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Preparation for Powerlifting Competition: A Case Study

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ABSTRACT

This study assessed a male competitive powerlifter over a 6-month period that encompassed his pre-contest preparation and post-contest recovery. We conducted the following monthly assessments: multi-frequency bioelectrical impedance analysis (MF-BIA), B-mode ultrasound evaluation of muscle thickness (MT), body circumferences, handgrip strength, vertical jump height, isometric lower body strength, and questionnaires for perceived mood and sleep. The athlete undertook a 3-month pre-contest preparatory period that included an extreme energy-restricted diet intended to sufficiently reduce body mass. This period also included an 8-week pre-contest training regimen with a 10-day taper intended to promote peak strength increases in the target lifts for competition. During the pre-competition period, the athlete experienced rapid and substantial losses of body mass (10.3%), body fat (6.5%) and lean mass (3.3%), the majority of which was regained in the 2-month post-competition recovery phase. The athlete's isometric knee extension strength rose sharply during the initial month of the pre-competition phase (336.4 Nm), followed by consistent declines (299 to 262.2 to 283 Nm) over the next 3 months, eventually returning close to baseline values 2 months post- competition Jump height remained steady in the 3 months in the pre-contest phase but increased (+1.4 cm) in the 2 months post-competition while handgrip strength increased during the months preceding the competition (47.5 kg to 49 kg) but decreased to 42.3 cm post-competition. Overall, the athlete did not seem to have any marked sleep disturbances. The most notable changes in mood parameters were increased tension, anger, and depression immediately preceding the competition.

Keywords: preparation; contest; competition; strength; powerlifter

INTRODUCTION

Powerlifting is a sport in which placings depend on an athlete's ability to exert maximal dynamic strength (3). Athletes compete in a given weight class and results are ultimately expressed on the sum total of 3 lifts: bench press, squat and deadlift. In all major powerlifting federations, results are adjusted for body mass via the Wilks formula or DOTS score to determine an overall best pound-for-pound winner at the conclusion of the competition (45).

Several published studies have objectively assessed the general practices of powerlifters for competition preparation. Surveys have been administered in competitive powerlifters to elucidate their training programs (38), nutritional regimens (20), tapering protocols (44), weight loss strategies (28), and the use of performance-enhancing substances (11). Findings from survey data indicate powerlifters typically incorporate some form of periodization scheme intended to optimize performance on contest day (41).

Since formulas used to evaluate powerlifting performance adjust for body mass, pre-contest preparation for a powerlifting event often includes a training period designated to reduce body mass without compromising maximal strength (20). Numerous case studies indicate that bodybuilders and weightlifters experience a variety of chronic adaptations during their pre-contest preparation including alterations in body composition, neuromuscular performance, hormonal levels, physiological adaptations, and psychometric outcomes (36) (42). However, despite the broad-based interest in the sport of powerlifting, no study to date has endeavored to document the changes that occur in powerlifters in response to preparation for competition. The purpose of this case study was to investigate the effects of pre-contest preparation in a competitive male powerlifter and provide descriptive information as to his preparatory methods as well as documenting anthropometric, neuromuscular and psychometric alterations that occurred over this period.

METHODS

Experimental Approach to the Problem

This study assessed a male competitive powerlifter over a period of 6 months that encompassed his pre-contest preparation and post-contest recovery. Testing was carried out monthly, with all testing sessions occurring at approximately 10 a.m. For each visit, the athlete arrived at the laboratory in a fasted state (no food or fluids for ≥ 8-hours) and having abstained from strenuous exercise for at least 48 hours. We conducted the following assessments in the following order: multi-frequency bioelectrical impedance analysis (MF-BIA), B-mode ultrasound evaluation of muscle thickness (MT), body circumferences, handgrip strength, vertical jump height, isometric lower body strength, and questionnaires for perceived mood and sleep. Immediately after body composition testing, the athlete was allowed ad libitum access to food and water as desired.

Participant

The athlete was a 25-year-old competitive male powerlifter with approximately 10 years of prior resistance training experience and approximately 3 years' experience competing in powerlifting. Prior to the competition the athlete was ranked in the top 15 in his federation and currently ranked 3rd in his state of residence. The investigation was conducted over a 3-month pre-contest period leading up to a powerlifting competition (at baseline and 3 preparatory months), and then a 2-month post-contest period. Approval for the study was obtained from the college Institutional Review Board. Written informed consent was obtained from the athlete prior to enrollment. The methods for the study were preregistered prior to data collection (https://osf.io/sxqdn).

Dietary Intake and Supplementation

The athlete maintained daily logs as to energy and macronutrient intake, as well as dietary supplementation. These logs were used to describe nutritional intake and changes across the study period.

Resistance Training Program

The athlete maintained daily logs as to his resistance training program, including details of previous training cycles, peaking, tapering, and session RPE. These logs were analyzed to determine resistance training habits and changes across the study period.

Progress Photos

The athlete provided progress photos for inclusion in the manuscript; his head and face were cropped out of all photos to preserve anonymity. Monthly photos were taken to provide visual evidence of changes that occurred across the pre- and post-contest period. For each photo session, the athlete wore compression shorts and posed for photos from the front, side and rear assuming a standardized position for all photos under similar lighting conditions (see figure S1 in the supplemental material).

Body Composition and Anthropometry

The athlete's height was measured using a Detecto Physicians Scale (Cardinal Scale Manufacturing Company, Webb City, MO). Assessment of body mass, fat mass, and fat free mass was carried out using an InBody 770 MF-BIA unit (Biospace Co. Ltd., Seoul, Korea) according to the manufacturer's instructions. The athlete was asked to void his bladder immediately before the test. Prior to each measurement, the soles of the athlete's feet were cleaned with an electrolyte tissue. The athlete then stood on the MF-BIA unit, placing the soles of his feet on the electrodes. The instrument derived the athlete's body mass, and his age and sex were manually entered into the display by the researcher. He then grasped the handles of the unit ensuring that the palm and fingers of each hand made direct contact with the electrodes. His arms were fully extended and abducted approximately 20 degrees throughout the scan. Analysis of body composition was determined by the unit with the athlete remaining as motionless as possible.

Circumference measurements were taken manually at the following sites using a Gulick tape measure: Upper arm, shoulders, chest, waist, and thigh. For the upper arm, measurements were taken at the midpoint between the acromion process of the shoulder and the olecranon process of the elbow, with the tape placed around the relaxed arm, perpendicular to its length. Shoulder measurements were taken at the widest part, typically around the deltoid muscles, by wrapping the tape horizontally across the back and front. Chest measurements were taken at the mid-chest level, wrapping the tape around the torso horizontally. Waist measurements were taken at the narrowest part of the torso, just above the belly button and below the rib cage, with the tape placed horizontally, parallel to the floor, and snug but not compressing the skin. Thigh measurements were taken at the midpoint between the inguinal fold (where the thigh meets the pelvis) and the top of the patella, with the tape placed around the thigh horizontally.

Muscle Thickness

As previously described (31), ultrasound imaging was used to obtain measurements of MT. A trained ultrasound technician performed all testing using a B-mode ultrasound imaging unit (Model E1, SonoScape, Corporation, Shenzhen, China). The technician applied a water-soluble transmission gel (Aquasonic 100 Ultrasound Transmission gel, Parker Laboratories Inc., Fairfield, NJ) to each measurement site, and a 4-12 MHz linear array ultrasound probe was placed perpendicular to the tissue interface without depressing the skin. When the quality of the image was deemed to be satisfactory, the technician saved the image to a hard drive and obtained MT dimensions by measuring the distance from the subcutaneous adipose tissue-muscle interface to either the aponeurosis or the muscle-bone interface. Measurements were taken on the right side of the body at the mid-thigh (a composite of the rectus femoris and vastus intermedius) and lateral thigh (a composite of the vastus lateralis and vastus intermedius). Measurements were obtained at 30%, 50% and 70% between the lateral condyle of the femur and greater trochanter. To ensure that swelling in the muscles from training did not obscure MT results, images were obtained at least 48 hours after any previous training sessions. This is consistent with research showing that acute increases in MT return to baseline within 48 hours following a RT session (29; 5) and that muscle damage is minimal after repeated exposure to the same exercise stimulus over time (6; 12). To further ensure accuracy of measurements, 3 successive images were obtained for each site and then averaged to obtain a final value. After completion of imaging, the values from each site were summed and averaged to obtain a final mean value for total quadriceps MT. The test-retest intraclass correlation coefficient (ICC) from our lab for MT measurements are excellent (>0.94) with coefficients of variation (CV) of ≤3.3%.

Handgrip Strength

Handgrip strength was assessed via a handheld hydraulic dynamometer (Jamar 5030-J1, Bolingbrook, IL, USA). The athlete stood with his back to the wall, feet shoulder-width apart, and completed 3 maximal contractions for the right and left hand, each lasting 5 seconds, with his elbow flexed at 90° and wrist held in neutral position. A 1-minute rest period was provided between trials to allow for sufficient recovery between each contraction. The values of the 3 trials were averaged to obtain a final score.

Vertical Jump Height

A vertical jump test was used as a proxy for measures of lower body muscular power. The athlete was instructed on proper performance of the countermovement jump as follows: The athlete began by assuming a shoulder-width stance with his body upright and hands on hips. When ready for the movement, he descended into a semi-squat position and then forcefully reversed direction, jumping as high as possible before landing with both feet on the ground. After instruction on performance, the athlete was allowed to perform a warm-up jump to ensure that his technique was sound.

Assessment of jump performance was carried out using a Just Jump mat (Probotics, Huntsville, AL), which was attached to a hand-held computer that records airtime and thereby ascertains the jump height. The athlete stood on the mat and performed 3 maximal-effort countermovement jumps with a 1-minute rest period between each trial. The highest jump was recorded as the final value.

Isometric Muscle Strength

Strength assessments were carried out using isometric dynamometry testing (Biodex System 4; Biodex Medical Systems, Inc. Shirley, NY, USA). After familiarization with the dynamometer and protocol, the athlete was seated in the chair and performed isometric actions of the knee extensors. All isometric testing was carried out on the athlete's dominant limb.

During knee extension trials, the athlete sat with his back flush against the seat back pad and maintained a hip joint angle of 85 degrees with the center of his lateral femoral condyle aligned with the axis of rotation of the dynamometer. The dynamometer arm length was adjusted to allow the shin pad to be secured with straps proximal to the medial malleoli. The athlete was instructed to hold onto the machine's handles for stability, and he also was strapped in across the ipsilateral thigh, hips, and torso to help prevent extraneous movement during performance. Testing was carried out at 70-degrees of knee flexion (22).

Each maximum voluntary contraction trial lasted 5 seconds, followed by 30 seconds rest, for a total of 4 trials. The athlete was verbally encouraged to produce maximal force throughout each bout. The highest peak net extension moment from each of the 4 trials was used for analysis.

Sleep

The athlete provided information as to sleep patterns derived from wearable technology (AEAC Smart Watch, Prattville, AL). This information included metrics such as sleep quality and sleep quantity, which were used to determine potential changes in physiological function across the duration of the case study.

Psychometrics

At the conclusion of each session, the athlete completed 2 questionnaires designed to assess psychometric outcomes. First, mood was assessed using the abbreviated Profile of Mood States (POMS) (26). The 20 activation adjectives were rated by the athlete to describe his immediate feelings on a Likert scale (0: not at all, 1: a little, 2: moderately, 3: quite a lot, 4: extremely). The abbreviated POMs scale comprises 40 adjectives that evaluate tension, depression, fatigue, vigor, confusion, anger, and esteem. The total score was calculated as an aggregate of the responses to the 7 subscales. Next, the Pittsburgh Sleep Quality Index (PSQI) survey was administered to assess perceived sleep quality (7). The PSQI survey comprises 19 self-rated questions that assess overall sleep quality, with higher scores indicative of poorer sleep quality.

Statistical Analyses

Considering that this is a descriptive study, we employed measures of central tendency on outcomes to assess changes over time. Other exploratory statistical methods were considered depending on the observed outcomes. We did not employ null hypothesis statistical testing methods on any outcome.

RESULTS

Training, Nutrition and Sleep

The athlete undertook a 3-month pre-contest preparatory period that included an extreme energy-restricted diet intended to sufficiently reduce body mass to qualify for his desired weight class. This period also included an 8-week pre-contest training regimen with a 10-day taper intended to promote peak strength increases in the target lifts for competition.

Changes in training volume load (sets x reps x load) were evident over the study period. As the athlete entered his 8-week pre-contest training regimen (i.e. weeks 5-12), the average volume load per 4-weeks for the back squat increased by 13.0%, and then decreased by 13.7% in weeks 9-12. Volume load decreased again by 33.8% in week 13, i.e. taper week. During week 14, i.e. meet week, squat volume dropped another 41.6% to the lowest level of the 23-week observation period. Following the competition, volume load in the back squat increased by approximately 158% weeks 15-16 to levels similar to weeks 9-12. Following week 16, average weekly volume load in the squat decreased by 9.6% in weeks 17-20 dropping again by 33.8% in weeks 21-23 as the athlete prepared to transition from higher repetition schemes to heavy singles. Weekly back squat sets ranged from 6-9, repetitions from 12-32, and volume load from 1936 kg - 5801 kg.

Similar trends to the back squat were seen for the bench press leading up to and following the competition, with average volume increasing by 53.4% in weeks 5-8 and dropping to the competition week values which were 35.2% of those in weeks 5-8, the highest of the study period. Average volume load increased in weeks 15-16 and dropped again in weeks 17-23 as the athlete transitioned to heavy singles. During the study weekly sets ranged from 8-16, repetitions from 20-69, and volume load from 2530 kg - 7709 kg.

Deadlift trends closely resembled those in the back squat, as average volume load increased by 44.5% in the first week of the 8-week preparatory period, dropped by 16.1% and 35.3% in weeks 9-12 and

13, respectively, and reached lowest values in week 14 when they decreased another 44.0%. Following the competition, volume load nearly tripled in weeks 15-16 and then fell in weeks 17-23 as the athlete transitioned to heavy single training. Weekly sets ranged from 6-10, repetitions from 12-37, and volume load from 2073 kg - 6820 kg.

Throughout the period of observation, changes in weekly volume load in the back squat and deadlift were driven primarily by fluctuations in per-set repetitions, while bench press volume load changes were driven to a larger extent by the number of sets performed. Additionally, the lowest weekly repetition and volume load values in the squat and deadlift were seen during competition week, while bench press volume load and repetition values were at their lowest in weeks 21-23. Highest repetition and volume load values for all 3 competition lifts were seen during weeks 5-8. Table 1 summarizes the athlete's training protocol for the primary lifts across the study period.

While the majority of the athlete's training comprised the back squat, bench press, and deadlift in repetition ranges aimed at eliciting strength adaptations, accessory and supplemental exercises in repetition ranges targeting muscular growth were also completed. Similar weekly averages in sets and reps were seen in upper body pushing exercises and exercises aimed at strengthening the "core" musculature (e.g. abdominals, obliques, erector spinae, etc.), with averages of 4 and 3 sets and 43 and 48 reps, respectively. Weekly average set, repetition, and volume load of pushing exercises fluctuated throughout the 23 weeks, with lows in weeks 1-4 (2 sets, 32 reps, 1053 kg), highs in weeks 17-20 (6 sets, 74 reps, 4556 kg) and decreases in weeks 21-23 (6 sets, 17 reps, 2304 kg). However, despite similarities in overall averages, core exercise numbers followed different trends from those of upper body pushing exercises. After averaging 5 sets, 86 reps, and 2915 kg of volume load in weeks 1-4, core exercises increased in both sets and volume load through week 12, after which they decreased from 6 to 2 and 3157 kg to 655 kg, respectively, in weeks 13-16. Core exercise repetitions, however, rose briefly from 86 in weeks 1-4 to 91 in weeks 5-8 and decreased to 83 in weeks 9-12, falling drastically to 18 in weeks 13-16. No core exercises were completed in weeks 17-23. The athlete also performed accessory movements

Table 1. Training protocol for the primary lifts across the study period

Week(s)	Training sessions (deload sessions)	Weekly training frequency	Exercises per session	Weekly sets per lift	Weekly Frequency per lift	Repetition range
1 - 4	16 (1)	4	1 - 2	Squat: 9 Bench: 13 Deadlift: 10	Squat: 2 Bench: 3 Deadlift: 2	1 - 5
5 - 8	16 (0)	4	1 - 2	Squat: 9 Bench: 14 Deadlift: 9	Squat: 2 Bench: 3 Deadlift: 2	1 - 8
9 - 12	16 (0)	4	1 - 3	Squat: 9 Bench: 13 Deadlift: 9	Squat: 2 Bench: 3 Deadlift: 2	1 - 7
13	4	4	1 - 2	Squat: 8 Bench: 15 Deadlift: 8	Squat: 2 Bench: 3 Deadlift: 2	1 - 5
14 (meet week)	3	3	2	Squat: 5 Bench: 15 Deadlift: 5	Squat: 2 Bench: 3 Deadlift: 1	1 - 4
15	0	0	0	Squat: 0 Bench: 0 Deadlift: 0	0	0
16 - 19	16 (0)	4	1 - 2	Squat: 7 Bench: 9 Deadlift: 7	Squat: 2 Bench: 2 Deadlift: 2	3 - 6
20 - 23	16 (0)	4	1 - 2	Squat: 8 Bench: 10 Deadlift: 8	Squat: 2 Bench: 2 Deadlift: 2	1 - 3

targeting upper body pulling movement patterns, averaging 13 sets, 143 reps, and 4978 kg per week across the 23 weeks. Averages peaked for sets in weeks 5-8 (16), repetitions in weeks 9-12 (194), and volume load in weeks 17-20 (6733 kg). The athlete completed an average of 9 sets of lower body exercises per week for 19 out of 23 weeks, averaging 6 sets in weeks 13-16. However, repetitions and volume load varied more and trended oppositely. Average weekly repetitions in lower body accessory exercises decreased from their peak of 103 in weeks 1-4 to 69 in weeks 13-16, rising to 82 in weeks 17-20 and then dropping to their lowest values of 65 in weeks 21-23. Overall, the athlete completed a weekly average of 8 sets, 84 reps, and 6408 kg volume load in lower body accessory exercises throughout the 23 weeks. Accessory movements directly targeting the arms showed weekly averages of 12 sets, 177 reps, and a volume load of 2590 kg were highest during weeks 5-8 averaging 15 sets, 244 reps, and 3169 kg.

Over the course of the 23 weeks our athlete reported an average Rating of Perceived Exertion (RPE) of 7.9. However, average session-to-session RPE ratings varied over the course of the 23 weeks, peaking in weeks 9-12 (8.8) and reaching the lowest averages in weeks 13-16 (7.3) — the time period that included competition week and the weeks preceding and following competition, the time when volume and intensity would typically be the lowest.

During the 23-week study, the average caloric intake in the first 4 weeks was 2439 cal/d and slowly increased to an average of 3429 cal/d in the final 3 weeks of the case study. Weekly protein (PRO) intake ranged from 166-138 g/day (1.9-2.2 g/kg body weight) during the period of observation, while carbohydrate (CHO) intake increased throughout. The athlete started with an average CHO intake of 284 g/d and ended with 529 g/d, adding about 245 g/d of CHO. The study also showed an increase in fat intake of 13 g/d reaching up to about 112g/d grams of fat before decreasing slightly in the following weeks but never dropping to baseline intake. Fiber intake increased by up to 9 g; however, in the ensuing weeks (weeks 9-20), fiber intake decreased before increasing again in weeks 21-23 to 32 g/d. Finally, the athlete consumed at least 2.5 L of water/d during the course of observation leading up to meet week.

During meet week, the athlete employed nutrition and hydration strategies aimed at reducing body weight to make his weight class while retaining muscle mass. Specifically, during days 1-3 leading up to the meet, the athlete consumed 170g of PRO/d, or 2.5 g/kg body weight. In addition, during these 3 days CHO intake fell by 36.5% to 265 g relative to pre-meet week levels, while fat intake rose by 266.7% to 160 g. The athlete also manipulated fiber intake during this time, with intake levels dropping to 55.2%, 24.5%, and 18.4% of the preceding week's average daily intake on days 1, 2, and 3 of meet week, respectively. Finally, the athlete recorded a water intake of 3.7, 3.7, and 1-1.5 L on days 1, 2, and 3, respectively. Overall during the 3 days leading up to competition the majority of the athlete's caloric intake was in liquid form.

On day 4, i.e. meet day, the athlete consumed 1 L of a sports drink immediately following weigh-in. The athlete ate ad libitum and did not track fiber intake on meet day following weigh-in, though he reported fiber intake to a minimum. Table 2 summarizes the athlete's nutritional protocol across the study period.

Table 2. Average daily nutritional protocol across the study period

Week(s)	Energy (cal)	CHO (g)	PRO (g)	Fat (g)	Fiber (g)	Water (oz)
1 - 4	2439	284	166	71	23	≥ 85
5 - 8	2578	345	163	61	34	≥ 85
9 - 12	2639	362	155	64	27	≥ 85
13	3082	450	153	75	30	≥ 85
14 (meet week)	Days 1-3: 3180 Meet day: Ad Libitum	Days 1-3: 265 Meet day: Ad Libitum	Days 1-3: 170 Meet day: Ad Libitum	Days 1-3: 160 Meet day: Ad Libitum	Day 1: 18 Day 2: 8 Day 3: 6 Meet day: Ad Libitum	Day 1: 125 Day 2: 125 Day 3: 32-50 Meet day: Ad Libitum
15	3498	460	153	117	31	Ad Libitum
16 - 19	3499	512	140	99	27	Ad Libitum
20 - 23	3420	527	139	84	32	Ad Libitum

Abbreviations: CHO: carbohydrate; PRO: protein; cal: calories; g: grams; oz: ounces

Over the 23-week study period, the total, REM, light, and deep sleep quantitative averages of the athlete remained relatively consistent, with the largest change being an increase in average total minutes of sleep of 45 (i.e. 11%) from weeks 9-12 to weeks 13-16, largely accounted for by an increase of 54 minutes of light sleep on average. These increases in sleep time did not coincide with any reported changes in sleep quality. Total, REM, light, and deep sleep averages per 4 weeks ranged from 407-452, 72-87, 233-287, and 59-72, respectively. During the competition week, i.e. week 14, the athlete averaged 432, 77, 281, and 53 minutes per night of total, REM, light, and deep sleep, respectively. Final average values following competition were very similar to those in weeks 1-4.

Anthropometry and Body Composition

Across the 3-month pre-competition phase, the athlete lost 7.9 kg of his body mass. From a body composition standpoint, this translated to a loss of 6.5% body fat with a corresponding loss of 2.1 kg of lean mass. In the 2-month post-competition recovery phase, the athlete regained 7.0 kg of body mass, 6.9% body fat and 1.1 kg of lean mass (figures 1A and 1B).

Regarding quadriceps femoris MT, the athlete showed a combined mean decrease of ~5 mm across all sites over the 3-month pre-competition period, all of which was regained by 2 months post-competition (figure 1C).

The sum of body circumference measurements decreased by 6.4% over the pre-competition period. From the completion of pre-contest preparation to the end of the 2-month recovery period, circumference measures increased by 5.4% to approach baseline values (figure 1D).

Strength and Power

Over the course of the 23-week study period, the athlete's isometric knee extension strength showed minimal variation, slightly decreasing from 284.4 Nm at baseline to 283 Nm at the end of observation. Notably, there was a sharp rise in isometric knee extension strength during the initial month of the pre-competition phase (336.4 Nm), followed by consistent declines (299 to 262.2 to 283 Nm) over the next 3 months, eventually returning close to baseline values 2 months post- competition (figure 2A). In contrast, the athlete's lower body power, measured through countermovement jump height,

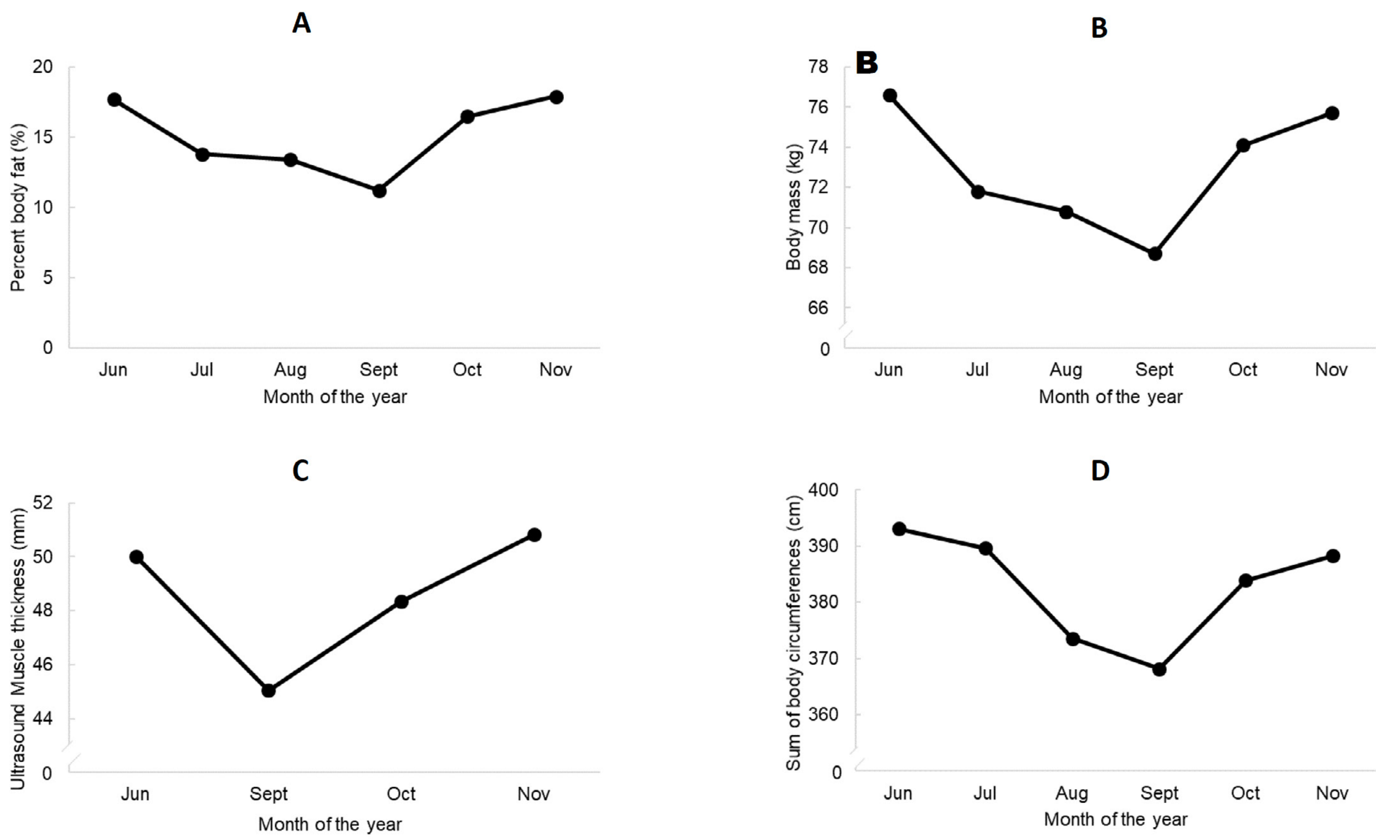

Figure 1. Body composition changes over the study period: (A) body mass; (B) % body fat; (C) muscle thickness; (C) sum of body circumferences.

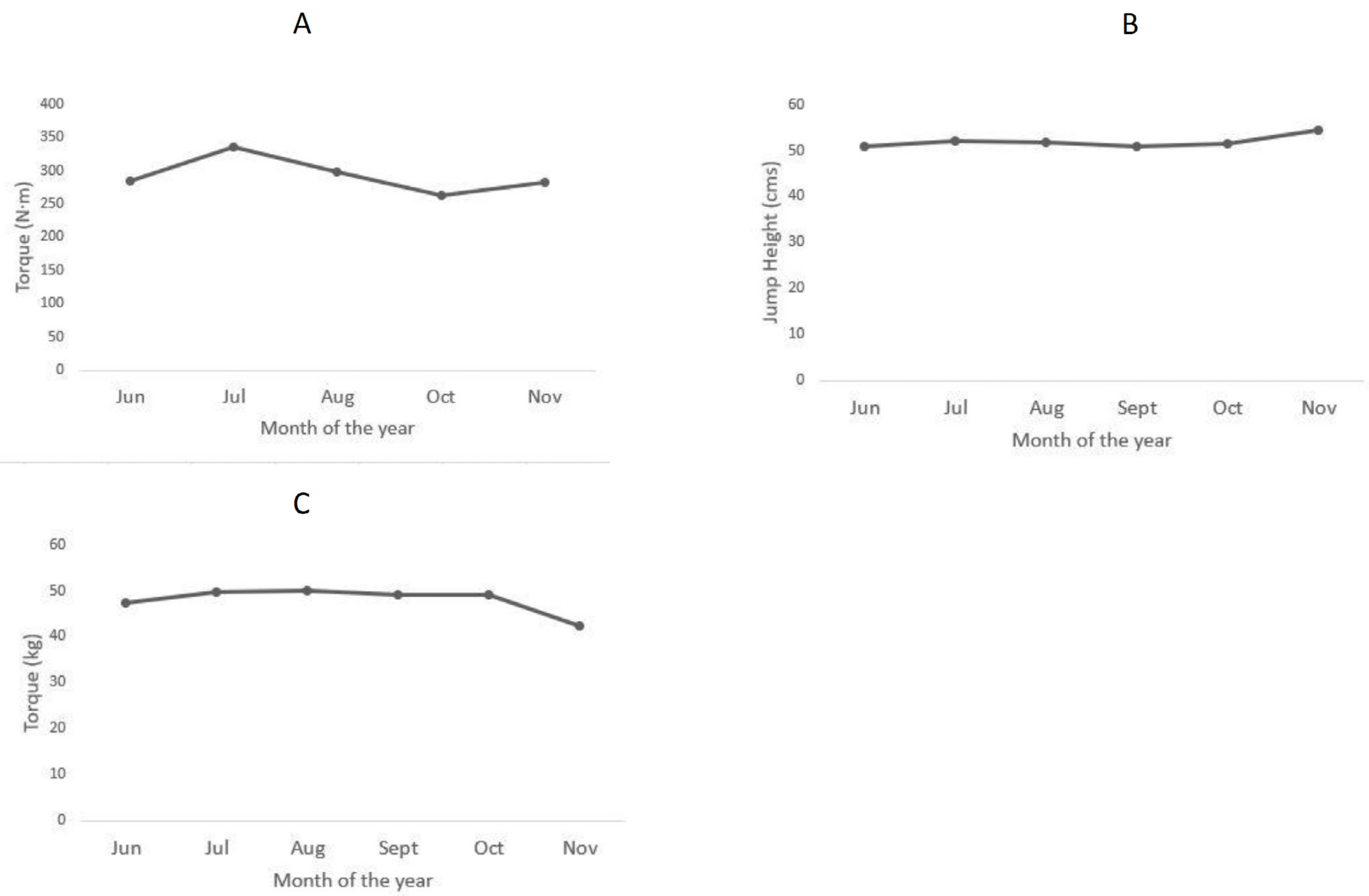

Figure 2. Strength and power changes over the study period: (A) isometric knee extension; (B) vertical jump height; (D) handgrip strength

remained steady in the 3 months leading up to the competition but increased (+1.4 cm) in the 2 months post-competition (figure 2B). Finally, the athlete's handgrip strength increased during the months preceding the competition (47.5 kg to 49 kg) but subsequently decreased to 42.3 kg post-competition (figure 2C).

Psychometrics

Over the 23-week study period, the athlete's global sleep quality remained relatively high and steady (figure 3A). He reported the greatest overall disruption (28.6% global sleep disturbance) during testing in weeks 5-8, which did not correlate with large changes in mood parameters nor coincide with changes in sleep time. The average global level of sleep disturbance over the entire test period was 19.8%. In addition, none of the individual sleep disturbance components assessed rose above "1" on a 0-4 Likert scale. The higher sleep disturbance in July was due to 6 of the 7 sleep disturbance components rising above "no difficulty". This included 'subjective sleep quality', 'sleep latency', 'sleep duration', 'habitual sleep efficiency', 'sleep disturbances', and 'daytime dysfunction', but not 'use of sleeping medications', which never rose above "0", or "no difficulty".

Over the study period, the athlete routinely showed high positive mood parameters, with vigor averaging around 35.8% and esteem-related affect averaging around 68.8%. These were relatively constant over the course of testing, with a slight decline from week 1 to week 23, with final esteem-related affect values demonstrating a total decrease of 20.8% from baseline to conclusion. In contrast, the negative mood parameters fluctuated in the weeks leading up to the competition (figure 3B). Prior to, and following the competition (weeks 1-12, and 17-23), negative mood parameters were reported to be relatively low and stable, apart from the weeks immediately preceding the competition. During the testing that took place 4 days prior to competition, tension (+33.3%), anger (+10.0%), and depression (+10.7%) showed a transient increase. The spike in negative mood parameters during that period led to the highest total mood disturbance (~26.3%) relative to the lower average value (~18.7%), with values returning in weeks 17-23 to similar levels as those in weeks 1-12.

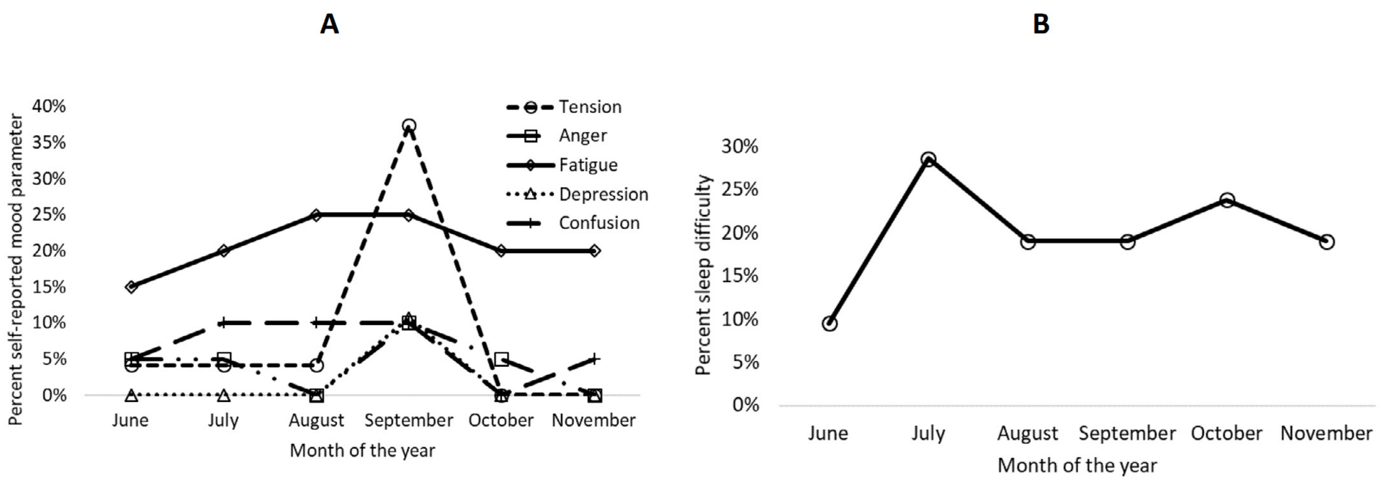

Figure 3. Sleep quality and mood changes across the study period: (A) global reported sleep disturbance; (B) negative mood parameters expressed as a percentage.

DISCUSSION

This is the first case study to describe the pre- and post-contest practices of a competitive powerlifter, as well as the adaptive changes that occurred across this period. In the following sections, we discuss the results in relation to the literature and consider their practical implications.

Training, Nutrition and Sleep

Notable time points during the period of observation included week 5, i.e. the beginning of an 8-week pre-competition preparatory phase; week 13, i.e. tapering week; week 14, i.e. meet week, and week 21, i.e. when the athlete prepared to transition to training with heavy singles. The volume-load decreases in the back squat, bench press, and deadlift in weeks 13 and 14 are consistent with tapering practices often used by powerlifting coaches to maximize recovery leading up to and prioritize performance on the day of competition (44). As the athlete prepared to transition to training with heavy singles in week 21, volume load in all three “competition lifts” unsurprisingly decreased, too, having increased following competition.

A common tapering practice is to reduce overall volume load by first reducing or removing accessory movements rather than competition movements (44), since accessory movements are often viewed as a lower priority closer to competition. Indeed, accessory exercise volume loads showed similar trends to the competition lifts, decreasing from higher to lower volumes as the competition date neared. Additionally, while the volume load of multi-joint push/pull movements and single-joint arm-focused exercises decreased in weeks 21-23 as the subject tapered into heavier singles in the competition lifts, lower body accessory movement volume load increased.

Average session RPE as reported by the athlete was approximately 8 RPE over the course of the 23-week observation period. RPE peaked during weeks 9-12 at approximately 9 RPE, despite the decrease in overall volume loads, and coinciding with an increase in loads lifted per repetition as competition neared. Similar to other training metrics, the average RPE decreased immediately following the competition, likely due to the week of detraining and a slow re-introduction to training upon the athlete’s return. Notably, despite approaching heavy singles in training toward the end of this 23-week period, RPE ratings following competition never surpassed the overall average session RPE rating of 8. This could be due to the reduction in overall volume during that period, where despite lifting loads of 95%+ 1RM, the total session sets, reps, and volume load were lower.

The athlete also tracked dietary intake in addition to training metrics. Despite body weight decreasing as the athlete cut weight to make his weight class, caloric intake increased during the preparatory period leading into the competition (week 14). During that same period, macronutrient intake shifted as well. As the competition date neared, average daily protein intake per 4-weeks slowly decreased while carbohydrate and fat intake increased. During the first 3 days of meet week, the athlete recorded the highest relative PRO intake, highest fat intake, and lowest CHO intake of the observation period. Post competition, however, protein consumption ultimately dropped, corresponding with drastic increases in carbohydrates and fats. Post-competition changes in macronutrient and total caloric intake may reflect the fact that the athlete ate 1-2 untracked meals each week, leading to slightly lower reported numbers. However, higher caloric averages were still seen post competition despite the untracked meals. This reduction in tracking strictness and higher caloric intake following the powerlifting competition is similar to post-competition eating patterns seen with some bodybuilders (2).

Despite the decreases in sleep quality, perhaps due to weight loss (36) and stress (23) as the competition neared, no notable changes or trends in sleep were seen. In fact, average total sleep per 4 weeks was its highest (452 minutes) in weeks 13-16, the period that included the competition in week 14. Similarly, light sleep reached a peak of 287 minutes during that same timeframe, and REM sleep reached its second-highest level of 82 minutes. Conversely, deep sleep was at its second-lowest level of 60 and 59 minutes in weeks 13-16 and 17-20, respectively. In week 14, stress related travel or the nearing competition may have affected the amount of time spent in deep sleep (23).

Anthropometry and Body Composition

The athlete's baseline weight, height and BMI were 76.2 kg, 159 cm and 30.1 kg/m2, respectively. During the pre-competition period, the athlete in the present study experienced rapid and substantial losses of body mass (10.3%), body fat (6.5%) and lean mass (3.3%). Reductions seen in body fat and lean mass via BIA comport with the reduction seen in circumference measures and site-specific muscle thickness measurements. The rate of body mass loss achieved by the powerlifting athlete was approximately double that of the average natural bodybuilding competitor during pre-contest preparation (0.66 vs −0.36 kg/week, respectively) (36).

Evidence indicates that a more gradual loss of body mass helps to preserve lean mass while losing body fat (14) (15). This phenomenon seemed to play out in the present case study. The extent of lean mass loss experienced by the present athlete (27% of total weight loss) was comparable to that observed in natural bodybuilders employing similar rates of body mass reduction. For example, Rossow et al. (33) reported a 3.6 kg reduction in lean mass (34% of total weight loss) for a natural bodybuilder losing body mass at a rate of 0.88 kg/week during the first 3 months of pre-contest preparation. Similarly, Kistler et al. (21) reported lean mass losses of 35% of total weight reduction during the first 3 months of pre-contest preparation in a natural bodybuilder who lost body mass at a rate of 0.68 kg/week. Conversely, Schoenfeld et al. (35) reported no lean mass loss across the first 3 months of pre-contest preparation in a natural bodybuilder who lost weight at a rate of 0.13 kg/week. Thus, it can be hypothesized that the relatively high lean mass loss observed in the present athlete may be attributed to the rapidity of body mass loss, mediated by a large energy deficit, in combination with a relatively low baseline body fat level.

Resistance training volume (calculated as sets per muscle per week) and proximity to failure have been proposed as important mediators of muscular adaptations (34). In this regard, both the athlete's pre-competition resistance training volume and proximity to failure were consistent with general recommendations for hypertrophy (34) and similar to that performed by bodybuilders during the pre-contest period (36). Thus, it appears that adhering to prescribed guidelines for these variables was insufficient to prevent lean mass loss in the presence of a large energy deficit. In addition, the athlete's protein intake (2.2 g/kg/d) was in line with general recommendations for resistance-trained individuals to optimize muscle hypertrophy (4) (39), although somewhat less than that reported for the average male bodybuilder during the pre-contest period (2.8 g/kg/d). Although speculative, it is possible that a higher protein intake may help to preserve lean mass during more extreme energy deficits, particularly when initial body fat levels are relatively low (17). This hypothesis warrants further exploration.

In the recovery period, the powerlifting athlete regained the majority of body mass, body fat and lean mass lost during pre-contest preparation. Again, these findings were consistent with post-contest increases in quadriceps muscle thickness and sum of body circumferences that approached baseline values. Several bodybuilding case studies show similar recuperation of body composition measures post-competition (30) (35), although case series data indicate this response varies between competitors (24) (8). The present findings indicate that detrimental effects of pre-contest powerlifting preparation on lean mass can be reversed upon return to usual and customary energy consumption, even following rapid short-term weight loss. However, it is important to note that the current athlete regained more body fat in a shorter time during the post-competition recovery phase (6.9% over 2 months) compared to the initial loss in body fat during the pre-competition phase (6.5% over 3 months). The rapid regain in body mass across the 2-month recovery phase (7.0 kg) may have contributed to a larger increase in body fat percentage. It is possible that the athlete would have experienced smaller increases in body fat percentage had he regained his body mass more gradually (16) (18) and thus achieved more favorable changes in body composition. Moreover, it appears that pre-contest powerlifting preparation has similar effects on body composition compared to pre-contest methods employed by bodybuilders.

Strength and Power

The athlete's isometric knee strength increased in the months leading up to his competition, something that may have been a result of engaging in progressive resistance training involving the squat and the deadlift, exercises that both involve knee extension (9). Additionally, the athlete's training pre-competition involved gradually reducing training volume while maintaining a high intensity (%1RM), something that aside from leading to 1RM strength increases (43) may have also played a role in increasing their isometric knee extension strength. Finally, the decline in isometric knee extension strength noted in the week after the competition could be attributed to the athlete's reduction in training volume for the squat and deadlift by approximately 30% and 26%, respectively, during that specific week. Previous research investigating the impact of a one-week deload on muscular adaptations revealed that individuals who took a week off from training experienced a decline in knee extension isometric strength when compared to a group that continued their training (10). The statement above leans towards speculation, as the observed decreases could potentially be attributed to heightened fatigue stemming from the athlete's recent competition.

The athlete's power output remained consistent during both the competition preparation period and the ensuing month but increased 2 months post-competition. This could be attributed to the athlete's training approach, wherein the training volume for all competition lifts was reduced by approximately 50-60%. The significant reduction in training volume might have enabled the athlete to demonstrate higher power levels, as fatigue can significantly impact jump height in trained individuals (19).

Finally, the alterations in the athlete's grip strength before and 2 months after the competition could be attributed to the athlete engaging in progressive resistance training and the reduction in training volume during the last month of measurements. Prior research indicates a notable correlation between hand grip strength and powerlifting performance (40), a factor that might have been influenced by the considerable decrease in training volume during the athlete's training, as training volume can significantly impact maximal strength (32).

Psychometrics

Overall, the athlete did not seem to have any marked sleep disturbances. The average global PSQI of 19.8% is lower than what has been reported for college-aged individuals (26.9%) or elite athletes (23.8%) (13). This value indicates a sum of total responses <5, which is considered the cutoff for detecting sleep disturbances (37). While there were fluctuations in the sleep quality global scores, they did not seem to coincide with the competition, but perhaps changes in sleep habits during the summer months.

The most notable changes in mood parameters were increased tension, anger, and depression immediately preceding the competition. Of these, tension rose from around 5% to almost 40% before dropping to zero following the competition. Several studies have used POMS to assess athletes' mood prior to competition (e.g., 23). However, many of these only look at pre-competition parameters compared to performance, sleep quality, or other measures. In addition, many sports that have seasons would likely follow a different trend than those with single events occurring throughout the year. A recent study that examined athletes prior to and following a triathlon did observe a high level of tension (36.9%) prior to competition, which decreased to 17.4% following competition (25). Both confusion and fatigue showed a slight, but more sustained increase approaching the competition, possibly owing to the caloric deficit sustained throughout training (27).

CONCLUSION

The athlete of this case study competed in the 67.5kg weight class in the open division at a national level competition. According to the lifter and his coach, the meet was an overall success due to a 2.5 kg increase in his competition total; however, the lifter expressed that this was below the desired outcome. Over the course of the 8-week preparation phase, the lifter did not set any personal training PRs in the squat, bench press or deadlift, possibly due to the significant weight cut during the 12 weeks leading into the competition. The lifter finished his preparatory period with a 213.2 kg back squat, a 145.2 kg bench press, and a 250 kg deadlift all reported to be RPE 10. While these were not overall PRs, they were personal bests for the lifter while training to compete in the 67.5kg weight class.

On the day of the competition (week 14, day 4), the lifter completed a back squat of 212.5 kg, bench press of 142.5 kg, and deadlift of 237.5 kg, setting a competition personal best and nearly matching his personal bests at that body weight. The lifter completed 8 out of 9 total lifts, missing his final deadlift attempt of 250 kg due to "downward motion" of the center of the bar. Although the lifter added 2.5 kg to his best competition total and had a DOTS score of 461.9, he did not place in the top 10. However, based on the data from the openpowerlifting.org database, which stores powerlifting competition data for every competition in the world, the athlete's 592.5 kg total places him in the top 2% of athletes in his weight class.

Future research should endeavor to further investigate the training and nutritional practices and their results of powerlifters during the pre- and post-contest periods to elucidate the similarities and differences between competitors.

PRACTICAL APPLICATIONS

This case study provides insights into the pre- and post-contest practices of a high-level powerlifting athlete, as well as highlighting corresponding changes in body composition, psychological state, and performance that occur during this period. Although results must be interpreted with caution, powerlifting athletes and coaches looking to maximize competition performance can use the case study's findings to inform their competition preparation phase. Consistent with the principle of specificity, the athlete's pre-contest training focused on the main competition lifts (squat, deadlift and bench press) using relatively high intensities of load. This was supplemented with accessory lifts designed to enhance/maintain muscle mass. As the competition neared, the athlete employed a tapering strategy, progressively reducing total volume load. This included a relatively slow taper during weeks 9 to 12 and then an aggressive taper during the final 2 weeks leading up to the competition. Given the virtually unlimited ways that training can be periodized to optimize performance outcomes, it remains undetermined whether alternative strategies may have improved results.

In an attempt to make weight for his competitive class, the athlete also employed an aggressive 3-month caloric restriction over the pre-contest period. This resulted in a substantial loss of body mass, but also involved appreciable losses of lean mass as well. Reductions in body mass were accompanying by a modest decrease in isometric leg extension torque It is unclear how these alterations affected his overall performance at the competition but, given the well-established relationship between strength and lean mass (1), a more gradual weight loss starting earlier in the pre-contest period should be considered for competitive powerlifters.

Finally, the athlete displayed notable changes in mood parameters including increased tension, anger, and depression immediately preceding the contest. This was likely due to the stressors of anticipating competition. The use of stress management interventions (e.g., meditation) may be appropriate to help alleviate pre-contest mood disturbances and thus potentially help to enhance performance during competition.

CONFLICTS OF INTEREST

There are no conflicting relationships or activities.

FUNDING

This study received no specific funding in order to be completed.

ETHICAL APPROVAL

Approval for the study was obtained from the college Institutional Review Board. Written informed consent was obtained from the athlete prior to enrollment. The methods for the study were preregistered prior to data collection (https://osf.io/sxqdn).

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