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THE DIETARY INTAKE OF MALE AND FEMALE BODYBUILDERS DURING COMPETITION PREPARATION

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THE DIETARY INTAKE OF MALE AND FEMALE BODYBUILDERS DURING COMPETITION PREPARATION

BY

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ABSTRACT

Background The growing popularity of the sport of bodybuilding has led to the creation of new categories such as men's physique, classic physique, figure, fitness, and bikini where little is known of the dietary strategies of these newer divisions. The primary aim of this study was to assess the kcal and macronutrient intake of bodybuilders during three time points of competition preparation and distinguish these strategies between divisions.

Methods This observational cross-sectional study consisted of one hundred forty-five participants (90 men aged 31.5 $\pm$ 8.9 and 55 women aged 31.7 $\pm$ 7.4). Participants completed a modified version of the Dietary Assessment of a Natural Bodybuilding Population Questionnaire which has been used in previous research assessing diet during three time points. At each time point, participants recorded dietary intake over a 24-hour period. Participants were categorized according to their competitive division and grouped together for dietary analysis (Bodybuilding: BB, Men's Physique: MP, and Women's Divisions: WD). Kcal and macronutrient analysis was performed using MyFitnessPal. Repeated measures analysis of variance (ANOVA) was used to examine and compare the kcal and macronutrient intake expressed in grams and g/kg bodyweight between competitive divisions during the three time points of competition preparation. Significance was set at $p \leq 0.05$.

Results Mean kcal and macronutrient intake in all groups significantly decreased from the initial to end time period ($p \leq 0.05$). Mean kcal intake of BB was significantly greater than MP and WD at all time periods ($p \leq 0.05$). Mean kcal intake of MP was significantly greater than WD at all time periods ($p \leq 0.05$). Mean CHO

intake of BB was significantly greater compared to MP and WD at all time points ($p \leq 0.05$). Mean CHO intake of MP was significantly greater compared to WD only at the initial time point of competition preparation ($p \leq 0.05$). Mean PRO intake of BB was significantly greater than WD at all time points ($p \leq 0.05$). Also, mean PRO intake of MP was significantly greater than WD at all times points ($p \leq 0.05$). Fat (g/kg BW) intake was significantly greater in BB compared to WD at all time points ($p \leq 0.05$).

Conclusions Competitors in the bodybuilding division consumed a greater amount of kcals and carbohydrates throughout the entirety of competition preparation compared to other divisions. Greater kcal and carbohydrate intake could theoretically be contributed to greater muscle mass and starting weight as different divisions place different expectations on competitors. To the best of our knowledge, this is the first study to differentiate dietary strategies between competitive divisions. However, future research is needed to increase generalizability for all divisions.

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Bodybuilding is the process of developing the musculature of the body through specific types of resistance training and dietary strategies, especially for competitive exhibition (7). During bodybuilding competitions, bodybuilders appear in lineups and perform specified poses for a panel of judges who rank them based on muscle mass, symmetry, stage presentation, and overall physical aesthetics (19). During competition preparation, bodybuilders typically consume a high protein and caloric restricted diet with the aim of achieving drastic reductions in body fat while maintaining their lean body mass (7).

The growing popularity of the sport of bodybuilding has led to the creation of new categories such as men's physique, classic physique, figure, fitness, and bikini (22). These newer categories have different lean and muscularity ideals for stage presentation. For example, the Mr. Olympia competition introduced a new category for men in 2013, one that aims to attract competitors with less extreme physiques (22). In the bodybuilding division, competitors aim to achieve maximum lean body mass, muscularity, and vascularity (having many prominent superficial veins) with body fat percentages ranging from 2-6% for men and 6-11% for women (14). On the contrary, competitors in newer divisions such as men's physique, aim to present a high level of muscularity and lean body mass but not as much as bodybuilders with moderate vascularity objectively determined by low body fat and low retained water, typically

falling between a body fat range of 4-9% (14). These guidelines are the same for women in the newer divisions of figure and fitness, however these competitors typically range from 8-15% body fat (14). On the other hand, the bikini division is judged by the most subjective rules where competitors aim to reach a moderate level of muscularity with some leanness and little vascularity ranging between 8-15% body fat (14). Furthermore, greater participation in bodybuilding competitions has been associated with more women within the newer categories (22).

The data in the sport of traditional bodybuilding have revealed that higher placing bodybuilders followed a high-protein and low-fat diet and consumed more carbohydrates than their less successful peers (4). However, there is insufficient quantities of research on bodybuilders (4). While a meta-analysis combined 18 separate studies on the dietary intake of traditional bodybuilders, the majority of the studies were published in the 1980s and 1990s and were non-specific about participants' divisions and phase of competition preparation (22). This review provides insights into dietary practices of competitive bodybuilders such as the carbohydrate intakes were below and protein intakes were above the current recommendations for strength athletes in men (22). Additionally, the most commonly reported dietary supplements were protein powders or liquids (22). However, the studies failed to provide details on the rationale for different dietary intakes and the authors acknowledged the need for further investigation into the topic (22). This review demonstrated that the literature on the dietary practices of bodybuilders during competition preparation is dated and of poor quality (22).

While there is limited research on the newer divisions in the sport of bodybuilding, there is some research examining nutrient intakes for bodybuilders (1). Current peer-reviewed recommendations are that caloric intake should be set at a level that results in bodyweight reduction of approximately 0.5 to 1% per week to maximize muscle retention (5). This caloric intake has been associated with bodybuilders responding best to consuming 2.3-3.1 g/kg of lean body mass per day of protein, 15-30% of calories from fat, and the remainder of calories from carbohydrate (7). Additionally, eating four to six meals per day each containing 0.4-0.5 g/kg bodyweight of protein is likely to maximize any benefits from nutrient timing and frequency (17). Although suggestions exist for nutrient intakes (10), these recommendations are not specific to the different competitive divisions and are open to interpretation (9). In conjunction, these dietary practices employed by bodybuilders in the newer categories have not been scrutinized (9).

In addition to a paucity of research concerning dietary strategies between competitive divisions, current data on bodybuilding are disproportionately focused on men and not women (1). Also, macronutrient intake may be different between categories due to various reasons including body composition and overall competitive goal (1). The majority of studies fail to provide detailed information on the dietary strategies during competition preparation and the most prevalent peaking strategies used by bodybuilders are unreported in the current literature (14). Consequently, evidence exists that a number of dietary strategies used by bodybuilders may be detrimental to health such as water restriction and electrolyte manipulation and that

these practices are increasingly becoming more popular (7), further highlighting the need to examine this association between the newer competitive divisions.

Although traditional bodybuilding has developed over the years and there is some research, many dietary strategies of modern bodybuilders lack scientific scrutiny, especially during competition preparation (3). Most information on the topic is anecdotal, with limited research about the nutritional habits of modern bodybuilders from newer categories (12). The lack of research on the practices employed within the newer divisions, may mislead bodybuilders as to what the most effective strategies are for competition preparation (3). One area that is unexplored is the breakdown and comparison of macronutrient intake, fluid intake, supplementation, and peaking strategies between the newer competitive divisions (12).

In the week prior to competition, bodybuilders employ tapering strategies for the body in attempt to maximize their competition day aesthetics (2). Known as "peak week" these strategies involve the manipulation of macronutrients, electrolytes, water, and exercise (2). The main goals of "peak week" are to maximize glycogen stores by optimally storing carbohydrates within muscle tissue, minimize subcutaneous fat, and minimize abdominal bloating via fiber restriction (2). However, different competitive divisions place different expectations on the athlete, which is likely to influence competition preparation and peaking strategies (18). These variables include the amount of carbohydrates consumed during peak week, nutrient timing, and water restriction (2).

There is no research of the comparison in these dietary strategies between the newer divisions in the sport of bodybuilding (5). Primarily, the current research is

restricted to small cross-sectional or case studies (5). Additionally, there is a lack of large-scale studies on competitive bodybuilders (7). The small number of participants does not allow for generalization; therefore, it is unconfirmed if the majority of bodybuilders between divisions adopt the same or similar dietary strategies (4). Data observing a larger number of competitors, each from different categories would add to the present analysis (7). Furthermore, additional research is required to better understand the role of dietary and peaking strategies in the bodybuilding culture (2).

Research examining macronutrients, fluid intake, supplementation, and peaking strategies between competitive divisions is imperative for employing evidence-based recommendations. Measuring kcal and macronutrient intake has been associated with weight change, indicating the unique role it may play in one's competition preparation (9). Further research examining the dietary strategies of competitors in the new categories at multiple time points during competition preparation is needed to further our understanding of their practices (12). Understanding the association of dietary strategies within newer competitive divisions would allow researchers to determine if evidence-based recommendations may provide better alternatives to allow this population to achieve their desired results more effectively.

Therefore, the primary aim of this study is to assess the kcal and macronutrient intake of bodybuilders during competition preparation and distinguish these strategies between divisions. The secondary aim is to examine these changes over three time periods within each division. We hypothesize that competitors in the bodybuilding division will consume a greater amount of protein, carbohydrates, and fat due to their

larger body mass throughout the entirety of competition preparation compared to other divisions.

CHAPTER 2

REVIEW OF LITERATURE

Traditional Bodybuilder Studies

A systematic review was done (Spendlove et al., 2015) that assessed the dietary practices of competitive bodybuilders with the objective to identify gaps in the literature. This study reviewed 18 studies with a total of 385 participants divided into 323 men (aged 26.9 $\pm$ 4.7) and 62 women (aged 28.6 $\pm$ 4.2) (22). Studies had to describe macronutrient consumption and participants had to be engaged in training for amateur or professional bodybuilding competitions across any category. Results showed that total protein intake ranged from 1.9 to 4.3 g/kg/day for men and from 0.8 to 2.8 g/kg/day for women (22). Additionally, total carbohydrate intake ranged from 3.0 to 7.2 g/kg/day for men and from 2.8 to 7.5 g/kg/day for women (22). Also, total fat intake across the studies ranged from 19 to 241 g/day for men and 9 to 124 g/day for women (22). Furthermore, total kcals consumed by men competitors were divided up as 52% of that energy coming from carbohydrates, 28% from protein, and 22% from fat (22). Total kcals consumed by women competitors were divided up as 59% energy from carbohydrate, 28% from protein, and 12% from fat (22).

However, this research has limitations including the majority of studies were published in the 1980s and 1990s. During competition preparation, competitors may be consuming more protein now compared to traditional dietary strategies used in the past. Also, evidence was not specific to a time period such as the off-season or in-

season phase, which can greatly impact macronutrient consumption for competitive bodybuilders. The study emphasized that many of these dietary strategies lack scientific scrutiny and that a deeper approach to evaluate the nutritional intake of bodybuilders is needed (22). Furthermore, little is known about women and the newer bodybuilding categories (22). This evidence highlights the needs to compare caloric and macronutrient intake between competitive divisions. Overall, the main finding of this study was that high quality research is needed in the area of dietary intake of bodybuilders with the potential to uncover strategies worthy of scientific exploration (22).

Additional evidence was presented (Lambert et al., 2004), that evaluated the literature and provided recommendations for dietary macronutrient composition and total energy intake for bodybuilders during the off-season and pre-contest phases. This research concluded that there is evidence that a relatively high protein intake (30% of energy intake) will reduce lean mass loss relative to a lower protein intake (15% of energy intake) (11). The higher protein intake will also provide a relatively large thermic effect that may aid in reducing body fat (11). The thermic effect is a metabolic response in which food intake results in an increase in energy expenditure due to the various steps of nutrient processing (15). Additionally, the researchers suggested that the composition of diets for bodybuilders should be 55-60% carbohydrates, 25-30% protein, and 15-20% fat, for both the off-season and pre-contest phases (11). In the off-season, the diet should be slightly increased (15% increase in energy intake) and during the pre-contest phase the diet should be decreased (15% decrease in energy intake) (11). While this study provided macronutrient recommendations for

bodybuilders, it did not take into consideration each competitive division and their own dietary strategies.

Modern Bodybuilder Studies

A study was done (Chappell et al., 2018) that investigated the nutritional strategies of high-level natural bodybuilders during competition preparation. This study utilized a cross-sectional design with 51 participants including 35 men (aged 32.2 $\pm$ 14) and 16 women (aged 34.4 $\pm$ 10.2) who competed at the British Natural Bodybuilding Federation (BNBF) finals (3). Participants were instructed to complete a 34-item questionnaire assessing their diet at three time points. During each time point, participants recorded their food intake over a 24-hour period. Participants were assigned to two groups: "placed" (meaning the competitor finished in the top five) and "non-placed" (meaning the competitor finished outside of the top five). The study found that total carbohydrate, protein, and fat intake decreased over three time points in both men and women cohorts ($p < 0.05$) (3). Additionally, men participants reduced their carbohydrate intake on average from 4.4 to 4.1 g/kg compared to women participants from 3.9 to 3.3 g/kg (3). Also, there were similar starting points of fat intake (0.8 g/kg) for men and women with only a small reduction at the end of competition preparation among women (0.6 g/kg) (3). Furthermore, placed men competitors consumed more carbohydrates at the start of competition preparation (5.1 vs 3.7 g/kg BW) than non-placed competitors (d = 1.02, 95% CI [0.22, 1.80]) (3). While this study compared macronutrient intake between placed vs. non-placed men and women competitors, the dietary recall only incorporated a single day of food intake on three separate time points. Furthermore, all men participants competed in the

bodybuilding category while the women participants were recruited from three categories. However, no specific comparisons were made between each category.

Further research evidence was presented (Chappell et al., 2019) that compared the nutritional strategies of British professional (PRO) and amateur (AMA) natural bodybuilders during competition preparation. This study utilized a cross-sectional design that consisted of 47 competitors (33 men aged 30.9 $\pm$ 8.7 and 14 women aged 39.4 $\pm$ 9.5) recruited from the BNBF regional qualifiers and the Drug Free Athletes Coalition (DFAC) British PRO Grand Prix during 2017. The men cohort included 8 PROs and 25 AMAs whereas the women cohort included 5 PROs and 9 AMAs (4). Participants completed a 34-item questionnaire (Dietary Assessment of a Natural Bodybuilding Population) on their dietary strategies at three time points: start, middle, and end phase of their competition diet. Results demonstrated a significant reduction in energy and macronutrients as competition preparation increased in both men and women (all $p < 0.05$) (4). Additionally, total carbohydrate and energy intake was higher in PRO men compared to AMA men (100 grams and 400 kcals or greater) at all time points of their competition diet ($p < 0.05$) (4). Limitations of this research include the lack of comparison between competitive divisions and the schedule of the participants was not assessed, which may have influenced the time spent in the off-season or in-season phase (4).

Another study was done (Ismaeel et al., 2018) that assessed the nutritional habits of competitive bodybuilders and compared the nutrient intakes of macronutrient-based dieting and strict dieting individuals. Macronutrient-based dieting was defined as a nutrition strategy that focuses on individual macronutrient intake

whereas strict dieting was defined as following a restricted diet with specific foods and portion sizes (9). Data from 41 participants (30 men aged 29.3 $\pm$ 7 and 11 women aged 28.8 $\pm$ 7.3 years) were used in analyses (9). Participants completed a comprehensive food questionnaire and diets were analyzed using a computer system. Men consumed an average of 2,577.2 kcal (SD = 955.1) with an average fat intake of 83.6g, average carbohydrate intake of 323.3g, and an average protein intake of 163.4g (9). No significant differences were found between men macronutrient-based dieting and strict dieting bodybuilders when compared for all nutrients (9). On the contrary, women consumed an average of 1,794 kcal (SD = 453.1) with an average fat intake of 58.3g, average carbohydrate intake of 217.8g, and an average protein intake of 103.8g (9). For men, macronutrient-based dieters consumed significantly greater amounts of protein, vitamin E, K, and C (9). The study concluded that competitive bodybuilders should be advised to take their micronutrition into greater consideration as over half of the participants consumed less than the recommended amounts. Similar to previous research, participants were not compared between competitive divisions.

Additional research reviewed (Iraki et al., 2019) the scientific literature on dietary topics related to bodybuilders during the off-season in order to provide practical recommendations. The authors recommendations were as follows: 1) bodybuilders in the off-season should focus on consuming a slightly hyper-energetic diet (10-20% above maintenance calories) with the aim of gaining 0.25-0.5% of bodyweight per week, 2) dietary protein intake is recommended to be 1.6-2.2 g/kg/day with a focus on sufficient protein at each meal (0.40-0.55 g/kg/meal) with an even distribution throughout the day (3-6 meals), 3) dietary fats should be consumed at

moderate levels, neither too low or high (0.5-1.5 g/kg/day), 4) all remaining calories should come from carbohydrates while ensuring sufficient amounts are consumed (>3.5 g/kg/day) (8). The authors emphasized for additional research on bodybuilders on a large-scale basis (8). The small number of participants in current research does not allow for generalization; therefore, it is unconfirmed if the majority of bodybuilders between divisions adopt the same or similar dietary strategies (4). Additionally, data from this study are only focused on the off-season phase. This evidence highlights the need for further research on bodybuilders between divisions during the in-season phase.

A systematic review (Helms et al., 2014) examined scientific literature relevant to competition preparation on nutrition and supplementation of natural bodybuilders in order to provide evidence-based recommendations. Electronic databases such as PubMed, MEDLINE, SPORTDiscus, and CINAHL were searched online for key words associated with calories and macronutrients. Each publication selected was carefully screened for studies that included healthy humans in a caloric deficit. After analyzing selected publications, the authors concluded that caloric intake should be set at a level that results in bodyweight loss on average of 0.5 to 1%/wk to maximize muscle retention (7). Additionally, the authors recommend that it may be best to pursue a gradual approach to weight loss towards the end of competition preparation compared to the beginning to avoid lean body mass loss in terms of caloric intake (7). Regarding protein intake, this review states most but not all bodybuilders will respond best to consuming 2.3-3.1 g/kg of lean body mass per day of protein (7). Regarding fat intake, the authors suggest a lower end consumption of 15-20% of calories from fat

can be appropriate if higher percentages would reduce carbohydrate or protein ideal ranges (7). If not, 15-30% of calories should come from fat (7). Regarding carbohydrate intake, the authors suggest the reminder of calories should come from carbohydrates (7). Similar to other research, the authors emphasized the lack of large-scale studies on competitive bodybuilders and the data relevant to natural bodybuilding are extremely limited (7). This evidence highlights the need for further research regarding the kcal and macronutrient intake of competitive bodybuilders within the newer divisions during competition preparation to better understand their dietary strategies.

Physique Athlete Studies

A study was done (Gentil et al., 2017) that reported and analyzed the practices adopted by bodybuilders to propose evidence-based alternatives. This observational case series interviewed six participants (four men aged 23.7 $\pm$ 4 and two women aged 29.5 $\pm$ 7.7) and asked them to describe in detail their nutritional practices. Participants consisted of two men's physique competitors, two bodybuilders, and two wellness competitors. Participants were analyzed for body composition before and after the bulking and cutting phases. During the bulking phase, bodybuilders aim to increase muscle mass without gaining unnecessary body fat (8). In comparison, the goal of the cutting phase is to achieve drastic reductions in body fat while maintaining muscle mass (7). This study found that bodybuilders ingested ~2.5g of protein/kg of bodyweight during the bulking phase compared to ~3 g/kg of bodyweight during the cutting phase (6). Also, 15% of calories came from fat and carbohydrate consumption decreased by 10-20% during the cutting phase (6). This study concluded that high

protein intakes (2.5 g/kg BW) are not obligatory to preserve lean mass while losing fat making it beneficial for people who do not tolerate severe restrictions in carbohydrate or fat intake (6). Limitations of this research include the very small sample size and therefore does not allow for generalization. The need for a larger study with more participants from each division is imperative for a comprehensive understanding of these dietary strategies (6).

More evidence was presented (Lenzi et al., 2019) that evaluated the dietary strategies of bodybuilders in the men's physique division during different time periods of the in-season phase. This study was a prospective study with a quasi-experimental design. Sixteen men's physique competitors (aged 29 $\pm$ 6 years) took part in the study and completed an in-person questionnaire describing their dietary and training habits throughout competition preparation (12). Additionally, nutritional intake was assessed by three 24-hour food diaries undertaken on three separate days. Dietary analysis revealed a low carbohydrate intake (below 6-10 g/kg BW) during bulking with a further decrease ($p < 0.05$) during cutting (12). Additionally, carbohydrate consumption consisted of 261g (2.98 g/kg) during the bulking phase and 178g (2.3g/kg) during the cutting phase (12). A significant decrease occurred from bulking to cutting phases in absolute and relative energy intake ($p = 0.003$) (12). During the cutting phase, protein intake (grams) was 273.29 $\pm$ 105.40 and fat intake (grams) was 49.09 $\pm$ 29.12 (all $p < 0.05$) (12).

This study demonstrates strong evidence for those competing in the new competitive category of men's physique. However, it contained a small sample size and the use of 24-hour food diaries can be considered a potential limitation due to

underreporting and overreporting (12). This is a concern of the 24-hour dietary assessment because data generated by this method may not represent the long-term dietary strategies of the competitor (16). Additionally, this study emphasized the need for further examination of the dietary strategies of competitors in the newer divisions to further understand their practices and help them achieve their goals more effectively (12).

A systematic review was done (Roberts et al., 2020) that provided nutritional recommendations for physique athletes. The goal of that review was to provide nutritional guidelines for men and women physique athletes during competition preparation and the recovery period. Long-term human studies were primarily selected for nutrition and macronutrient intake from the electronic databases PubMed, SPORTDiscus, Google Scholar, and MEDLINE. Based on the evidence from each study, the authors suggested a protein intake of 1.8-2.7 g/kg/day or up to 3.5 g/kg/day for those trying to mitigate hunger (17). Additionally, recommendations of carbohydrate intake should be adjusted in order for training performance to be optimized while consuming adequate caloric intake to reach the desired physique (17). This means that competitors should allow for what calories remain in the "energy budget" to come from carbohydrates to combat the negative impact of caloric restriction and weight loss on training performance (17). Therefore, the authors recommended men and women physique athletes to consume 2-5 g/kg per day to reach the desired level of leanness with the majority of carbohydrates coming from whole grains, fruits, and vegetables (17). The authors recommended that a fat intake of 10-12% will allow for individual variability and dietary flexibility yet they advise caution

for very low-fat intake for long periods of time (17). The authors emphasized additional study of physique athletes is needed to provide more specific guidelines (17). These data highlight the need for further research on kcal and macronutrient consumption between divisions in the sport of bodybuilding in order to provide specific guidelines for each category.

Discussion / Future Directions

Cumulatively, these data from each study indicates that there is a need for additional research on the dietary strategies of bodybuilders within the newer divisions. Current evidence demonstrates that a wide range of carbohydrate and fat intake is typically consumed by physique athletes (17). The consumption of macronutrients varies widely across competitors and the current phase of competition preparation in which intake occasionally falls outside the recommended ranges. Furthermore, greater participation in bodybuilding competitions has been associated with more women within the newer categories (22). This emphasizes the need for more research on women bodybuilders during competition preparation.

Dietary fat intake has been previously recommended as a lower level of 15-20% of total calories for bodybuilders (7). However, it is unlikely all competitors stay within this range during competition preparation as levels are as low as ~9% (17). Major issues in the current literature include the lack of large-scale studies which does not allow for generalization and the lack of research on the newer bodybuilding categories. As the sport of bodybuilding has grown, the newer categories of men's physique, classic physique, figure, fitness, and bikini present different ideals for stage presentation. There are multiple factors to consider when determining the kcal and

macronutrient intake of bodybuilders during competition preparation and these variables highly depend on the individual and what division the competitor is competing in. Currently, there is no research that has examined and compared the kcal and macronutrient intake of bodybuilders according to the multiple divisions within the sport. Research examining these dietary strategies between competitive divisions is required to greater understand these practices and may uncover alternative recommendations through future evidence to help competitors reach their results more effectively.

CHAPTER 3

METHODOLOGY

Observational Approach to the Problem

The dietary intake of male and female bodybuilders during competition preparation, a cross-sectional study, began in 2020 under the direction of principal investigator, Disa Hatfield, PhD. Data were collected using a modified version of the Dietary Assessment of a Natural Bodybuilding Population Questionnaire that has been used in previous research (4). All recorded information was not able to readily identify each participant and was stored electronically in one folder on one password protected computer in Dr. Hatfield's locked office. Missing questionnaire data and clarification of strategies were followed up via email. This research was approved by the University of Rhode Island Institution Review Board (Reference #: 1650638-2).

Participants

Participants read and signed an IRB-approved informed consent form before agreeing to participate in the study. Participants were asked to provide as much detail as possible on the questionnaire assessing their diet at three time points during competition preparation.

One hundred forty-five participants were needed to appropriately assess the study aim of examining the kcal and macronutrient intake (protein: PRO, carbohydrate: CHO, and fat) of men and women competitive bodybuilders between divisions. This number allowed us to gain at least 10 participants in most competitive

divisions and account for incomplete data and participant drop-out. This study used a purposeful sampling technique to recruit men and women competitive bodybuilders in any division between the ages of 18 and 62 years old. Participants must have competed in a bodybuilding competition in the past or is currently in preparation for their first competition. Participants were recruited by word-of-mouth, social media postings, email, and text message. Participants that were interested in the study were assessed for inclusion and exclusion criteria and if deemed eligible, they completed the modified version of the Dietary Assessment of a Natural Bodybuilding Population Questionnaire. Exclusion criteria included failure to participate in a bodybuilding competition or not falling between the specified age range.

Study location: All study procedures took place electronically via the internet through email, social media, and online forms.

Procedures

IRB-Approved Informed Consent: All participants received and signed an informed consent form before agreeing to participate in the study regarding the purpose, procedures, risks, and benefits of participating in this proposed study.

Modified Version of the Dietary Assessment of a Natural Bodybuilding Population Questionnaire: This questionnaire has been used in previous research in which significant differences ($p < 0.05$) of carbohydrate and energy as well as a difference ($p < 0.03$) in the estimated energy deficit were recorded between professional men and amateur bodybuilding competitors (4). Additionally, the questionnaire was used in another study (2) where the findings are in agreement with previous research which reported a similar focus on carbohydrate, water, and sodium manipulation during peak

week amongst bodybuilders (13). Participants were instructed to provide as much detail as possible for each section on the questionnaire.

- Competitor Information: Participants were instructed to complete this section of the questionnaire and provide information regarding their bodybuilding division, years training, weeks dieting for competition, current weight at the start of competition preparation, and current weight at the end of competition preparation. Body fat percentage and the method used to estimate was recorded if it was known by the participant.
- Fluid Intake: Participants were instructed to complete this section of the questionnaire and provide information regarding their daily fluid intake recorded in ounces, the use of artificial sweeteners or sugar free drinks, and other beverage intakes according to the given options on the questionnaire and record how many times per day, week, or month each beverage was consumed during competition preparation.
- Supplementation: Participants were instructed to complete this section of the questionnaire and provide information regarding their supplement intake by marking what supplements they used according to the given options on the questionnaire and record the brand name of each supplement if it is known.
- Dietary Approach: Participants were instructed to complete this section of the questionnaire and provide information regarding their diet style. Diet style included clean eating (consuming whole foods and avoiding processed foods), if it fits your macros (IIFYM), and cheat meals. Protein, fat, and carbohydrate

consumption were recorded as high, medium, or low during competition preparation. High, medium, and low were up to participant interpretation.

- Competition Diet: Participants were instructed to complete this section of the questionnaire and provide information regarding their foods and beverages consumed and record them in either portion sizes, ounces, or grams at three time points during their competition preparation. This included their initial diet (first few weeks), middle diet (halfway phase), and end diet (final weeks). Refeed and cheat meals were assessed by asking participants how many times per week on average these meals were consumed and to provide what they ate and the nutritional facts of the meal if possible.
- Peaking Strategies: This was assessed by instructing participants to check what peaking strategy they used according to the given options on the questionnaire and provide detail including food types, number of days, amount, and timing.
- Competition Day Plan: This was assessed by instructing participants to check what competition day strategy they used according to the given options on the questionnaire and provide detail including food types, amount, timing before stepping on stage, and brand used. Additionally, one item on the questionnaire asked about the duration of time used to "pump up" before going on stage.
- Resistance Training Program: Participants were instructed to complete this section of the questionnaire and provide information regarding their resistance training regimen according to the given options during three time points of their competition preparation. This included the first few weeks, halfway phase, and final weeks.

- Cardiovascular Training Program: Participants were instructed to complete this section of the questionnaire and provide information regarding their cardiovascular training regimen according to the given options during three time points of their competition preparation. This included the first few weeks, halfway phase, and final weeks.

Pre-recorded Dietary Records: Participants were asked to voluntarily provide their pre-recorded dietary records that they followed during their competition preparation. These data were not used for the purpose of this thesis, instead it was used to help establish the validity and reliability of the main outcomes (kcal and macronutrient intake) on the questionnaire for the different competitive divisions.

Diet History Questionnaire (DHQIII) Survey (Past Month with Portion Size): Participants were asked to voluntarily complete the DHQIII survey. These data were not used for the purpose of this thesis, instead it was used to help establish the validity and reliability of the main outcomes (kcal and macronutrient intake) on the questionnaire for the different competitive divisions.

Rights and Permissions: The Dietary Assessment of a Natural Bodybuilding Population Questionnaire was distributed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/) which permits unrestricted use, distribution, and reproduction in any medium. We would like to acknowledge the authors Dr. Chappell, Dr. Simper, and Dr. Helms from previous research (4) for allowing this questionnaire to be used. Changes made to the original questionnaire include: front cover modifications to match the purpose of this study, removal of competitor number and smoking status questions, changed

measurement units (kg to lbs, cm to in, ml to oz), added refeed / cheat meals question, added peaking strategies and contest day plan page from a previous version of the questionnaire (2), included “pump up” question, and modified resistance training program questions.

Statistical Analysis

SPSS 27 statistical software by IBM in Armonk, New York was used for data analysis in this study. Men participants were grouped together and women participants were grouped together due to the various numbers of competitors in each division (Bodybuilding: BB, Men’s Physique: MP, and Women’s Divisions: WD). Participants were grouped together based on homogenous characteristics and we did not have sufficient power to compare the individual dietary intakes of each division. A *p*-value of less than or equal to 0.05 was used as a level of significance. Nutrient analysis was performed using MyFitnessPal by Under Armour in San Francisco, California.

Repeated measures analysis of variance (ANOVA) was used to examine and compare the association of kcals and macronutrients (dependent variables) expressed in grams between competitive divisions (independent variables) during the three time points of competition preparation. Additionally, repeated measures ANOVA with the Bonferroni correction was used to examine and compare the association of the macronutrient (g/kg) and energy intake (kcal/kg) scaled to the starting bodyweight of the competitive groups. All statistical analysis was performed in Independence Square at the University of Rhode Island.

CHAPTER 4

FINDINGS

Participant Characteristics

One hundred forty-five participants (90 men aged 31.5 ± 8.9 and 55 women aged 31.7 ± 7.4) were recruited and data from one hundred thirty-seven participants (5.5% decrease) were used in statistical analysis due to participant drop-out and incompletion of the Dietary Assessment of a Natural Bodybuilding Population Questionnaire. There was a 2.2% decrease in men participants and a 10.9% decrease in women participants. This may be due to the cancellation of bodybuilding competitions during the time of data collection. Bodybuilding (BB) included 38 men competitors in the bodybuilding division. Men's Physique (MP) included 50 competitors: 34 men's physique and 16 classic physique. Women's Divisions (WD) included 49 competitors: 34 bikini, 9 figure, 3 women's physique, 1 wellness, 1 fitness, and 1 fit body. Participant characteristics between each division are presented in the following tables (Table 1: competitive groups, Table 2: men's physique, Table 3: bikini, Table 4: figure, Table 5: classic physique, Table 6: bodybuilding, Table 7: fit body, Table 8: wellness, Table 9: women's physique, Table 10: fitness).

Table 1: Participant Characteristics of Competitive Groups

	Group 1 Bodybuilding (BB) N = 38		Group 2 Men's Physique (MP) N = 50		Group 3 Women's Divisions (WD) N = 49	
Variable	**Mean**	**SD ±**	**Mean**	**SD ±**	**Mean**	**SD ±**
Age (years)	34.7	9.8	29.3	7.5	31.7	7.4
Height (cm)	174.1	7.1	177.1	7.2	162.8	7.2
Start Weight (kg)	88.5	11.8	90.1	10.1	61.5	6.6
Stage Weight (kg)	76.4	10.8	78.2	9.3	52.8	5.4
Weight loss (%)	13.6	4.4	13.2	4.1	13.8	5.2
Years training	13.7	10.1	8.3	8.0	5.4	4.6
Years competing	7.3	6.6	4.4	7.1	3.7	4.4
Competitions this season	2.0	1.3	1.4	0.8	2.0	1.6
Diet Length (weeks)	23.1	10.1	19.7	11.1	24.5	12.9
Start BMI (kg/m2)	29.2	3.5	28.7	2.9	23.2	2.1
Stage BMI (kg/m2)	25.2	2.9	24.9	2.7	19.9	1.9

Abbreviations: BMI = body mass index, SD = standard deviation.

Table 2: Participant Characteristics of Men's Physique Competitors

Variable	**N = 34**	**Mean**	**SD ±**
Age (years)		28.8	7.5
Height (cm)		177.1	7.2
Start Weight (kg)		88.8	9.4
Stage Weight (kg)		76.8	8.7
Weight loss (%)		13.4	4.3
Years training		7.4	6.9
Years competing		3.7	5.7
Competitions this season		1.4	0.8
Diet Length (weeks)		19.5	11.5
Start BMI (kg/m2)		28.3	3.0
Stage BMI (kg/m2)		24.5	2.7

Abbreviations: BMI = body mass index, SD = standard deviation.

Table 3: Participant Characteristics of Bikini Competitors

Variable	**N = 34**	**Mean**	**SD ±**
Age (years)		30.1	5.4
Height (cm)		164.6	7.3
Start Weight (kg)		61.2	7.2
Stage Weight (kg)		52.1	5.7
Weight loss (%)		14.5	5.6
Years training		4.5	3.0
Years competing		2.7	2.0
Competitions this season		2.1	1.8
Diet Length (weeks)		25.1	13.1
Start BMI (kg/m2)		22.5	1.8
Stage BMI (kg/m2)		19.2	1.6

Abbreviations: BMI = body mass index, SD = standard deviation.

Table 4: Participant Characteristics of Figure Competitors

Variable	N = 9	Mean	SD ±
Age (years)		32.4	10.9
Height (cm)		159.7	5.9
Start Weight (kg)		64.1	5.5
Stage Weight (kg)		55.4	4.0
Weight loss (%)		13.3	3.7
Years training		7.6	8.2
Years competing		6.3	8.7
Competitions this season		1.7	0.9
Diet Length (weeks)		21.7	12.4
Start BMI (kg/m2)		25.1	2.3
Stage BMI (kg/m2)		21.7	1.5

Abbreviations: BMI = body mass index, SD = standard deviation.

Table 5: Participant Characteristics of Classic Physique Competitors

Variable	**N = 16**	**Mean**	**SD ±**
Age (years)		30.1	7.8
Height (cm)		177.1	7.3
Start Weight (kg)		93.1	10.9
Stage Weight (kg)		81.3	10.1
Weight loss (%)		12.7	3.6
Years training		10.2	9.9
Years competing		5.9	9.4
Competitions this season		1.4	0.8
Diet Length (weeks)		20.2	10.5
Start BMI (kg/m2)		29.6	2.5
Stage BMI (kg/m2)		25.8	2.4

Abbreviations: BMI = body mass index, SD = standard deviation.

Table 6: Participant Characteristics of Bodybuilding Competitors

Variable	**N = 38**	**Mean**	**SD ±**
Age (years)		34.7	9.8
Height (cm)		174.1	7.1
Start Weight (kg)		88.5	11.8
Stage Weight (kg)		76.4	10.8
Weight loss (%)		13.6	4.4
Years training		13.7	10.1
Years competing		7.3	6.6
Competitions this season		2.0	1.3
Diet Length (weeks)		23.1	10.1
Start BMI (kg/m2)		29.2	3.5
Stage BMI (kg/m2)		25.2	2.9

Abbreviations: BMI = body mass index, SD = standard deviation.

Table 7: Participant Characteristics of Fit Body Competitors

Variable	N = 1	Mean	SD ±
Age (years)		38	
Height (cm)		156.2	
Start Weight (kg)		59.4	
Stage Weight (kg)		52.6	
Weight loss (%)		11.4	
Years training		3.5	
Years competing		3.5	
Competitions this season		1.0	
Diet Length (weeks)		28.5	
Start BMI (kg/m2)		24.3	
Stage BMI (kg/m2)		21.5	

Abbreviations: BMI = body mass index, SD = standard deviation.

Table 8: Participant Characteristics of Wellness Competitors

Variable	N = 1	Mean	SD ±
Age (years)		35.0	
Height (cm)		160.0	
Start Weight (kg)		64.4	
Stage Weight (kg)		55.3	
Weight loss (%)		14.1	
Years training		9.0	
Years competing		1.0	
Competitions this season		1.0	
Diet Length (weeks)		52.0	
Start BMI (kg/m2)		25.1	
Stage BMI (kg/m2)		21.6	

Abbreviations: BMI = body mass index, SD = standard deviation.

Table 9: Participant Characteristics of Women's Physique Competitors

Variable	**N = 3**	**Mean**	**SD ±**
Age (years)		43.6	3.5
Height (cm)		157.4	6.7
Start Weight (kg)		58.1	5.4
Stage Weight (kg)		53.2	8.2
Weight loss (%)		8.6	5.7
Years training		8.3	3.5
Years competing		7.3	4.0
Competitions this season		2.3	0.5
Diet Length (weeks)		21.3	4.6
Start BMI (kg/m2)		23.4	1.4
Stage BMI (kg/m2)		21.4	2.5

Abbreviations: BMI = body mass index, SD = standard deviation.

Table 10: Participant Characteristics of Fitness Competitors

Variable	N = 1	Mean	SD ±
Age (years)		40.0	
Height (cm)		154.9	
Start Weight (kg)		57.6	
Stage Weight (kg)		50.8	
Weight loss (%)		11.8	
Years training		5.0	
Years competing		5.0	
Competitions this season		3.0	
Diet Length (weeks)		12.0	
Start BMI (kg/m2)		23.9	
Stage BMI (kg/m2)		21.1	

Abbreviations: BMI = body mass index, SD = standard deviation.

Kcal and Macronutrient Intake

Mean kcal and macronutrient intake during the initial, middle, and end time periods of competition preparation for the competitive groups are reported in Table 11. Results of the repeated measures ANOVA identified a significant decrease in mean kcal and macronutrient intake in all groups over time from the initial to end time period ($p \leq 0.05$). Mean kcal intake of BB was significantly greater than the mean kcal intake of MP and WD at all time periods of competition preparation ($p \leq 0.05$). Also, mean kcal intake of MP was significantly greater than the mean kcal intake of WD at all time periods ($p \leq 0.05$). Additionally, mean CHO intake of BB was significantly greater than the mean CHO intake of MP and WD at all time points ($p \leq 0.05$). Furthermore, mean CHO intake of MP was significantly greater than the mean CHO intake of WD only at the initial time point of competition preparation ($p \leq 0.05$). There were no significant differences seen among each group in absolute mean fat intake. Mean PRO intake of BB was significantly greater than the mean PRO intake of WD at all time points ($p \leq 0.05$). Also, mean PRO intake of MP was significantly greater than the mean PRO intake of WD at all times points ($p \leq 0.05$). However, mean PRO intake of BB did not significantly differ from MP at any time point.

Macronutrient and energy intake scaled to starting bodyweight of competitive groups during each diet phase is reported in Table 12. Results of the repeated measures ANOVA identified a significant decrease in energy (kcal/kg BW) in BB, MP, and WD from the initial to middle phase, middle to end phase, and initial to end phase ($p \leq 0.05$). Also, BB significantly decreased CHO (g/kg BW) intake from the initial to middle phase and initial to end phase ($p \leq 0.05$). Additionally, MP and WD

significantly decreased CHO (g/kg BW) intake from the initial to middle phase, middle to end phase, and initial to end phase ($p \leq 0.05$). Fat (g/kg BW) intake was significantly greater in BB compared to WD at all time points ($p \leq 0.05$). BB significantly decreased fat (g/kg BW) intake from the initial to middle phase, middle to end phase, and initial to end phase ($p \leq 0.05$). In comparison, MP and WD significantly decreased fat (g/kg BW) intake from the initial to middle phase and initial to end phase ($p \leq 0.05$). PRO (g/kg BW) intake of BB and WD significantly decreased from the middle to end phase ($p \leq 0.05$). There were no significant differences in PRO (g/kg BW) intake of MP.

Table 11: Mean Kcal and Macronutrient Intake of Competitive Groups

		Initial Phase				Middle Phase				End Phase			
Group	**N**	**Kcals**	**CHO (g)**	**Fat (g)**	**PRO (g)**	**Kcals**	**CHO (g)**	**Fat (g)**	**PRO (g)**	**Kcals**	**CHO (g)**	**Fat (g)**	**PRO (g)**
Bodybuilding (BB)	38	2836.2+	309.9^	104.6	203.0~	2474.1	243.3^	88.6	199.9~	2038.2*	190.2^	72.4	188.6~
SD ±		737.0	136.1	107.5	73.8	693.4	108.7	85.8	79.9	883.2	179.4	74.9	75.65
Men's Physique (MP)	50	2446.6+	226.1-	99.8	189.8~	2133.4	193.6	82.9	184.4~	1739.4*	134.9	66.5	174.0~
SD ±		1050.3	168.3	100.7	78.2	817.8	152.3	81.9	83.9	606.9	86.3	61.8	85.4
Women's Divisions (WD)	49	1729.7+	161.2	75.2	134.9=	1563.1	146.4	61.3	131.9=	1352.6*	123.7	54.6	126.1=
SD ±		752.8	107.6	61.6	58.7	620.6	93.0	52.6	57.5	461.9	66.2	45.7	70.6

Abbreviations: Kcals = kilocalories, CHO = carbohydrate, PRO = protein, SD = standard deviation.
*Denotes mean kcal intake of BB is significantly greater than MP and WD at all phases ($p \leq 0.05$).
+Denotes significant decrease in kcal and macronutrient intake in all groups from the initial to end phase ($p \leq 0.05$).
^Denotes mean CHO intake of BB is significantly greater than MP and WD at all phases ($p \leq 0.05$).
-Denotes mean CHO intake of MP is significantly greater than WD at the initial phase ($p \leq 0.05$).
~Denotes mean PRO intake of BB and MP is significantly greater than WD at all phases ($p \leq 0.05$).
=Denotes mean PRO intake of MP is significantly greater than WD at all phases ($p \leq 0.05$).

Table 12: Macronutrient and Energy Intake Scaled to Starting BW of Competitive Groups

		Group 1 Bodybuilding (BB) N = 38		Group 2 Men's Physique (MP) N = 50		Group 3 Women's Divisions (WD) N = 49	
Variable	**Diet Phase**	**Mean**	**SD ±**	**Mean**	**SD ±**	**Mean**	**SD ±**
Energy (kcal/kg BW)	Initial	30.8*	10.4	27.9*	10.0	28.4*	12.4
	Middle	27.1	9.8	25.6	9.6	24.3	9.9
	End	21.7	7.5	22.4	6.4	19.4	7.2
CHO (g/kg BW)	Initial	2.6+	1.1	2.9^	1.5	2.8^	2.2
	Middle	2.1	1.1	2.6	1.5	2.3	1.8
	End	1.8	1.5	2.2	1.1	1.5	0.9
Fat (g/kg BW)	Initial	1.6~	1.4	1.1	1.1	0.8-	0.4
	Middle	1.3	1.1	1.0	0.9	0.6	0.3
	End	0.9	0.9	0.9=	0.8	0.5=	0.3
PRO (g/kg BW)	Initial	2.2	1.2	2.0	0.8	2.3	0.7
	Middle	2.1>	1.2	2.0	0.8	2.2>	0.7
	End	1.8	0.9	2.1	1.2	2.0	0.7

Abbreviations: BW = bodyweight, CHO = carbohydrate, PRO = protein, SD = standard deviation.

*Denotes significant decrease in energy in BB, MP, and WD from each diet phase ($p \leq 0.05$).

+Denotes BB significantly decreased CHO (g/kg BW) intake from initial to middle and initial to end phase ($p \leq 0.05$).

^Denotes MP and WD significantly decreased CHO (g/kg BW) intake from each diet phase ($p \leq 0.05$).

-Denotes fat (g/kg BW) intake of BB is significantly greater compared to WD at all phases ($p \leq 0.05$).

~Denotes BB significantly decreased fat (g/kg BW) intake from each diet phase ($p \leq 0.05$).

=Denotes MP and WD significantly decreased fat (g/kg BW) from initial to middle and initial to end phase ($p \leq 0.05$).

>Denotes PRO (g/kg BW) intake of BB and WD significantly decreased from the middle to end phase ($p \leq 0.05$).

CHAPTER 5

CONCLUSION

Discussion

In this investigation, we identified several significant differences in mean kcal, protein, and carbohydrate intake of BB compared to MP and WD. Additionally, we identified significant changes in mean kcal and macronutrient intake over three time points of competition preparation.

Kcal Intake

As expected, mean kcal and macronutrient intake of all groups was higher at the initial time point of competition preparation compared to the end time point. Similar findings have been reported in previous observations (22). On average, a significant decrease in mean kcal and macronutrient intake was identified in all groups from the initial time period to the end time period ($p \leq 0.05$). BB consumed 2836.2 $\pm$ 737 kcals during the initial diet compared to 2474.1 $\pm$ 693.4 kcals during the middle diet whereas MP consumed 2446.6 $\pm$ 1050.3 and 2133.4 $\pm$ 817.8 kcals, and WD consumed 1729.7 $\pm$ 752.8 and 1563.1 $\pm$ 620.6 kcals respectively. This observation is similar to research done (Ismaeel et al., 2018) that assessed the nutritional habits of competitive bodybuilders. Men consumed an average of 2,577.2 kcals (SD = 955.1) and women consumed an average of 1,794 kcals (SD = 453.1) (9). Furthermore, our findings are consistent with previous research (Chappell et al., 2019) where competitors decreased their energy intake over three time points during competition preparation. This

strategy of bodybuilders consuming less energy over time during the in-season phase is done to reduce body fat and achieve a lean physique (7).

Also, mean kcal intake of BB was significantly greater than the mean kcal intake of MP and WD at all time periods of competition preparation ($p \leq 0.05$). Furthermore, mean kcal intake of MP was significantly greater than the mean kcal intake of WD at all time periods ($p \leq 0.05$). This finding may represent some of the different requirements between each competitive division as they have different lean and muscularity ideals for stage presentation (19). Different physique classes place different expectations on their athletes, which likely influenced their practices during competition preparation (2). For example, competitors in the bodybuilding division aim to achieve maximum lean body mass, muscularity, and vascularity with body fat percentages ranging from 2-6% for men and 6-11% for women (14). On the contrary, competitors in newer divisions (men's physique, figure, and fitness) aim to present a high level of muscularity and lean body mass but not as much as bodybuilders with moderate vascularity typically falling between a body fat range of 4-9% for men and 8-15% for women (14). This evidence highlights the different expectations for competitors in each division as their goals depend on their different physique ideals for stage presentation.

Carbohydrate Intake

In the sport of bodybuilding, dietary strategies of high carbohydrate intake are considered to be the performance training standard (7). Carbohydrate intake for strength sports, including bodybuilding, is recommended to be between 4 to 7 g/kg depending on the phase of training (21). Inadequate carbohydrate intake can impair

strength training and reduce glycogen repletion (21). However, carbohydrate intake is customized to the individual and during bodybuilding competition preparation, intake is unlikely to be at the higher end of recommendations (7).

Carbohydrate was the most abundant macronutrient across all time periods and was reduced from the start to the end of competition preparation in all groups ($p \leq 0.05$). Also, mean CHO intake of BB was significantly greater than the mean CHO intake of MP and WD at all time points ($p \leq 0.05$). Furthermore, mean CHO intake of MP was significantly greater than the mean CHO intake of WD only at the initial time point of competition preparation ($p \leq 0.05$). The present findings suggest that men bodybuilding, men's physique, and classic physique competitors consume more energy in the form of carbohydrates compared to bikini, figure, women's physique, wellness, fit body, and fitness competitors. These findings are consistent to research done (Ismaeel et al., 2018) where men competitors consumed a greater amount of carbohydrates (323.3g) than women competitors (217.8g). Additionally, these findings may be contributed to the greater start weight and stage weight of BB and MP compared to WD as these competitors were able to consume more energy throughout competition preparation.

Moreover, mean CHO intake was between 2-3 g/kg scaled to starting bodyweight (BW) in all competitive groups at each time period. This relative mean CHO intake is in agreement with a previous recommendation that men and women physique athletes should consume 2-5 g/kg BW of CHO per day to reach their desired levels of leanness (17). Furthermore, Chappell (4) concluded that elite professional men bodybuilders consume more energy in the form of a diet consisting of higher carbohydrates

compared to lower competitive levels. It may be beneficial to examine sugar, starch, and fiber consumption within mean CHO intake of each division. These data may allow for further differentiation of the dietary strategies between divisions and provide a rationale for carbohydrate manipulation strategies which have been examined in previous research (2). These strategies involve the restriction of carbohydrates for multiple days followed by increased carbohydrate consumption for multiple days with the goal of enhanced glucose transport and increased muscle glycogen supercompensation (20).

Fat Intake

Fat intake for competitive bodybuilders is typically emphasized on maintaining an adequate consumption while focusing on carbohydrates to fuel performance and protein to build and repair lean body mass (7). Bodybuilders are recommended to consider their dietary fat intake during competition preparation when attempting to preserve their muscle mass as evidence has shown low fat consumption negatively influences testosterone levels (11). Previously, it has been suggested that a fat intake of 15-20% of total calories for bodybuilders is appropriate if greater amounts would reduce protein and carbohydrate ideal ranges (11). Thus, this is an acceptable range of fat intake as low carbohydrate diets may negatively impact resistance training performance (21).

Fat was the lowest amongst the three macronutrients and was decreased over time in all groups during each time period of competition preparation ($p \leq 0.05$). There were no significant differences between each group for absolute mean fat intake at each diet phase. However, relative mean fat intake (g/kg BW) was significantly

greater in BB compared to WD at all time points ($p \leq 0.05$). The absolute mean fat intakes recorded in the present study were 104.6g, 88.6g, 72.4g (BB), 99.8g, 82.9g, 66.5g (MP), and 75.2g, 61.3g, 54.6g (WD) at the initial, middle, and end time points respectively. This decrease in fat intake is similar to the appropriate strategy that suggests bodybuilders respond best to consuming 15-30% of calories from fat (7).

In comparison, these findings are higher than previous accounts reported by Chappell (4) during each time period of competition preparation for men competitors and all but one time period for women competitors. The research done by Chappell (4) included professional and amateur competitors only recruited from the British Natural Bodybuilding Federation whereas the present study recruited participants from any bodybuilding federation. The different results in fat intake may be due to the different participant characteristics between the present study and research done by Chappell (4) as well as the differences that exist between competitors competing in the bodybuilding, men's physique, classic physique, or bikini divisions (12).

In comparison, mean fat intake during the middle time period in men and women participants (BB: 88.6g, MP: 82.9g, and WD: 61.3g) were similar to the men fat intake (83.6g) and women fat intake (58.3g) of competitors reported by Ismaeel (9). These findings may be due to the similar characteristics between participants in the present study and research done by Ismaeel (9) as both sample sizes consisted of competitive bodybuilders currently in competition preparation. Overall, more research is needed to assess the various fat intakes of competitors between divisions to determine significant differences. One unexplored area is the consumption between polyunsaturated and monounsaturated fats.

Protein Intake

Adequate protein consumption during competition preparation is required to support the maintenance of lean body mass (7). Higher protein intakes are suggested for athletes to support increased levels of exercise and for weight lifters to support muscle growth (11). Research has suggested that a protein intake of 1.2 to 2.2 g/kg is optimal to allow training adaptations for athletes who are consuming calories at or above their energy needs (23). However, bodybuilders restrict calories and achieve very lean physiques during competition preparation (7). Consequently, optimal protein intake for competitive bodybuilders may be higher than existing recommendations (7).

In the present study, mean PRO intake of BB was significantly greater than the mean PRO intake of WD at all time points ($p \leq 0.05$). These protein intakes recorded (BB: 203g, 199.9g, 188.6g and WD: 134.9g, 131.9g, 126.1g) at the initial, middle, and end time points suggests that men bodybuilders consume more protein than women competitors during competition preparation. This finding is in agreement with results reported by Ismaeel where men competitors consumed a greater amount of protein (163.4g) compared to women competitors (103.8g) (9).

Furthermore, mean PRO intake of MP was significantly greater than the mean PRO intake of WD at all times points ($p \leq 0.05$). This finding may be due to the greater amount of muscle mass and overall bodyweight in men's physique and classic physique competitors compared to women competitors. Each competitive group was consuming a minimum relative mean PRO intake of 1.8 g/kg BW during all time periods. This finding is in agreement with the recommendation by Roberts (17) that men and women physique athletes should consume 1.8-2.7 g/kg BW of protein.

Although the consumption of protein (g/kg BW) in the present study is lower than bodybuilding recommendations of 2.3 to 3.1 g/kg (7), it seems likely that all competitors were consuming enough protein for the preservation of muscle mass. Additionally, mean PRO intake of BB did not significantly differ from the mean PRO intake of MP at any time point. This result may be due to the similarities in start weight and stage weight between competitors in the bodybuilding, men's physique, and classic physique divisions.

Limitations

The present investigation is not without limitations. Primarily, there was not an equal number of participants in each competitive division which limits generalizability. An equal number of participants in each division would allow for increased generalizability as each dietary strategy would be individually analyzed. This evidence would allow researchers to find specific differences or similarities between each division instead of analyzing groups of competitors from multiple categories. Due to the unbalanced number in each division, participants were grouped together and we did not have sufficient power to compare the individual dietary intakes of each category.

Following a similar dietary plan for consecutive weeks is common in all competitors in the sport of bodybuilding (4) and underreporting is common in studies of dietary intake (12). However, bodybuilders are known for their careful nutritional tracking and adherence to their dietary plan (7). Furthermore, we only obtained information on participants' diet from three time points of competition preparation (start, middle, and end). Therefore, we were unable to capture any changes that may

have occurred in-between those time periods. Additionally, we did not report participants' lean body mass or fat mass as this would have further differentiated each division. Finally, bodybuilders and coaches should be mindful that these strategies are only likely to be effective for competitors in the same division with a similar start weight and length of dieting for competition preparation.

Conclusions / Practical Applications

There are significant differences among each competitive group in mean kcal and macronutrient intake. Throughout the entirety of competition preparation, competitors in the bodybuilding division consumed a greater amount of kcals and carbohydrates compared to all other divisions.

To our knowledge, this is the first study to document and describe dietary strategies between competitive divisions in the sport of bodybuilding. Additionally, this study filled gaps in the current research where little is known about women and the newer bodybuilding categories (22). The findings of this study are likely to be of interest to competitive bodybuilders and coaches. However, these data should be interpreted with caution as most dietary plans are created on a one-on-one basis depending on the competitor's individual body adaptations. Our findings provide evidence in the current bodybuilding practices between divisions when competitors are grouped together. However, future research should focus on larger studies that incorporate an equal number of participants in each division. Data observing a larger and equal number of participants from each division would add to the present analysis and increase generalizability. An equal number of participants in each division would allow for their dietary strategies to be individually analyzed and this evidence could be

used to demonstrate specific differences or similarities between kcal and macronutrient intake.

APPENDICES

APPENDIX A

Consent Form for Research

THE UNIVERSITY OF RHODE ISLAND

IRB
Exempt Consent

Dr. Hatfield
Department of Kinesiology
Dietary Intake of Male and Female Bodybuilders during Competition Preparation

You are being asked to take part in a research study. The purpose of the research study is to evaluate the dietary and nutritional supplementation strategies of bodybuilders on a large-scale basis in order to comprehensively provide a guide of their current practices during the "in-season" period leading up to a competition. Please read the following before agreeing to be in the study. If you agree to be in this study, you are confirming that you are a male or female that has competed or is currently competing in a bodybuilding competition. Additionally, you are confirming that you are at least 18 years old. It will take you approximately 20 minutes to complete this online survey in addition to providing your pre-recorded dietary records. Questions will be asked about dietary strategies, nutritional supplementation, and training during the "in-season" period leading up to a competition. Subjects who fully complete the online survey and provide their pre-recorded dietary records will be entered in a drawing to receive a $50 Amazon gift card, with five winners selected in total. There are no known risks or compensation with participating in this study.

Your responses will be strictly confidential. The responses may be used in a research paper or thesis presentation.

The decision to participate in this study is entirely up to you. You may refuse to take part in the study at any time without affecting your relationship with the investigators of this study or the University of Rhode Island (URI). Your decision will not result in any loss of benefits to which you are otherwise entitled. You have the right not to answer any single question, as well as to withdraw completely from the survey at any point during the process; additionally, you have the right to request that the researchers not use any of your responses.

You have the right to ask questions about this research study and to have those questions answered by me before, during or after the research. If you have questions about the study, at any time feel free to contact Dr. Hatfield from the Department of Kinesiology at the University of Rhode Island (URI), at 401-874-2980.

Additionally, you may contact the URI Institutional Review Board (IRB) if you have questions regarding your rights as a research participant. Also contact the IRB if you have questions, complaints or concerns which you do not feel you can discuss with the investigator. The University of Rhode Island IRB may be reached by phone at (401) 874-4328 or by e-mail at researchintegrity@etal.uri.edu. You may also contact the URI Vice President for Research and Economic Development by phone at (401) 874-4576.

Also, you will be asked to voluntarily fill out and complete the DHQIII survey (past month with portion size). This survey will take you approximately 45 minutes to complete. This is not required for full participation in this research study and you will still be entered in the $50 Amazon gift card drawing if you choose not to complete it.

If you would like to keep a copy of this document for your records, please print or save this page now. You may also contact the researcher to request a copy.

By signing or typing your name below, you indicate that you have read and understood the above and volunteer to participate in this study.

_____
Signature of Participant

_____
Date

APPENDIX B

Advertisement / Recruitment Email

THE UNIVERSITY OF RHODE ISLAND

All Advertisements and Recruitment Emails

Dr. Hatfield
Department of Kinesiology

Dietary Intake of Bodybuilders during Competition Preparation

Hello!

My name is Garrett Grill and I am a graduate student in the Kinesiology Department at the University of Rhode Island. I am working with Dr. Hatfield, the principal investigator, on a research study here at URI. The purpose of this study is to evaluate the dietary and nutritional supplementation strategies of male and female bodybuilders on a large-scale basis in order to provide a comprehensive guide on their current practices during competition preparation.

In order to be eligible to participate in this study, participants must be a male or female of at least 18 years old and have competed or are currently competing in a bodybuilding competition. There are no direct risks associated with participating in this online survey study, which would take no more than 20 minutes to complete.

Incentives: Participants who fully complete the online survey will be entered in a drawing to receive a $50 Amazon gift card, with five winners selected in total. Additionally, another five participants who fully complete the online survey will be randomly selected to receive a free apparel item of choice from House of Pain Apparel.

This research has been approved by The University of Rhode Island Institutional Review Board.

If there are any questions about the study, please do not hesitate to contact us.

Contact Information

- Garrett Grill, garrett_grill@uri.edu, 845-216-7858
- Dr. Hatfield, doch@uri.edu, 401-874-5183

Thank you for your help!

Sincerely,
Garrett Grill & Dr. Hatfield

SEPTEMBER 2020

APPENDIX C

Dietary Assessment of a Natural Bodybuilding Population Questionnaire

Dietary Intake of Male and Female Bodybuilders during Competition Preparation Survey

THE UNIVERSITY OF RHODE ISLAND

Department of Kinesiology

Dr. Disa Hatfield

Garrett Grill

PLEASE ANSWER All QUESTIONS RELATED TO YOUR COMPETITION PREPARATION

If you are unsure about any of the questions then please ask a researcher for clarification

Competitor Information

Competitor Class / Division:_____Age:_____

Years bodybuilding training:_____Years competing:_____Competitions this season: ____

Weeks dieting for this competition:_____

Current contest weight (lbs):_____Weight at start of preparation (lbs):_____

Height (in):_____Bodyfat % and the method used to estimate (leave blank if unsure):

_____

Highest bodybuilding accolade (example: IFBB Pro Men's Physique Overall Champion 2020):

_____

Fluid Intake

Typical daily fluid intake (ounces):_____

Do you use artificial sweeteners? Yes/No Do you use sugar free flavored drinks/syrup? Yes/No

Beverage intake during competition preparation, please mark (X) as appropriate

Standard Serving: can of soda 11oz, cup of tea 5oz, take away coffee 8oz									
Normal serving	Less than once a month	1 - 3 per month	1 per week	2 - 4 per week	5 - 6 per week	1 per day	2 - 3 per day	4 - 5 per day	6+ per day
Coffee									
Espresso									
Tea									
Herbal tea									
Energy drink									
Fizzy drinks									
Diet fizzy drinks									
Alcohol									

Supplementation

Supplement intake during competition preparation, please mark (X) as appropriate

Supplement	please mark (☒)	Brand
Multivitamin		
Vitamin C		
Vitamin D		
Mineral supplement		
Joint supplement		
Omega-3 / Cod liver oil		
Protein powder		
BCAA / EAA		
Individual amino acid		
Carbohydrate supplement		
Creatine (directly or indirectly)		
Fat burners		
Pre-workout supplements		
Protein bars		
Other		

Dietary Approach

Which best describes your dietary approach? Circle or highlight where appropriate:

Diet Style:	Clean eating	If it fits your macro's	Cheat meals
High:	Protein	Carbohydrate	Fat
Medium:	Protein	Carbohydrate	Fat
Low:	Protein	Carbohydrate	Fat

Competition Diet

In the space below, please record the diet followed (in either portion sizes, ounces, or grams) at the start, middle and end (not including peak week) of your competition preparation. Please be as specific as possible.

Initial Diet (first few weeks)	Middle Diet (halfway phase)	End Diet (final weeks)
Example Diet ***M1:*** *3 whole boiled eggs, 1 banana* ***M2:*** *40g whey protein shake, ½ cup of oats, 1 tablespoon of all-natural peanut butter* ***M3:*** *6 oz of grilled chicken, ¾ cup of white jasmine rice, 1 cup of pineapple* ***M4 (pre training):*** *6 oz of grilled chicken, 1 cup of white jasmine rice, 1.5 tablespoons of coconut oil* ***Pre-Workout:*** *1 scoop (19g) of Cellucor C4 Ultimate icy blue razz flavor* ***During Training:*** *10g of essential amino acids mixed with water* ***M5: (post training):*** *40g whey protein shake, 2 cups of Reese's puff cereal, 1 cup of sweetened almond milk* ***M6:*** *6 oz of shrimp, 1.5 cups of broccoli, 6 oz of white potato* ***Drinks:*** *2 cups of instant black coffee with meal 1* *1 can of Diet Coke*	**Example Diet** ***M1:*** *1 whole boiled egg, 1 cup of egg whites, 1 cup of spinach* ***M2:*** *40g whey protein shake, 1 tablespoon of all-natural peanut butter* ***M3:*** *6 oz of grilled chicken, 1 cup of green beans, ½ cup of white jasmine rice* ***M4 (pre training):*** *6 oz of grilled chicken, 1 cup of white jasmine rice, 1 tablespoon of coconut oil* ***Pre-Workout:*** *1 scoop (19g) of Cellucor C4 Ultimate icy blue razz flavor* ***During Training:*** *10g of essential amino acids mixed with water* ***M5: (post training):*** *40g whey protein shake, 1 Thomas' whole wheat bagel, 1 cup of unsweetened almond milk* ***M6:*** *6 oz of shrimp, 1.5 cups of broccoli, 6 oz of white potato* ***Drinks:*** *2 cups of instant black coffee with meal 1* *1 can of Diet Coke*	**Example Diet** ***M1:*** *1.5 cups of egg whites, ½ cup of oats* ***M2:*** *40g whey protein shake, 1 tablespoon of all-natural peanut butter* ***M3:*** *6 oz of grilled chicken, 1 cup of green beans, ½ cup of white jasmine rice* ***M4 (pre training):*** *6 oz of grilled chicken, 1 cup of white jasmine rice* ***Pre-Workout:*** *1 scoop (19g) of Cellucor C4 Ultimate icy blue razz flavor* ***During Training:*** *10g of essential amino acids mixed with water* ***M5: (post training):*** *40g whey protein shake, 1 cup of pineapple* ***M6:*** *6 oz of shrimp, 1.5 cups of broccoli* ***Drinks:*** *2 cups of instant black coffee with meal 1* *1 can of Diet Coke*

Initial Diet (first few weeks)	Middle Diet (halfway phase)	End Diet (final weeks)

On average, how many refeed / cheat meals did you consume each week during competition prep (include what you ate and macros if possible. This does not include peak week).

Peaking Strategies

Please check (☒) and provide additional detail where appropriate

Peaking Strategy	check (☒)	Details (food types, number of days, amount, timing etc.)
No Peaking Strategy, Regular Diet		
Carbohydrate depletion		
Carbohydrate loading		
Water loading		
Water depleting		
Sodium loading		
Sodium depleting		
Vitamin C or Citrus loading		
Other		

Contest Day Plan

Please check (☒) and provide additional detail where appropriate

Contest day strategy	check (☒)	Details (food types, amount, timing before stage, and brand)
High GI/ sugary carbohydrate pre stage		
Carbohydrate loading		
Fat loading		
Protein loading		
Regular diet		
use of alcohol		
use of sodium or salt foods		
Water depleting		
Minimal fiber		
Other		

How long did you "pump up" before going on stage? _____

Resistance Training Program

Please circle or highlight as appropriate

Resistance training at the start of competition preparation (first few weeks)

Number of resistance training sessions per week:	1	2	3	4	5	6	7+
Number of chest training sessions per week:	1	2	3	4	5	6	7+
Number of back training sessions per week:	1	2	3	4	5	6	7+
Number of leg training sessions per week:	1	2	3	4	5	6	7+
Number of exercises for chest, back, or quads:	1	2	3	4	5	6	7+
Typical sets per exercise for chest, back, or quads:	1	2	3	4	5	6	7+
Number of sets between 1 and 5 repetitions:	1	2	3	4	5	6	7+
Number of sets above 13 repetitions:	1	2	3	4	5	6	7+

Resistance training in the middle of competition preparation (halfway phase)

Number of resistance training sessions per week:	1	2	3	4	5	6	7+
Number of chest training sessions per week:	1	2	3	4	5	6	7+
Number of back training sessions per week:	1	2	3	4	5	6	7+
Number of leg training sessions per week:	1	2	3	4	5	6	7+
Number of exercises for chest, back, or quads:	1	2	3	4	5	6	7+
Typical sets per exercise for chest, back, or quads:	1	2	3	4	5	6	7+
Number of sets between 1 and 5 repetitions:	1	2	3	4	5	6	7+
Number of sets above 13 repetitions:	1	2	3	4	5	6	7+

Resistance training at the end of competition preparation (final weeks)

Number of resistance training sessions per week:	1	2	3	4	5	6	7+
Number of chest training sessions per week:	1	2	3	4	5	6	7+
Number of back training sessions per week:	1	2	3	4	5	6	7+
Number of leg training sessions per week:	1	2	3	4	5	6	7+
Number of exercises for chest, back, or quads:	1	2	3	4	5	6	7+
Typical sets per exercise for chest, back, or quads:	1	2	3	4	5	6	7+
Number of sets between 1 and 5 repetitions:	1	2	3	4	5	6	7+
Number of sets above 13 repetitions:	1	2	3	4	5	6	7+

Cardiovascular Training Program

Start of competition preparation (first few weeks)

Did you engage in fasted cardio? Yes/ No

Number of high intensity interval training (HIIT) or steady state cardio performed per week?

HIIT: 0 1 2 3 4 5 6 7 8 Other: _____

Duration and any additional information: _____

Steady State: 0 1 2 3 4 5 6 7 8 Other: _____

Duration and any additional information: _____

Habitual cardio sessions, example: walking to and from work, occupational cardio, etc.

Number of sessions: 0 1 2 3 4 5 6 7 8 Other:_____

Duration and additional information: _____

Middle of competition preparation (halfway phase)

Did you engage in fasted cardio? Yes/ No

Number of high intensity interval training (HIIT) or steady state cardio performed per week?

HIIT: 0 1 2 3 4 5 6 7 8 Other: _____

Duration and any additional information: _____

Steady State: 0 1 2 3 4 5 6 7 8 Other: _____

Duration and any additional information: _____

Habitual cardio sessions, example: walking to and from work, occupational cardio, etc.

Number of sessions: 0 1 2 3 4 5 6 7 8 Other:_____

Duration and additional information: _____

End of competition preparation (final weeks)

Did you engage in fasted cardio? Yes/ No

Number of high intensity interval training (HIIT) or steady state cardio performed per week?

HIIT: 0 1 2 3 4 5 6 7 8 Other: _____

Duration and any additional information:_____

Steady State: 0 1 2 3 4 5 6 7 8 Other: _____

Duration and any additional information:_____

Habitual cardio sessions, example: walking to and from work, occupational cardio etc.

Number of sessions: 0 1 2 3 4 5 6 7 8 Other:_____

Duration and additional information: _____

End of Questionnaire

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