A Case Report: Compositional, Physiological, and Psychological Responses to Contest Preparation in a First-time Bikini Competitor

Case Study

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Abstract

Introduction: The purpose of this report was to document a novice, natural, female, physique athlete's physiological and psychological responses to a 6-month preparation and 1-month post-competition period.

Methods: The athlete's protocol throughout preparation was a high-protein caloric deficit with ~2 refeed days per week, as well as resistance and cardiovascular training. The athlete self-reported bodyweight and adherence via a weekly electronic survey. Once monthly during preparation, compositional, physiological, and psychological assessments were administered by a technician. Blood samples were drawn at the beginning of preparation and during the week of competition.

Results: Bodyweight decreased throughout preparation (51.9 to 46.7kg; Δ5.2kg) and further post-competition (46.3kg, R^2=0.96), with a similar decrease in body fat percentage (17.2 to 12.3%; Δ4.9%) and fat-free mass (42.9 to 41.0kg; Δ1.9kg) during preparation. Mild somatic (8/30) and depressive (5/27) symptoms manifested approximately 1-month prior to competition. Depressive (7/27) and anxiety (5/21) symptoms peaked post-competition but were not clinically significant. This aligned with a peak in emotional eating post-competition (5/12) and an increase in the athlete's previously elevated cortisol levels (761.76 to 839.04nmol/L).

Conclusions: The present report may be the first empirical documentation of a female physique competitor reducing fat-free mass during contest preparation and what is anecdotally known as "post-show blues."

Key Words: Dieting; Bodybuilding; Fat loss

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Introduction

Bodybuilding involves altering one's physique to meet judging criteria for a chosen division, focusing on muscular hypertrophy, symmetry, and leanness. [1] The pursuit of a competitive physique can be psychologically demanding, with bodybuilders often reporting symptoms of anxiety and depression. [2] Inexperienced (i.e. true novice) bodybuilders may struggle with these psychological challenges more than experienced athletes. Despite the growth in popularity surrounding bodybuilding, there is a paucity of research on the psychological and physiological effects of competition in true novice bodybuilders.

Due to the highly individualistic nature of the sport, where each individual athlete requires different training, nutrition, and cardiovascular protocols to attain a competitive physique, case reports have shown to be the most practical, effective, and accessible way to research the bodybuilding population. [3] Previous case reports have focused on assessing body compositional, physiological, hormonal, psychological, and neuromuscular metrics, although seldom altogether.

[3] A recent systematic review of bodybuilding case studies included 12 total reports; of those 12 reports, only one-third assessed at least four different kinds of metrics and only two did so in women. [3-5] Because bodybuilding performance is physique-based, factors like psychological stress, hormonal changes, and physiological responses to contest preparation directly impact performance and must be considered. While researchers often operate with limited resources, the unique access that a case report design offers allows for greater insight into the different facets of a bodybuilder's experience and can better inform future practice.

Previous research describes a common theme of adverse health effects among bodybuilders during competition season. [3,6] It is unknown how these adverse effects impact true novice competitors' commitment to continue in the sport, as well as their psychological and physiological state through preparation and post-competition. Therefore, the purpose of this case report was to comprehensively assess the psychological, hormonal, body compositional, and physiological effects of a 6-month contest preparation period, as well as 1-month post-competition, in a drug-free true novice female physique athlete.

Methods

Participants

We report the case of a 21-year-old, true novice, natural female bikini competitor with approximately 4 years of prior recreational resistance and aerobic training experience, who was followed for 6 months prior to the competition and 1-month (4 weeks) post-competition. This retrospective case report was deemed exempt by the University of South Florida Institutional Review Board; all ethical guidelines outlined in the Declaration of Helsinki were adhered to throughout this report, and the athlete gave informed consent and permission to publish after reviewing the final version.

Contest Preparation Protocol

The athlete's coach, who had 7 years of combined competing and coaching in the bikini division, developed and administered all exercise and nutritional protocols. The program was designed to take the athlete from their recreationally active lifestyle and slowly progress towards the week of competition, in line with evidence-based recommendations. [7,8] Exercise programming for the first 9 weeks of contest preparation emphasized building muscular strength and hypertrophy, with the rest of contest preparation (weeks 10 – 20) focused on increasing muscular hypertrophy and total daily energy expenditure. The post-competition period (weeks 21 – 24) were a "reverse dieting" period, where exercise volume progressively decreased and caloric intake progressively increased.

The athlete did not complete any formal cardiovascular activity at the start of preparation and ended preparation completing 2,200 kcal of cardio per week (approximately 315 kcals/day) on an aerobic exercise machine of her choosing. Four weeks post-competition, she was completing 400 kcal of aerobic exercise per week (approximately 60 kcals/day) on an aerobic exercise machine of her choosing. Resistance training was completed 4 times per week using an upper/lower body split (2 upper-body sessions and 2 lower-body session each week) consisting of 4-22 repetitions at the start of preparation and progressed to 5 times per week (adding 1 full-body session) completing 10-22 repetitions at the end of preparation with an intensity between 8-10 out of 10 rating of perceived exertion (RPE). Post-competition, the athlete returned to training 4 times per week completing 4-22 repetitions. Additional details regarding exercise programming are provided in Supplemental File 1. Nutritional protocols are also detailed in Supplemental File 1. The nutritional protocol was a high protein caloric deficit with ~2 refeed days (i.e., days of increased caloric intake) per week. Dietary supplementation included 5000 IU of Vitamin D and 4 g of Creatine monohydrate per day, which were both started during the first week of preparation. During the third week of preparation, 1 serving of Revive Thyroid Support (Revive MD™, Stuart, FL, USA), and 600 mg of magnesium citrate was added to the athlete's daily supplementation regimen, which was maintained post-competition. The athlete had used monophasic oral hormonal birth control (HBC) for 3 years prior to preparation and continued intake throughout preparation and post-competition.

Body compositional, physiological, and psychological data were collected once every 4 weeks after an overnight fast (≥ 8 hours) and a 24-hour abstinence from exercise. Each data collection session began with bioelectrical impedance analysis (BIA), followed by 15 minutes of supine rest, resting metabolic rate (RMR) assessment, hemodynamic assessments, skinfold and ultrasound body composition assessments, and psychological questionnaires, in that order. Each monthly assessment of the athlete was conducted by the same trained technician, who was a certified exercise physiologist. Blood was drawn and analysed immediately preceding the 6-month preparation and on the week of competition by a third-party laboratory service (LabCorp, Burlington, NC, USA). Food records were kept by the athlete

through an electronic food diary (MyFitnessPal®, Under Armor®, San Francisco, CA, USA) and were reported via an electronic weekly check-in survey. This weekly check-in survey also included Likert scale questions to assess athlete's subjective adherence to their coach's protocols, as well as a week-by-week self-assessed body mass via a standard at-home scale (Loftilla™, Arboleaf Corporation, Plano, TX, USA).

Body Composition Assessments

Body mass was assessed in tandem with body composition via a multifrequency BIA scale (InBody®570 Body Composition Analyzer; Biospace, Inc. Seoul, South Korea). Body composition was assessed in triplicate, also utilizing 7-site skinfold technique following the American College of Sports Medicine guidelines[9] (Lange® caliper, Cambridge Scientific Industries, Inc., Cambridge, MD, USA) and 7-site A-mode ultrasonography (BodyMetrix™, IntelaMetrix®, Brentwood, CA, USA) with Jackson & Pollock and Siri equations for determining body density and body fat percentage, respectively. [10,11] Fat mass (FM) and fat-free mass (FFM) were both calculated by multiplying body mass by body fat percentage for both skinfold and ultrasound assessments. The average values between BIA, skinfolds, and ultrasound were reported to mitigate potential errors in estimation from each technique. The technician conducting these assessments had a generalizability coefficient of 0.99 for both skinfolds and ultrasound, demonstrating excellent measurement reliability while accounting for absolute error variance due to the different days of measurement. [12]

Physiological Assessments

Prior to the start of each RMR assessment, the athlete rested in a supine position with legs elevated for 15 minutes. RMR was then measured using indirect calorimetry via a ParvoMedics TrueOne® 2400 Canopy System (ParvoMedics, Inc., Salt Lake City, UT, USA) for 20 minutes as the athlete laid motionless and awake. The device was calibrated immediately preceding each assessment. The initial 5 minutes of each assessment were discarded, leaving the final 15 minutes included within the analysis.

Resting blood pressure (RBP) and resting heart rate (RHR) were measured on the brachial region of the left arm using an automated cuff (Omron series Model BP742, Lake Forest, IL). Measurements were taken immediately following 20 minutes of rest during a supine RMR assessment and were taken rested while seated in a chair with legs un-crossed. RHR and blood pressure were assessed in triplicate, and the average of each value was recorded.

Psychological Assessments

Nutritional behaviors were assessed with the Three-Factor Eating Questionnaire (TFEQ-R18) which includes 17 categorical questions with ordinal responses scored 1-4, and an 18th question that allows a written ordinal score ranging from 1-8. [13] The questions are divided into 3 categories (cognitive restraint, uncontrolled eating, and emotional eating) and summed, with a higher score in each category representing an increased prevalence of the respective behavioral type. [13]

The Patient Health Questionnaire is a combination of 3 smaller questionnaires aimed at assessing somatic (PHQ-15), anxiety (GAD-7), and depressive (PHQ-9) symptoms. For each subcategory, a higher score represents a greater prevalence of the respective symptoms. [14] The PHQ-15, GAD-7, and PHQ-9 all use scores of 5, 10, and 15 as thresholds for mild, moderate, and severe symptoms, respectively, with a score of 10 also representing the threshold for clinical significance. [14]

The Sport Commitment Questionnaire-2 (SCQ-2) was used to assess commitment to bodybuilding. It is a 58-item questionnaire using a 1-5 strongly disagree-strongly agree Likert scale for each question. [15] The questions are divided into 12 different factors that influence commitment to sport, with a higher score representing a greater influence of each respective factor. [15] Enthusiastic commitment, constrained commitment, and sport enjoyment were the 3 factors of interest to the authors and thus are the only reported factors; data on all 12 factors can be made available upon request.

The athlete filled out a weekly electronic survey (Google Forms, Alphabet Inc., Mountain View, CA, USA) in which protocol adherence, sleep quality, and energy levels were self-reported with 1-5 Likert scales, with 1 being poor/low and 5 being perfect/high. Mindset was also self-reported with a 1-5 Likert scale, with 1 being highly negative and 5 being highly positive. A weekly average for body mass was self-reported using free response, and somatic symptoms were self-reported using a combination of multiple-choice responses and free response. Only body mass assessed monthly by the technician was used to determine the R^2 of weight loss.

Results

From the beginning of preparation to the week of competition, there was a 5.6 kg reduction in body mass ($R^2 = 0.96$) and 3.1 kg reduction in FM. Table 1 shows monthly changes in body mass, body composition, and metabolism. Of note is that measurements for visit 6 took place during the "peak week," 5 days prior to competition. Figure 1 illustrates weekly changes in macronutrient intake throughout the preparation and post-competition phases. Figure 2 includes the weekly changes in self-reported body mass. RBP and RHR were reduced slightly through the preparation phase. The athlete began preparation with a RBP of 100/65 mmHg and RHR of 76 bpm and had a RBP of 93/63 mmHg and RHR of 69 bpm during the week of competition. Both RBP and RHR increased slightly 1-month post-competition, 98/63 mmHg and 74 bpm, respectively.

Table 1. Body Composition and Metabolic Changes

Visit	Total Body Mass (kg)	Avg. Body Fat %	Avg. FFM (kg)	RMR (kcal)
1	51.9	17.2	42.9	1253
2	52.1	16.6	43.4	1224
3	50.7	15.6	42.7	1342
4	49.5	14.9	42.1	1266
5	48.1	13.4	41.6	1193
6[a]	46.7	12.3	41.0	1095
7[a]	46.3	12.8	40.4	1216

[a]Visit 6 occurred during the week of competition. Visit 7 occurred 4 weeks post-competition. Abbreviations: Avg. = average; FFM = fat-free mass; RMR = resting metabolic rate.

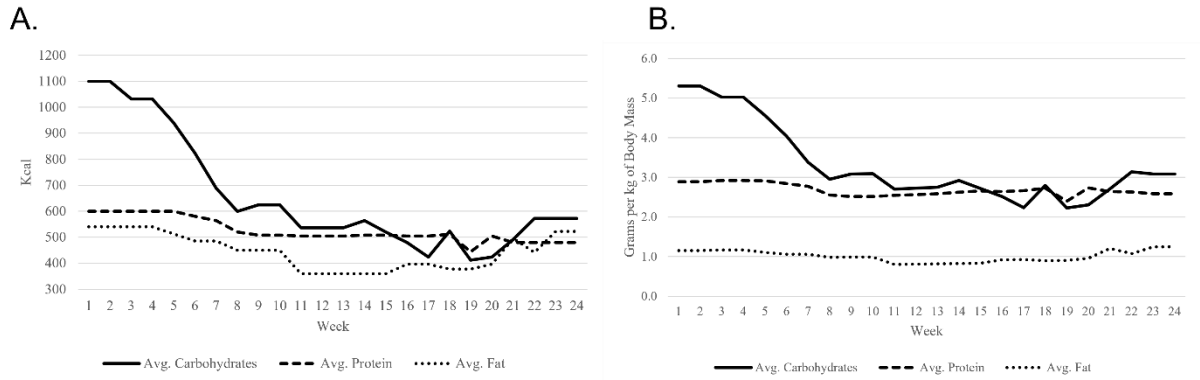

Figure 1. Absolute (A) and relative (B) weekly macronutrient changes during contest preparation (weeks 1 – 20) and post-competition (weeks 21 – 24) phases. Avg. = Average; Carb = Carbohydrate.

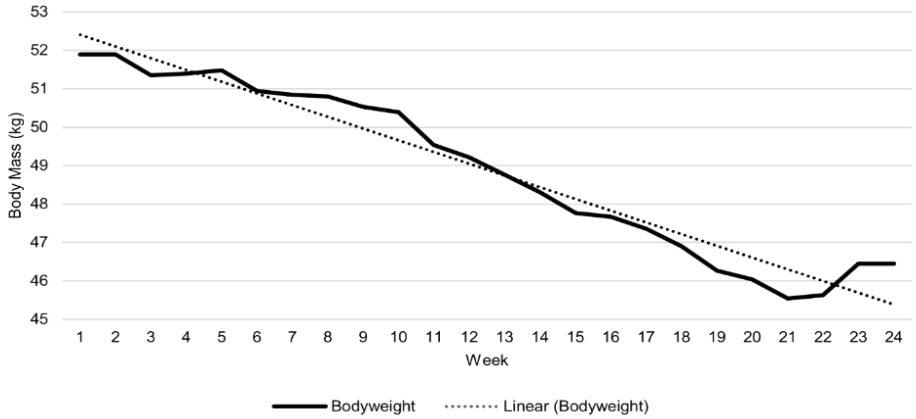

Figure 2. Weekly changes in self-reported body mass during contest preparation (weeks 1 – 20) and post-competition (weeks 21 – 24) phases. Avg. = Average; Carb = Carbohydrate.

Table 2. Blood Analysis Results

Variable	Pre-Preparation	Competition Week
TSH	2.82mIU/L	3.38mIU/L
Free T4	16.90pmol/L	18.58pmol/L
T3	3.0ng/L	2.6ng/L
Reverse T3	0.388nmol/L	0.391nmol/L
Estradiol	48.44pmol/L	40.37pmol/L
Progesterone	1.91nmol/L	2.23nmol/L
Free Testosterone	7.29pmol/L	5.55pmol/L
Total Testosterone	1.60nmol/L	0.94nmol/L
DHEA-S	6.27µmol/L	5.30µmol/L
Cortisol	761.76nmol/L	839.04nmol/L
Insulin	8.9mIU/L	2.5mIU/L
Ferritin	22.0µg/L	52.0µg/L
C-Reactive Protein	2.47mg/L	0.57mg/L
Creatinine	92.82µmol/L	108.73µmol/L
BUN	6.78nmol/L	9.28nmol/L
Lymphs Absolute	30 x 10^9/L	33 x 10^9/L
Vitamin D	183.8nmol/L	169.0nmol/L

Abbreviations: BUN = blood urea nitrogen; DHEA-S = dehydroepiandrosterone sulfate; T3 = Triiodothyronine; T4 = Thyroxine; TSH = thyroid-stimulating hormone.

Table 2 presents the changes in 17 different variables analyzed via blood samples immediately preceding preparation and 6 days prior to competition during the "peak week."

Table 3. Psychological Questionnaire Results

Visit	PHQ-15 (/30)	GAD-7 (/21)	PHQ-9 (/27)	Cognitive Restraint[b] (/28)	Uncontrolled Eating[b] (/36)	Emotional Eating[b] (/12)	En Comm[c] (/30)	Con Comm[c] (/25)	Sport Enjoyment[c] (/25)
1	0	2	0	14	11	3	22	6	22
2	2	2	1	14	13	3	25	10	22
3	2	3	1	18	14	3	26	10	23
4	2	4	2	17	16	3	25	9	25
5	8*	3	5*	19	17	3	24	7	23
6[a]	4	3	5*	23	17	3	24	7	22
7[a]	7*	5*	7*	17	12	5	30	8	25

[a]Visit 6 occurred during the week of competition. Visit 7 occurred 4 weeks post-competition. [b]Data is from Three-Factor Eating Questionnaire Revised-18 version. [c]Data is from Sport Commitment Questionnaire 2. "*" = denotes mild score of symptoms. En Comm = Enthusiatic Commitment; Con Comm = Constrained Commitment.

Table 3 presents the scores for each psychological questionnaire completed during monthly assessments. One month prior to competition, the athlete reached mild levels of somatic and depressive symptoms. During the week of competition, she reached mild levels of depressive symptoms, with mild levels of somatic and anxiety symptoms reached one-month post-competition.

The self-reported weekly adherence to the coach's protocols throughout preparation and post-competition ranged from 80-100% adherence with an average of 93%. The athlete also reported numerous symptoms throughout preparation, including soreness, tiredness, aching joints, injury, sickness, frequent waking up, trouble falling asleep, nightmares, trouble waking up, gas, constipation, and abdominal discomfort. The self-reported energy level and sleep scores both decreased throughout preparation and post-competition, while self-reported mindset scores remained stable.

Discussion

The athlete lost both FFM and FM throughout preparation. This contrasts with a recent systematic review of case studies on bodybuilding athletes, which stated that female athletes either maintain or gain FFM during preparation. [3]

This is of interest considering protein intake remained high throughout preparation (2.4 g/kg), exercise volume was slowly progressed, and diet refeeds were employed throughout preparation, all of which have been demonstrated in previous literature to protect against FFM loss in a caloric deficit. [16,17] However, since calories decreased by ~1000 kcal by the end of preparation, this may have minimized the protective effect of protein on FFM. These findings contrast with a previous case report of a female athlete that decreased calories by ~1000 kcals, yet did not experience any FFM loss throughout preparation. [18] This suggests additional factors, such as hypercortisolemia, may have negated the protection of FFM enhanced by refeeds and high protein intake, although more research with larger sample sizes is needed to support that theory.

Of further interest, by the end of the preparation period, energy intake alone was approximately 32.2 kcal/kg FFM, likely placing the athlete at risk of relative energy deficiency in sport (RED-S), which is defined as an energy availability < 30 kcal/kg FFM after accounting for energy expenditure. [19] These risks include negative impacts of hormones, body composition, and metabolic rate; many of which were experienced at the end of the competition period. [19] In a previous case report of a natural figure competitor undergoing a 20-week preparation, energy availability also decreased below 30 kcal/kg while holding protein intake above 2.0 g/kg, yet FFM was maintained throughout preparation. [6] This report did not include hormonal analysis, so it is unknown if that competitor faced similar hormonal challenges during preparation as the present athlete. Previous case studies reported the loss of an athlete's menstrual cycle for over 3- and 12-months post-competition, respectively, following low energy availability during preparation. [5,6] However, this contrasts with the current athlete's experience as she did not exhibit amenorrhea, potentially due to HBC's influence on the menstrual cycle.

The athlete's pre-preparation blood analysis depicted a seemingly unfavorable environment for the desired physique modifications and may have contributed to her loss of FFM as well as her slow decline in FM for the first half of preparation. Both reverse T3 and C-reactive protein (CRP) were elevated at the start of preparation, and as preparation continued CRP levels decreased (from 2.47 to 0.57 mg/L) while reverse T3 remained elevated (from 0.388 to 0.391 nmol/L). Of particular interest was the athlete's cortisol concentrations as previous research reviews have suggested heightened cortisol levels may relate to a negative body composition. [20,21] The present athlete had considerably elevated cortisol concentrations that remained high throughout the 20-week preparation period, increasing from 761.76 to 839.04 nmol/L, which is among the highest cortisol concentrations reported in the scientific literature for a physique athlete. [3]

The present athlete experienced large reductions in plasma testosterone concentrations, decreasing from 1.60 to 0.94 nmol/L. The decrease in total testosterone was similar to a group of female fitness competitors that underwent 16 weeks of dieting using similar protocols (energy deficit achieved by reducing carbohydrate intake and increasing aerobic exercise while maintaining a high level of protein intake and resistance training) as the current case report athlete. [22] The present athlete's changes in testosterone and cortisol levels also impacted her total testosterone:cortisol ratios, which represent the balance between an anabolic and catabolic hormonal state. [23] Total testosterone:cortisol ratios decreased from 0.0021 to 0.0011, indicating a shift towards a greater catabolic state and corresponds with the loss of FFM. This is lower than that of a previous case report that observed a decrease in total testosterone:cortisol ratio from 0.0031 to 0.0028 during preparation in a female physique competitor. [18] Despite the shift towards a more catabolic state, the present athlete did not experience a dramatic change in progesterone and estradiol levels throughout preparation, likely due to HBC use.

Related to psychological outcomes, the athlete demonstrated the highest levels of enthusiastic commitment and sport enjoyment four weeks following competition. This is likely due to the favorable outcome for this athlete's first competitive season (three first-place wins), as supported by a previous study conducted in paralympic swimmers which reported higher-placing swimmers were happier than lower-placing swimmers. [24] She also demonstrated the highest emotional eating post-competition, likely due to a combination of her increasing metabolic rate and hunger signals, as well as the removal of an immediate competitive goal. A previous randomized-control trial reported that male competitors who lost both FFM and FM during a dieting phase experienced a subsequent increase in hunger and desire to eat when the diet was over; however, these findings were not significant in female competitors ($p < 0.05$). [25] The athlete also reached mild levels of somatic symptoms, general anxiety disorder, and depression post-competition despite the favorable outcome of her show. This is similar to documented psychiatric distress in athletes following retirement from their chosen varsity sports. [26] This suggests the removal of an immediate goal may have an acute negative impact on the psyche. Previous literature on the mental health of bodybuilders reported higher levels of anxiety and depression as a consequence of muscle dysmorphia when compared to non-bodybuilding resistance

trainers; although, it is important to note this study was conducted in men only. [2] The athlete also self-reported poor sleep and energy scores post-competition, despite increasing caloric intake, decreasing aerobic exercise volume, and a positive outcome to her bodybuilding experience. Longstrom and colleagues reported similar decreases in sleep quality post-competition in 4 experienced female physique athletes. [27] However, changes in emotional well-being were small and variable between the experienced competitors. [27] In context with the present results, the peaks in anxiety and depression that we observed suggest that first-time competitors may differ from experienced competitors in their post-competition psychological states. Some bodybuilding athletes anecdotally report experiencing "the post show-blues," and that phenomenon may be felt differently based on competition experience.

Limitations

Records of the participant's exercise training were limited in detail and accessibility, with their coach utilizing prescription based on duration and estimated caloric expenditure interchangeably. Additionally, while the use of blood analyses by third-party labs is widespread and externally valid in bodybuilding practice, they present a financial burden to bodybuilding athletes. Therefore, the present athlete only completed these assessments twice, limiting the ability to monitor hormonal adaptations to contest preparation continuously, present detailed information on lab techniques for blood draws and analyses, and enable replication by other researchers and lab technicians. Similarly, the use of gold-standard 5-compartment models for body composition may not be practical for bodybuilding athletes due to accessibility and financial constraints, so this case report was limited to more accessible and generalizable body composition techniques, such as BIA and skinfolds.

Conclusions

The present athlete completed her first bodybuilding competition with success on stage but also experienced several undesired effects offstage. She accumulated numerous symptoms associated with RED-S and displayed indications of mild depression and anxiety post-competition. This research could be of use to athletes who wish to participate in bodybuilding as a method of fully understanding the costs of competing on physical and mental health; however, these results should be interpreted cautiously given the single participant within a case study design. Additional insight is needed into the impact of bodybuilding on the psyche and physiology of new competitors in different divisions.

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Conflicts of Interest

The authors have no financial conflicts of interest to disclose. A.R. is the founder and owner of Elysian Athletica, a bodybuilding coaching company. B.L. has received grants and contracts to conduct research on dietary supplements; has served as a paid consultant for industry; has received honoraria for speaking at conferences and writing lay articles about sports nutrition ingredients and topics; is a member of the International Protein Board; and has served as an expert witness on behalf of the plaintiff and defense in cases involving dietary supplements; and receives compensation for writing and providing educational services related to exercise and nutrition-related topics.

References

1. Escalante G, Stevenson SW, Barakat C, Aragon AA, Schoenfeld BJ. Peak week recommendations for bodybuilders: an evidence based approach. *BMC Sports Sci Med Rehabil*. Jun 13 2021;13(1):68. doi:10.1186/s13102-021-00296-y
2. Mitchell L, Murray SB, Cobley S, Hackett D, Gifford J, Capling L, O'Connor H. Muscle Dysmorphia Symptomatology and Associated Psychological Features in Bodybuilders and Non-Bodybuilder Resistance Trainers: A Systematic Review and Meta-Analysis. *Sports Med*. Feb 2017;47(2):233-259. doi:10.1007/s40279-016-0564-3
3. Schoenfeld BJ, Androulakis-Korakakis P, Pinero A, et al. Alterations in Measures of Body Composition, Neuromuscular Performance, Hormonal Levels, Physiological Adaptations, and Psychometric Outcomes during Preparation for Physique Competition: A Systematic Review of Case Studies. *J Funct Morphol Kinesiol*. May 8 2023;8(2)doi:10.3390/jfmk8020059
4. Chappell AJ, Simper TN. Nutritional Peak Week and Competition Day Strategies of Competitive Natural Bodybuilders. *Sports (Basel)*. Oct 24 2018;6(4)doi:10.3390/sports6040126

5. Tinsley GM, Trexler ET, Smith-Ryan AE, Paoli A, Graybeal AJ, Campbell BI, Schoenfeld BJ. Changes in Body Composition and Neuromuscular Performance Through Preparation, 2 Competitions, and a Recovery Period in an Experienced Female Physique Athlete. *J Strength Cond Res*. Jul 2019;33(7):1823-1839. doi:10.1519/JSC.0000000000002758
6. Halliday TM, Loenneke JP, Davy BM. Dietary Intake, Body Composition, and Menstrual Cycle Changes during Competition Preparation and Recovery in a Drug-Free Figure Competitor: A Case Study. *Nutrients*. Nov 20 2016;8(11)doi:10.3390/nu8110740
7. Helms ER, Aragon AA, Fitschen PJ. Evidence-based recommendations for natural bodybuilding contest preparation: nutrition and supplementation. *J Int Soc Sports Nutr*. 2014;11:20. doi:10.1186/1550-2783-11-20
8. Helms ER, Fitschen PJ, Aragon AA, Cronin J, Schoenfeld BJ. Recommendations for natural bodybuilding contest preparation: resistance and cardiovascular training. *J Sports Med Phys Fitness*. Mar 2015;55(3):164-78.
9. Liguori G, American College of Sports Medicine. *ACSM's guidelines for exercise testing and prescription*. 11th ed. Lippincott Williams & Wilkins; 2021.
10. Jackson AS, Pollock ML. Generalized equations for predicting body density of men. *Br J Nutr*. Nov 1978;40(3):497-504. doi:10.1079/bjn19780152
11. Siri WE. Body composition from fluid spaces and density: Analysis of methods. *National Academy of Sciences*. 1956;
12. Monteiro S, Sullivan G, M., Chan T. M. Generalizability theory made simple (r): An introductory primer to G-studies. *J Grad Med Educ*. 2019;11(4):365-370.
13. Karlsson J, Persson LO, Sjostrom L, Sullivan M. Psychometric properties and factor structure of the Three-Factor Eating Questionnaire (TFEQ) in obese men and women. Results from the Swedish Obese Subjects (SOS) study. *Int J Obes Relat Metab Disord*. Dec 2000;24(12):1715-25. doi:10.1038/sj.ijo.0801442
14. Kroenke K, Spitzer RL, Williams JB, Lowe B. The Patient Health Questionnaire Somatic, Anxiety, and Depressive Symptom Scales: a systematic review. *Gen Hosp Psychiatry*. Jul-Aug 2010;32(4):345-59. doi:10.1016/j.genhosppsych.2010.03.006
15. Scanlan TK, Chow GM, Sousa C, Scanlan LA, Knifsend CA. The development of the Sport Commitment Questionnaire-2 (English version). *Psychology of Sport and Exercise*. 2016;22:233-246. doi:https://doi.org/10.1016/j.psychsport.2015.08.002
16. Mettler S, Mitchell N, Tipton KD. Increased protein intake reduces lean body mass loss during weight loss in athletes. *Med Sci Sports Exerc*. Feb 2010;42(2):326-37. doi:10.1249/MSS.0b013e3181b2ef8e
17. Campbell BI, Aguilar D, Colenso-Semple LM, et al. Intermittent Energy Restriction Attenuates the Loss of Fat Free Mass in Resistance Trained Individuals. A Randomized Controlled Trial. *J Funct Morphol Kinesiol*. Mar 8 2020;5(1)doi:10.3390/jfmk5010019
18. Rohrig BJ, Pettitt RW, Pettitt CD, Kanzenbach TL. Psychophysiological Tracking of a Female Physique Competitor through Competition Preparation. *Int J Exerc Sci*. 2017;10(2):301-311.
19. Elliott-Sale KJ, Tenforde AS, Parziale AL, Holtzman B, Ackerman KE. Endocrine Effects of Relative Energy Deficiency in Sport. *Int J Sport Nutr Exerc Metab*. Jul 1 2018;28(4):335-349. doi:10.1123/ijsnem.2018-0127
20. Tomiyama AJ, Mann T, Vinas D, Hunger JM, Dejager J, Taylor SE. Low calorie dieting increases cortisol. *Psychosom Med*. May 2010;72(4):357-64. doi:10.1097/PSY.0b013e3181d9523c
21. Peeke PM, Chrousos GP. Hypercortisolism and obesity. *Ann N Y Acad Sci*. Dec 29 1995;771:665-76. doi:10.1111/j.1749-6632.1995.tb44719.x
22. Hulmi JJ, Isola V, Suonpaa M, et al. The Effects of Intensive Weight Reduction on Body Composition and Serum Hormones in Female Fitness Competitors. *Front Physiol*. 2016;7:689. doi:10.3389/fphys.2016.00689
23. Mohammadi H, Rezaei M, Sharafkhaneh A, Khazaie H, Ghadami MR. Serum testosterone/cortisol ratio in people with obstructive sleep apnea. *J Clin Lab Anal*. Jan 2020;34(1):e23011. doi:10.1002/jcla.23011
24. Martin J, Vassallo M, Carrico J, Armstrong E. Predicting Happiness in Paralympic Swimming Medalists. *Adapt Phys Activ Q*. Jun 27 2019;36(3):309-324. doi:10.1123/apaq.2018-0140
25. Turicchi J, O'Driscoll R, Finlayson G, et al. Associations between the proportion of fat-free mass loss during weight loss, changes in appetite, and subsequent weight change: results from a randomized 2-stage dietary intervention trial. *Am J Clin Nutr*. Mar 1 2020;111(3):536-544. doi:10.1093/ajcn/nqz331
26. Giannone ZA, Haney CJ, Kealy D, Ogrodniczuk JS. Athletic identity and psychiatric symptoms following retirement from varsity sports. *Int J Soc Psychiatry*. Nov 2017;63(7):598-601. doi:10.1177/0020764017724184
27. Longstrom JM, Colenso-Semple LM, Waddell BJ, Mastrofini G, Trexler ET, Campbell BI. Physiological, Psychological and Performance-Related Changes Following Physique Competition: A Case-Series. *J Funct Morphol Kinesiol*. Apr 25 2020;5(2)doi:10.3390/jfmk5020027

Supplemental File 1

Supplemental Table 1. Weekly averages of macronutrient consumption.

Week	Body Mass (kg)	Avg. Carb (kcal/day)	Avg. Carb (g/day)	Avg. Carb (g/kg/day)	Avg. Protein (kcal/day)	Avg. Protein (g/day)	Avg. Protein (g/kg/day)	Avg. Fat (kcal/day)	Avg. Fat (g/day)	Avg. Fat (g/kg/day)	Avg. Total (kcal/day)	Avg. Total kcal/kg/day
1	51.9	1100	275	5.3	600	150	2.9	540	60	1.2	2240	43.2
2	51.9	1100	275	5.3	600	150	2.9	540	60	1.2	2240	43.2
3	51.4	1032	258	5.0	600	150	2.9	540	60	1.2	2171	42.3
4	51.4	1032	258	5.0	600	150	2.9	540	60	1.2	2171	42.2
5	51.5	940	235	4.6	600	150	2.9	513	57	1.1	2054	39.9
6	50.9	824	206	4.0	580	145	2.8	486	54	1.1	1894	37.2
7	50.8	688	172	3.4	564	141	2.8	486	54	1.1	1740	34.2
8	50.8	600	150	3.0	520	130	2.6	450	50	1.0	1570	30.9
9	50.5	624	156	3.1	508	127	2.5	450	50	1.0	1581	31.3
10	50.4	624	156	3.1	508	127	2.5	450	50	1.0	1581	31.4
11	49.5	536	134	2.7	504	126	2.5	360	40	0.8	1403	28.3
12	49.2	536	134	2.7	504	126	2.6	360	40	0.8	1403	28.5
13	48.8	536	134	2.7	504	126	2.6	360	40	0.8	1403	28.8
14	48.3	564	141	2.9	508	127	2.6	360	40	0.8	1434	29.7
15	47.8	520	130	2.7	508	127	2.7	360	40	0.8	1389	29.1
16	47.7	480	120	2.5	504	126	2.6	396	44	0.9	1378	28.9
17	47.4	424	106	2.2	504	126	2.7	396	44	0.9	1321	27.9
18	46.9	524	131	2.8	512	128	2.7	378	42	0.9	1416	30.2
19	46.3	412	103	2.2	444	111	2.4	378	42	0.9	1234	26.7
20	46.0	424	106	2.3	504	126	2.7	396	44	1.0	1321	28.67
21	45.4	492	123	2.7	480	120	2.6	495	55	1.2	1467	32.3
22	45.6	572	143	3.1	480	120	2.6	441	49	1.1	1493	32.7
23	46.4	572	143	3.1	480	120	2.6	522	58	1.3	1574	33.9
24	46.4	572	143	3.1	480	120	2.6	522	58	1.3	1574	33.9

Note. Avg. = Average; Carb = Carbohydrate. Values were self-reported using food tracking software (MyFitnessPal®, Under Armor®, San Francisco, CA, USA). Week 20 was the week of the contest, with Weeks 21 – 24 (underneath the dotted horizontal line) representing the post-contest period.

Supplemental Table 2. Weekly exercise program.

Week	Resistance Training Program		Aerobic Training Program			
	Training frequency (1 session per day)	Training Split	Training frequency (1 session per day)	HIIT	MISS	LISS
1	4 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions	1 session	N/A	N/A	70 min.
2	4 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions	2 sessions	7 rounds, 20s:100s work:rest	N/A	N/A
3	4 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions	2 sessions	7 rounds, 20s:100s work:rest	N/A	N/A
4	4 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions	2 sessions	7 rounds, 20s:100s work:rest	N/A	N/A
5	4 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions	3 sessions	N/A	75 min.	N/A
6	4 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions	3 sessions	N/A	75 min.	N/A
7	4 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions	5 sessions	N/A	175 min.	N/A
8	4 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions	4 sessions	N/A	700 kcal	N/A
9	4 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions	3 sessions	N/A	1600 kcal	N/A
10	5 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions, 1 Full-Body Session	4 sessions	N/A	1600 kcal	N/A
11	5 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions, 1 Full-Body Session	3 sessions	N/A	1200 kcal	N/A
12	5 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions, 1 Full-Body Session	4 sessions	N/A	1500 kcal	N/A
13	5 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions, 1 Full-Body Session	3 sessions	N/A	1500 kcal	N/A
14	5 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions, 1 Full-Body Session	4 sessions	N/A	1750 kcal	N/A
15	5 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions, 1 Full-Body Session	4 sessions	N/A	1400 kcal	N/A
16	5 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions, 1 Full-Body Session	4 sessions	N/A	2000 kcal	N/A
17	5 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions, 1 Full-Body Session	5 sessions	N/A	2200 kcal	N/A
18	5 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions, 1 Full-Body Session	4 sessions	N/A	1700 kcal	N/A
19	5 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions, 1 Full-Body Session	5 sessions	N/A	2200 kcal	N/A
20	5 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions, 1 Full-Body Session	6 sessions	N/A	2400 kcal	60 kcal
21	4 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions, 1 Full-Body Session	3 sessions	N/A	1200 kcal	N/A
22	4 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions, 1 Full-Body Session	4 sessions	N/A	1200 kcal	N/A
23	4 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions, 1 Full-Body Session	4 sessions	N/A	600 kcal	N/A
24	4 sessions	2 Upper-Body Sessions, 2 Lower-Body Sessions, 1 Full-Body Session	4 sessions	N/A	400 kcal	N/A

Note: N/A = Not Applicable (that type of aerobic training was not done that week). Wk = week. Min = minutes. HIIT = High-Intensity Interval Training. MISS = Moderate-Intensity Steady State, defined at 40-59% of heart rate reserve. LISS = Low-Intensity Steady State, defined as < 40% of heart rate reserve. The athlete predominantly utilized a stair-stepping machine to complete their MISS and used a treadmill to complete their LISS. At week 8, the athlete's coach began to program aerobic training load based on estimated caloric expenditure via the exercise equipment's (stair-stepping machine and treadmill) display board. The athlete's smart watch was used to estimate heart rate to ensure they were within the programmed MISS or LISS intensity domains. Week 20 was the week of the contest, with Weeks 21 – 24 (underneath the dotted horizontal line) representing the post-contest period