lifters competing at the highest level—the IPF World Championship—we may have enhanced the reliability of our findings. Finally, the use of a validated, as opposed to a non-validated scale, is notable, as relationships between such scales with performance can rival or even surpass that of relationships with lab-based physiological testing (Saw et al., 2016).

Our findings show that RWL may influence perceived stress and recovery, with certain effects (NES and GLP) more pronounced in female powerlifters than males. However, further work is needed to determine if this is truly a sex-specific effect. At the very least, it may be that powerlifters with higher GLP experience fewer negative effects from RWL than lower-caliber competitors. Therefore, we speculate that with regular practice and familiarity with RWL protocols, lifters may experience lower stress and higher recovery during the weight-making process. However, despite the strength of our research, certain limitations exist. A major limitation is the observational and exploratory nature of this study, as we did not control for the specific RWL methods used. While participants may have experienced similar losses in body mass, different RWL methods may disproportionately affect certain SRSS scores. For example, dehydration-based methods may significantly increase subjective mood scores, such as fatigue and confusion (Nuccio et al., 2017), compared to gut volume manipulation, which may be more tolerable (Foo et al., 2022). Our study was also designed as an exploratory analysis and included GLP as a proxy for the competitive caliber of the athlete. We acknowledge the limitations of the GLP score, such as potential disfavoring weight classes on either extreme (47 kg, 59 kg, 84 kg, 120 kg and above), bidirectionality with the SRSS score, which might be subject to post-treatment bias, and thus the coefficients should be interpreted carefully, as associations and not as isolated causal effects. Additionally, the unique training protocols followed by each powerlifter prior to competition (i.e., the use or nonuse of a taper and subsequent differences in load, frequency, and volume) introduce an uncontrolled variable, potentially contributing to differing levels of fatigue, possibly influencing SRSS scores. A final unexplored factor is travel distance: powerlifters travel from various parts of the world to compete, likely causing differing levels of circadian rhythm disruptions, sleep deprivation, and jetlag, all of which may affect scores (Lee & Galvez, 2012). Given these limitations, we encourage future researchers to explore these trends using experimental designs to better elucidate these relationships and to confirm or refute our conclusions.

The categories measured and analyzed in this study—such as body weight change over time, GLP, and sex—were determined based on insights from previous research and anecdotal coaching experience. Given the exploratory nature of this study, our findings and conclusions should be considered tentative. Furthermore, with a relatively small sample size of 53 participants, it is possible that future results may differ if conducted with a larger cohort.

Nevertheless, based on the present data, we conclude that certain measures of readiness, including PPC, MPC, OVR, MS, and LOA, are influenced by relative body weight changes resulting from RWL. Consistent with previous research, our findings suggest that female lifters may experience a greater impact on these measures than their male counterparts, although this could also be related to competitive caliber.

Coach's corner

A summary of findings relevant for coaches can be found in the table below (Table 1). Based on this exploratory study of elite powerlifters, RWL approaching or exceeding ~2% in the final 48 hours before weigh-in (day −2 to day 0) is associated with significantly worse subjective recovery (reduced PPC, MPC, and OVR), increased stress (higher MS), and particularly elevated LOA on competition day.

Higher-caliber athletes (indicated by higher GLP scores) demonstrated greater resilience to these negative effects; while this relationship is speculative, it may stem from greater experience, familiarity with the process, and optimized RWL protocols. Female lifters appeared more susceptible, exhibiting heightened NES with increasing weight loss magnitude.

Coaches should therefore be aware of these potential negative perceptual impacts when the acute RWL magnitude approaches 2% in the final 48 hours, and consider how effects may vary by athlete caliber and biological sex. This awareness enables informed decisions: either avoiding cuts beyond this threshold (especially lower-caliber and female lifters) or treating RWL as a trainable skill through repeated practice to build

Table 1. Summary of findings.

Factor	Direction of Association	Affected SRSS Subscales	Key Effects	Sex-Specific Notes
Proximity to Competition (day −2 vs. day 0)	Closer to competition → Better subjective state	PPC, MPC, EB, OVR (higher recovery); MS, LOA, OS (lower stress)	45–65% lower odds of higher recovery scores on day −2; Lower stress scores closer to competition	No sex difference noted
Acute Relative Body Weight Loss (day −2 → day 0)	Greater loss → Worse subjective state	PPC, MPC, OVR (lower recovery); MS, LOA (higher stress)	Each additional 1% loss associated with lower odds of high recovery and higher odds of elevated stress (e.g., ~1.4–1.6× greater odds of higher LOA per 1% loss, implying meaningful risk elevation the greater the % of acute RWL)	Females: Additional effect on NES
Competitive Calibre (higher GLP)	Higher GLP → Better subjective state	PPC, MPC, OVR (higher recovery); NES (lower negative emotions)	3–5% greater odds of higher recovery per 1 GLP point; 4% lower odds of higher NES per 1 GLP point	Females: Greater weight loss associated with higher GLP (possible calibre confound)
Sex (female vs. male)	Females more negatively impacted by RWL	NES (higher negative emotional state)	Each additional 1% relative weight loss → 52% higher odds of elevated NES in females (not observed in males)	Potential interaction with lower average GLP in females

familiarity and experience, which optimizes psychological and emotional readiness for competition day.

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