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Female Natural Bodybuilding Competition Preparation: A 6-Week Case Study

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FEMALE NATURAL BODYBUILDING COMPETITION PREPARATION: A 6-WEEK CASE STUDY

by

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(Under the Direction of Professor Amy Jo Riggs)

ABSTRACT

Bodybuilding is unlike any other sport. Competitors are judged on appearance rather than performance, where muscle size and definition are keys to achieving success. This case study tracked four, drug-free, female bodybuilders for 6-weeks leading up to their competitions. The purpose of this project was to examine the physiological and psychological experiences of female bodybuilders as they prepare for competition. Each competitor reported for testing at three occasions to evaluate cardiovascular measures, body composition, resting metabolic rate, performance measures of strength, power, muscular endurance, and maximal oxygen consumption, mood state, social physique anxiety, and overall experience. Each subject in this study partook in their own methods of competition preparation, resulting in decreases of body fat percentages, in order to achieve their desired physiques. Due to differing techniques, experiences and results were highly individualized among subjects. This case study provides a thorough documentation of an array of tests, psychological and physiological, monitoring the changes that occur in female natural bodybuilders as they prepare for competition.

INDEX WORDS: Bodybuilding, Female, Dieting, Weight-loss, Resistance training, Competition preparation, Cutting, Conditioning, Body composition

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by

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TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

CHAPTER 1

INTRODUCTION

Bodybuilding is unlike any other sport. Competitors are judged on appearance rather than performance, where muscle size and definition are keys to achieving success. Competitors prepping for a show will utilize reduced caloric intake and increased exercise volume as methods to reduce fat mass (Walberg-Rankin, Edmonds, and Gwazdauskas, 1993). A competition preparation phase is dependent on the athlete, but generally lasts between 6 and 12 weeks in order to preserve maximum lean body mass. Losing weight too fast can lead to increased loss of muscle mass and performance (Garthe, Raastad, Refsnes, Koivisto, and Sundgot-Borgen, 2011; Lambert, Frank, and Evans, 2004; Marttinen, Judelson, Wiersma, and Coburn, 2011).

Previous research on bodybuilding competitors has demonstrated substantial loss of fat mass and changes in body composition during the preparation phase of competition. A study in 2013 documented a reduction of 14.8% to 4.5% body fat during a 12-week case study of one, drug-free male bodybuilder (Rossow, Fukuda, Fahs, Loenneke, and Stout, 2013). Similarly, a study in 2001 monitored changes in body composition in female bodybuilders during the preparation phase of competition, lasting 12-weeks (Van der Ploeg, Brooks, Withers, et al., 2001). Results indicated a significant loss in body mass of -4.42kg, a majority of the loss (76.2%) coming from fat mass (-4.42kg). Body fat percentages decreased significantly from 18.3 to 12.7%.

Changes in body composition, due to reduced caloric intake, have been linked to changes in resting metabolic rate (RMR). In a study using fifteen obese men and twenty obese females, researchers monitored the existence of adaptive thermogenesis during prolonged energy restriction over a 15-week period (Doucet, St-Pierre, and Almeras, et al., 2001). In this study by Doucet, St-Pierre, and Almeras, resting energy expenditure (REE) drastically declined two weeks into the energy restriction by 469 and 635 KJ/d for men and women, respectively. By week 8, REE declined by 963 and 614 KJ/d for men and women, respectively. Similar results have been observed in semi-starvation research studies (Dulloo and Jacquet, 1998).

Changes in cardiovascular measures during a competition preparation phase have been observed in male bodybuilders. Dramatic changes occurred in a case study by Rossow et al, 2013 after 12-weeks of training the subject's resting heart rate dropped from 53 beats per minute (bpm) to 27 bpm. In the same study, resting blood pressure reduced from 132/69 mmHg to 103/63 mmHg. Similarly in 2015, a study monitored a male during contest preparation and observed a drop of 54 bpm to 37 bpm in resting heart rate (Robinson, Lambeth-Mansell, Gillibrand, Smith-Ryan, and Bannock, 2015). In another study, the participant gradually lost weight (17.5% to 7.4%) and researchers observed a decline in blood pressure (128/61 to 113/54 mmHg) and heart rate (71 to 44 beats per minute) (Kistler, Fitschen, Ranadive, Fernhall, and Wilund, 2014).

Reduced caloric intake has been associated with reduced performance markers in several studies monitoring bodybuilders. One such study monitored a male bodubuilder and observed a 13.8% decrease from initial 1-repitition-

maximum for the squat, 8.4% decrease for bench press, and 7.0% for deadlift (Rossow et al., 2013). Bamman et al, (1993) monitored a male during contest preparation and observed that maximal isometric deadlift force decreased significantly over the 12-week period by -129N. In addition to strength and power, Robinson, et al, (2015) observed a decreased from 4.2 to 3.4 L/min absolute VO_{2max} and 49 to 46 ml/kg/min for relative VO_{2max} from baseline to week 14. Previous research has monitored a wide range of performance markers, as featured above, including strength and aerobic endurance.

Mood disturbances have previously been observed in diet related studies. Rossow et al, (2013) used a profile of mood states (POMS) assessments to monitor change in mood disturbances and observed an increase from 6 to 43 units during the 6-months before the competition. These units summarize how anxious, fatigued, etc an athlete is feeling based on a numeric scale. Similar studies have observed a negative effect of contest preparation and mood disturbances (Marttinen et al., 2011; Andersen, RE, Bartlett, SJ, Morgan, GD, and Brownell, KD, 1995). Contrastingly, in another similar study monitoring a single, male subject, the participant displayed below average anger, confusion, depression, fatigue and tension and fatigue was the only marker that increased from baseline to final assessment (Robinson, et al 2015). In the sport of bodybuilding, it is understood that certain aspects of health and performance are compromised in order to reach extremely low body fat percentages.

Utilizing a case study approach, a detailed profile of female bodybuilders validates previous research and further provides insight to the adaptations that take place during a long-term weight loss program.

Research Question:

What are the psychological and physiological experiences that occur in females as they prepare for a bodybuilding show?

Purpose:

The purpose of this project was to examine the physiological and psychological experiences of female bodybuilders as they prepare for competition. Though research exists monitoring the adaptations to the sport of bodybuilding, female bodybuilders have yet to be followed to the same extent as males. Some research that has been done on females include components of psychological state, diet, and body composition (Newton, et al., 1993; Walberg-Rankin et al., 1993; Van der Ploeg et al., 2001) as outlines in the introduction, and have demonstrated a small glimpse into the journey of a female prepping for a bodybuilding show.

Limitations:

- A convenience sample will be utilized. Subjects were recruited from the Statesboro, Georgia community, representing bodybuilding females ages 18-30.
- Subjects will not be monitored therefore workouts and nutrition log will be taken at the word of each subject.

CHAPTER 2

LITERATURE REVIEW

Bodybuilding

Bodybuilding is unlike any other sport. Competitors are judged by appearance rather than performance, where muscle size and definition are keys to achieving success in a show. During the off-season, muscle size is the main objective. During this time, bodybuilders are in a positive energy balance to elicit muscle growth. Pre-competition, however, competitors continuously eliminate calories and add exercise volume in attempt to maintain muscle and reduce fat, creating the desired muscle definition. This phase typically last 6 to 12 weeks (Lambert, et al., 2004).

As a result to a negative energy balance, certain aspects of health, wellness, and performance may be compromised. Previous research on these athletes has been focused on body composition and nutritional changes and has predominantly been focused on males.

Rossow et al. (2013) produced a case study following a natural, male bodybuilder during the preparation and recovery phases surrounding a competition. The aim of the study was to create a comprehensive physiological profile of a bodybuilding competitor before and after a show. For 12-months the male subject was assessed for cardiovascular parameters, body composition measurements, strength, aerobic capacity, critical power, mood state, resting energy expenditure, hormonal and other blood parameters. The results revealed that heart rate decreased from 53 to 27 beats/min during the preparation phase, brachial

blood pressure dropped from 132/69 to 104/56 mmHg, percent body fat went from 14.8% to 4.5%, strength decreased, testosterone declined from 9.22 to 2.27 ng/mL, and total mood disturbance increased from 6 to 43 units during the 6-months before the show. All values returned to baseline, with the exception of strength, during the six months post competition. This study serves as a comprehensive profile of the physiological changes observed during natural bodybuilding competition and recovery.

Hayward et al. (1989) compared anthropometric data, body composition, and nutritional profiles for nine female and nine male bodybuilders during different stages of training. Data was collected for six to seventeen weeks prior to competition and 24 to 48 hours after competition. Hydrostatic weighing, 6-site skin fold, and three-day diet records were employed to observe changes before and after competition. Significant weight loss was observed ($p<0.001$) for men (-5.4kg) and women (-6.0kg), as a result of increased training and reduced intake. Largest changes in subcutaneous fat were at the thigh for women, and abdomen for men. Nutrient intake was at or close to recommended values for both genders and macronutrients were also relatively the same, with the exception of men consuming more protein during the competitive state. In conclusion, this study observed realistic weight loss goals and nutrient intakes to aid in preparing for a bodybuilding show.

Robinson et al. (2015) implemented a nutrition and conditioning intervention to prepare a natural bodybuilder for competition. The purpose of this study was to examine a method of abstaining from the common methods of

dehydration periods, prolonged fasting and sever restriction, excessive cardiovascular exercise, and inappropriate use of diuretics and steroids. Researchers followed a 21-year-old male and instructed him to follow several rules: eat a variety of foods, not neglect any macronutrient groups, exercise regularly but not excessively, and incorporate rest days. After 14-weeks, the participant experienced a body mass loss of 11.7kg's (6.7 kg fat mass and 5.0 kg lean mass), decreased resting metabolic rate (1993 kcal/d to 1814 kcal/d), increased fat oxidation during exercise (0.24 g/min to 0.59 g/min), hamstring concentric peak torque decreased (1.7 to 1.5 Nm/kg), an increase in hamstring eccentric (2.0 to 2.9 Nm/kg), quadriceps concentric (3.4 to 3.7 Nm/kg), and quadriceps eccentric (4.9 to 5.7 Nm/kg). Psychological mood-state was observed using BRUMS scale and the participant remained below average, indicating the intervention did not negatively influence the participant. In conclusion, it was observed that healthy and structured nutrition and training can be implemented to achieve the desired results without the use of conventional bodybuilding practices.

Kistler et al. (2014) followed a male, natural bodybuilder during a 26-week contest preparation. The purpose of the study was to document the physiological changes that occur during a prolonged preparation. Weight was monitored bi-weekly, body composition was assessed monthly using DXA, and cardiovascular structure and function was monitored every two weeks by ultrasound, applanation tonometry, and heart rate variability. Cardiorespiratory performance was measured using VO_{2peak} at baseline, 13 weeks, and 26 weeks. Participant experienced a body weight change of 88.6 kg to 73.3 kg across the preparation phase with a loss of

greater than 10% body fat (17.5 to 7.4%). Blood pressure improved from 128/61 to 113/54 mmHg, resting heart rate dropped from 71 to 44 beats per minute, and heart rate variability shifted from a ratio of low to high frequency (209.2 to 30.9%). Absolute VO_2 saw very little change and relative VO_2 increased (41.9 to 47.7 ml/kg). Results of the long-term contest preparation displayed an effective method in achieving the desired body composition.

A study by Newton, et al. (1993) monitored the psychological state, diet, and body composition of six male and two female bodybuilders (ages 25 to 37 years) for the 12-weeks leading up to competition. The purpose of this study was to identify changes in psychological state and self-reported diet during various phases of competitive bodybuilders. Every three weeks, participants met for testing of body composition and psychological analysis using Profile of Mood States and Beck Depression Inventory questionnaires. Nutritional food logs were collected at weeks 12, 6, and 1. Psychological data revealed that participants experienced increasing fatigue, vigor (23.14 to 15.86, $p<0.05$), depression, tension, and confusion as participants progressed toward competition. Dietary profiles indicated decreased caloric intake and a similar macronutrient distribution for both genders. With a gradual reduction in calories, carbohydrates remained about the same while fat percentage dropped and protein increased. Results indicated psychological state is most altered for both genders during the bodybuilding competition preparation phase, due to a rigorous exercise and diet program.

Physiological Adaptations: Changes in Body Composition

In a study by Walberg-Rankin et al. (1993), diet and weight changes were observed a month before and a month post competition in six female bodybuilders. Participants experienced weight loss in the month prior and weight gain in the month post competition. Each macronutrient was consumed at a moderate level with a modest reduction prior to competition. Post competition, participants intake increased by double and fat intake increased by tenfold. This study observed the nutritional and weight pattern of a female bodybuilder in the months surrounding competition. Researchers concluded that extreme dietary control was utilized in preparing for a show, reducing caloric intake and decreasing fat intake prior and higher energy and fat intake in the month following the show.

Van der Ploeg et al. (2001) monitored changes in body composition in female bodybuilders during the preparation phase of competition. Five female competitive bodybuilders and five active females were matched for percent body fat and height, using the active females as a control group. Measurements of anthropometric profile, body density via underwater weighing, total body water using deuterium dilution, and bone mineral content using DXA were taken at three intervals (beginning, middle, and end) in a 12-week period. Body fat percentage was calculated using total body water, bone mineral content, and body density measurements. Results indicated a significant ($p<0.001$) loss in body mass of -4.42kg, a majority of the loss (76.2%) coming from fat mass (-4.42kg). Interestingly, the decrease in mass was significantly greater in the final 6-weeks when compared to the first 6-weeks of competition preparation. Body fat percentages decreased

significantly ($p<0.001$) from 18.3 to 12.7%, whereas the control group remained constant at 19.1-19.6%. This study concluded that while body mass declined significantly through the pre-competition phase, a majority of that was due to fat loss and preserved lean body mass.

The speed in which weight is lost can play a large roll in the success of a bodybuilding athlete. Garthe et al. (2011) compared two weight loss rates on body composition, strength and power, as it related to performance. Twenty-four male athletes were randomized into two groups: slow reduction (SD, -0.7%) and fast reduction (FD, -1.4%). Each athlete followed an individualized energy-restricting diet, measured for weight-loss needs and logged 4 resistance-training sessions per week. Laboratory measurements included body weight, body composition, 1-reprition maximum tests, 40-meter sprint, and counter movement jumps, all pre and post intervention. Results showed body weight decreased in both groups (SR; 5.6% ± 0.8%, FR; 5.5% ± 0.7%), lean body mass increased for the SL group (2.1% ± 0.4%, $p <0.001$) and unchanged for the FR group (-0.2% ± 0.7%). The results for changes in lean body mass were significantly different ($p<0.01$). In conclusion, a slower weight loss method of 0.07% a week is preferred for preserving lean body mass and strength during a weight loss period.

Physiological Adaptations: Changes is RMR

Optimal body composition can be very beneficial for sport performance. Often, athletes aim to lose fat mass and preserve lean mass for competition

purposes. In doing so, evidence indicates metabolic adaptations leading to decreased energy expenditure and increased metabolic efficiency.

Dulloo and Jacquet (1998) observed the relationship between basal metabolic rate (BMR) in response to food deprivation in humans. Thirty-two men were utilized for this study and participated in a semi-starvation and refeeding protocol. Participants consumed approximately 3,600 kilocalories for the control period, 1,500 kilocalories for the semi-starvation phase, and the recovery phase was dependent on the individual and group placement. Refeeding phase divided the subjects into four groups, varying protein content and kilocalorie intakes. Basal metabolic rate and body composition were assessed at a preservation phase (control) of 6-weeks, semi-starvation at 12 and 24 weeks, and after 12-weeks of restricted refeeding. Results found a positive and significant ($p<0.01$) relationship between the reduction of thermogenesis and the degree of fat loss during the semi-starvation and refeeding phases, suggesting that in response to weight loss, the human body attempts to conserve energy resulting in reduced BMR.

Doucet et al. (2001) set out to find evidence for the existence of adaptive thermogenesis during prolonged energy restriction. Using fifteen obese men and twenty obese women in a 15-week weight loss program, the study monitored body composition, weight, and resting energy expenditure (REE). Measurements were taken at baseline, 2 and 8 weeks of energy restriction, as well as 2-4 weeks after the end of the 15-week program. Results showed a significant decrease in body weight and fat mass in both men and women without change to fat free mass. REE drastically declined two weeks into the energy restriction by 469 and 635 KJ/d for

men and women, respectively. By week 8, REE declined by 963 and 614 KJ/d for men and women, respectively. After recovery to baseline weight, subjects REE improved substantially for women returning to original values, while men experience a deficit of 622 KJ/d. The results of this experiment further confirm the existence of thermogenesis adaptations as it relates to weight loss in a calorie restricted diet.

Physiological Adaptations: Changes in Cardiovascular Measures

Rossow et al. (2013) produced a case study following a natural, male bodybuilder during the preparation and recovery phases surrounding a competition. The aim of the study was to create a comprehensive physiological profile of a bodybuilding competitor before and after a show. For 12-months the male subject was assessed for cardiovascular parameters, body composition measurements, strength, aerobic capacity, critical power, mood state, resting energy expenditure, hormonal and other blood parameters. Initially, heart rate was 53 beats/min and dropped significantly to 27 beats/min in the final days of reduced intake. Brachial blood pressure also decreased from baseline at 132/69mmHg to, at its lowest, 103/63 mmHg. The data reflects that as the subject increased exercise volume and decreased energy intake, heart rate and blood pressure also significant declined.

Robinson et al. (2015) implemented a nutrition and conditioning intervention to prepare a natural bodybuilder for competition. The purpose of this study was to examine a method of abstaining from the common methods of

dehydration periods, prolonged fasting and severe restriction, excessive cardiovascular exercise, and inappropriate use of diuretics and steroids. Researchers observed a 21-year-old male, and instructed him to follow several rules: eat a variety of foods, not neglect any macronutrient groups, exercise regularly but not excessively, and incorporate rest days. Cardiovascular measures of resting heart rate were taken at baseline and week 13. Baseline resting heart rate was 54 beats per minute and after 13 weeks declined to 37 beats per minute. In conclusion, with the increase of exercise volume and a reduction in caloric intake, resting heart rate was influenced in the negative direction.

Kistler et al. (2014) followed a male natural bodybuilder during a 26-week contest preparation. The purpose of the study was to document the physiological changes that occur during a prolonged preparation. As the participant gradually lost weight (17.5% to 7.4%) researchers observed a significant decline in blood pressure (128/61 to 113/54 mmHg) and heart rate (71 to 44 beats per minute). These results are not surprising are similar to that observed by Rossow et al., (2013) and Robinson et al., (2015), whom completed similar studies monitoring the changes of male natural bodybuilders during the contest preparation phase.

Physiological Adaptations: Changes in Performance

Bamman et al. (1993) observed changes in body composition, strength and power in six male bodybuilders in a 12-week period prior to competition. Measurements were taken at baseline and every three weeks using repeated measures ANOVA ($p<0.05$). Circumference measurements decreased significantly at

each location ($p<0.05$) except chest. The biggest changes in circumference were observed at the waist (-6.9cm) and hips (-4.3cm). Maximal isometric deadlift force decreased significantly over the 12-week period ($p<0.05$) by -129N. Participants recorded exercise and observed that an increase in resistance and aerobic training volume. Exercise routine combined with reduced intake led to a result of reduced strength and performance. In conclusion, participants were effective in reducing fat and maintaining muscle mass, however strength was compromised.

Rossow et al. (2013) produced a case study following a natural, male bodybuilder during the preparation and recovery phases surrounding a competition. The aim of the study was to create a comprehensive physiological profile of a bodybuilding competitor before and after a show. For 12-months the male subject was assessed for cardiovascular parameters, body composition measurements, strength, aerobic capacity, critical power, mood state, resting energy expenditure, hormonal and other blood parameters. Participant observed a 13.8% decrease from initial 1-reprition-maximum for the squat, 8.4% decrease for bench press, and 7.0% for deadlift. This was in spite of minimal loss of lean body mass (-3.9%), during the competition preparation phase. The loss of strength did however, correlate with increased fatigue and decreased vigor as identified by POMS. In addition to strength detriments, absolute VO_{2peak} (4.46 to 3.97 L/min) and critical power (223.3 to 199.3W) were compromised as well as the subject progressed in cutting calories. Concluding that performance markers can be negatively influenced during the competition preparation phase.

Robinson et al. (2015) implemented a nutrition and conditioning intervention to prepare a natural bodybuilder for competition. The purpose of this study was to examine a method of abstaining from the common methods of dehydration periods, prolonged fasting and sever restriction, excessive cardiovascular exercise, and inappropriate use of diuretics and steroids. Researchers followed a 21-year-old male, and instructed him to follow several rules: eat a variety of foods, not neglect any macronutrient groups, exercise regularly but not excessively, and incorporate rest days. Conditioning consisted of 4 resistance-training sessions each week, with the addition of high intensity interval training and low-intensity steady state exercise, as needed. After 14-weeks, the participant lost a total of 11.7 kg's with an average weight loss of .98%/week. Performance changes were observed using absolute and relative VO_{2peak}, and hamstring and quadriceps concentric and eccentric peak torque. From baseline to week 13, the participant decreased from 4.2 to 3.4 L/min absolute VO_{2oeak} and 49 to 46 ml/kg/min for relative VO_{2max}. In addition, the number of sub maximal stages completed by the participant, during maximal oxygen consumption testing, with a RER <1.0 increased during the study (5 stages to 10 stages). Strength and power measurements after14-weeks displayed mixed results. While hamstring concentric strength decreased (146 Nm to 114 Nm), hamstring eccentric strength increased (172 Nm to 218 Nm). Quadriceps observed a similar trend, absolute quadriceps concentric strength declined (293 Nm to 273 Nm) and concentric motion remained similar (424 Nm to 423 Nm). The results are not surprising, due to the participants' loss of fat free mass (5.0 kg) and increase of aerobic exercise volume over time. In

conclusion, the participant experienced changes in performance, however, bodybuilders are not primarily concerned with these assessments to be successful for competition.

Physiological Adaptations: Changes in Mood

Bodybuilders are not the only athletes whom utilize reduced caloric intake and increased exercise volume to achieve sport goals. Wrestlers commonly use short-term weight-loss for the purpose of making their desired weight class.

Marttinen et al. (2011) observed the effect of self-selected weight-loss methods on changes in mass, and the performance and mood changes as a result, in collegiate male wrestlers. Wrestlers are unique because they tend to drop weight, quickly, right before competition. This study aimed to determine the effects of "weight cutting" on mood, grip strength, and lower body power prior to competition. Sixteen male, college aged wrestlers were selected for this study (age=20 ± 2 years, height=177.5 ± 7.2cm) and were weighed and tested 10-days prior to competition as well as 6 and 2 days before. Wrestlers self-selected methods and timing of weight loss. Most mass was lost the 2-days prior with a direct correlation between weight loss and increased confusion using a Brunel Mood Scale (BRUMS). Participants lost 0.0-0.8% of their body mass using various methods. Wrestlers who lost <4% body fat experienced no difference in confusion. No significant difference was found in performance markers across time for grip strength, lower-body power and Wingate. This study suggests that self-selected

weight loss plays a role in psychological functioning without affecting performance markers.

Rossow et al. (2013) created a descriptive profile of a male bodybuilder during the preparation and recovery phases surrounding a competition. The aim of the study was to create a comprehensive physiological profile of a bodybuilding competitor before and after a show. For 12-months the male subject was assessed for cardiovascular parameters, body composition measurements, strength, aerobic capacity, critical power, mood state, resting energy expenditure, hormonal and other blood parameters. Mood state was altered in a positive direction for the first four months before competition, however, dropped significantly in the final two months of preparation. At the one-month marker, POMS indicated the participant increased in the confusion-bewilderment subscale. Total mood disturbances increased greatly in the fatigue-inertia and tension-anxiety subscale, accompanied with a decrease in the vigor-activity subscale. These results reflect the results of the POMS assessment, although participant reported that he enjoyed the preparation and that he felt excited for the show. Concluding that mood disturbances were experienced during the training and preparation.

Robinson et al. (2015) implemented a nutrition and conditioning intervention to prepare a natural bodybuilder for competition. The purpose of this study was to examine a method of abstaining from the common methods of dehydration periods, prolonged fasting and sever restriction, excessive cardiovascular exercise, and inappropriate use of diuretics and steroids. Researchers followed a 21-year-old male, and instructed him to follow several rules:

eat a variety of foods, not neglect any macronutrient groups, exercise regularly but not excessively, and incorporate rest days. Participant completed a BRUMS assessment at baseline and at week 13. Through the intervention, the participant displayed below average anger, confusion, depression, fatigue and tension. Fatigue was the only marker that increased from baseline to final assessment. These findings are in contrast to other studies (Rossow et al. 2013) in which observed severe mood disturbances through the competition preparation phase as well as in recovery after the show.

Andersen at al. (1995) examined the weight loss practices, nutrition, and psychological factors of 45 male bodybuilders competing in a natural bodybuilding show. Participants completed a questionnaire the morning of the competition. The survey assessed weight loss and dietary history, psychological distress, reports of binge eating, and supplement use. Participants reported a mean weight loss of 6.8 kg for competition, gain of 6.2 kg after competition, and 46% of participants reported binge eating post-show. A majority (81.5%) reported frequent, often, or constant preoccupied with the thought of food during preparation. Results also showed that 50% of participants reported feeling anxious, short-tempered, and anger when preparing for competition. Due to the nature of bodybuilding's severe dieting and restricting nature, potential physiological and psychological implications may ensue.

The Minnesota Starvation Experiment is an extreme example of the negative effects of a semi-starvation diet (Keys, Brozek, Henschel, et al., 1950). The purpose of this study was to determine the physical and mental effects of long-term semi-

starvation and rehabilitation from that state. Thirty-six men were selected from the Civilian Public Service for the study. The study started with a control phase of 12-weeks, a 24-week starvation phase, and a recovery phase. For three months the men received ~3,200 kilocalories, this was the control phase. The following six months, the semi-starvation phase, consisted of half that, ~1,800 kilocalories. In the final three months, the men consumed one of four energy intakes meant to observe the best method to rehabilitate post-war. The result was an average of 25% weight reduction and significant increases in emotional distress and depression. Though this study was extreme, it is not unlikely that bodybuilders undergoing this process do not reflect similarly psychologically.

CHAPTER 3

METHODS

Subjects

Four women bodybuilders between the ages of 18 and 30 years were recruited for this study through word of mouth in the Statesboro, Georgia area. Competitors were resistance-trained females, either previously contemplating competing in a natural bodybuilding competition or had competed in a natural bodybuilding show. Participants were allowed to remove themselves from the study at any time for any reason. Prior to participation, participants completed an informed consent and considered healthy and free of disease as evaluated by a Health History Questionnaire. Participants were excluded if banned or anabolic androgenic substances had been consumed within the last seven years. This

included clostebol, fluoxymesterone, metandienone, metenolone, nandrolone, stanozolo, testosterone, growth hormone, erythroropoietin cortocotropin, chorionic gonadotrophin, ephedrine, amineptine, mesocarb, pipradol, anavolic steroids, beta2-agonists, and related substances as outlined in NPC competition rules and guidelines. Participants were excluded for orthopedic, muscular and/or cardiovascular issues as determined by the Health History Questionnaire. Other exclusion criteria included participation in any other training study within the last 12 weeks prior to enrollment for this study or investigators uncertainty about participants' capability or willingness to comply with protocol according to feedback disclosed on the Health History Questionnaire and additional questioning. This study was approved by the Georgia Southern University Institutional Review Board.

Diet and Exercise

Diet and exercise was tracked and recorded for the 6-week duration of the study. Diet was tracked using MyFitnessPal where caloric intake and macronutrient distribution was visible to researchers throughout the study duration for observation and to ensure compliance. Exercise logs were completed and turned in to researchers on the same days of testing. Participants followed a diet and exercise regimen that is particular to their strategy for competition. It was expected that all participants weigh and monitor food intake for the duration of the study. Participants were expected to follow a constant diet and exercise protocol based on their individual strategy throughout the entire 6 weeks.

Laboratory Assessments

All laboratory assessments were completed in the following order to ensure consistency and validity. Participants arrived to the lab fasted for body composition measurements. Performance assessments took place on a separate day to allow participants to eat prior to testing for maximum results.

Cardiovascular Measures. At each test date, participants had measures of resting heart rate and blood pressure taken. Participants were asked to lay supine on an examining table. An automated cuff was wrapped around the subjects' right arm, and after 10 minutes of quiet rest, investigators began the resting heart rate and blood pressure test. The blood pressure cuff automatically inflated to the desired pressure and deflated upon data retrieval. This was done twice to ensure accuracy. If resting heart rate was 10bpm different or blood pressure was 10mmHg different, a third test was warranted. Mean values were recorded.

Body-Composition Measures. Participants had body-composition measured three times; baseline, mid, and end of the 6-week study. Testing included bioelectrical impedance spectroscopy (BIS), BodPod, and body mass on each testing date. Fat mass was determined using a 3-compartment model (Siri, 1961). Each of the following tests were utilized in the 3-compartment model to achieve accurate results for body composition. For all tests, participants were asked to wear tight fitting clothing and refrain from exercise 24 hours prior to measurements. Participants were fasted for a period greater than 8 hours and were done in the morning at the same time as their last measurement.

BIS was used to estimate total body water (TBW) following the procedures recommended by the manufacturer (Bodystat Quadscan 4000: Bodystat LTD, Douglas, UK). This technique used a range of frequencies (5KHz-200KHz), both low and high ranges that allow electrical current to pass around and through each cell. After resting in a supine position for 5 to 10 minutes, TBW estimates were taken while the participant lay in the supine position on a table with arms ≥30° away from the torso and legs separated. Prior to each analysis, each participant's height, weight, and gender were entered into the BIS device. Electrodes were placed at the wrist (dorsal surface at the ulnar styloid process) and ankle (dorsal surface between the malleoli) with additional electrodes being placed 5 centimeters from the wrist and ankle. Before electrode placement the skin was cleaned with alcohol at each site. Multifrequency (5, 50, 100 and 200 kHz) currents were introduced from the positive leads and travel throughout the body to the negative leads. Resistance values were used to calculate extracellular water (ECW) and intracellular water (ICW) and summed to equal TBW.

Body density (BD) was estimated from air-displacement plethysmography using the BOD POD® (BP; Life Measurements Inc. Concord, California, USA). Prior to each test, the BP was calibrated according to the manufacturer's instructions using a two-point calibration. It was first calibrated with the chamber empty, and then with a cylinder of known volume (50.097 L). Prior to testing participants were instructed to wear tight fitting compression shorts and swimming cap, and asked to remove all metal, including jewelry and watches. Body mass was measured to the nearest 0.01 kg using the system's calibrated scale. Participants were instructed to

sit in the chamber, breathe normally, but minimize any movement. A minimum of two trials were performed and if measurements were not within 150 ml of each other, a third trial was conducted. Thoracic gas volume was estimated using the BP software, which uses standard prediction equations.

Fat mass was estimated using the 3-compartment model (%fat = [(2.118/BD) - (0.78 × TBW/Body Mass (kg)) - 1.354] × 100) in which utilizes body density from air-displacement plethysmography, total body water from bioimpedance spectroscopy, and total body mass.

Performance Measures

Exercise assessments were taken on a separate day of the same week as the fasted, resting measures. Measurements were collected at baseline, middle, and at the end of the 6-week study, as changes may be minimal week to week. Participants will refrain from resistance training on days of performance testing.

Strength. This was assessed using a 1-repitition maximum (1RM) for two exercises: bench press and squat. The first tested upper body strength using a bench press 1RM and the second was a squat 1RM to assess lower body strength. As instructed by the spotters, participants performed a light warm up of 5-10 reps at approximately 40-60% 1RM. After a minute of light stretching, the participants performed an increased intensity warm up of 3-5 reps at 60-80% 1RM. After the warm up, participants were instructed to find their 1RM and to rest 3-5 minutes between successful attempts. If successful, participants increased weight by 5-10lbs for bench press and 10-15lbs for squat. In working with a spotter, participants achieved their 1RM within 3-5 maximal efforts.

Power. Maximal vertical jump (VJ) was assessed using the Sargent Jump test protocol. For the Sargent Jump Test participants stood against a wall and brought one arm up (as is raising their hand for a question), initial reach was recorded. Participants jumped and placed a piece of double sided tape at the tip of their fingers at the peak height of jump. The difference was calculated by subtracting the initial reach height from the jumping reach height. Each participant performed 3 trials and the average was recorded.

Muscular Endurance. Muscular endurance was tested using a 1-minute push-up test and a 1-minute curl-up test. Participants performed push-ups on their knees, hands placed under their shoulders, and lower to a rolled up towel placed below on the ground. Repetitions will be counted and time was monitored. For the curl-up assessment, participants will lay in a supine position with knees bent. Participants were instructed to crunch up using hands to touch a marker on the floor to ensure the necessary contraction was achieved. Repetitions were counted and investigator monitored time.

$V0_2$ Peak. Each participant was measured for height and weight to ensure accuracy of testing and results and fitted with a HR monitor linked to the treadmill machine for monitoring. The exercise protocol should have caused fatigue in less than 12 minutes on a treadmill (Froelicher, 1974). Exercise initiation began once the participant felt comfortable with the mouthpiece, nose-clip, and the gas exchange tube connected to the monitor. TrueOne® 2400 Specifications were used on a Woodway treadmill to measure maximum O_2 consumption. Breath by breath analysis was taken and recorded every 15 seconds by Parvo Machinery and

averaged to acquire $V0_2$ and the maximum observed was understood to be the $V0_2$ Peak. Participants went through a Peake protocol, an eleven-stage protocol that increases first by speed, and then by incline during the final five stages. Using a GXT protocol on a treadmill, subjects performed at increasing intensity and grade for a maximum of 8-12 minutes at 2-minute stages (Luks, 2013). The first stage started at 6.2 mph and continued for 2 minutes, the second increased speed to 7.5mph, and increases continued until volitional fatigue.

Other

POMS. Mood was evaluated for each participant using the profile of mood states (POMS) standard form (MHS, North Tonawanda, NY). This analysis uses 65 adjectives for the participants to rate on a scale of 1 to 5-point Likert scale. Using POMS, researchers were able to assess 6 mood states: tension-anxiety, depression–dejection, anger–hostility, vigor–activity, fatigue–inertia, and confusion–bewilderment. The score was then subtracted from the sum to determine the score. A higher mood-disturbance score will indicate a greater mood disturbance. Internal consistency of POMS has been reported at 0.63 to 0.96 Cronbach alpha rating.

SPAS-7. Social physique anxiety was used to assess participants' relationship with their body in terms of social anxiety related to physique throughout the study. Participants were asked to take the Social Physique Anxiety Scale (SPAS-7) on each testing date, after resting metabolic rate testing, cardiovascular measures, and POMS assessments. This scale was developed by Hart, Leary, and Rejeski (1989) and originally consisted of 12-items. A seven-item test has since been validated by Scott, Burke, Joyner, and Brand (2004), using a test-retest method. This study found

single intraclass correlation values of 0.85 for men and 0.89 for women, as well as average intraclass correlation values of 0.92 and 0.94 respectively (Scott et al., 2004). Factorial validity and invariance of 7-item SPAS was established by Motl and Conroy (2001), internal consistency calculated to be 0.72.

***Overall Experience*.** Participants were asked one question at the end of the study, "when you think about your experience with training for competition, what comes to mind?" Answers were recorded by the lead researcher as an observation of initial reactions.

Resting Metabolic Rate. Analysis was completed in approximately 10 minutes using Medgem® Metabolic Testing (Microlife Medical Home Solutions, Inc, Golden, CO). Medgem has been clinically validated medical device cleared for measuring resting metabolic rate (Stewart, 2005). Participants were rested and comfortably seated in a reclined position. Participants breathed through a mouthpiece attached to the device and a nose clip will be worn to ensure a good seal. For the duration of the test, participants were instructed to remain as still as possible and to hold on to the device, resting an elbow on an armrest or pillow. Expired air was collected in intervals and calculated by Medgem, to determine resting metabolic rate.

Study Timeline

Week 1. Participants were recruited and scheduled for an initial meeting to discuss study requirements, set testing dates, and completed informed consent and health history questionnaire (HHQ). Researchers meticulously reviewed all HHQ

answers in order to determine that the participant meets all criteria. At the time, participants were able to voice any concerns prior to committing to the study.

Data collection 1, 3 & 6. Upon commencement of the study, each participant was required to report to the Human Performance Lab on weeks 1, 3, and 6, leading up to the anticipated competition date. Every testing session included performance assessments, cardiovascular measures, resting metabolic rate, body composition testing, POMS, SPAS-7, and overall experience questioning. Participants were required to turn in training logs at each testing session and complete MyFitnessPal logs at three intervals: baseline, week-3, and week-6. Participants were asked to report after an overnight fast for resting metabolic rate testing. As such, participants were allowed to bring food to each testing session, and asked to bring a similar meal to eat every testing session in attempt to ensure reliability. Participants are asked to bring food in order to ensure hunger did not negatively affect psychological measures that followed metabolic testing.

Throughout the course of the study, participants were asked to record daily macronutrient intake using the MyFitnessPal application. This was used to track changes in caloric intake throughout the course of contest preparation as well as to ensure that participants met the established criteria. Reporting of macronutrient intake was also used to determine differences in manipulation of intake throughout the course of contest preparation. Dietary recommendations were not provided to participants by the investigator.

CHAPTER 4

SUBJECTS AND DESIGN

Subject 1

Subject 1 is a 23 year old, white female, natural, amateur bodybuilder competing in her first bikini competition. This was a case study. This study was approved by the Georgia Southern University institutional review board (protocol #H16296). The subject was informed of all aspects of the study and signed an informed consent.

Diet and Exercise

Throughout the entire study, subject 1 consumed 5 meals per day at the beginning and 3 meals per day at the end, approximately spaced out by 3-4 hours. Subject kept to a macronutrient split of 43% carbohydrates, 37% protein, and 20% fat for the duration of the study. As subject 1 moved from week to week, caloric intake decreased by from 1,650 to 1,250 calories, maintaining the same macronutrient breakdown.

During the 6-weeks, subject 1 maintained resistance training 6 times each week, 1 high-intensity day of interval training (6 sprints of 30 seconds), and 3 days of low-intensity, steady-state, aerobic exercise. Aerobic exercise varied from beginning to end, starting with 20 minutes and finishing with 60 minutes in duration, each day. The resistance training consisted of targeting different muscle groups each training session.

When asked, "When you think about your experience with training for competition, what comes to mind?" Subject 1 responded by saying, "my experience has been good. There have been ups and downs but this process has changed the

way I think about my body. I have learned that food is an important tool and patience and consistency are key components to success in bodybuilding".

Cardiovascular measures, weight, body composition, resting metabolic rate, exercise performance, POMS, and SPAS results are presented in Table 1. Visual analysis showed changes in variables over time (Figures 1a-1d).

Table 1.

	Time Point			
Measure	**1**	**3**	**6**	**Difference**
Weight(kg)	56.14	54.2	52.8	-3.34
Body Composition (%)	23.4	22.4	21.9	-1.5
Resting Heart Rate (bpm)	63	55	50	-13
Resting Blood Pressure (mmHg)	115/58	115/55	110/50	
Resting Metabolic Rate	1110	1010	1000	-110
Vertial Jump (inches)	14	14	14.5	0.5
1RM Bench (lbs)	115	110	110	-5
1RM Squat (lbs)	205	205	200	-5
VO2 Max (ml/kg/min)	42.4	41.6	44.8	2.4
Push Up Test	56	52	50	-6
Curl Up Test	54	50	45	-9
Psychological POMS total mood disturbances (-32 to 200)	13	18	20	7
Tension-anxiety (0-48)	9	8	8	-1
Depression-dejection(0-28)	2	6	4	2
Anger-hostility (0-60)	2	1	5	3
Vigor-activity(0-28)	4	8	8	4
Fatigue-intertia (0-36)	10	8	9	-1
Confusion-bewilderment (0-32)	14	13	13	-1
SPAS (7 to 49)	19	14	14	-5

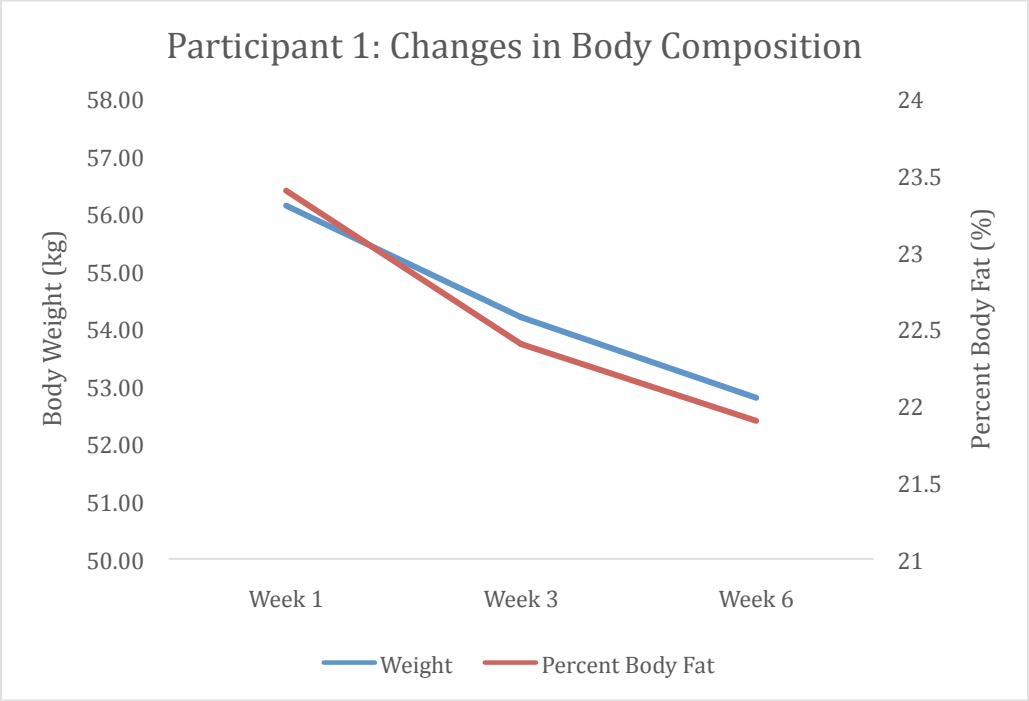
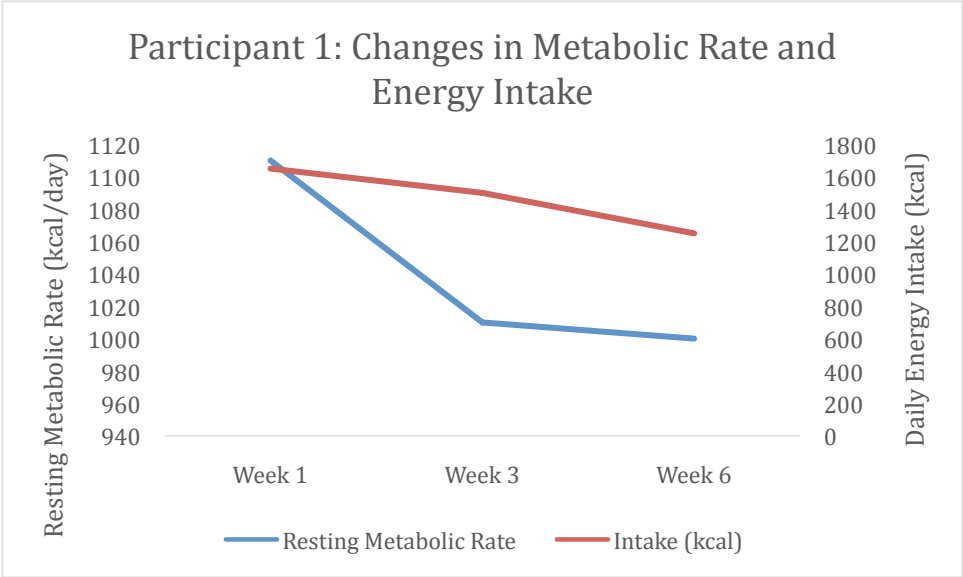


Figure 1a.



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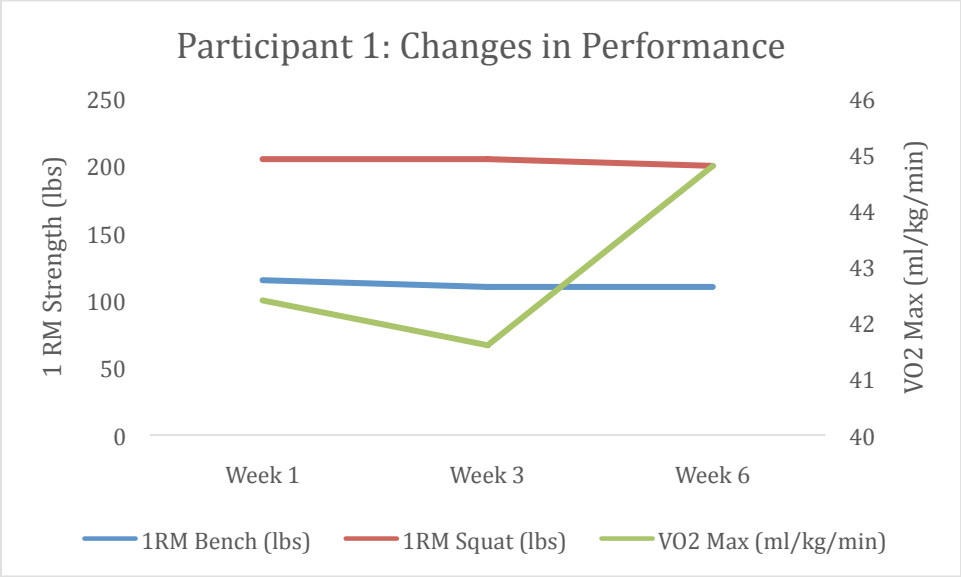

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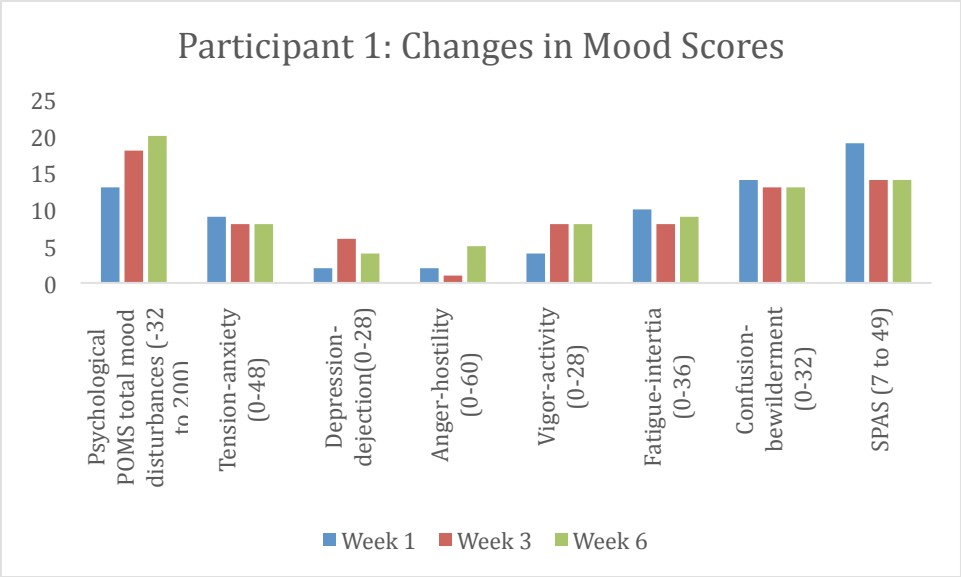


Figure 1d.

Subject 2

Subject 2 is a 25 year old, white female, natural, amateur bodybuilder competing in her first bikini competition. This was a case study. This study was approved by the Georgia Southern University institutional review board (protocol #H16296). Subject 2 was informed of all aspects of the study and signed an informed consent.

Diet and Exercise

Throughout the entire study, Subject 2 consumed 3-5 meals per day, approximately spaced out by 3-5 hours. Subject 2 kept to an approximate macronutrient split of 40% carbohydrates, 35% protein, and 25% fat for the duration of the study. As Subject 2 moved from week to week, caloric intake decreased from 1,800 to 1,550 calories to achieve her ideal weight change and desired figure. Subject 2 did not always track intake, and used and intuitive eating approach.

During the 6-weeks, subject 2 resistance trained 4 times each week and 2 (at week 1) to 6 days (at week 6) of low-intensity, steady-state, aerobic exercise. Aerobic exercise varied from beginning to end, starting with 20 minutes and finishing with 60 minutes in duration, each day. The resistance training consisted of targeting different muscle groups each training session.

When asked, "When you think about your experience with training for competition, what comes to mind?" Subject 2 responded by saying, "I enjoyed this process and everything got easier as I started seeing more results. I plan to do it again, but to improve from what I have learned about my body and this process since it is my first competition prep. I was constantly tired which was the most difficult part of the process."

Cardiovascular measures, weight, body composition, resting metabolic rate, exercise performance, POMS, and SPAS results are presented in Table 2. Visual analysis showed changes in variables over time (Figures 2a-2d).

Table 2.

	Time Point			
Measure	**1**	**3**	**6**	**Difference**
Weght (kg)	51.57	50.52	50.2	-1.37
Body Composition (%)	17.6	16	15.6	-2
Resting Heart Rate (bpm)	68	65	63	-5
Resting Blood Pressure (mmHg)	115/57	110/50	110/48	
Resting Metabolic Rate	1270	1280	1300	30
Vertial Jump (inches)	12.5	12.5	12	-0.5
1RM Bench (lbs)	80	85	85	5
1RM Squat (lbs)	210	210	205	-5
VO2 Max (ml/kg/min)	39.3	38.7	43.4	4.1
Push Up Test	39	38	38	-1
Curl Up Test	56	55	56	0
Psychological POMS total mood disturbances (-32 to 200)	-2	3	12	14
Tension-anxiety (0-48)	2	0	2	0
Depression-dejection(0-28)	5	4	7	2
Anger-hostility (0-60)	0	1	0	0
Vigor-activity(0-28)	3	5	10	7
Fatigue-intertia (0-36)	2	3	4	2
Confusion-bewilderment (0-32)	14	10	11	-3
SPAS (7 to 49)	9	10	12	3

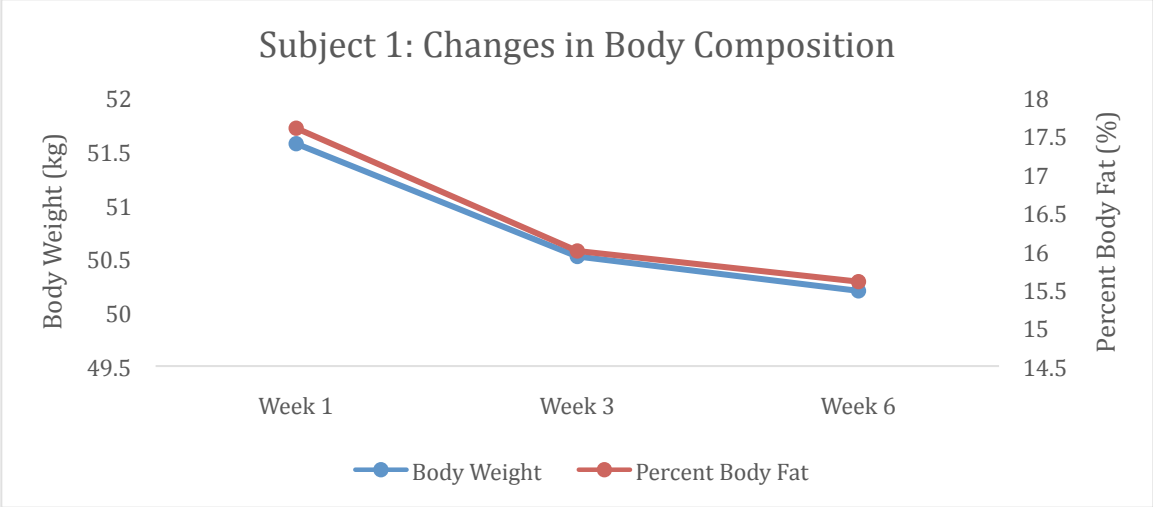
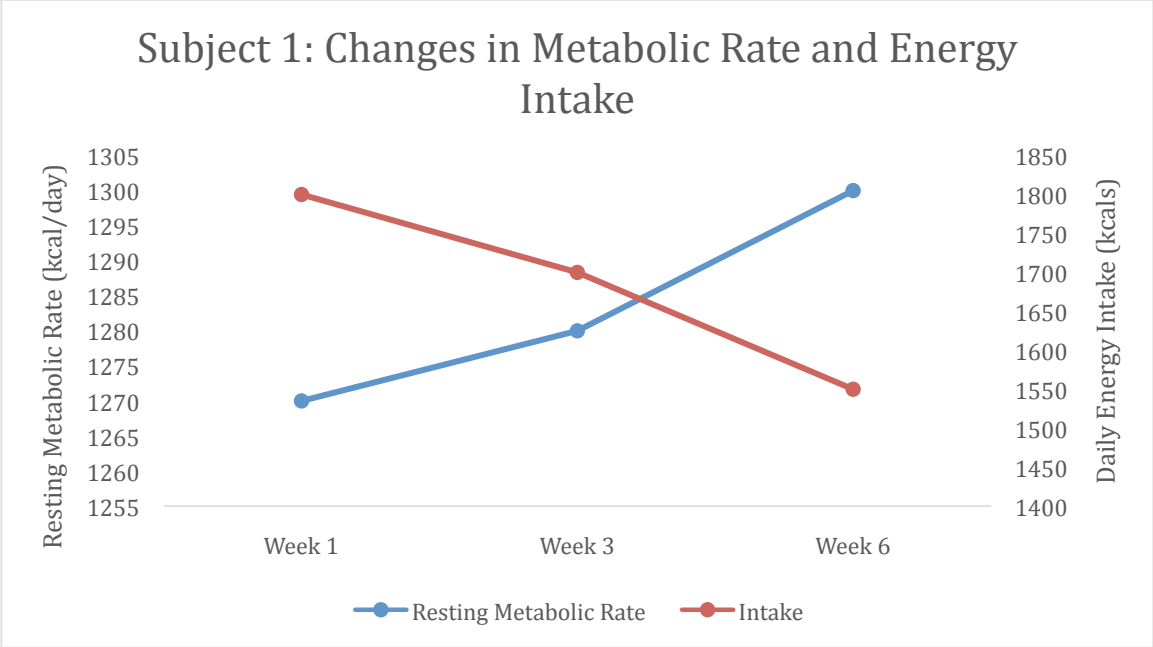


Figure 2a.



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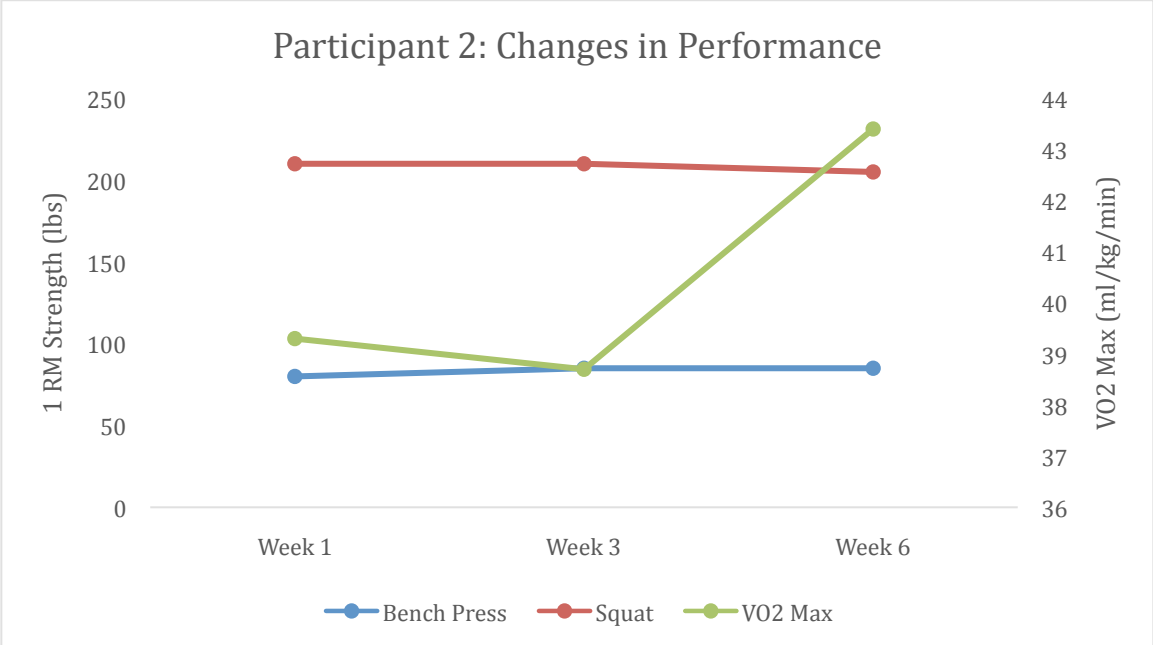

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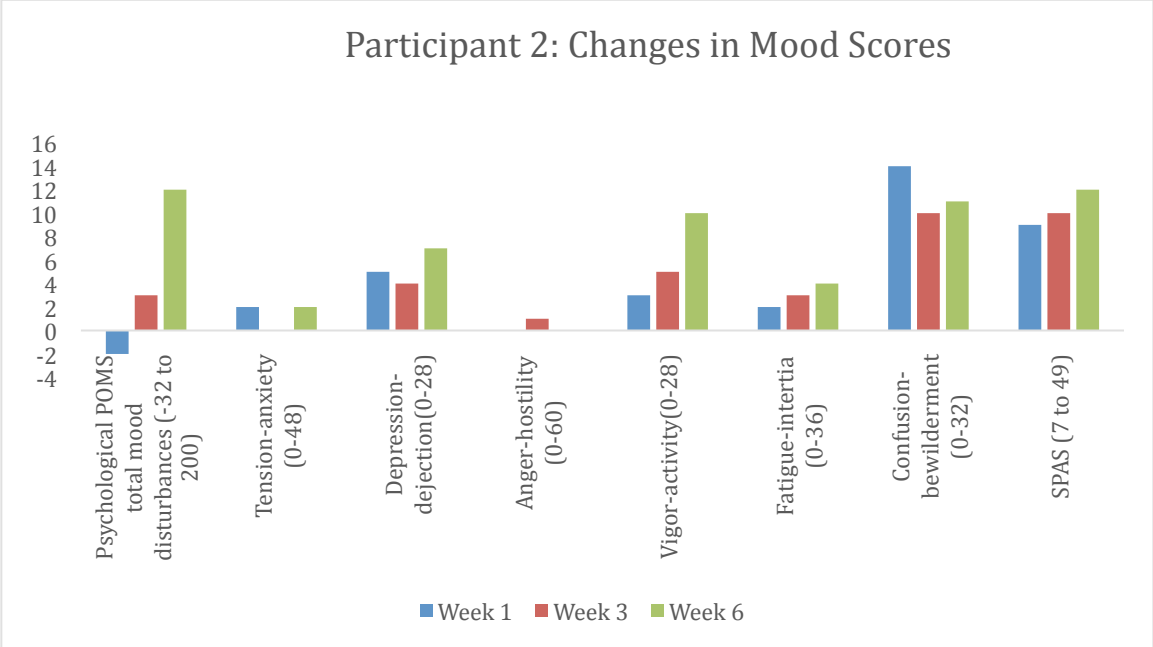

Figure 2d.

Subject 3

Subject 3 is a 29 year old, white female, natural, amateur bodybuilder competing in her third figure competition. This was a case study. This study was approved by the Georgia Southern University institutional review board (protocol #H16296). Subject 3 was informed of all aspects of the study and signed an informed consent.

Diet and Exercise

Throughout the entire study Subject 3 consumed 5 meals per day, approximately spaced out by 3-4 hours. Subject 3 kept to a macronutrient split of 50% carbohydrates, 30% protein, and 20% fat at the start of the study, and adjusted to 38% carbohydrates, 43% protein, and 19% fat at the end of the 6 weeks (closer to competition). As Subject 3 moved from week to week, carbohydrate intake decreased by 10-15 grams and fat decreased by 0-5 grams, as needed to achieve her

ideal weight change and desired figure. Starting at 2,100 and ending at 1,500 calories per day.

During the 6-weeks, Subject 3 maintained resistance training 5 times each week and taught fitness classes 5 hours each week. Additionally, 2 days of low-intensity, steady-state, aerobic exercise (at week 1) and 6 days (at week 6) were used to increase the energy deficit each week. Aerobic exercise duration varied from beginning to end, starting with 30 minutes and finishing with 45 minutes in duration, each day. Resistance training consisted of targeting different muscle groups each training session. In week 6 of data collection, subject 3 sustained a foot injury keeping her from performing final performance measures.

When asked, "When you think about your experience with training for competition, what comes to mind?" Subject 3 responded by saying, "Since this was my third prep, I knew what I was getting into. This one was much better than the previous ones because I know my body better and I know what works and what doesn't for me. It was much more enjoyable and I feel good."

Cardiovascular measures, weight, body composition, resting metabolic rate, exercise performance, POMS, and SPAS results are presented in Table 3. Visual analysis showed changes in variables over time (Figures 3a-3d).

Table 3.

	Time Point			
Measure	**1**	**3**	**6**	**Difference**
Weight (kg)	67.36	67.39	66.52	-0.84
Body Composition (%)	12.6	12.3	11.6	-1
Resting Heart Rate (bpm)	68	65	65	-3
Resting Blood Pressure (mmHg)	110/50	95/50	95/48	
Resting Metabolic Rate	1340	1330	1300	-40
Vertial Jump (inches)	17.5	20	19.5	2
1RM Bench (lbs)	155	155	150	-5
1RM Squat (lbs)	215	220	200	-15
VO2 Max (ml/kg/min)	46.7	47	41.8	-4.9
Push Up Test	75	60	58	-17
Curl Up Test	83	80	80	-3
Psychological POMS total mood disturbances (-32 to 200)	-21	-5	8	29
Tension-anxiety (0-48)	2	8	1	-1
Depression-dejection(0-28)	1	1	4	3
Anger-hostility (0-60)	0	4	1	1
Vigor-activity(0-28)	0	1	13	13
Fatigue-intertia (0-36)	2	5	6	4
Confusion-bewilderment (0-32)	26	24	17	-9
SPAS (7 to 49)	8	7	7	-1

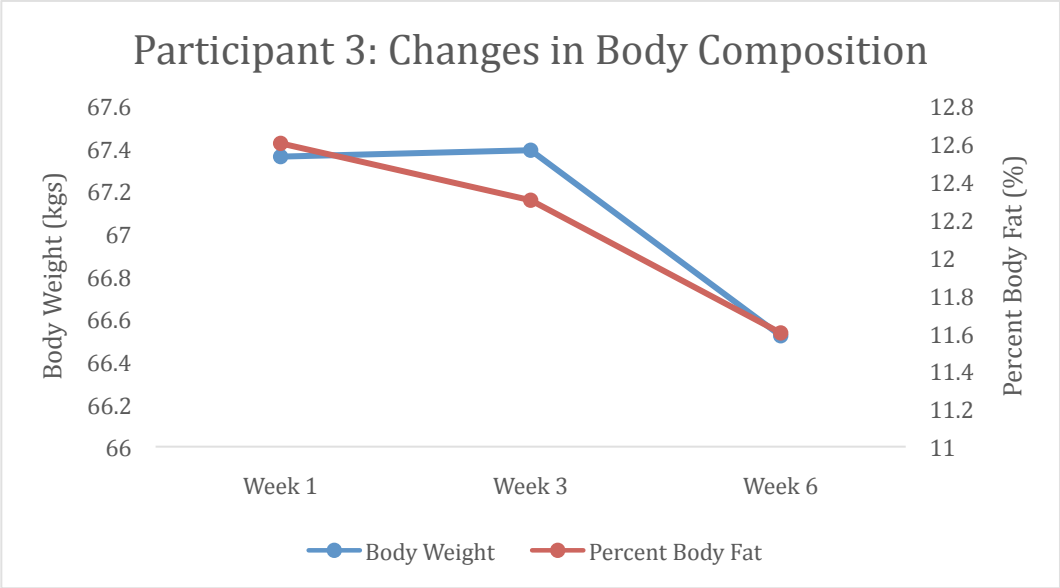

Figure 3a.

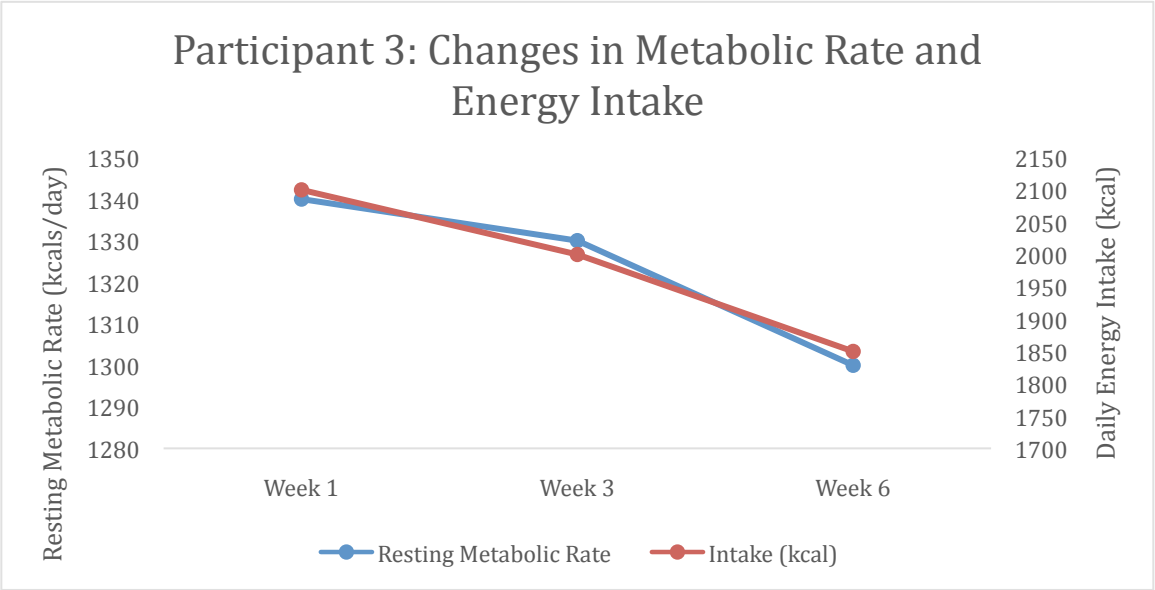

Figure 3b.

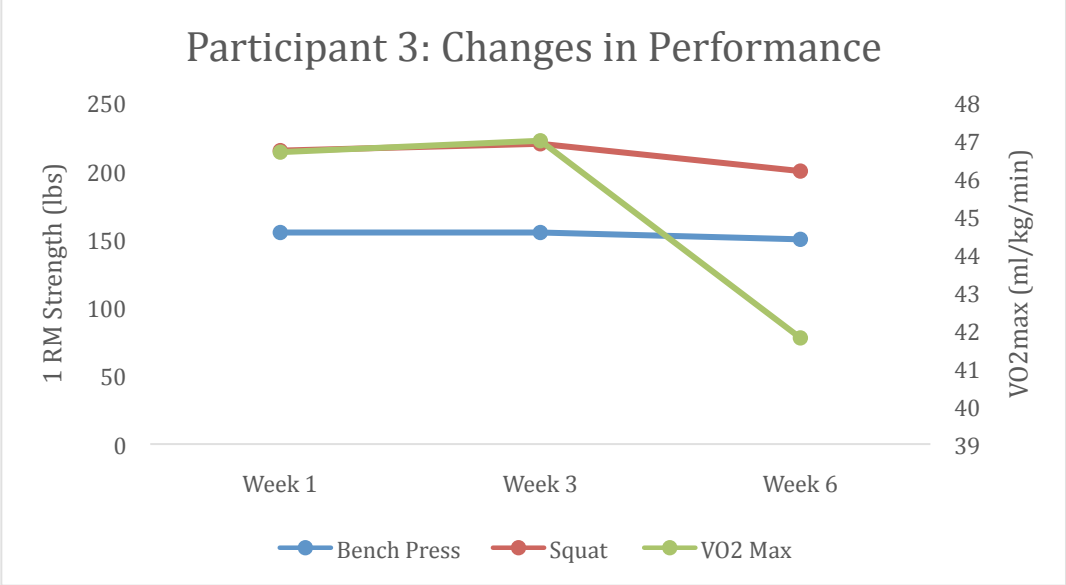

Figure 3c.

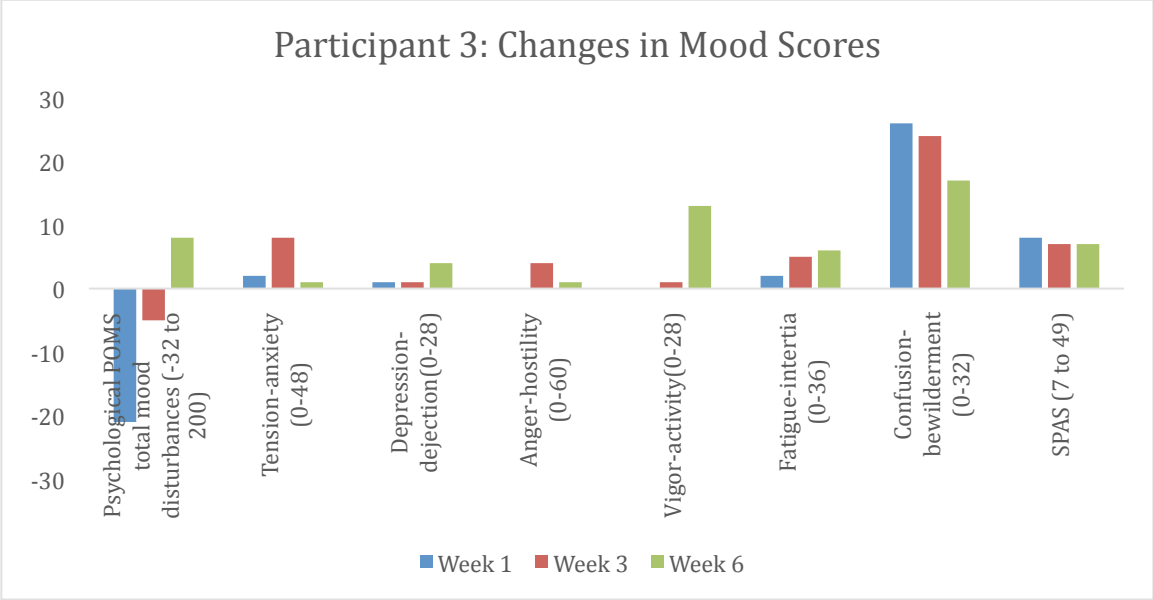

Figure 3d.

Subject 4

Subject 4 is a 24 year old, African American female, natural, amateur bodybuilder competing in her first figure competition. This was a case study. This study was approved by the Georgia Southern University institutional review board (protocol #H16296). Subject 4 was informed of all aspects of the study and signed an informed consent.

Diet and Exercise

Throughout the entire study, Subject 4 consumed 3-4 meals per day and two snacks, approximately spaced out by 2-4 hours. Subject 4 kept to a macronutrient split of 45% carbohydrates, 35% protein, and 20% fat at the start of the study, and adjusted to 30% carbohydrates, 48% protein, and 22% fat at the end of the 6 weeks (closer to competition). As subject 4 moved from week to week, caloric intake

decreased by 50-100 calories as needed to achieve her ideal weight change and desired figure.

During the 6-weeks, subject 4 maintained resistance training 6 times each week. Additionally, subject engaged in low-intensity, steady state, aerobic exercise daily. Aerobic exercise duration varied from beginning to end, starting with 30 minutes and finishing with 90 minutes in duration, each day. The resistance training consisted of targeting different muscle groups each training session.

When asked, "When you think about your experience with training for competition, what comes to mind?" Subject 4 responded by saying, "I feel good about what I have been able to accomplish. I was dedicated, patient, and devoted in all areas of my lifestyle while preparing for my competition. I would definitely consider doing another show to further test my boundaries, mentally and physically."

Cardiovascular measures, weight, body composition, resting metabolic rate, exercise performance, POMS, and SPAS results are presented in Table 4. Visual analysis showed changes in variables over time (Figures 4a-4d).

Table 4.

	Time Point			
Measure	**1**	**3**	**6**	**Difference**
Weight (kg)	57.96	57.48	57.3	-0.66
Body Composition (%)	22.7	21.6	20.3	-2.4
Resting Heart Rate (bpm)	62	54	52	-10
Resting Blood Pressure (mmHg)	117/58	105/50	105/50	
Resting Metabolic Rate	1140	1300	1290	150
Vertial Jump (inches)	15.5	15	N/A	
1RM Bench (lbs)	90	90	90	0
1RM Squat (lbs)	180	175	N/A	
VO2 Max (ml/kg/min)	47.9	47.2	N/A	
Push Up Test	54	43	44	-10
Curl Up Test	69	68	68	-1
Psychological POMS total mood disturbances (-32 to 200)	0	12	17	17
Tension-anxiety (0-48)	3	6	0	-3
Depression-dejection(0-28)	1	5	6	5
Anger-hostility (0-60)	0	1	1	1
Vigor-activity(0-28)	7	10	7	0
Fatigue-intertia (0-36)	7	8	16	9
Confusion-bewilderment (0-32)	18	18	13	-5
SPAS (7 to 49)	16	15	13	-3

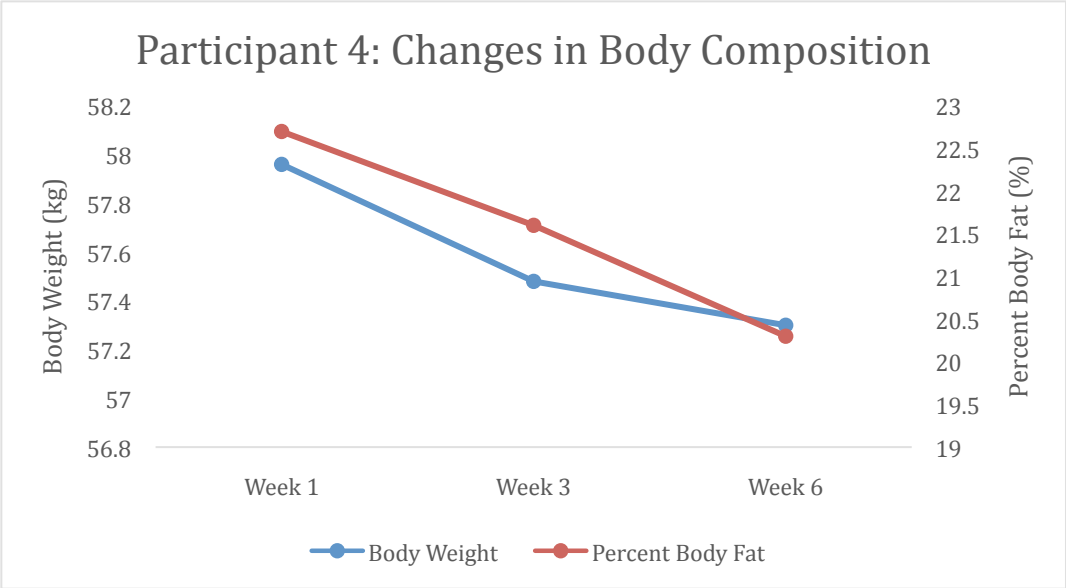

Figure 4a.

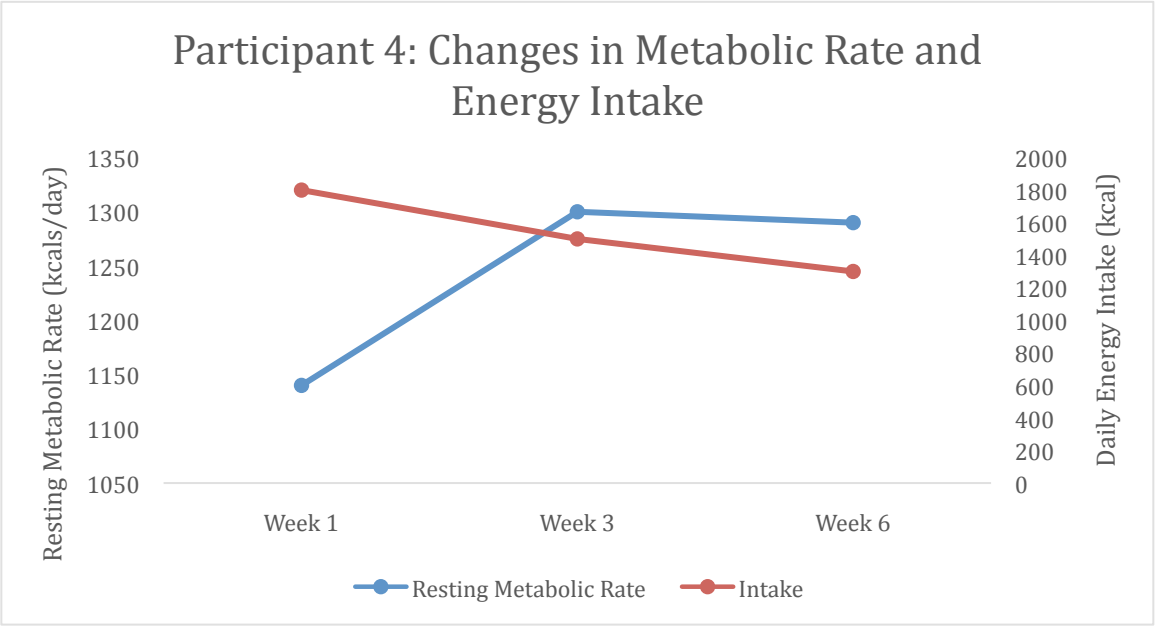

Figure 4b.

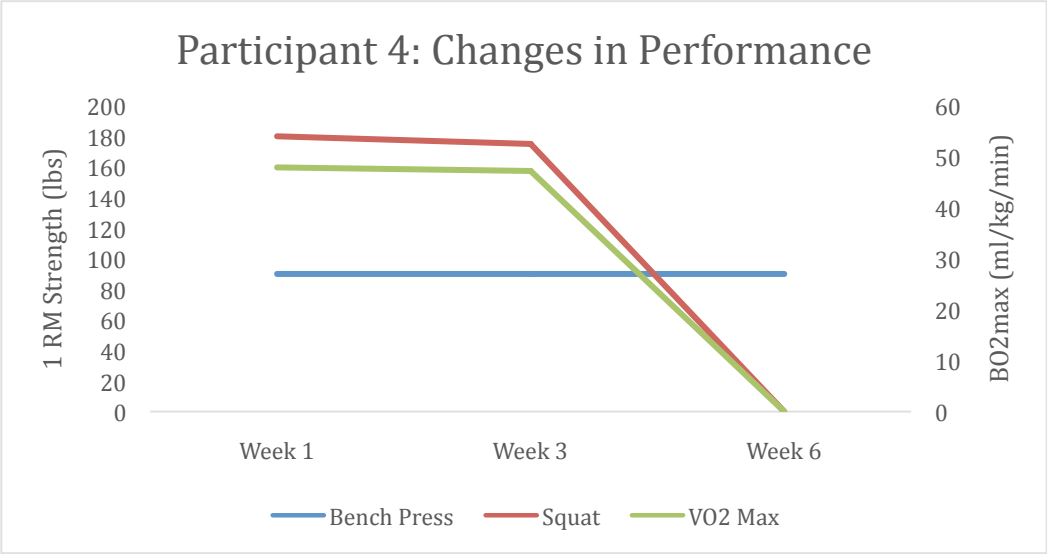

Figure 4c.

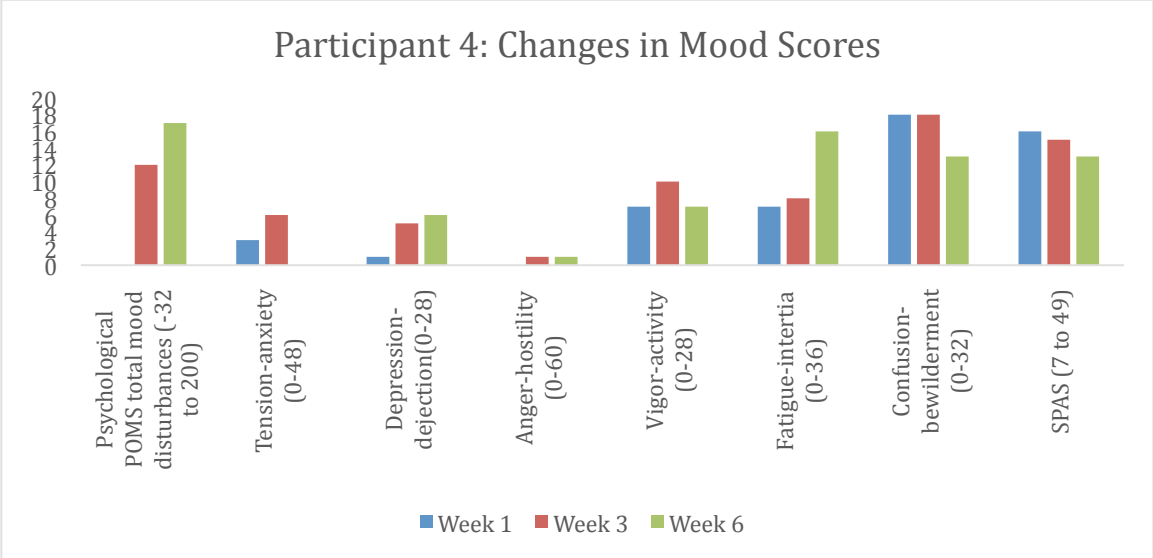

Figure 4d.

CHAPTER 5

DISCUSSION

This study provides a comprehensive profile of the psychological and physiological changes observed of four female, natural bodybuilders. Each experienced different training and nutritional strategies and as a reflection, displayed very individualized results. At the start of the competition preparation for each athlete, it was understood that gaining muscle was not a priority or plausible due to a state of caloric deficit. The intention of this period was strictly to reduce fat-mass and maintain fat-free mass. In doing so, competitors took a long-term approach, minimally reducing caloric intake and increasing exercise volume over time.

Body Composition. Each subject in this case study experienced weight loss and reduced body fat percentages. Subject 1 (-3.34kg, 23.4 to 21.9% BF), Subject 2

(-1.37kg, 17.6 to 15.6% BF), Subject 3 (-0.66kg, 22.7 to 20.3% BF), and Subject 4 (-0.84 kg, 12.0 to 11.6% BF) each utilized different approaches to achieve their weight loss goals. Previous research monitoring this population has observed similar changes in body composition. Hayward et al. (1989) compared anthropometric data, body composition, and nutritional profiles for nine female and nine male bodybuilders during different stages of training. Significant weight loss was observed for men (-5.4kg) and women (-6.0kg), as a result of increased training and reduced intake. Kistler et al (2014) also recorded similar weight loss in a case study observing a male, natural bodybuilder during a 26-week competition preparation (88.6kg to 73.3kg, 17.5 to 7.4%).

Resting Metabolic Rate. Each subject observed a change in resting metabolic rate during the 6-week period. Subject 1 (1110 to 1000) and Subject 4 (1340 to 1300) observed a reduced rate, while Subject 2 (1270 to 1300) and Subject 3 (1140 to 1290) observed an increased rate. Metabolic response to food deprivation was monitored in a study by Dulloo and Jacquet (1998). Similar to results observed here, they found a positive and significant relationship between the reduction of thermogenesis and the degree of fat loss during the semi-starvation and refeeding phases was found, suggesting that in response to weight loss, the human body attempts to conserve energy resulting in reduced RMR. In a study using fifteen obese men and twenty obese females, researchers monitored the existence of adaptive thermogenesis during prolonged energy restriction over a 15-week period (Doucet, St-Pierre, and Almeras, et al., 2001). Results showed that resting energy expenditure (REE) drastically declined two weeks into the energy restriction by 469

and 635 KJ/d for men and women, respectively. By week 8, REE declined by 963 and 614 KJ/d for men and women, respectively. Though the current study did not observe such definitive results, it brings further interest to the subject of adaptive metabolic response during this calorie-restricted period.

Exercise Performance. Despite the slow weight-loss tactics employed, strength was similarly compromised for upper body (bench press) and lower body (squat). During testing for 1RM, Subject 1 and Subject 4 were unable to reach their initial maximum bench press (-9.5% and -8.2%, respectively), while Subject 2 exceeded initial upper body strength by 6.5%. In addition, all subjects also performed submax lower body squat over time. Subject 1 experiences a loss of 5lbs (205 to 200lbs), Subject 2 experiences similar (210 to 205bs), Subject 3 decreased by 15lbs (215 to 200lbs), and Subject 4 performed a submax by 5lbs (180 to 175). These results have also been observed in similar studies. Notably, Rossow et al. (2013) monitored a male, natural bodybuilder during the six months prior to competition and witnessed significant decreases in upper body strength (-8.4%). The decrease in strength was accompanied by an increase in fatigue, as determined by the profile of mood states (POMS) assessment. As body mass decreased, power (vertical jump), muscular endurance, and VO_{2Peak} did not greatly change, however a small amount of change was observed in all fields, excluding $VO_{2Peak.}$ Due to increased cardiovascular exercise over time, it is not surprising that this may have been observed.

Cardiovascular Measures. In this study, Subject 1 (63 to 50bpm, 115/58 to 110/50 mmHg), Subject 2 (68 to 63bpm, 115/57 to 110/48), Subject 3 (62 to 52

bpm, 117/58 to 105/50 mmHg) and Subject 4 (68 to 65, 110/50 to 95/48 mmHg) observed changes from baseline to week-6. Decreases in resting heart rate were minimal compared to previous studies observing male competitors (Rossow, et al 2013) where the subject's heart rate was 53 beats/min (initially) and dropped significantly to 27 beats/min in the final days leading to competition. Brachial blood pressure also decreased from baseline at 132/69mmHg to, at its lowest, 103/63 mmHg. These decreases in cardiovascular measures were measured over the course of six months. In another study by Robinson et al. (2015) a male partaking in a competition preparation period observed a baseline resting heart rate of 54 beats per minute and after 13 weeks declined to 37 beats per minute. Results of this study are consistent with previous studies monitoring male athletes.

***Psychological Parameters*.** From baseline to week-6, subjects observed an increase in POMS mood disturbances and a reduction in the assessment of social physique anxiety (SPAS). Most change in the POMS assessment occurred in the vigor-activity and fatigue-inertia subscales. These results are similar to that found in previous literature. Rossow et al. (2013) observed that total mood disturbances increased greatly in the fatigue-inertia and tension-anxiety subscale, accompanied with a decrease in the vigor-activity subscale. These results reflect the results of the POMS assessment. However, the participant reported that he enjoyed the preparation and that he felt excited for the competition, concluding that mood disturbances were experienced during the training and preparation. Quite similarly, this study observed increases in mood disturbances from beginning to end, especially in the subcategories of vigor-activity. Not all subjects experienced similar

states of mood or social physique anxiety. This is a reflection of individual variance and differences expected with each strategy and approach to preparing for a bodybuilding competition. Social physique anxiety (SPAS) for all subjects changed from beginning to end. Subject 1 (-5), Subject 3 (-1), and Subject 4 (-3) experiences a decrease in SPAS while Subject 2 (+3) felt more anxiety related to physique. Though all subjects explained that they enjoyed the process and would do it again it can be speculated that this process is challenging mentally and physically, but overall rewarding. Further research identifying the psychological response in relation to sacrifice and reward would increase the understanding of this population.

STRENGTHS AND LIMITATIONS

The ability to observe female bodybuilders as they prepare for a bodybuilding competition had yet to be done, so this is a true strength of this study. The small sample size in this case study allowed for a large range of tests to observe as many changes, both psychologically and physiologically, as possible in this difficult-to-study population. A limitation of this study is the length of data collection and observation. More time would have allowed a clearer picture of psychological and physiological changes.

DELIMITATIONS

Subjects utilized for this study were required to pass a Health History Questionnaire (Appendix A) and were recruited by word of mouth in the Statesboro, Georgia area.

PRACTICAL APPLICATIONS

As very little research and observations have been done on this population, this study provides evidence to some of the changes that occur during this unique experience.

CHAPTER 6

CONCLUSION

This study provides a thorough documentation of the changes observed in four subjects during the preparation phase of a natural bodybuilding competition. Subjects experienced a variety of changes from the start (baseline) of the study to the end (week 6). Including decreases in body mass, fat mass, performance markers and increases in mood disturbances (POMS) for all subjects. Contrasts in data between subjects may be a result of differences in training methods and dieting programs. Most of the changes that occurred are similar to what can be expected during a period of reduced caloric intake and increased caloric output.

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APPENDIX A

HEALTH HISTORY QUESTIONNAIRE

Name _____ Date_____

Preferred Method of Contact_____

Person to contact in case of emergency_____

Emergency Contact Phone _____ Birthday (mm/dd/yy)____/_____/_____

Personal Physician _____Physician's Phone_____

Gender _____Age _____(yrs) Height _____(ft)_____(in) Weight_____(lbs)

A. HEALTH STATUS

1. Have you ever had a definite or suspected heart attack or stoke?.....Yes No

2. Have you ever had coronary bypass surgery or any other type of heart surgery?....Yes No

3. Do you have any other cardiovascular or pulmonary (lung) diseases?.....Yes No
(*other than* asthma or allergies)

4. Do you have a history of: diabetes, thyroid, kidney, liver disease?.....Yes No
(circle all that apply)

5. Have you ever had an abnormal resting or exercise (treadmill) electrocardiogram (EKG)?.....Yes No

If you answered Yes to any of Questions 1-5, please describe:

_____

_____

_____

6. Are you pregnant or have been in the last year?.....Yes No

7. Do you currently smoke cigarettes or have quit within the past 12 months?.....Yes No

8. Have you taken banned or anabolic androgenic substances within the last seven years……..Yes No

*This includes clostebol, fluoxymesterone, metandienone, metenolone, nandrolone, stanozolo, testosterone, growth hormone, erythroropoietin cortocotropin, chorionic gonadotrophin, ephedrine, amineptine, mesocarb, pipradol, anavolic steroids, beta2-agonists, and related substances

9. Do you currently have any of the following:

a. Pain or discomfort in the chest or surrounding areas that occurs when you engage in physical activity? ……..Yes No

b. Shortness of breath? ……..Yes No

c. Problems with bones, joints, or muscles that may be aggravated with exercise?……..Yes No

d. Back or neck problems?.....Yes No

If you answered Yes to any of questions 6-9, please describe:

_____

_____

_____

B. CURRENT MEDICATION USAGE (List the drug name and the condition being managed)

MEDICATION ***CONDITION***

_____

_____

_____

C. FAMILY HISTORY (✓Check if any of your blood relatives . . . parents, brothers, sisters, aunts, uncles, and/or grandparents . . . have or had any of the following)

( ) Heart Disease
( ) Heart Attacks or Strokes (prior to age 50)
( ) Elevated Blood Cholesterol or Triglyceride Levels
( ) High Blood Pressure
( ) Diabetes
( ) Sudden Death (other than accidental)

I have answered the Health History Questionnaire questions accurately and completely. I understand that my medical history is a very important factor in determining my eligibility to participate in this study. I understand that certain medical or physical conditions, which are known to me, but that I do not disclose, may result in serious injury to me. If the above conditions change, I will immediately inform the lead investigator to those changes. I, knowingly and willingly, assume all risks of injury resulting from my failure to disclose accurate, complete, and updated information. The lead researcher also verbally explained this statement to me to my understanding.

_____

Participant Signature Date

_____

Investigator Signature Date

APPENDIX B

7-item Social Physique Anxiety Scale
(Hart, Leary, & Rejeski, 1989)

The following questionnaire contains statements concerning your body physique or figure. By physique or figure we mean your body's form and structure; specifically, body fat, muscular tone, and general body proportions.

Instructions: Read each item carefully and indicate how characteristic it is of you according to the following scale.

1 = Not at all characteristic of me
2 = Slightly characteristic of me
3 = Moderately characteristic of me
4 = Very characteristic of me
5 = Extremely characteristic of me

_____ 1. I wish I was not so up-tight about my physique or figure.

_____ 2. There are times when I am bothered by thoughts that other people are evaluating
my weight or muscular development negatively.

_____ 3. Unattractive features of my physique/figure make me nervous in certain social settings.

_____ 4. In the presence of others, I feel apprehensive about my physique or figure.

_____ 5. I am comfortable with how fit my body appears to others.

_____ 6. It would make me uncomfortable to know others were evaluating my physique/figure.

_____ 7. When it comes to displaying my physique or figure to others, I am a shy person.

Scoring:
The 7-item SPA scale measures the extent to which one feels anxiety relating to body image/physique perceptions in social situations. Each item is scored on a Likert-type scale from *1 (not at all characteristic of me)* to *5 (extremely characteristic of me).* Responses are then summed to calculate an overall score ranging from 7-49, with higher scores indicating higher levels of SPA. Note that item 5 is reverse scored.

APPENDIX C

Profile of Mood States (POMS) Assessment

This questionnaire (link below) consisted of 65 adjectives in which the subject described, on a scale, how they had been on testing day as well as the week leading to testing.

http://www.brianmac.co.uk/poms.htm