

THE EFFECTS OF CARBOHYDRATE SUPPLEMENTATION
ON MOOD STATES OF BODYBUILDERS CONSUMING
A LOW ENERGY DIET

by

Christine E. Randall

Thesis submitted to the faculty of
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE IN EDUCATION
in
Exercise Physiology

APPROVED:

Dr. Janet Walberg-Rankin, Chairperson

Dr. Don R. Sebolt

Dr. Doug Southard

August, 1994
Blacksburg, Virginia

THE EFFECTS OF CARBOHYDRATE SUPPLEMENTATION ON MOOD
STATES OF BODYBUILDERS CONSUMING A LOW ENERGY DIET

(Abstract)

Christine E. Randall

Many bodybuilders attempt to lose large amounts of weight in short periods of time through the use of low energy diets. Research suggests that consumption of a low energy, low carbohydrate diet may negatively affect mood states. Further research suggests that carbohydrate consumption can positively affect mood states. This study evaluated two main ideas: (1) does the consumption of a carbohydrate supplement affect mood states during weight training bouts and (2) does carbohydrate supplementation affect perception of effort of a weight training bout. Male weightlifters (N=17) consumed a low energy diet for four days (21 kcal/kg body weight). On the fifth day, the weightlifters consumed either a carbohydrate beverage ("Sports Shot" at 1.15gm CHO/kg bw) or a placebo beverage ("Challenge" at 1.06gm protein/kg bw) before testing was started. The subjects filled out a Profile of Mood States (POMS) questionnaire fifteen minutes prior to and immediately after a bench press exercise test. The flat bench press exercise test consisted of lifting 7 sets of decreasing repetitions at 60% of their maximum lift with the final set continuing until volitional fatigue. Ratings of

Perceived Exertion (RPE) were recorded between each set. Data were analyzed by three-way ANOVA. The carbohydrate group had a significantly ($p < 0.05$) lower total POMS score compared with the placebo and control groups (30 ± 5.84 vs. 46.6 ± 5.84 and 42.3 ± 5.46). There were no differences in RPE between groups. These results suggest that carbohydrate ingestion 15 minutes prior to lifting weights decreases the total mood disturbance that may be experienced while lifting on a low-calorie diet.

ACKNOWLEDGEMENTS

I would like to sincerely thank the following individuals for their time and effort contributed towards the completion of this research project:

Dr. Janet Walberg-Rankin, chairman of my committee, for your guidance and support throughout this project: and Dr. Don Sebolt and Dr. Doug Southard for serving on my committee.

Lynette Poland, for being a great friend and partner during this entire research project.

In addition I wish to thank my parents for their continued support and encouragement throughout my academic career.

I wish to give special thanks to Vince Hatcher for all the extra support he provided.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....	iv
LIST OF TABLES.....	vii
LIST OF FIGURES.....	viii
CHAPTER I: INTRODUCTION.....	1
STATEMENT OF PROBLEM.....	2
SIGNIFICANCE OF THE STUDY.....	5
RESEARCH HYPOTHESIS.....	5
DELIMITATIONS.....	6
LIMITATIONS.....	7
BASIC ASSUMPTIONS.....	7
DEFINITIONS AND SYMBOLS.....	8
SUMMARY.....	8
CHAPTER 11: REVIEW OF LITERATURE.....	9
PRE-COMPETITION PRACTICES OF BODYBUILDERS.....	10
Dietary Practices.....	10
Exercise Practices.....	13
FUEL USE DURING WEIGHTLIFTING.....	16
DIETARY RESTRICTION INFLUENCES MOOD STATE.....	20
Caloric Restriction.....	20
Carbohydrate Content of Energy Restricted Diet.....	23
CARBOHYDRATE INGESTION IMPROVES MOOD STATE.....	26
MOOD ALTERATIONS WITH EXERCISE.....	29
Chronic Exercise.....	29
Single Bout Exercise.....	30
RATINGS OF PERCEIVED EXERTION (RPE)...	32
RPE Use.....	32
Glucose Ingestion and its effect on RPE.....	32
Psychological Influences on RPE.....	36
PROFILE OF MOOD STATES.....	37
SUMMARY.....	41
CHAPTER III: JOURNAL MANUSCRIPT.....	42
Abstract.....	43
INTRODUCTION.....	44
METHODS.....	46
Subjects.....	46
General Protocol.....	47
1-Repetition Maximums - Day 1.....	48
Practice Session 1 - Day 2.....	49

Practice Session 2 - Day 3.....	50
Three Day Maintenance Diet -	
Days 4 through 6.....	51
Four Day Low Calorie Diet -	
Days 7 through 11.....	52
Statistics.....	54
RESULTS.....	55
DISCUSSION.....	59
Effect of Carbohydrate on Mood	
State.....	59
Effect of Negative Energy Balance...	60
Effect of Weightlifting Bout on	
Mood State.....	61
Effect of Carbohydrate Ingestion	
on Mood State.....	62
Summary.....	65
REFERENCES.....	65
LIST OF CAPTIONS.....	68
CHAPTER IV: SUMMARY.....	80
DISCUSSION.....	82
RESEARCH IMPLICATIONS.....	89
RECOMMENDATIONS FOR FURTHER RESEARCH..	70
REFERENCES.....	92
Appendix A: METHODOLOGY.....	99
Appendix B: SAMPLE SUBJECT PERSONAL DATA SHEETS.....	109
Appendix C: DATA COLLECTION SHEETS.....	126
Appendix D: DIET AND SUPPLEMENT PORTIONS.....	150
Appendix E: RESULTS OF STATISTICAL ANALYSIS.....	155
Appendix F: RAW DATA.....	163
VITA.....	175

LIST OF TABLES

Table

1	Descriptive Statistics of Subjects.....	73
2	Exchange Diet of Carbohydrate and Placebo Groups..	74
3	Prescribed Lifting Program for Carbohydrate and Placebo Groups.....	75
4	Low Energy Diet Provided for Carbohydrate and Placebo Groups.....	76
5	RPE Scores.....	77
6	Results of Final Questionnaire.....	78
7	Body Weight of Subjects.....	79

LIST OF FIGURES

Figure

- 1 Mean POMS total score for groups across time..... 69
- 2 Mean POMS anger for groups across time..... 70
- 3 Mean POMS vigor for groups across time..... 71
- 4 Mean POMS fatigue for groups across time..... 72

Chapter I

INTRODUCTION

Several types of athletes are faced with the challenge of losing large amounts of weight in relatively short periods of time--bodybuilders are an example. Through rapid weight loss, bodybuilders try to improve their physique rather than their athletic performance. The ultimate goal of bodybuilders is to achieve large muscle mass that is clearly defined and symmetrical. To achieve rapid weight loss and muscle definition, body builders often opt to consume low energy diets. Reports of the diets of male bodybuilders during preparation for a contest show that those studied consumed 1936 - 3020 kcal/d (60). This is approximately 1000 kcal/d less than the energy intake reported during other times of the year (69). The diets had very little fat and a high protein content (69). The carbohydrate content composed only approximately half of the calories, but some of the men reported carbohydrate loading a few days before the contest (69). By restricting calories and carbohydrates, bodybuilders may be reducing body carbohydrate stores which may affect the quality of their workout. Thus carbohydrate supplements may be helpful to increase blood glucose levels and conserve muscle glycogen levels during preparation for a competition.

STATEMENT OF PROBLEM

Bodybuilders report doing resistance weight training up to two hours per day (60). The fuels used to sustain prolonged resistance exercise would include not only creatine phosphate but also muscle glycogen (12). When energy expenditure is intermittent but highly intense, as in resistance weight training, carbohydrate metabolism depends on muscle glycogen availability (63). A significant decrease in muscle glycogen has been reported after resistance exercise (24). Performance of many intense resistance sets show that carbohydrate availability could affect performance and peripherally sensed fatigue (63). By supplementing bodybuilders with carbohydrate before their lifting routine, there may ultimately be a conservation of muscle glycogen.

In addition to its effects on muscle glycogen, rapid weight loss can also adversely affect psychology--possibly due to inadequate dietary carbohydrate. Weight fluctuation caused by dietary restriction has been shown to alter psychological function in athletes who put an emphasis on low weight and low percent body fat (9). This impairment in psychological function can be detrimental to the health and the competitive edge of the athlete (9). Wrestlers report

interference in work, thoughts, personal relations, and feeling about self during the periods that they are restricting their dietary intake (14). Other populations show similar trends towards deterioration in mood and self esteem, as well as an increase in hunger, as is seen in the first week of dieting in obese individuals (52). Fasting individuals related experiences of increased aggression and irritability, depression and anxiety (72). The first week of hypocaloric dieting appears to be the most stressful in obese individuals (52).

The carbohydrate content of a diet may influence the magnitude of these psychological changes. In a technical review, Costill reported that three days of low carbohydrate, but regular caloric consumption caused athletes in general to become irritable, hypoglycemic, and unable to train (12). This is especially true when athletes undergo a carbohydrate loading regimen in which carbohydrates are severely restricted for several days. Wrestlers have reported decreases in drive and increases in depression (8) and obese individuals experienced hunger and dysphoria (52) when consuming a low-carbohydrate diet as compared to a normal carbohydrate diet. While studying obese individuals, Rosen could find no reason for the effects of low carbohydrate ingestion on mood and claimed

blood glucose levels could not readily be a mechanism for the adverse effects. Yet, he did conclude that changes in mood were improved with the addition of more dietary carbohydrate (52).

Female cyclists reported significant feelings of tension, depression, anger, and less vigor when following a low carbohydrate diet as compared with a moderate and high carbohydrate diet (30). Training with reduced muscle glycogen levels may have been difficult and, thus, adversely affected mood state (30). In effect, changes in mood states may be related to a diet that deviated from a subject's "normal" diet. Therefore, increasing carbohydrate intake may better be able to mirror the athlete's "normal" diet (30).

It has been postulated by Morgan (41) that successful athletes have superior mental and emotional health. Many factors could affect bodybuilder psychological states throughout the competitive phase, including not only the stress of the impending competition but also the rigor of training and dieting. It has been concluded that dieting for more than two weeks is consistently associated with adverse psychological symptoms (46). Newton found that during the 12 weeks they studied six male and two female bodybuilders who were preparing for a competition, there was

a significant trend to become more fatigued, depressed, tense, confused, and significantly less vigorous (46).

SIGNIFICANCE OF THE STUDY

Results of this study could help to provide more information regarding carbohydrate use in bodybuilders during the low calorie diet phase of competition preparation. Previous research has suggested that a combined regimen of dieting and intense exercise training in preparation for competition may be related to changes in psychological status. Administration of a single high-carbohydrate meal versus a high-protein meal has also been shown to alter the mood of obese and normal weight human subjects. The combination of these two statements appears to lead to a logical investigation. If an athlete is irritable, tired, or hungry, he probably does not get much out of his workout (48). Thus, carbohydrate supplements may improve the quality of a resistance training workout via its effect on psychological status.

RESEARCH HYPOTHESES

The following null hypotheses were developed to define the objectives of the present study:

1. Ho: There was no difference in psychological status during a weight lifting bout in dieting weightlifters who consumed carbohydrate compared to those who consumed a low carbohydrate supplement.
2. Ho: There was no difference in Ratings of Perceived Exertion during a weight lifting bout in dieting weightlifters who consumed carbohydrate compared to those who consumed a low carbohydrate supplement.

DELIMITATIONS

The following delimitations were incorporated into the study by the investigator:

1. The subject population was delimited to males (N=17) who were apparently healthy and had been weight training for at least one year, four to five days a week for approximately one hour per session.
2. This investigation was delimited to only four days of low-calorie intake.
3. This investigation was delimited to only the mood states measured in the Profile of Mood States questionnaire (Tension, Anger, Vigor, Confusion, Fatigue, and Depression) and Ratings of Perceived Exertion.

LIMITATIONS

The investigation acknowledged the following limitations:

1. Due to the specific population evaluated in this study, the results are limited to apparently healthy males who have been weightlifting for at least one year.
2. No Profile of Mood States scores were recorded prior to any intervention.
3. There was no control of the exercise prescription and prescribed diet.
4. There was a difference between the carbohydrate beverage and the protein (placebo) drink.

BASIC ASSUMPTIONS

The following assumptions were made at the onset of this investigation:

1. The subjects complied with all prescribed exercise and dieting regimens.
2. The subjects reported honestly on all questionnaires.
3. The subjects performed a true maximal effort in all performance measurement trials.

DEFINITIONS AND SYMBOLS

Profile of Mood States- A 65 five-point adjective rating scale developed to identify and assess transient, fluctuating affective states. The affective states include Tension-Anxiety, Depression-Dejection, Anger-Hostility, Vigor, Fatigue, and Confusion-Bewilderment.

Rating of Perceived Exertion- Self-rating scale developed by Borg (1962) to measure an individual's perceived efforts during exercise.

Bodybuilder- A male who has been lifting for at least one year, four to five times a week for approximately one hour per session.

SUMMARY

Bodybuilders are often challenged with losing large amounts of weight in short periods of time. They often choose to decrease energy intake, and consequently carbohydrate intake, to abnormally low levels. This decrease in dietary consumption can cause changes in mood states and, as a result, hinder weightlifting sessions. The purpose of this study was to evaluate the effects of carbohydrate ingestion on the mood states of bodybuilders during the low-energy phase of competition preparation.

Chapter II

REVIEW OF LITERATURE

According to a recent study, the extreme training and dieting that's routine before a bodybuilding competition may be hazardous to the mental health of a bodybuilder (46). Even with intense daily workouts consisting of almost two hours of weight lifting and lots of aerobic work, bodybuilders tend to keep their diets extremely low in fat and energy. And ironically, instead of becoming more mentally prepared as competition nears, bodybuilders tend to become more fatigued, depressed, tense and have significantly less vigor. The stress of competition, dieting, and intense training can all take a toll on a competitor's mental well-being.

This review will first be looking at some of the common nutritional practices of bodybuilders. It will then document how a strict regimen of weightlifting and low dietary carbohydrate levels can negatively affect mood states. Further, it will discuss the effect of carbohydrate supplementation on mood states. Finally, it will bring together the above ideas to demonstrate to how bodybuilders may derive mental benefits from carbohydrate

supplementation. An additional section will discuss the methods used to assess mood and psychological states.

PRE-COMPETITION PRACTICES OF BODYBUILDERS

Dietary Practices

During the competitive phase, bodybuilders attempt to achieve the lowest possible subcutaneous fat. This is accomplished through exercise and dieting. The ultimate goal of bodybuilders is to achieve maximum muscular development that is clearly defined and symmetrical. To achieve rapid weight loss and muscle definition, bodybuilders often choose to consume low calorie diets. Just prior to competing, several dietary manipulations are used to achieve the desired physique (60). Dieting for a contest is considered by many to be the most difficult aspect of competitive bodybuilding (55).

Steen's case study of one male bodybuilder showed a mean caloric intake during the off-season of 4,193 kcal/day. The percentage of calories from macronutrients was 72% carbohydrate, 5% fat, and 23% protein. Energy intake averaged 49 kcal/kg. Carbohydrate intake averaged 8.7 g/kg and protein averaged 2.8 g/kg (60). Sandoval et al reports that the total energy consumption (kcal) of bodybuilders,

when they are not dieting for competition, meets or exceeds the recommended dietary allowance (RDA), and the average relative percentages of energy intake typically range between 44-51% for carbohydrate, 23-34% for fat, and 22-26% for protein (55).

One report of the diets of male bodybuilders during preparation for a championship contest show that those studied consumed 2100 - 2350 kcal/day during training periods less than seven days before the competition (31). Steen's case study reported that three months prior to the contest the bodybuilder studied consumed a mean caloric intake of 3,020 (37 kcal/kg) with the percentage of calories from carbohydrate was 65%, from protein, 29%, and from fat, 6%. Carbohydrate intake average 6.1 g/kg and protein averaged 2.7 g/kg (60). Sandoval et al show an average relative percentage of energy intake for carbohydrate, fat, and protein ranging from 50-69, 10-16, and 21-37%, respectively. The protein intakes were on the average 1.7 to 3.0 time greater than the RDA (55). Sandoval et al's precompetition data was collected for the 3 days preceding competition.

In general, of the macronutrients, fat tends to be the most severely restricted. Protein content tends to increase as compared to RDA levels and carbohydrate content ranges

from 50% to 69% of the calories consumed depending upon the bodybuilder's individual diet (69). However, the carbohydrate intake two days prior to a competition increased to 78% in one case study; this is likely to be a method of carbohydrate loading. A strategy some bodybuilders use to try to enhance muscularity is to promote temporary swelling of the muscles the day of the contest by carbohydrate loading (60). Carbohydrate stores are depleted for three days after which the glycogen supercompensation is attained by a carbo-loading phase for the next three days during which high levels of carbohydrate are attained.

Data from Walberg-Rankin et al (69) showed that some of the foods commonly consumed by bodybuilders were chicken, tuna, egg whites, brown rice, rice cakes, and pasta. The bodybuilders tend to avoid egg yolks, red meats, and dairy products. Steen also showed that her subject followed a rigid monotonous dietary regimen (60). The types of food consumed were strictly limited to combinations that included chicken, turkey, tuna packed in water, egg whites, brown rice, pasta, whole grain cereal, vegetarian beans, banana baby food, tea, and water. Alcoholic beverages were rarely consumed. Sandoval et al showed similar results 3-4 months prior to competition with decreased food selections from the

milk exchange and eggs, poultry, and fish as the major protein sources (55). There was virtually no consumption of items from the dessert and alcoholic beverage groups in the precompetition diet.

As an end result, low energy intake can cause a reduction in lean body mass. Of the bodybuilders observed by Heyward et al (25), 75% of those dieting before a competition lost lean body mass with those who consumed the least amount of energy losing the most lean tissue. Unfortunately, this is opposite of what bodybuilders want to achieve. Bodybuilders want to increase their lean muscle mass and the most important nutritional factor to achieve this is adequate energy intake to allow for anabolism.

Exercise Practices

Bodybuilders tend to have a strict lifting protocol both during the off-season and precompetition. Steen's case study showed that during the off-season the subject she studied trained 4 days a week for 2 to 2 1/2 hours each day (60). He trained 4 days on and 1 day off, focusing on different muscle groups. A typical 4 days of training included the following:

Monday: Chest, Calves, abdomen

Tuesday: lower back, triceps, hamstrings

Wednesday: shoulders, biceps, calves, abdomen

Thursday: quadriceps, forearms

Friday: off

Depending on the muscle group, the bodybuilder performed 12-16 sets and 8-12 repetitions for each set. On Monday and Tuesday he rode a stationary bike for 30-45 minutes. At 3 months, weight training was similar to the off-season regimen. Aerobic activity was increased during this phase, as the stationary bike was used every day for 30 minutes.

Precontest weight training started 2 months prior to competition. During this time, workout decreased to 1-1 1/2 hours per day. As opposed to earlier training when heavier weight and less repetitions were used, lighter weights and more repetitions were used. Depending on the muscle group, the subject performed 5-8 sets and 15-30 repetitions for each. The stationary bike was used every other day during this time. The subject trained 3 days on and 1 day off. A typical 3 days included the following:

Monday: chest, lower back, biceps, forearms

Tuesday: upper back, hamstrings, abdomen

Wednesday: triceps, shoulders

Thursday: off

The week of a contest, all weight training stopped 4 days prior to the competition. Weightlifting involving the legs stopped 6 days prior to the competition (60).

Newton et al (46) showed a significant increase in training in bodybuilders going from off-season workouts to precontest workouts. The bodybuilders went from lifting an average of 5.7 days per week, 1.8 hours per day to 6.0 days per week, 2.2 hours per day. The total hours spent lifting each week went from 10.5 to 13.0. Newton et al also showed a significant increase in aerobic training. Bodybuilders went from 0.2 days per week for 0.1 hours per day in the off-season to 3.0 days per week for 0.4 hours per day. The total time spent in aerobic work went from 0.1 hours to 1.2 hours.

In general, bodybuilders tend to have a high total energy output. Hickson et al (26) found that the net energy cost for a 36 minute exercise session for an upper body and lower body routine was 174 and 222 kcal respectively. Workouts incorporating a high number of repetitions and sets are likely to make an individual expend more calories than and individual performing a higher intensity, lower volume workout (34).

Most bodybuilders perform long resistance training workouts up to six days per week. Most of these athletes also tend to participate in aerobic activity in an effort to reduce body fat. With such long workouts so often each week, bodybuilders tend to expend large amounts of calories.

FUEL USE DURING WEIGHTLIFTING

The depletion of muscle glycogen can make the maintenance of an intense effort difficult and eventually cause termination of the activity. As the intensity of exercise increases, glucose progressively becomes a more important fuel, and at very high workloads, nearly all of the energy for muscular work is derived from glucose metabolism (12). Glucose is provided to the muscles by the breakdown of muscle glycogen stores and by extraction from circulation. Blood glucose concentrations are maintained by increased glucose production from the liver (glycogenolysis and gluconeogenesis) and from ingested carbohydrates (18).

The relative amounts of glucose and fatty acids oxidized also change with increasing duration of exercise. Initially, there is a rapid increase in glucose oxidation with rapid utilization of muscle glycogen stores. The decreased endurance during low carbohydrate diets is associated with low preexercise muscle glycogen concentrations and exhaustion correlates well with depletion of muscle glycogen (5). Moderate aerobic exercise is associated with slight decreases in the blood glucose concentration, and increases in the concentrations of

lactate, pyruvate, glycerol, free fatty acids and ketone bodies. However, there is an increase in blood glucose concentration with intense exercise. The increases in blood lactate and pyruvate concentrations also increased, suggesting that some glucose is metabolized during exercise (28).

Fielding et al (20) has also demonstrated that the ability to perform intense anaerobic exercise has been related to the availability of muscle glycogen. A reduction in the capacity to perform exhaustive sprint activity has been demonstrated with both dietary manipulation of muscle glycogen stores and exercise-induced depletion of muscle glycogen. Fielding et al studied nine men during three 4-hour cycling bouts to determine the effects of frequency and dosage of carbohydrate feedings on muscle glycogen utilization and exercise performance. In one trial, subjects ingested 10.75 g of carbohydrate at 30-minute intervals; and in a second trial, subjects ingested 21.5 g of carbohydrate at 60-minute intervals. Blood glucose was significantly higher in the second trial 20 minutes after carbohydrate ingestion but returned to normal 50 minutes after ingestion. In the first trial, blood glucose maintained a constant level throughout the entire 4-hour trial. However, differences in blood glucose levels between

the trials did not significantly change the rate of muscle glycogen utilization. In a sprint ride to exhaustion at the end of each trial, the subjects had a significantly longer ride when consuming carbohydrate every 30 minutes as compared to the control trials (consuming a placebo). Fielding et al suggest that the elevations in blood glucose observed with carbohydrate feedings did not affect muscle glycogen use but may have enhanced sprint performance following prolonged exercise.

Dudley (15) reviewed the metabolic consequences of resistive-type exercise. He reports that resistive-type exercises (bodybuilding and power weightlifting) tend to have a larger power output than endurance exercise. Since there is such a large output of power, resistive-type exercise relies on the anaerobic pathways of energy metabolism versus aerobic metabolism. He found that hydrolysis of phosphocreatine and ATP, glycogenolysis, and glycolysis are all evident during an acute bout of resistive-type exercise. As the numbers of repetitions per set increase, there is an increased emphasis put on an energy supply coming from glycolysis. This is substantiated because immediately after resistive exercise, there are substantial increases in blood lactate suggesting energy contributions from glycolysis (15).

Lambert et al studied carbohydrate feedings on multiple-bout resistance exercise (35). Seven experienced resistance athletes were studied in two separate trials. One trial the athletes consumed a carbohydrate beverage (10% glucose solution) and the other trial they consumed a placebo. The subjects then performed leg extensions at 80% of their 10-repetition maximum, with three minutes of rest between sets. Subjects performed 10 repetitions the first set and continued until they failed to perform seven repetitions for a set (fatigue). Additional carbohydrate or placebo was given after the fifth, 10th, and 15th sets. They found that performance was greater for the carbohydrate ingestion trial than for the placebo trial but did not reach significance. His results suggest that carbohydrate availability may become a limitation during multiple-bout resistance exercise, and that enhancing carbohydrate availability through glucose polymer ingestion may tend to enhance performance. He found that when approximately 15 resistance exercise sets are performed for a leg extension exercise, a 10% glucose polymer (1 g/kg body weight) ingestion resulted in an elevated blood lactate and blood glucose and trends for improved exercise performance.

Resistive exercise, such as weightlifting, has not had extensive research done regarding muscle metabolism.

However, it appears that resistive exercise results in the decline of high energy phosphate and glycogen contents and results in the accumulation of glycolytic intermediates including lactate.

DIETARY RESTRICTION INFLUENCES MOOD STATE

Caloric Restriction

Rapid weight loss can adversely affect psychology, especially when the weight loss is frequent and of a large magnitude. Bodybuilders are an example of a group of athletes who try to achieve drastic, temporary changes in weight that are often unhealthy (27). Weight fluctuation, along with changes in diet and activity, can alter psychological function (9). Brownell et al (9) researched the weight regulation practices of athletes who maintain low weight and low percent body fat (e.g., distance runners, gymnasts, and figure skaters). He reported that discussions of food intake and weight patterns generate strong feelings among athletes. Anecdotally, he writes that some female athletes complain that keeping their weight down is a chronic struggle. Feelings of deprivation are common. He observed this to be less true of men, but the phenomenon has not been documented in either sex. Brownell et al concluded on the point that the weight loss and dieting practices of

athletes may have powerful psychological effects.

As set-point theory predicts, a body has a natural weight it seeks to defend, (8), and if individuals force their weight below this point, complex effects could occur. As a result emotional side effects could occur. Steen reported that as energy was restricted further in her bodybuilder's competition preparation, the bodybuilder reported feeling irritable and difficult to get along with (60). During the later part of his preparation, the bodybuilder said, "personal relationships are impossible to cope with." During the final phase the bodybuilder expressed feeling within himself, angry, hostile, and irritable. He complained that his diet was boring and that it made him tired and grouchy. Overall his mental state severely deteriorated during competition preparation.

The dysphoric affects that drastic dieting may provoke can often not be managed. Individuals on both total and supplemental fasts have reported to experience increased aggression and irritability (32). Kollar et al also documented episodes of depression and anxiety in fasting individuals. Modified fasting may provoke emotional complications that would be difficult to surmount and the untoward effects Kollar described must constantly be considered.

Severe caloric restriction may produce symptoms of emotional illness. It has been concluded from a review of literature that dieting for more than two weeks is consistently associated with adverse psychological symptoms (62). It was also shown in another study that 54% of the patients undergoing a six month treatment of very low calorie dieting and behavior modification demonstrated increased depression (68). The depression was proven to be an increase of 25% or more on the Beck Depression Inventory (BDI).

Rosen et al (52) reports a consistent trend for a deterioration in mood, diet-related attitude, and self-esteem during the first week of dieting in obese individuals consuming a low energy diet. Among the many causes of nonadherence to conventional dietary restrictions are persistent feelings of hunger and dysphoria which many dieters cannot tolerate and overcome. He also shows there is a trend towards increased hunger and craving during the first week of dieting in the same individuals. These factors combined together appear to be consistent with the reports from his subjects for a relative feeling of dysphoria. It appears as though the first week of dieting is the most stressful and the dieter becomes generally discouraged.

Newton et al (46) has demonstrated that the typical bodybuilder diet during preparation for competition causes the athletes to have altered mood states. During the 12 weeks of her study, there was a trend for bodybuilders to become more fatigued, depressed, tense, confused, and less vigorous. The trend was not statistically significant; however, her sample size was small (only 8 subjects total). The BDI also indicated that the bodybuilders depression scores increased significantly across the twelve weeks of her study but did not meet the clinical definition of depression. The final conclusion from this bodybuilding study showed that a combined regimen of dieting and intense exercise training in preparation for competition may be related to changes in psychological state.

Carbohydrate Content of Energy Restricted Diet

The carbohydrate content of a diet may influence the magnitude of these psychological changes. Failure to consume adequate carbohydrate while weight training tends to create irritable and depressed individuals. In a technical review, Costill (12) reported that three days of low carbohydrate intake caused athletes to become irritable, hypoglycemic, and unable to train. This is especially true when athletes undergo a carbohydrate loading regimen in which carbohydrates are severely restricted for several

days.

Obese individuals have been found to be less anxious after finishing a six week diet regimen consuming either a carbohydrate-restricted diet or a carbohydrate-containing diet (52). However, these individuals were found to have a more dramatic decrease in anxiety during the carbohydrate-containing phases of the dieting regimen.

Rosen et al introduced the theory that appetite suppression and mood elevation are due to ketosis (52). (Ketones are known to be increased by a low carbohydrate diet.) Two studies systematically measured appetite during varying degrees of ketosis and neither one found that ketosis was associated with a decrease in appetite (3,57). But because these investigations compared diets that were not isocaloric, the effects of ketosis, if any, could not be distinguished from the effects of caloric restriction. Also, changes in mood were not tested. Rosen found the "ketogenic" response in the two diets he studied were significantly different. Fasting ketone concentrations were significantly higher in the carbohydrate restricted diet than in the carbohydrate diet (52). The study gives no support to the idea that the type of carbohydrate-free protein supplemented fast used in the study specifically decreases appetite. Thus, suppression of appetite alone

does not appear to be sufficient reason in itself for using diets of this type.

Keith et al (30) have also shown that carbohydrate-containing diets have been related to psychological and behavioral changes in humans. Keith cited other literature also includes anecdotal reports of athletes "not feeling well" (increased irritability, depression, and fatigue) during the low-carbohydrate phase of the classical glycogen loading protocol (exercise to exhaustion followed by 3 days of a low-carbohydrate diet and then 3 days of a high-carbohydrate diet) (57). While on week-long low carbohydrate diets (1.2g/kg), cyclists had significantly greater scores for tension, depression and anger and less vigor (30). Total Profile of Mood State scores for the low carbohydrate diet was greater than the values for the medium (4.3 g/kg) and high carbohydrate (6.4 g/kg) diets.

Keith et al explain that the reasons for the adverse effects of low carbohydrate diets on mood are not known. Differences cannot be readily attributable to differences in blood glucose levels. He suggests that perhaps training with reduced muscle glycogen levels may have been difficult and, thus, adversely affected mood state. Another reason may simply be that the diet was different from the diet normally consumed by the subjects. It may be that in some

cases a diet that deviates from a subject's "normal" diet may be perceived somewhat adversely. Keith concluded by stating that the changes in mood were generally of an adverse nature and could be considered detrimental to training and performance.

The carbohydrate content of a diet influences the mood state of athletes. When the carbohydrate content of a diet is restricted, it tends to create mood alterations such as irritability, depression, anxiety, and fatigue.

CARBOHYDRATE INGESTION IMPROVES MOOD STATE

It has been suggested by Morgan et al (41) that successful athletes have superior mental and emotional health. Since many factors, including not only the stress of the impending competition but also the rigor of training and dieting, could affect the psychological state of bodybuilders throughout the competitive phase, it is seems logical that the competitive bodybuilder would like to obtain every advantage possible over his peers. If an athlete is irritable, tired, or hungry, he probably does not get much out of his workout (49).

Other studies have also shown that the administration of a single high-carbohydrate meal versus a high-protein meal can alter the mood of obese and normal-weight human

subjects (36). These changes in mood were shown to improve with the addition of more dietary carbohydrate. Lieberman et al introduced the suggestion that most nonobese adults exhibit increased drowsiness and impaired performance after carbohydrate ingestion. Changes in serotonergic neurotransmission may be responsible, in part, for these alterations in mood observed after carbohydrate consumption. Carbohydrate ingestion increases the brain's uptake of tryptophan, the amino acid precursor to serotonin, thereby enhancing brain serotonin synthesis and release. When sufficient amounts of protein are consumed along with the carbohydrate, these increases are prevented from occurring (19). Serotonergic neurons have been reported to participate in sleep, mood, and pain sensitivity (36), and it has been suggested that a deficiency in serotonin release may characterize some depressive illnesses (67).

The obese individuals in Lieberman et al's study (36) who craved carbohydrates and consumed the carbohydrate-rich lunch had a decrease in subjective depression as measured by the Profile of Mood States. This could resemble the effects of pure tryptophan on some depressed patients. In studies in which tryptophan has been used as an antidepressant, it has been shown to have some efficacy in mild or moderately depressed subjects (65). The decrease in depression seen in

the carbohydrate cravers suggests that carbohydrate foods may themselves have antidepressant-like properties.

When comparing the effects of a high-protein or high-carbohydrate meal on mood, Spring (59) found females reported greater sleepiness after a carbohydrate meal was consumed as opposed to a protein meal. However, the male subjects reported greater calmness, not sleepiness, after a carbohydrate meal was consumed as opposed to a protein meal. Spring also asserts that diet might exert measurable effects on behavior via the influence of precursor availability on the synthesis and release of brain neurotransmitters.

Kreider et al's (33) research on psychological states of field hockey players supplemented with carbohydrate showed that the supplementation reduced perceptions of fatigue during training compared to those who consumed a placebo. Kreider et al had two groups of field hockey players consume either a drink containing 1g/kg of carbohydrate four times daily or an identical volume of a flavored water placebo in addition to their ad libitum diets. The Profile of Mood States psychological inventory was administered prior to and following 10 practices held during a seven day period. He demonstrated that pre-exercise fatigue values tended to be lower in the carbohydrate containing groups and post-exercise fatigue

values were significantly lower in the carbohydrate containing groups (33). Results indicated that carbohydrate supplementation increased dietary availability of carbohydrate and reduced perception of fatigue during training.

Restoration of carbohydrate content to at least the normal amount an individual consumes can positively affect mood states. It can reduce fatigue, depression, anxiety, and make for a generally more positive mood state.

MOOD ALTERATIONS WITH EXERCISE

Chronic Exercise

A variety of psychological benefits have been attributed to regular participation in exercise. Numerous studies have concluded that there is a positive relationship between physical activity and various psychological states. Wifley & Kuncce (72) discovered significant increases in physical self-concept and reductions in tension-anxiety following an 8-week prescribed exercise program. At the conclusion of a 14-week swimming class college-age participants reported significantly less tension-anxiety, depression-dejection, anger-hostility, confusion-bewilderment, and more vigor-activity (4). Watson (70) found that exercise and social activity were strongly

related to positive affect.

However, not all studies indicate that exercise can improve mood. Overtraining can lead to the state known as staleness. It has been reported that the yearly incidence of staleness in college swimmers who train up to 14,000 m/day is about 10% (43). Furthermore, the career prevalence of staleness in elite distance runners has been reported to be 60% (43). Results of another Morgan et al study indicates that it is possible to provoke significant increases in mood disturbance within a period of 3 to 4 days following the onset of increased training, and the magnitude of this elevation approximates the values previously observed across long-term training (41). However, Morgan et al pointed out that the observed mood disturbances in his study was not of clinical significance. Example--even though there was an increase in depression, an individual's mean values fell within the normal range for college students.

Single Bout Exercise

McGowan et al (37) concluded in his study that participation in a single bout of exercise may produce positive changes in affect in normal college-age individuals. McGowan studied three 75-minute activities including running, karate, and weightlifting. He

administered the Profile of Mood States Test prior to and immediately after exercise bouts. He noted that participation in a single bout of exercise (either running or weight-lifting) significantly reduced reported total mood disturbance, tension, depression, anger, and confusion. Similarly, Thayer found that a 10-minute brisk walk decreased tension and increased feeling of vigor (64). Runners, specifically, reported less anxiety and depression (53), enhanced self-esteem, self-concept, and self-awareness (21), increased vigor, and clear-mindedness (42).

Similarly, Morgan (39) found evidence that tension states may be reduced as a consequence of the distraction from stress afforded by exercise. His explanation does not necessarily require that physiological change be present. These effects have been observed in the absence of measurable physiological change in some studies. Morgan was able to demonstrate that selected cognitive activities (e.g. dissociation) can reduce distress and enhance physical performance without measurable physiological effects.

The influence of increased physical activity on mood state can be affected by a variety of factors, including the type of exercise, the environment, and the cognitive and physical characteristics of the individual. The mood dimension is equally important. Studies of mood state and

exercise suggest that increased activity is more likely to reduce negative affect rather than enhance positive affect.

RATINGS OF PERCEIVED EXERTION (RPE)

RPE use

It is important to distinguish between the concept of fatigue and the concept of perceived exertion. Fatigue relates to a feeling of mental tiredness resulting in a diminishing performance capacity (7). Although the same performance reduction occurs with perceived exertion at high intensities, at moderate to low intensities perceived exertion may relate to an 'activation' or positive effect on performance (71). Borg and Ottoson also stated that earlier studies on the perception of fatigue did not measure changes in intensity.

Borg's RPE scale is by far the most frequently used (71). This scale has been shown to have a linear relationship with the physical workload and a high degree of validity and reliability (1). Borg's RPE scale has gained large acceptance in the perceived exertion field in a relatively short period of time, and hence an extensive literature has evolved on perceived exertion as measured by RPE (71).

Glucose ingestion and its effect on RPE

Major reviews in the area of ratings of perceived exertion generally agree that local factors dominate. "The assumed dominance of physiological factors has been challenged by the contention that in field situations, in which a variety of social psychological influences operate, psychological determinants of perceived exertion may be vastly more influential than previously estimated" (71). "Identification of the primary determinants of perceived exertion and knowledge of how these factors are integrated is vital for a concrete theory of perceived exertion to evolve."

With regard to the contributing role of energy substrates, both blood glucose and muscle glycogen content are thought to influence perceptual signal strength (50). Oral supplementation of carbohydrate before and/or during exercise delays muscle fatigue and prolongs submaximal endurance performance, probably by maintaining blood glucose and as a fuel for glycogen depleted muscle (13). "The delay in the onset of fatigue during endurance exercise when subjects are fed carbohydrate may be reflected in a lower peripheral rating of exertion for a given submaximal VO_2 , especially in the legs during the mid to later portions of prolonged cycling exercise" (11). "The decrease of the peripheral perceptual signal in the carbohydrate condition

may be related to the maintenance of a high rate of total carbohydrate oxidation made possible by the presence of high blood glucose pools" (37).

Burgess et al explains further, however, that a direct relationship may not exist between blood glucose and Ratings of Perceived Exertion under all conditions; it just appears that the maintenance of blood glucose is an important factor in decreasing peripheral exertional ratings during the latter stages of cycling exercise. Burgess et al studied the effects of glucose ingestion on RPE during prolonged cycling exercise. In two different trials, seven trained males cycled for 180 minutes at 70% of peak VO₂. Subject's consumed an 8% glucose/electrolyte drink or placebo every 15 minutes throughout the exercise. RPE was noted prior to the ingestion of the drink. RPE was found to be significantly lower when ingesting glucose versus the placebo during the last hour of cycle exercise. Burgess et al also found that ingestion of carbohydrate beverages during endurance cycling can maintain plasma glucose and carbohydrate oxidation during the latter stages of exercise. As a result, it appears that a relationship exists between RPE, blood glucose, and carbohydrate oxidation late in prolonged exercise.

Tabata et al studied the effect of blood glucose concentration on Ratings of Perceived Exertion during prolonged low-intensity exercise (65). They observed seven young healthy males performing bicycle exercise. They infused glucose after one hour of the initiation of exercise. Twenty percent glucose was infused intravenously to maintain a constant blood glucose level for 20 minutes. This was followed by 20 minutes of a placebo infusion. During the first 120 minutes of exercise, the ratings of perceived exertion increased gradually without any effects of the glucose infusion. Thereafter, RPE tended to decrease during glucose infusion, and finally showed a significant decrease from 180 minutes to 190 minutes. Presumably RPE was reduced by glucose infusion during the later part of the exercise because the inadequate content of glycogen in the muscle was balanced by the additional glucose available. Tabata demonstrated that glucose infusion affects perceived exertion only during the later part of physical exercise at low intensity, and suggested that this effect is related to the glycogen content of working muscle.

In general research suggests that as work intensity increases and physiological cues become stronger, RPE will increase. RPE is mediated by expected task duration only at moderate workloads (71).

Psychological Influences on RPE

Morgan et al (40) suggests that psychological factors may account for 33% of the variance in perceived exertion. Pandolf (48) asserts that, in field situations in which a variety of social psychological influences operate, psychological determinants of perceived exertion may account for more than this 33%. Sleep deprivation and physical fatigue elevate RPE when the exercise bout is of several minutes duration but not for shorter bouts (i.e. 30 seconds) (45). An increase in RPE under conditions of sustained work and sleep loss have also been reported by Ryman and co-workers (53). In his study, Ryman et al (53) reported that a negative mood rating contributed to the elevation in RPE. Increased RPE and performance decrements for conditions of sleep deprivation and sustained work cannot be prevented by high energy diets (51).

The effect of food deprivation on perceived exertion is unclear. Elia et al (16) had subjects walk or cycle at a standard pace for 20 minutes before, after and during four days of total starvation. He measured RPE (assessed with the Borg scale for perceived exertion) and found subjects to feel that the work load was greater during starvation than either before or after starvation.

Research suggests that RPE may be easily influenced by mood state. Individuals in a negative mood state may tend to report higher RPE than when the same individual is in a positive mood state.

PROFILE OF MOOD STATES (POMS)

The measurement of emotions, or mood states, is a difficult undertaking, especially when there is a need for a rapid, economical method of assessing fluctuating mood states. Such a circumstance arose in this study. It was important for the scale to identify several of the mood states that are most affected in the dieting bodybuilder. But the scale also had to be sufficiently easy so that it could be completed rapidly and with little to no instruction.

Several scales were investigated including the Beck Depression Inventory (BDI), Circular Mood Scales (CMS), and Profile of Mood States. The BDI was eliminated almost immediately because it only looks at one mood state-- depression. The CMS was then eliminated because it tended to be complex to understand and required much "teaching" to administer. It was also a difficult scale to score. The POMS was chosen because it is quickly administered, easy to score, and easy to understand.

The Profile of Mood States (POMS) is a 65-item, adjective rating scale designed to measure multiple dimensions of affect both economically and rapidly (38). The POMS has been employed widely since its publication in 1971 and has been particularly useful in psychological studies. The POMS consists of 65 adjectives that describe moods or feelings, to which the client responds on a 5-point scale that ranges from "Not at all" (0) to "Extremely" (4). The POMS measures six identifiable mood/affective states: Tension-Anxiety (T); Depression-Dejection (D); Anger-Hostility (A); Vigor-Activity (V); Fatigue-Inertia (F); and Confusion-Bewilderment (C). The scale is easily administered and quickly scored with norms provided for psychiatric outpatients and college students.

Several studies report data that indicates a highly reliable test (58). The results from such studies indicate that the individual items within the six mood scales that they measure the same mood factor at a level near .90 or above. The several different studies utilizing POMS indicate that test-retest reliability is high.

The six different mood factors used in the POMS have been easily replicated and can be seen to produce a highly

valid test. Further examination of each of the individual items in the POMS have also been shown to further support the content validity of the factor scores (58). In addition, reaserch in the area of pyschotherapy studies, controlled outpatient drug trials, cancer reaserch, drug abuse and addiction research, studies of response to emotion-inducing conditions, research on sports and athletes, and studies of concurrent validity coeffelcents and other POMS correlates provide eveidence of the predictive and construct valiidity of the POMS (58).

The POMS has been cited in at least 56 publications since its widespread use in sports research in 1975. Several authors have utilized the POMS in their exercise research. Stewart (61) used the POMS before and after his subjects exercised for a 10 week period. He measured a total mood disturbance score, which provides a single global estimate of affective state and is calculated by summing the scores across all six factors. He was able to find

significant differences across the different subject groups using this method.

Farrell (17) also utilized the POMS in this manner. He administered the test before and immediately after his subjects performed a 10-mile road race. He had subjects complete the POMS in a "right now" manner (subjects were to report their mood states as they were feeling "right now"). Kreider (33) administered the POMS immediately before and after field hockey team members had practice. He looked at total mood disturbance scores as well as each mood affect separately.

Norcross et al's (47) study of the factor structure of the POMS, provides two partial replications. Three of the six POMS scales--Anger/Hostility, Vigor/Activity, and Fatigue/Inertia--were replicated successfully and should be scored separately. The remaining three scales--Depression/Dejection, Tension/Anger, and Confusion/Bewilderment--did not emerge consistently as major independent components. Rather, he "found them to be highly correlated and factorially complex dimensions of psychopathology" (47). Norcross advised caution when using separate scoring and interpretation.

SUMMARY

A combined regimen of dieting and intense exercise training in preparation for competition may be related to changes in psychological state. Since athletes generally want every advantage they can get over their competitors, they look for any type of aid they can find. Since bodybuilders tend to get extremely fatigued, irritable and hungry during the final months of preparation for competition, it seems logical that they would like something to relieve these negative psychological effects. Since carbohydrate supplementation has been proven to improve mood states in other populations, it seems likely that it may help in bodybuilders. Therefore, the purpose of this study is to observe the effects of carbohydrate ingestion prior to a lifting sessions on mood states in bodybuilders in negative energy balance.

ABSTRACT

Many bodybuilders attempt to lose large amounts of weight in short periods of time through the use of low energy diets. Research suggests that consumption of a low energy, low carbohydrate diet may negatively affect mood states. Further research suggests that carbohydrate consumption can positively affect mood states. This study evaluated two research questions: (1) does the consumption of a carbohydrate supplement before a weightlifting bout affect mood states afterwards and (2) does carbohydrate supplementation affect perception of effort of a weight training bout. Male weightlifters (N=17) consumed a low energy diet for four days (21 kcal/kg body weight) or consumed their usual daily energy intake. On the fifth day, the weightlifters consumed either a carbohydrate beverage ("Sports Shot" at 1.15gm CHO/kg bw), a placebo beverage ("Challenge" at 1.06gm protein/kg bw), or nothing at all before testing was started. The subjects then filled out a Profile of Mood States (POMS) questionnaire fifteen minutes prior to and immediately after bench press exercise test. The flat bench press exercise test consisted of lifting 7 sets of decreasing repetitions at 60% of their maximum lift with the final set continuing until volitional fatigue. Ratings of Perceived Exertion (RPE) were recorded between

each set. Data were analyzed by three-way ANOVA. The carbohydrate group had a significantly ($p < 0.05$) lower total POMS score compared with the placebo and control groups (30 ± 5.84 vs. 46.6 ± 5.84 and 42.3 ± 5.46). There were no differences in RPE between groups. These results suggest that carbohydrate ingestion 15 minutes prior to a bench press test decreases the total mood disturbance that may be experienced while lifting weights on a low-energy diet.

INTRODUCTION

Several types of athletes are faced with the challenge of losing large amounts of weight in relatively short periods of time--bodybuilders are an example. To achieve rapid weight loss and, consequently, muscle definition, bodybuilders often choose to consume low calorie diets. Studies which have analyzed these diets report that they typically have very little fat, high protein content, and moderate carbohydrate at only approximately half of the calories (12,13).

Weight fluctuation caused by dietary restriction has been shown to alter psychological function in athletes who put an emphasis on low weight and low percent body fat (2). This impairment in psychological function can be detrimental to the health and the competitive edge of the athlete (2).

Attention Patron:

Page 44 is missing
from all copies

Newton (10) has demonstrated that the typical bodybuilder diet during preparation for competition causes the athletes to have altered mood states. During the 12 weeks of their study, there was a trend for bodybuilders to become more fatigued, depressed, tense, confused, and less vigorous. Steen (8) also reported in her case study that as energy was restricted further in the diet of the bodybuilder studied while preparing for competition, the bodybuilder reported feeling irritable and difficult to get along with.

The carbohydrate content of a diet may influence the magnitude of these psychological changes. In a technical review, Costill reported that three days of low carbohydrate, but regular caloric consumption caused athletes in general to become irritable, hypoglycemic, and unable to train (3). This is especially true when athletes undergo a carbohydrate loading regimen in which carbohydrates are severely restricted for several days.

The mechanism for the effects of low carbohydrate ingestion on mood is not clear since blood glucose levels cannot be readily attributed to the adverse effects. However, it has been concluded that changes in mood were improved with the addition of more dietary carbohydrate (11,6). In effect, changes in mood states may be related to a diet that deviated from a person's "normal" diet, and thus

increasing carbohydrate intake may better be able to mirror the athlete's "normal" diet (4).

A combined regimen of dieting and intense exercise training in preparation for competition may be related to changes in psychological status. If an athlete is irritable, tired, or hungry, he probably does not get much out of his workout (15). Thus carbohydrate supplements may improve the quality of a resistance training workout via its effect on psychological status.

The purpose of this investigation is to determine if carbohydrate supplementation can affect the mood state of bodybuilders consuming a low energy diet.

METHODS

Subjects

The subjects included 17 males who had been training for a period of at least one year. Training was defined as having consistently lifted for sixty minutes four times a week. (The subject pool started at n=24; however, several subjects had to be dropped due to self-reported lack of compliance to either the prescribed diet or exercises or failure to complete testing protocol.) Subjects were recruited from the Virginia Tech campus and surrounding areas. Subject's were informed of any risks associated with

the study, signed forms of consent, and were not included in the study if they had any health problems that might have put them at risk during this study or if they would be unable to complete any portion of the study. Subject's were randomly assigned to groups. (Carbohydrate group n=6, Placebo group n=6, Control group n=5).

General Protocol

The general protocol of the study is presented below.

Timeline of Study

DAY												
1	2	3	4	5	6	7	8	9	10	11		
I	---	I	---	I	---	I	---	I	---	I	---	I
1-RM		P-2				PRT				PST		
	P-1		I--MD	---	I							
							I-----	LC-----				

1-RM = 1-Repetition Maximum Testing

P-1 = Practice Session 1

P-2 = Practice Session 2

MD = Three Day Maintenance Diet

PRT = Pre-Diet Test (7-9a.m.)

LC = Four Day Low-Calorie Diet

PST = Post-Diet Test (7-9a.m.)

The study began on Day 1 which included performance of 1-repetition maximums (1-RM) of several different

weightlifting exercises. These 1-RM's were used to prescribe weightlifting exercises to be performed during the study. Days 2 and 3 were designated for practice sessions of the bench press test. These sessions were to help reduce any learning effect on the performance test. The subjects then were prescribed a three day maintenance diet (Days 4 through 6) to get all subjects to approximately the same eating patterns and carbohydrate consumption prior to the start of the low calorie dieting phase. Subjects in the control group did not follow this diet but rather consumed their usual daily energy intake. The subjects were brought in on the first morning of the low energy diet (Day 7) to consume a supplement (controls consumed nothing), fill out the Profile of Mood States (POMS) questionnaire, perform a bench press exercise, and finally fill out a second POMS questionnaire (this was called the pre-diet test). The low energy diet was followed for four days (Days 7 through 10), with the exception of the control group that consumed its usual energy intake, and on the fifth morning (Day 11) subjects were brought in for the final time to perform a post-diet test which was exactly the same as the pre-diet test. The post-diet test was performed at the same time of day as the pre-diet test and subjects consumed the same supplement they consumed for the pre-diet test.

1-Repetition Maximums - Day 1

1-RM's were performed for each exercise the subjects would be using in their prescribed exercise workout. Subjects were allowed to perform an individual warm-up on each exercise. Subjects were asked to think about what weight their maximum lift might be and to lower that to a lift they knew they could perform. Subjects increased the weight according to how difficult the previous lift was and continued on until no heavier lift could be attained. Subjects were allowed from four to five sets in order to determine their maximum lift. Subjects were allowed to rest between sets until they felt they could continue.

Practice Session 1 - Day 2

The first practice session required subjects to come to laboratory between 7 and 11 a.m. The session started with some general subject measurements. Each subjects' height, weight, and percent body fat was obtained. Percent body fat was determined using John Bull (British Indicators, Inc.) skin fold calipers. The skin fold sites were taken in triplicate and averaged for the chest, abdomen, and thigh. Percent body fat was determined using equations obtained from the book Guidelines for Exercise Testing and

Prescription put out by the American College of Sports Medicine.

Subjects then performed the bench press exercise. This exercise consisted of lifting seven sets at 60% of their flat bench 1-RM. The repetitions decreased with each set (starting at 18 and decreasing down to 15, 12, 10, 8, and 6) until the seventh set at which time the subject's were asked to perform repetitions until volitional fatigue. Each set had a two minute and 30 second rest period following it before the next set was begun.

Ratings of Perceived Exertion (RPE) were reported by the subject between each set immediately upon completion of the previous set. Borg's 6-20 RPE scale was utilized. Subject's were instructed that they should concentrate on their total, inner feeling of physical stress, effort and fatigue when reporting their number. They were given the reference points that 6 was equivalent to sitting at home watching television and that 20 was maximal effort.

Practice Session 2 - Day 3

The second practice session occurred between 7 and 11 a.m. and started with education regarding the maintenance diet the subjects were going to be following for three days. Subjects were instructed as to the use of the Diabetic

Exchange diet and how many exchanges they were allowed per food group. They were shown samples of the different sizes of the portions for each exchange. Subjects were also given forms to be filled out regarding their adherence to both the diet and their weightlifting routine. Subjects then performed the bench press exercise exactly as was done during practice session one.

Three Day Maintenance Diet - Days 4 through 6)

Diet - The diet to be followed for three days was the Diabetic Exchange diet. Fat was set to be 30% of the diet, protein at 15%, and carbohydrate at 55% with caloric consumption at 35kcal/kg of body weight. Exchanges were determined relative to body weight (Table 2). Records were filled out regarding the consumption of these exchanges to validate that all, but no more, exchanges were consumed. Subjects were free to call the investigator with any questions regarding the diet. No dietary supplements or alcohol were allowed to be consumed during these three days.

Exercise - The exercises performed during these three days were determined via the 1-RM's performed earlier (Table 3). On day four subjects lifted exercises for the legs, calves, biceps, and abdominal; on day five they lifted exercises for the chest, back, and abdominal; and on day six

they lifted exercises for shoulders, triceps, and abdominal. Subjects also performed 30 minutes of aerobic exercise each day on a stationary bicycle that was in a convenient place for them. Subjects were instructed to keep their heart rate between 65-75% of their age-adjusted maximum. These values were given to them along with instructions how to take their heart rate. Charts were filled out to validate the proper completion of the prescribed workout for each workout session. Subject's were encourage to call the investigator with any problems regarding the exercises prescribed to them.

Four Day Low Calorie Diet - Days 7 through 11

Diet - The diet for the next four days was set at 21 kcal/kg body weight. The diet consisted of 15% fat, 30% protein, and 55% carbohydrate. The diet was provided to the subjects each day and consisted of spaghetti, tomato sauce, rice cakes, peanut butter, rice, tuna fish, and oatmeal (Table 4). Subjects were to report each morning of this diet between the hours of 7-9a.m. to pick up their daily food, be weighed, and fill out a brief report of any unusual problems arising from the diet. Subject's were given check off sheets with the food they were provided listed to record that all food was consumed and that nothing extra was eaten.

These sheets were turned in all together when the subject reported for the post-test. The subject's were not allowed to consume any dietary supplements or alcohol during these four days.

Exercise - The subjects did not do any exercise the first day of their low calorie diet. The subjects followed the exact same exercise routine that they had followed during the three day maintenance diet (Days 4-6) during the remaining three days.

Pre-diet test (Day 7) and Post-diet test (Day 11) - Subjects were instructed to come in on the morning of each test having fasted for 12 hours, not exercising for 18 hours, and not consuming caffeine or tobacco products for 4 hours prior to their testing time. Subjects were given either a carbohydrate beverage ("Sports Shot" at 1.15gm CHO/kg body weight and 4.6kcal/kg body weight) or a placebo beverage ("Challenge" at 1.06gm of protein/kg body weight and 4.25 kcal/kg body weight). Subject's were required to consume the beverage within 10 minutes. The time was noted when the subject had completely consumed his beverage. The subject was then instructed to fill out a Profile of Mood States questionnaire as to how he was feeling at that moment. Fifteen minutes after the

consumption of the beverage the subject started the bench press exercise. The bench press exercise was exactly the same as the one followed during practice sessions 1 & 2. As soon as subjects were able to be seated at a desk and handed the questionnaire upon completion of the bench press exercise, subjects filled a second Profile of Mood States.

Following the completion of the Post-diet test, subjects filled out a brief questionnaire. Subjects were asked a forced choice question whether or not they felt they complied with the diet and exercise prescriptions. Subjects were also asked an open-ended question as to whether they could tell what kind of beverage they were consuming and forced choice question to determine if they felt it helped them either psychologically, physically, or both.

Statistics

To determine the effects of carbohydrate supplements on a bodybuilder's mood, a three-way ANOVA was performed. Where indicated, A Duncan's post-hoc test was used to determine the individual differences between means. To determine effects of carbohydrate supplements on a bodybuilder's Rating of Perceived Exertion, a two-way ANOVA, adjusted for repeated measures, was performed. Where indicated a Duncan's post-hoc test was used to determine

differences between means.

RESULTS

Combined subject body weight decreased during the low energy diet (Days 7 through 10) of this study. The carbohydrate group lost an average of 0.3 ± 0.1 kg and the placebo group lost an average of $1.9 \pm .4$ kg. The control group body weight remain essentially the same, changing only 0.1 kg. Table 7 shows body weight changes from Pre to Post-Tests. There was no statistical difference between pre and post body weights of any of the groups.

Total Mood Score - Figure 1

The total mood disturbance score for the carbohydrate group when collapsed over all four measurement times was significantly less ($p < 0.05$) than either the placebo or control group (Figure 1). The carbohydrate group had a mean score of 30 ± 5.84 whereas the placebo group had a mean score of 46.6 ± 5.84 and the control group had a mean score of

42.3±5.46 when collapsed over all measurement periods.

The negative energy balance and the weightlifting bout itself did not affect total mood scores for any groups when collapsed across measurement periods.

Anger - Figure 2

When scores were collapsed, there tended to be lower ($p=0.18$) POMS anger scores for the carbohydrate groups than either the placebo or control groups. The carbohydrate group had the score of 0.77 ± 2.25 , whereas the placebo group had the score of 6.23 ± 2.25 and the control group had the score of 3.97 ± 2.11 when collapsed over all measurement periods.

There was no effect of the negative energy balance on POMS anger scores for any group when collapsed for each trial.

There were significantly lower ($p<0.05$) scores reported for anger after the weightlifting bout.

Vigor - Figure 3

The POMS score for vigor (when collapsed) showed no difference between the carbohydrate group, placebo (protein) group, and control group.

There was no effect of the negative energy balance on POMS vigor scores.

There was a significant effect of the weightlifting bout on the subjects' vigor scores. The subjects had a trend of higher scores ($p=0.059$) after the weightlifting bout when trials and groups were collapsed.

Fatigue - Figure 4

The POMS score for fatigue when collapsed across over all time measurement periods tended to be lower ($p=0.17$) for the carbohydrate group than either the placebo (protein) or control groups. The carbohydrate group had the score of 4.75 ± 1.43 , whereas the placebo (protein) groups had the score of 5.22 ± 1.43 and the control group had the score of 5.36 ± 33 when collapsed over all measurement periods.

There was no effect of the low energy diet on fatigue scores when averages were collapsed for each trial.

There was a significant effect of the weightlifting bout on the subjects' fatigue scores. The subjects had significantly higher degrees of fatigue after the weightlifting bout ($p=0.057$).

There were no significant interactions between the independent measures on scores of total mood, vigor, anger, and fatigue.

Effect of Supplement on Ratings of Perceived Exertion

Ratings of Perceived Exertion (RPE) were analyzed in two different manners. First, average RPE scores for sets one through six were compared between groups for the pretest and posttest. No significant difference was found to occur. Second, the average RPE scores given between each set (sets 1 - 6) during the bench press test of the post-test were compared between groups and, once again, no significant effect was found (Table 5). However, there was a significant effect of time on RPE.

Responses to Final Questionnaire

The most positive responses to the final questionnaire (Table 6) appeared to be from the carbohydrate group. Fifty-seven percent of the carbohydrate group was able to determine what they were drinking. Only 43% of the placebo (protein) group was able to determine what they were drinking. Seventy-one percent of the carbohydrate group felt the carbohydrate beverage helped them psychologically and 57% felt it helped them physically. Of the placebo group, no one felt it helped them psychologically and only 14% felt it helped them physically.

DISCUSSION

Effect of Carbohydrate on Mood State

The present study demonstrates that carbohydrate ingestion 15 minutes prior to a bench press test had positive effects on the mood states of bodybuilders. It shows that total mood disturbance is lower, vigor tended to be higher, and fatigue and anger tended to be lower in bodybuilders consuming a carbohydrate supplement before a weight training bout compared to those consuming no supplement or a protein supplement. However, a limitation to this study is presented by not having a baseline measurement of the POMS without supplement use.

Keith showed results that were similar to these findings (4). His study with seven highly trained female cyclists who consumed diets varying in dietary carbohydrate, protein, and fat intake showed that subjects on the low carbohydrate diet had significantly greater baseline anger (22.8 ± 12.4) and total mood disturbance (88.2) and less vigor (9.4 ± 5.1) than the medium carbohydrate (7.8 ± 4.4 , 63.8, 18.4 ± 3.2) and high carbohydrate groups (7.8 ± 5.0 , 68.4, 16.4 ± 7.2). The placebo group of the current study showed greater change in total mood disturbance (46.6 ± 5.5), less

vigor (16.6 ± 1.4), and greater anger (5.0 ± 2.3) and fatigue (6.5 ± 1.4) than the carbohydrate group (30 ± 5.8 , 13.6 ± 1.4 , 0.8 ± 2.3 , 4.6 ± 1.4).

Kreider et al looked at carbohydrate supplementation during intense field hockey training on psychological status (5). His subjects ingested the carbohydrate supplement four times daily. He then measured Profile of Mood States prior to and immediately after each practice. His results indicated that carbohydrate supplementation reduced perceptions of fatigue (pre-exercise= 5.8 ± 3.6 and post-exercise= 10.7 ± 6.2) during training. However, unlike the current study, his results did not show any degree of change in total mood disturbance (pre-exercise= 9.5 ± 18.3 and post-exercise= 22.3 ± 25.9).

The differences across the scores between this study, Keith's study and Krieder's study can be attributed to special circumstances under which each study was conducted. Since the POMS is a sensitive questionnaire designed to monitor minor changes in mood and the circumstances between the three studies were different, it makes sense that the studies show differences between scores while still maintaining similar trends in mood score shifts.

Effect of Negative Energy Balance

The results of this study indicate that a negative energy balance can decrease vigor. These results are similar to the results reported in several other studies. Newton et al (10) report that during the twelve weeks that they studied bodybuilders at a reduced energy intake, their subjects tended to be more fatigued (6.3 ± 2.63), depressed (4.57 ± 7.39), tense (9.0 ± 6.7), confused (6.9 ± 2.6) and significantly less vigorous (15.9 ± 5.9) than prior to dieting (3.4 ± 3.6 ; 1.4 ± 1.6 ; 4.9 ± 4.7 ; 3.4 ± 2.2 ; and 23.1 ± 5.5). Newton et al concluded that a combined regimen of dieting and intense exercise training in preparation for competition may be related to changes in psychological state.

Steen's case study of a male bodybuilders demonstrates similar mood state changes (12). While decreasing his energy intake, Steen's bodybuilder found himself reporting feelings of anger, hostility, and irritability. Steen's study did not use any formal questionnaire, such as the POMS to determine mood state changes; therefore, no comparisons of scores can be made.

This study did not find any changes in factors such as anger, vigor, or fatigue. This may be due to the fact that this study only lasted four days, whereas, Steen's study lasted a matter of weeks.

Effect of a Weightlifting Bout on Mood State

The results of this study show an increase in vigor, yet an increase in fatigue after a weightlifting bout. This is similar to the results of Morgan et al's study (9). Morgan studied the affective benefits of vigorous physical activity such as walking or running. He found that it is unclear why exercise causes positive effects on mood shifts. He reports that there is evidence that tension states may be reduced as a consequence of the distraction from stress afforded by exercise. He explains that a physiological change does not have to be present for this to occur. Morgan states that these effects have been observed in the absence of measurable physiological change in some studies.

McGowan et al (7) studied mood alterations with a single bout of physical activity such as running and weightlifting. He observed college-age males after participating in a variety of physical activities. He found that participating in a single bout of exercise significantly reduced reported total mood disturbance, tension, depression, anger, and confusion. The magnitude of these changes was greater than what was seen in this study. However, the scores for these variables in their study were higher than they were in the current study.

Effects of Carbohydrate Ingestion on RPE

The current study did not find that type of supplement ingested affected RPE during a weight training bout. This is different from results of studies looking at carbohydrate supplement before aerobic exercise. Burgess et al (1) studied the effects of glucose ingestion on RPE. She had subjects consume carbohydrate every 15 minutes throughout a cycling protocol. Their results appear to show that a relationship exists between RPE and blood glucose late in prolonged exercise.

Tabata et al was also able to establish this relationship (14). The purpose of their investigation was to determine the relationship between blood glucose concentration and perceived exertion during prolonged low-intensity exercise. Tabata et al studied seven males performing bicycle exercise over several hours. The subject's were alternately infused with a glucose solution and placebo solution every twenty minutes throughout the exercise bout. Tabata et al found several hours into the exercise bout that subject's RPE tended to decrease during the glucose infusion. He found that an increase in blood glucose concentration has a significant effect on perceived exertion, even when exercise time is prolonged. He found that glucose infusion had the greatest effect on RPE when muscle glycogen content was not at lower than normal levels.

The results of the current study did not show any effect of carbohydrate supplementation on RPE. These results may have been contrary to previous studies for two main reasons. One, the current study looked at carbohydrate ingestion before exercise rather than during exercise as in the previously discussed studies. Two, the current study had exercise lasting only approximately 20 minutes whereas the previous research discussed had exercise lasting 180 minutes.

Central and local factors both play a role in fatigue during physical exercise. A central factor may be described as the cardiovascular system and the arm muscles may be an example of local factors (14). Central nervous system distress is considered to be caused by hypoglycemia (14). Arm fatigue is believed to result from an inadequate supply of carbohydrate to the working muscle. Therefore, both of these factors are believed to be related to carbohydrate deficiency. Possibly, the results of this study showed no change in RPE due to the fact that the intramuscular glycogen was high enough to meet the carbohydrate demand. However, if the exercise bout was prolonged beyond 20 minutes (as a typical weightlifting bout is), there may have been a sufficient reduction in muscle glycogen to cause changes in RPE. Carbohydrate ingestion in this case may

have reduced RPE.

SUMMARY

The primary objective of this study was to evaluate carbohydrate ingestion 15 minutes prior to exercise on the mood state of bodybuilders on a low-calorie diet. The results of this study indicate that carbohydrate ingestion has a positive effect on mood states.

These data provide information regarding the improved psychological status of bodybuilders on low-calorie diets. This could have implications for bodybuilders preparing for competition. By consuming a carbohydrate supplement prior to a workout session, this type of athlete may have an improved mood state.

REFERENCES

1. Burgess, M.L., R.J. Robertson, J.M. Davis, and J.M. Norris. RPE, blood glucose, and carbohydrate oxidation during exercise: effects of glucose feedings. Med. Sci. Sports Exer. 23(3): 353-359. 1991.
2. Brownell, K.D., S.N. Steen, and J.H. Wilmore. Weight regulation practices in athletes: analysis of metabolic and health effects. Med. Sci. Sports Exerc. 14: 382-389. 1982.
3. Costill, D.L. Carbohydrates for exercise: dietary demands for optimal performance. Int. J. Sports Med. 9: 1-18. 1988.
4. Keith, R.E., K.A. O'Keeffe, D.L. Blessing, and G.D. Wilson. Alterations in dietary carbohydrate, protein, and fat intake and mood state in trained female cyclists. Med. Sci. Sports Exerc. 23(2): 212-216. 1991.
5. Kreider, R.B., D. Hill, G. Horton, M. Downes, S. Smith, B. Anders. Effects of carbohydrate supplementation during intense field hockey training on dietary patterns, psychological status, and performance. Department of Movement Science & Education, Memphis State University, Memphis, TN 38152 & the Departments of Intercollegiate Athletics & HPER, Old Dominion University, Norfolk, VA 23529.
6. Lieberman, H.R., J. Wurtman, and B. Chew. Changes in mood after carbohydrate consumption among obese individuals. Am. J. Clin. Nutr. 44: 772-778. 1986.
7. McGowan, R.W. and E.F. Pierce. Mood alterations with a single bout of physical activity. Percept. and Motor Skills. 72: 1203-1209, 1991.
8. McNair, D.M., M. Lorr, and L.F. Droppleman. Profile of Mood States Manual. San Diego, CA: Educational and Industrial Testing Service, 1971.
9. Morgan, W.P. Psychological factors influencing perceived exertion. Med. Sci. Sports. 5: 97-103, 1985.

10. Newton, L.E., G. Hunter, M. Bammon, and R. Roney. Changes in psychological state and self-reported diet during various phases of training in competitive bodybuilders. J. Strength and Cond. Res. 7(3): 153-158, 1993.
11. Rosen, J.C. D.A. Hunt, E. Sims, C. Bogardus. Comparison of carbohydrate-containing and carbohydrate-restricted hypocaloric diets in the treatment of obesity: effects on appetite and mood. Am. J. Clin. Nutr. 36: 463-469, 1982.
12. Steen, S.N. Precontest strategies of a male bodybuilder. Inter. J. Sport Nutr. 1: 69-78, 1991.
13. Sandoval, W.M., and V.H. Heyward. Food selection patterns of bodybuilders. Inter. J. of Sport Nutr. 1:61-68. 1991.
14. Tabata, I., and A. Kawakami. Effects of blood glucose concentration on ratings of perceived exertion during prolonged low-intensity physical exercise. Jap. J. of Phys. 41: 203-215, 1991.
15. The Physician and Sports Medicine. Weight reduction in wrestling. 9: 79-96. 1981.

LIST OF CAPTIONS

Figure

- 1 Mean POMS total score for groups across time
- 2 Mean POMS anger for groups across time
- 3 Mean POMS vigor for groups across time
- 4 Mean POMS fatigue for gourps across time

Table

- 1 Descriptive Statistics of Subjects
- 2 Exchange Diet of Carbohydrate and Placebo Groups
- 3 Prescribed Lifting Program for Carbohydrate and Placebo Groups
- 4 Low Energy Diet Provided for Carbohydrate and Placebo Groups
- 5 RPE Scores
- 6 Results of Final Questionnaire
- 7 Body Weights of Subjects

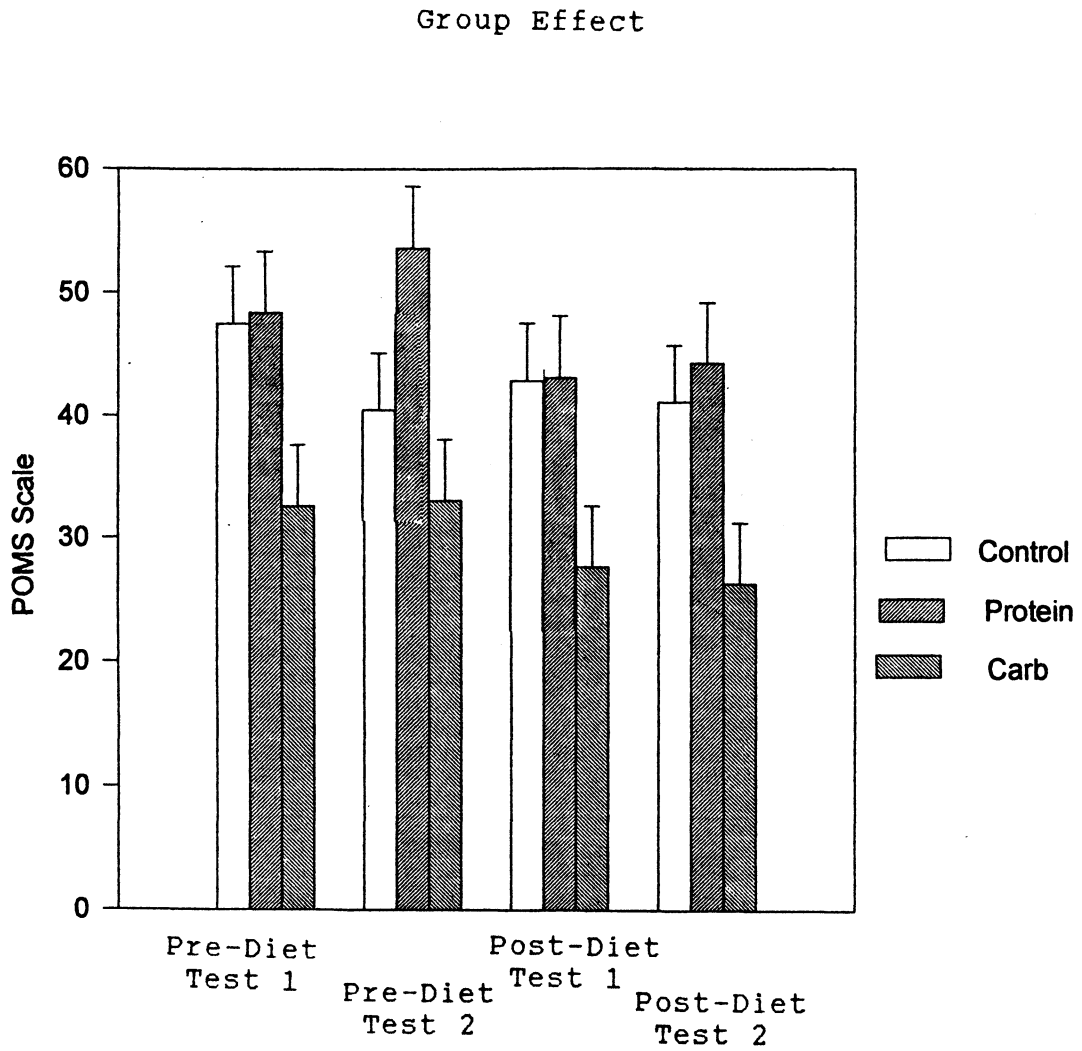
Figure 1. Mean POMS total score for groups across time

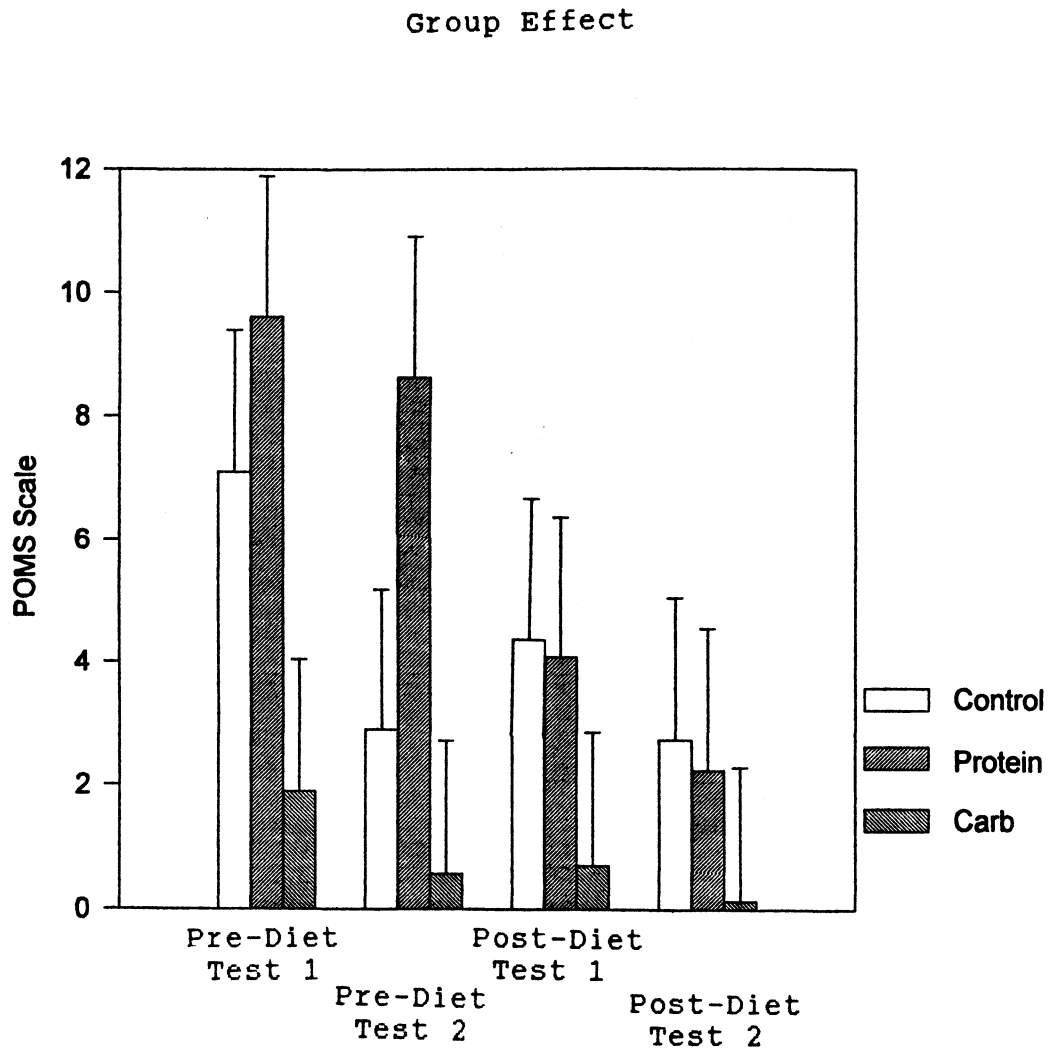
Figure 2. Means POMS anger for groups across time

Figure 3. Mean POMS vigor for groups across time

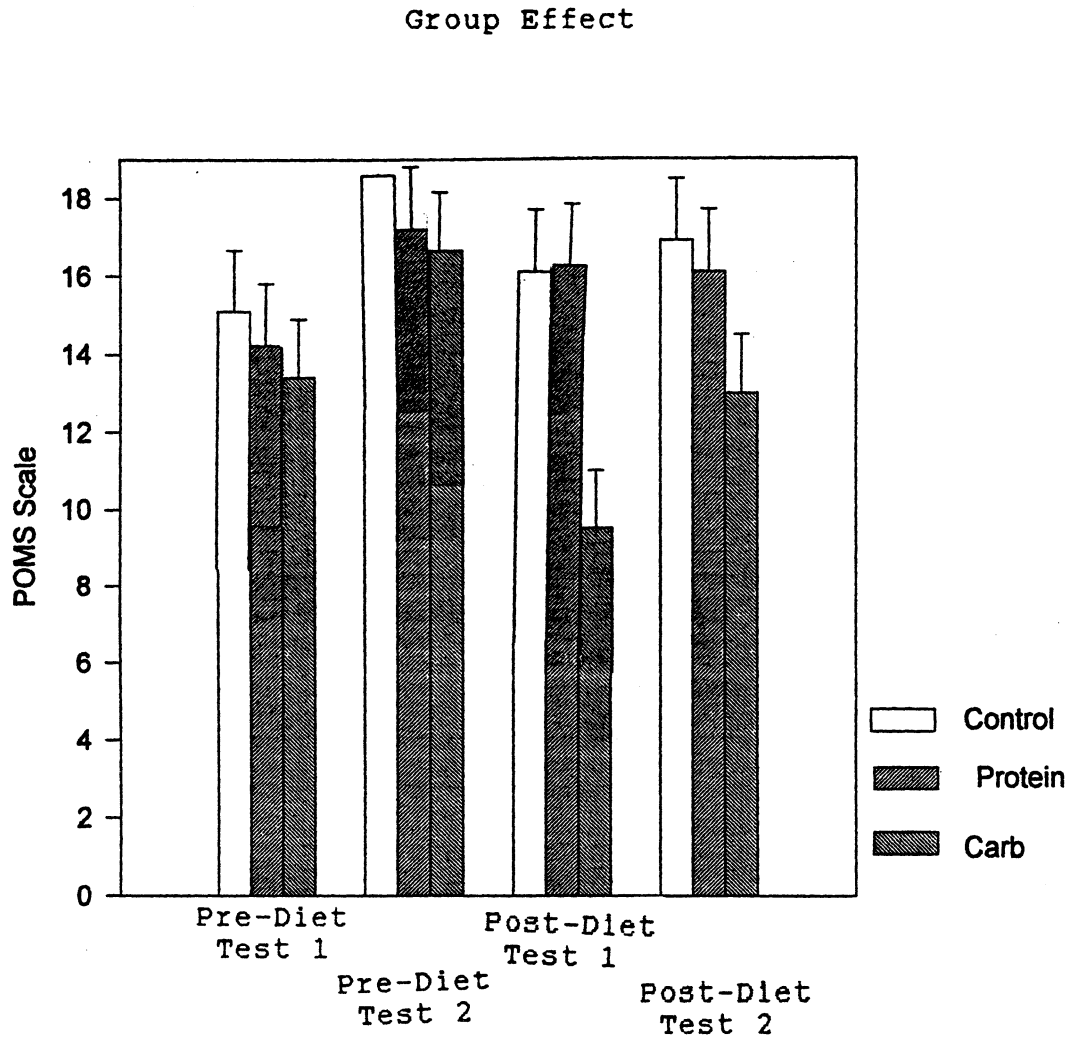
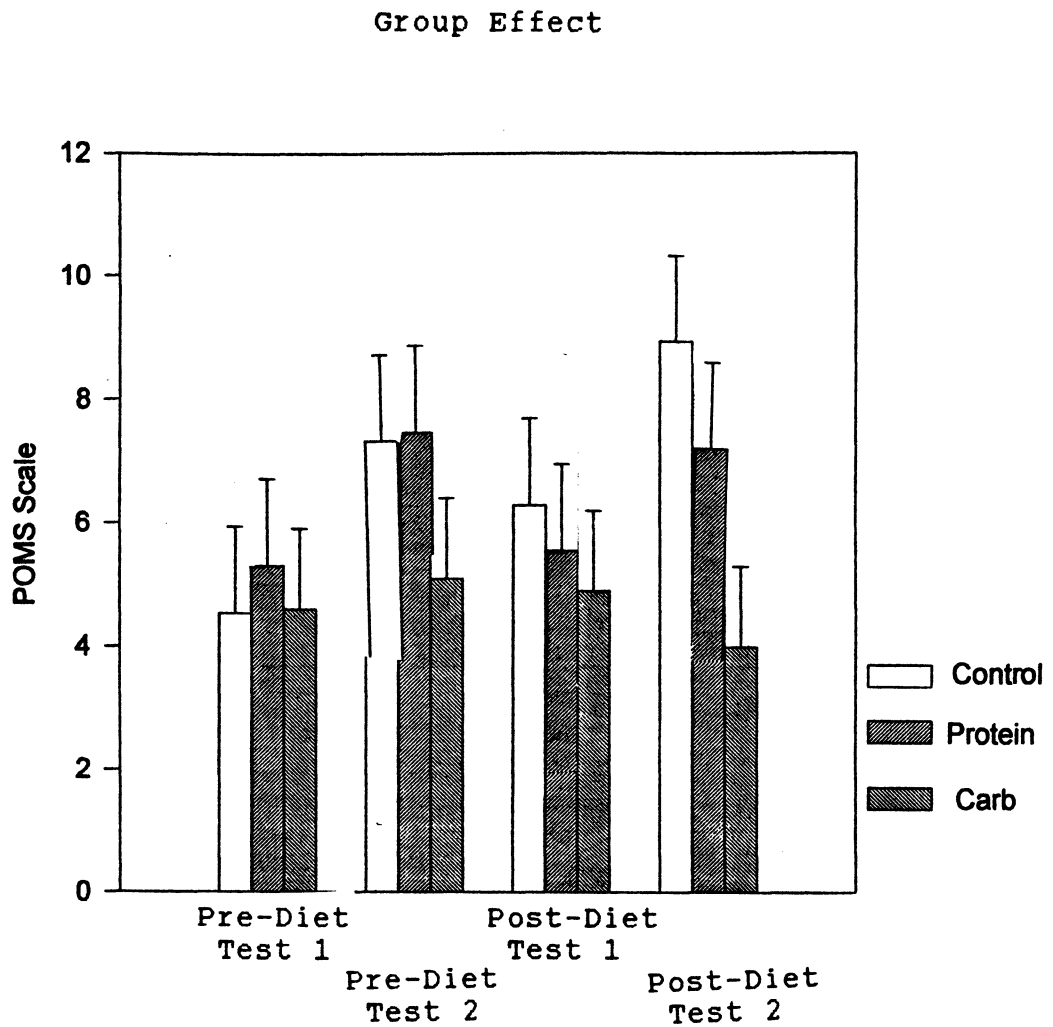


Figure 4. Means POMS fatigue for groups across time

Descriptive Statistics for Subject's Age, Body Weight, Height, Number of Years Lifted, and Percent Body Fat

	<u>Carb</u>	<u>Protein</u>	<u>Control</u>
	n = 6	n = 6	n = 5
AGE	23.8 \pm 0.7637	22.5 \pm 0.7637	22.2 \pm 0.7637
BODY WT (kg)	81.4 \pm 3.909	84.1 \pm 3.909	81.8 \pm 3.909
HEIGHT (cm)	181.4 \pm 1.836	182.2 \pm 1.836	180.8 \pm 1.836
YRS LIFT	3.7 \pm 0.729	5.3 \pm 0.729	6.6 \pm 0.729
% BF	10.4 \pm 1.097	12.9 \pm 1.097	10.3 \pm 1.097

Table 1

MAINTENANCE DIET EXCHANGES

BW	Bread	Meat	Vegetable	Fruit	Milk	Fat
60	8	3	7	6	3	6
62.5	9	4	7	6	3	6
65	9	4	7	6	3	6
67.5	10	4	8	7	3	7
70	10	4	8	7	3	7
72.5	10	4	8	7	3	7
75	11	4	9	8	3	8
77.5	11	4	9	8	3	8
80	11	5	9	8	3	8
82.5	12	5	10	8	4	8
85	12	5	10	9	4	9
87.5	12	5	10	9	4	9
90	13	5	10	9	4	9
92.5	13	5	11	9	4	9
95	13	5	11	10	4	10

Body Weight was measured in kilograms.

Exchanges are based on the Diabetic Exchange Diet.
Each exchange constitutes a serving.

Table 2

Exercise Protocol

Day 1 - Legs, calves, and biceps

<u>Exercise</u>	<u>Sets</u>	<u>Repetitions</u>
Squats	4	10 - 12
Leg Press	3	12 - 15
Leg Extension	4	8 - 15
Leg Curls	4	8 - 15
Calf Raises	4	12 - 20
Preacher Curl	3	12 - 20
Dumbbell Curl (Both Arms)	2	12 - 15
Crunches	4	50+
Stationary Cycling for 30 minutes		

Day 2 - Back and chest

<u>Exercise</u>	<u>Sets</u>	<u>Repetitions</u>
Pull-ups	3	fatigue
Lat Pull-Downs	4	8 - 15
Bent-Over Rows	4	8 - 15
Incline Bench Press	3	12 - 15
Dips	2	12 - 15
Crunches	3	50+
Stationary Cycling for 30 minutes		

Day 3 - Shoulders and triceps

<u>Exercise</u>	<u>Sets</u>	<u>Repetitions</u>
Military Press	3	8 - 12
Side Lateral Raises	2	12 - 15
Front Lateral Raises	2	12 - 15
Rear Lateral Raises	2	12 - 15
Shrugs	2	12 - 15
Tricep Cable Pushdowns	2	15 - 20
Tricep Kickbacks (Both Arms)	2	12 - 15
Tricep Extensions	2	12 - 15
Crunches	4	50+
Stationary Cycling for 30 minutes		

Table 3

LOW-CALORIE DIET FOOD MEASUREMENTS

Body Weight	Rolled Oats	Rice Cake	Tuna	Rice	Spaghetti	Tomato Sauce	PB
60	73.2	30.6	244.2	44.4	97.8	195.6	18.6
62.5	76.3	31.9	254.4	46.3	101.9	203.8	19.4
65	79.3	33.2	264.6	48.1	105.9	211.9	20.2
67.5	82.4	34.4	274.7	49.9	110	220	20.9
70	85.5	36	285	52	114	228	21.4
72.5	88.5	36.9	295	53.7	118.2	236	22.5
75	91.5	38.3	205.3	55.	122.3	244.5	23.3
77.5	94.6	39.5	315.4	57.4	126.3	252.6	24
80	97.6	40.8	325.6	59.2	130.4	260.8	24.8
82.5	100.7	42.1	335.8	61.1	134.5	268.9	25.6
85	103.7	43.4	345.9	62.9	138.6	277.1	26.4
87.5	106.8	44.6	356.1	64.8	142.6	285.3	27.1
90	109.8	45.9	366.3	66.6	146.7	293	27.9
92.5	112.9	47.2	376.5	68.5	150.8	301.6	28.7
95	115.9	48.5	386.7	70.3	154.9	309.7	29.5

Body Weight was measured in kilograms.

All food was measured in grams.

Table 4

RATINGS OF PERCEIVED EXERTION - PRE-DIET TEST

<u>Subject</u>	<u>Set 1</u>	<u>Set 2</u>	<u>Set 3</u>	<u>Set 4</u>	<u>Set 5</u>	<u>Set 6</u>	<u>Set 7</u>
Carbohydrate							
1	12	13	14	14	13	12	16
2	13	14	13	15	13	12	15
3	13	14	16	16	14	13	15
4	8	12	15	16	13	9	18
5	16	16	15	13	11	6	17
6	15	15	14	13	12	11	16
Average	12.8	14	14.5	14.5	15	10.5	12.8
Placebo							
7	13	15	14	14	12	12	15
8	7	11	9	8	7	7	18
9	11	12	12	12	11	10	15
10	12	13.5	14.5	15.5	14	12	16
11	14	14	17	16	14	8	18
12	8	10	12	11	10	9	12
Average	10.8	10.9	13	12.8	11.3	9.7	15.7
Control							
13	12	13	13	13	13	12	15
14	13	15	15	14	13	11	13
15	10	12	12	14	13	11	15
16	13	13	13	14	13	12	15
17	10	12	13	14	13	12	16
Average	11.6	11	13.2	13.8	13	11.6	14.8

RATINGS OF PERCEIVED EXERTION - POST-DIET TEST

<u>Subject</u>	<u>Set 1</u>	<u>Set 2</u>	<u>Set 3</u>	<u>Set 4</u>	<u>Set 5</u>	<u>Set 6</u>
Carbohydrate						
1	12	13	14	14	13	11.5
2	12	13	15	15	13	13
3	15	15	16	16	15	12
4	10	16	17	15	13	11
5	16	17	15	13	8	7
6	15	15	15	14	13	12
Average	13.3	14.8	15.3	14.5	12.5	11.1
Placebo						
7	13	14	14	15	13	12
8	13	14	12	11	9	9
9	11	11	10	10	9	8
10	12	13.5	14.5	15.5	14	12
11	12	15	15	16	13	7
12	9	12	10	10	9	8
Average	11.7	13.3	10.9	12.9	11.2	9.3
Control						
13	13	15	16	14	13	13
14	11	13	14	13	12	10
15	13	13	14	13	13	11
16	12	13	13	12	11	11
17	11	12	13	14	13	11
Average	12	13.2	14	13.2	12.4	11.2

Table 5

RESPONSE TO FINAL QUESTIONNAIRE

<u>Subject</u>	<u>Able to tell Beverage</u>	<u>Helped Psych</u>	<u>Helped Physical</u>
Carbohydrate			
1	yes	yes	no
2	no	yes	no
3	yes	yes	yes
4	no	yes	yes
5	yes	no	no
6	no	yes	yes

50% knew what the beverage was

83% thought it helped them psychologically

50% thought it helped them physically

Placebo (Protein)

7	yes	no	no
8	no	no	no
9	yes	no	yes
10	no	no	no
11	no	no	no
12	no	no	no

33% knew what the beverage was

no one thought it helped them psychologically

16% thought it helped them physically

Control

no controls answered these questions since they were not applicable to their portion of the study

Table 6

Comparison Between Pre and Post Test Body
Weight of Subjects

	Control	Placebo*	Carbohydrate
Pre-Test BW (kg)	89.3±6.5	81.9±6.9	82.1±6.9
Post-Test BW (kg)	89.4±6.7	79.9±7.1	81.7±7.1

* Indicates significant difference in body weight from the other groups going from pre to post-tests.

Table 7

Chapter IV

SUMMARY

According to a recent study, the extreme training and dieting that's routine before a bodybuilding competition may be hazardous to the mental health of a bodybuilder (45). Even with intense daily workouts of almost two hours of weight lifting and lots of aerobic work, bodybuilders tend to keep their diets extremely low in fat and calories. And ironically, instead of becoming more mentally prepared as competition nears, bodybuilders, tend to become more fatigued, depressed, tense and have significantly less vigor. The stress of competition, dieting, and intense training can all take a toll on a competitor's mental well-being.

Seventeen apparently healthy subjects participated in a four day low-calorie intake diet. The subjects consumed a carbohydrate beverage before a lifting session and filled out the Profile of Mood States (POMS) questionnaire. The POMS was filled out prior to and immediately after the lifting session.

Subjects consuming the carbohydrate beverage showed a significantly lower total mood disturbance than did the placebo group (30 ± 5.84 vs. 46.6 ± 5.84). The carbohydrate group also showed a trend towards increased vigor during the

pre-diet test (13.4 ± 1.60 to 17.1 ± 1.60) and post-diet test (10.8 ± 1.60 to 13 ± 1.60) as compared with the placebo group (14.3 ± 1.60 to 18.1 ± 1.60) in the pre-diet test and 16.8 ± 1.60 to 17.3 ± 1.60) in the post-diet test. The carbohydrate also showed a trend to have less anger (0.77 ± 2.25) than the placebo group (6.2 ± 2.25). Finally, the carbohydrate group showed less fatigue (4.6 ± 1.4) than the placebo group (6.5 ± 1.4).

The negative energy balance the bodybuilders were exposed to did not affect the weightlifting bout. There was no effect of the low energy diet on vigor, anger or fatigue scores.

The weightlifting bout had significant ($p < 0.05$) effects on the subjects' vigor and fatigue. The subjects had significantly more vigor ($p = 0.059$) after the weightlifting bout and significantly higher degrees of fatigue after the weightlifting bout ($p = 0.057$). There was also significantly ($p = 0.04$) lower scores reported for anger after the weightlifting bout.

Ratings of Perceived Exertion (RPE) were observed in two different manners. First, RPE scores for sets one through six were combined and compared for the pretest and posttest. No significant difference was found to occur. Second, RPE scores for the posttest were compared across

groups and, once again, no significant difference was found to occur.

Responses to the final questionnaire appeared to have the most positive responses from the carbohydrate group. Fifty-seven percent of the carbohydrate group was able to determine what they were drinking. Only 43% of the placebo (protein) group was able to determine what they were drinking. Seventy-one percent of the carbohydrate group felt the carbohydrate beverage helped them psychologically and 57% felt it helped them physically. Of the placebo group, no one felt it helped them psychologically and only 14% felt it helped them physically.

DISCUSSION

The present study demonstrated that low-calorie dieting can adversely affect mood states during a workout if carbohydrate supplements are not consumed prior to the workout. The placebo group demonstrated this since their total mood disturbances were greater than the carbohydrate group. The placebo group also exhibited greater degrees of anger and fatigue and less vigor than the carbohydrate group. These findings are in agreement with previous

studies showing changes in mood state when consuming low calorie diets.

Rapid weight loss can adversely affect psychology, especially when it is frequent and large. Bodybuilders are an example of a group of athletes who try to achieve drastic, temporary changes in weight that are often unhealthy (26). Weight fluctuation, along with changes in diet and activity, can alter psychological function (9). Brownell researched the weight regulation practices of athletes who maintain low weight and low percent body fat (e.g., distance runners, gymnasts, and figure skaters). He reported that discussions of food intake and weight patterns generate strong feelings among athletes. Anecdotally, he writes that some female athletes complain that keeping their weight down is a chronic struggle. Feelings of deprivation are common. He observed this to be less true of men, but the phenomenon has not been documented in either sex. Brownell concluded on the point that the weight loss and dieting practices of athletes may have powerful psychological effects. Severe caloric restriction may produce symptoms of emotional illness. It has been concluded from a review of literature that dieting for more than two weeks is consistently associated with adverse psychological symptoms (62).

Newton has demonstrated that the typical bodybuilder diet causes the athletes to have altered mood states. During the 12 weeks of her study, there was a trend for bodybuilders to become more fatigued, depressed, tense, confused, and less vigorous. The trend was not statistically significant; however, her sample size was small (only 8 subjects total).

Rosen (52) reports a consistent trend for a deterioration in mood, diet-related attitude, and self-esteem during the first week of dieting in obese individuals consuming a low-calorie diet. Among the many causes of non adherence to conventional dietary restrictions are persistent feelings of hunger and dysphoria which many dieters cannot tolerate and overcome. These factors combined together appear to be consistent with the reports from his subjects for a relative feeling of dysphoria. It appears as though the first week of dieting is the most stressful and the dieter becomes generally discouraged.

Keith (30) has shown that carbohydrate-containing diets have been related to psychological and behavioral changes in humans. Keith cited other literature also includes anecdotal reports of athletes "not feeling well" (increased irritability, depression, and fatigue) during the low-carbohydrate phase of the classical glycogen loading

protocol (exercise to exhaustion followed by 3 days of a low-carbohydrate diet and then 3 days of a high-carbohydrate diet) (57). While on a week-long low carbohydrate diets (1.2g/kg), cyclists had significantly greater scores for tension, depression and anger and less vigor (Keith 1991). Total Profile of Mood State scores for the low carbohydrate diet was greater than the values for the medium (4.3g/kg) and high carbohydrate (6.4g/kg) diets.

The present study also supports the idea that carbohydrate supplements can enhance mood when consumed prior to an exercise bout. This is seen in the carbohydrate group. They exhibited less of a disturbance in total mood state, greater vigor, and less anger and fatigue than either the placebo or control group. This is also in agreement with previous research.

Other studies have shown that the administration of a single high-carbohydrate meal versus a high-protein meal can alter the mood of obese and normal weight human subjects (36). These changes in mood were shown to improve with the addition of more dietary carbohydrate. Male subjects report greater calmness after a carbohydrate meal was consumed as opposed to a protein meal (59).

Kreider's research on psychological states of field hockey players supplemented with carbohydrate showed that

the supplementation reduced perceptions of fatigue during training compared to those who consumed a placebo. He demonstrated that pre-exercise fatigue values tended to be lower in the carbohydrate containing groups and post-exercise fatigue values were significantly lower in the carbohydrate containing groups (33). Results indicated that carbohydrate supplementation increased dietary availability of carbohydrate and reduced perception of fatigue during training.

The results of this study indicate that a negative energy balance can decrease vigor. These results are similar to the results reported in several other studies. Newton et al (46) studied the changes in psychological state during various phases of training in competitive bodybuilders. She found that bodybuilders decrease their energy intake down to an average of 24.4kcal/kg body weight. This values comes close to the energy intake of the subjects in this study. She also found that while on such a low energy diet subjects complained of becoming more fatigued, depressed, tense, confused, and significantly less vigorous. Such mood state changes were also seen in this study. Newton et al concluded that a combined regimen of dieting and intense exercise training in preparation for competition may be related to changes in psychological state.

Steen also found mood state changes in her case review of a bodybuilder (60). She studied the dietary strategies of a 25-year old bodybuilder as he prepared for a contest. Her bodybuilder cut his energy intake to 25.4kcal/kg body weight; he subsequently reported feeling tired and grouchy. The results of this study show an increase in vigor, yet a corresponding increase in fatigue after a weightlifting bout. These results are a little confusing. Morgan studied several hypotheses regarding the affective benefit of vigorous physical activity. There are a number of plausible explanations for the improved mood state following acute physical activity; however, it is unclear why exercise is associated with an improved mood shift. He found that tension states may be reduced as a consequence of distraction from the stress afforded by exercise. This explanation does not require physiological changes to be present.

The increase in vigor found with the current study is similar to that found in McGowan et al' study (37). McGowan et al looked at mood alterations with a single bout of physical activity. He looked at three 75-minute activity classes (running, karate, and weightlifting) and found that participation in the running and weightlifting classes significantly reduced reported feelings of total mood disturbance, tension, depression, anger, and confusion.

The present study did not show any difference in Ratings of Perceived Exertion between groups. This is contrary to previous research.

With regard to the contributing role of energy substrates, both blood glucose and muscle glycogen content are thought to influence perceptual strength (50). Oral supplementation of carbohydrate before and/or during exercise delays muscle fatigue and prolongs submaximal endurance performance, probably by maintaining blood glucose and as a fuel for glycogen depleted muscle (13). The delay in the onset of fatigue during endurance exercise when subjects are fed carbohydrate may be reflected in a lower peripheral rating of exertion for a given submaximal $\dot{V}O_2$, especially in the legs during the mid to later portions of prolonged cycling exercise (11).

Burgess explains, that a direct relationship may not exist between blood glucose and RPE under all condition; it just appears that the maintenance of blood glucose is an important factor in decreasing peripheral exertional ratings during the later stages of cycling exercise. It should be noted that in Burgess' study, PRE continued to increase late in exercise despite the maintenance of blood glucose. Her findings provide support for a physiological link between blood glucose, carbohydrate oxidation, and RPE late in

prolonge cycling at 70% of VO₂max.

Tabata found results similar to those of Burgess. He also looked at the relationship between blood glucose concentration and RPE during prolonged low-intensity exercise. He found that an increase in blood glucose concentration has a significant effect on perceived exertion, even if exercise time is prolonged.

The current may not have the same conclusion as other previous research due to the short duration of exercise. The studies cited above had exercise durations of 180 minutes; the current study only had an exercise duration of approximately 20 minutes. Previous research also had glucose infusion during the exercise sessions where as the current study had carbohydrate ingestion prior to exercise.

RESEARCH IMPLICATIONS

The primary objective of this study was to determine if carbohydrate ingestion improved the mood state of bodybuilders consuming a low-calorie diet. The Profile of Mood State scores demonstrated that the mood states of the group consuming carbohydrate prior to exercise had less of a change in negative mood state.

This could have implications for bodybuilders preparing for competition. Since many factors, including not only the

stress of the impending competition but also the rigor of training and dieting, could affect the psychological state of bodybuilders throughout the competitive phase, it seems logical that the competitive bodybuilder would like to obtain every advantage possible over his peers. By consuming carbohydrate beverage prior to his workout, a bodybuilder could possibly have an improved mood state. By having an improved mood state, a bodybuilder can possibly have a better workout.

RECOMMENDATIONS FOR FURTHER RESEARCH

In order to fully understand the significance of the improved mood state of the carbohydrate consuming group, further research is necessary. The following are suggestions for further research relating to carbohydrate supplementation and bodybuilding.

- 1) It also may be important to look at a weight lifting session of longer duration. Since most weight lifting sessions last longer than 20 minutes, this seems like a logical next step in research.

- 2) Building on number two, it may be important to look at carbohydrate ingestion during the workout session, especially if the duration has been increased to greater than 20 minutes.

3) It would also be beneficial to look at all of the above mentioned further research topics with regard to Ratings of Perceived Exertion.

REFERENCES

1. Arstilla, M., H. Wendelin, I. Vuori, I. Valimaki. Comparison of two rating scales in the estimation of perceived exertion in a pulse conducted exercise test. Ergonomics. 17: 577-584. 1974.
2. Bagby, G.J., H.J. Green, S. Katsuta, and P.D. Gollnick. Glycogen depletion in exercising rats infused with glucose, lactate or pyruvate. J. Appl. Physiol.: Respirat. Environ. Exerc. Physiol. 45: 425-429. 1978.
3. Baird, I.M., R.L. Parsons, A.N. Howard. Clinical and metabolic studies of chemically defined diets in management of obesity. Metabolism. 23:645-647. 1974.
4. Berger, B.G., & D.R. Owen. Mood alteration with swimming: swimmers really do feel better. Psychosomatic Med. 45: 425-433, 1983.
5. Bergstrom, J. and E. Hultman. A study of the glycogen metabolism during exercise in man. Scand. J. Clin. Lab. Invest. 19: 218-228. 1967.
6. Berstrom, J., L. Hermansen, E. Hultman, and B. Saltin. Diet, muscle glycogen and physical performance. Acta. Physiol.Scand. 71: 140-150. 1967.
7. Borg, G., D. Ottoson. (Eds). The perception of exertion in physical work. Macmillan, London. 1986.
8. Brownell, K.D., M.R.C. Greenwood, E. Steller, E.E. Shrager. The effects of repeated cycles of weight loss and regain in rats. Physiol. Behav. 38: 459-464. 1986.
9. Brownell, K.D., S.N. Steen, and J.H. Wilmore. Weight regulation practices in athletes: analysis of metabolic and health effects. Med. Sci. Sports Exerc. 19: 546-556. 1987.
10. Burgess. M.L., R.J. Robertson, J.M. Davis, and J.M. Norris. RPE, blood glucose, and carbohydrate oxidation during exercise: effects of glucose feedings. Med. Sci. Sports Exerc., 23(3): 353-359. 1991.

11. Cafarelli, E. Peripheral contributions to the perception of effort. Med. Sci. Sports Exerc. 14: 382-389. 1982.
12. Costill, D.L. Carbohydrates for exercise: dietary demands for optimal performance. Int. J. Sports Med. 9: 1-18. 1988.
13. Coyle, E.F., A.R. Coggan, M. Hemmert, and J.L. Ivy. Muscle glycogen utilization during prolonged strenuous exercise when fed carbohydrate. J. Appl. Physiol. 61: 165-172. 1986.
14. Depalma, M.T., W.M. Koszewski, J.G. Case, R.J. Barile, B.F. Depalma, and S.M. Oliaro. Weight control practices of lightweight football players. Med. Sci. Sports Exerc. 25(6): 694-701, 1993.
15. Dudley, Gary A. Metabolic consequences of resistive type exercise. Med. Sci Sports Exerc. 20: S158-S161 1988.
16. Elia, M., O. Lammert, C. Zed, G. Neale. Energy metabolism during exercise in normal subjects undergoing total starvation. Human Nutr: Clin. Nutr. 38C: 355-362, 1984.
17. Farrell, P.A., W.K. Gates, W.P. Morgan, and C.B. Pert. Plasma leucine enkephalin-like radioreceptor activity tension-anxiety before and after competitive running. Biochemistry of Exerc. 637-644, 1983.
18. Felig, P., J. Wahren. Fuel homeostasis in exercise. N. Engl.J.Med. 293: 1078-1084. 1975.
19. Fernstrom, J., R. Wurtman. Brain serotonin content, physiological regulation by plasma neutral amino acids. 178:414-416. 1972.
20. Fielding, R.A., D.L. Costill, W.J. Fink, D.S. King, M. Hargreaves, and J.E. Kovaleski. Effect of carbohydrate feeding frequencies and dosage on muscle glycogen use during exercise. Med Sci Sports Exerc. 17(4): 472-476. 1985.
21. Folkins, C.H., & W.E. Sime. Physical Fitness training and mental health. Am. Psychologist. 36: 373-389, 1981.

22. Grunewald, K.K., and R.S. Bailey. Commercially marketed supplements for bodybuilding athletes. Sports Medicine. 15(2): 90-103. 1993.
23. Hargreaves, M.D., D.L. Costill, A. Coggan, and W.J. Fink. Effect of carbohydrate feeding on muscle glycogen utilization and exercise performance. Med. Sci. Sports Exerc. 16: 219-222. 1984.
24. Hermansen, L., E. Hultman, and B. Saltin. Muscle glycogen during prolonged severe exercise. Acta. Physiol. Scand. 71: 129-139. 1967.
25. Heyward, V.H., W.M. Sandoval, B.C. Colville. Anthropometric, body composition, and nutritional profiles of bodybuilders during training. J. Appl. Sports Sci. Res. 3(2): 22-29. 1989.
26. Hickson, J.F., K. Hinkelmann. Exercise and protein intake effects on urinary 3-methylhistidine excretion. Am.J. Clin. Nutr. 41: 246-253. 1985.
27. Hickson, J.F., T.E. Johnson, W. Lee, and R.J. Sidor. Nutrition and the precontest preparations of a male bodybuilder. J. Am. Diet. Assoc. 90: 264-267. 1990.
28. Horton, E.S. Effects of low energy diets on work performance. Am. J. Clin. Nutr. 35: 1228-1233. 1982.
29. Ivy, J.L., D.L. Costill, W.J. Fink, R.W. Lower. Influence of caffeine and carbohydrate feedings on endurance performance. Med. Sci. Sports. 11(1): 6-11. 1979.
30. Keith, R.E., K.A. O'Keeffe, D.L. Blessing, G.D. Wilson. Alterations in dietary carbohydrate, protein, and fat intake and mood state in trained female cyclists. Med. Sci. Sports Exerc. 23(2): 212-216. 1991.
31. Kleiner, S.M., T.L. Bazzarre, and M.D. Litchford. Metabolic profiles, diet, and health practices of championship male and female bodybuilders. J. Am. Diet. Assoc. 90: 962-967. 1990.
32. Kollar, E.J., R.M. Atkinson. Responses of extremely obese patients to starvation. Psychosom. Med. 28: 227-246. 1966.

33. Kreider, R.B., D. Hill, G. Horton, M. Downes, S. Smith, and B. Anders. Department of Movements Science and Education, Memphis State University, Memphis, TN 38152 & the Departments of Intercollegiate Athletics & HPER & Old Dominion University, Norfolk, VA 23529. 1994
34. Kuehl, K., D.L. Elliot, L. Goldberg. Predicting caloric expenditure during multi-station resistance exercise. J. Appl. Sport Sci. Res. 4: 63-67. 1990.
35. Lambert, C.P., M.G. Flynn, J.B. Boone, Jr., Michaud J. Rodrigues-Zayas. Effects of carbohydrate feeding on mutiple-bout resistance exercise. J. Appl. Sport Sci. Res. 5(4): 192-197. 1991.
36. Lieberman, H.R., J. Wurtman, and B. Chew. Changes in mood after carbohydrate consumption among obese individuals. Am. J. Clin. Nutr. 44: 772-778. 1986.
37. McGowan, R.W., E.F. Pierce. Mood alterations with a single bout of physical activity. Percept. Motor Skills. 72: 1203-1209. 1991.
38. McNair, D.M., M. Lorr, and L.F. Droppleman. Profile of Mood States Manual. San Diego, CA: Educational and Industrial Testing Service, 1971.
39. Morgan, W.P. Affective beneficence of vigorous physical activity. Med. Sci. Sports Exerc. 17(1): 94-100. 1985.
40. Morgan, W.P., Psychological factors indluencing perceived exertion. Med. Sci. Sports. 5: 97-103. 1973.
41. Morgan, W.P., D.L. Costill, M.G. Flynn, J.S. Raglin, P.J. O'Connor. Mood disturbance following increased training in swimmers. Med. Sci. Sports Exerc. 20(4): 408-414. 1988.
42. Morgan, W.P., P.J. O'Connor, P.B. Sparling, and R.P. Pate. Psychologic characterization of the elite female distance runner. Int. J. Sports Med. 8: 124-131, 1988.
43. Morgan, W.P., D.R. Brown, J.S. Raglin, P.J. O'Connor, and K.A. Ellickson. Psychological monitoring of overtraining and staleness. Br. J. Sports Med. 21: 107-114, 1987.

44. Myhill, J., M. Lorr. Comparisons of psychiatric patients with controls on bipolar Profile of Mood States. Psych. Reports. 56: 779-782. 1985.
45. Myles, W.S., Sleep deprivation, physical fatigue, and the perception of exercise intensity. Med. Sci. Sports Ex. 17: 580-584, 1985.
46. Newton, L.E., G. Hunter, M. Bammon, and R. Roney. Changes in psychological state and self-reported diet during various phases of training in competitive bodybuilders. J. Strength and Cond. Res. 7(3): 153-158. 1993.
47. Norcross, J.C., E. Guadagnoli, and J.O. Prochaska. Factor structure of the Profile of Mood States (POMS): two partial replications. J. Clin. Psych. 40(5): 1270-1277. 1984.
48. Pandolf, K.B. Advances in the study and application of perceived exertion. In Terlung (Ed). Ex. Sport Sci. Reviews. 11: 118-158 Franklin Institute, PA 1983.
49. The Physician and Sports Medicine. Weight reduction in wrestling. 9: 79-96, 1981.
50. Robertson, R.J., R.L. Gillespie, J. McCarthy, and K.D. Rose. Differentiated perceptions of exertion: Part II. Relationship to local and central physiological responses. Percept. Mot. Skills. 49: 691-697. 1979.
51. Rognum, T.O, F. Vartdal, K. Rodahl, P.K. Opstad, O. Knudsen-Baas, et al. Physical and mental performance of soldiers on high and low-energy diets during prolonged heavy exercise combined with sleep deprivation. Ergonomics. 29: 859-867, 1986.
52. Rosen, J.C., D.A. Hunt, E. Sims, C. Bogardus. Comparison of carbohydrate-containing and carbohydrate-restricted hypocaloric diets in the treatment of obesity: effects on appetite and mood. Am. J. Clin. Nutr. 36: 463-469. 1982.
53. Ryman, D.H., P. Naitoh, C.E. Englund. Perceived exertion under sustained work and sleep loss. Work & Stress. 3: 57-68. 1989.
54. Sachs, M.H., & M.L. Sachs. Psychology of running. Champaign, IL: Human Kinetics (1981).

55. Sandoval, W.M., and V.H. Heyward. Food selection patterns of bodybuilders. International J. of Sport Nutrition. 1: 61-68. 1991
56. Schacham, S. A shortened version of the Profile of Mood States. J. of Personality Assessment. 47(3): 305-306. 1983.
57. Sherman, W.M. Carbohydrates, muscle glycogen and muscle glycogen supercompensation. Ergogenic Aids in Sports. 3-26. 1983.
58. Silverstone, J.T., J.E. Stark, R.M. Buckle. Hunger during total starvation. Lancet. 1: 1343-1344. 1966.
59. Spring, B., O. Maller, J. Wurtman, L. Digman, and L. Cozolino. Effects of protein and carbohydrate meals on mood and performance: interactions with sex and age. J. Psychiatr. Res. 17(2): 155-167. 1982/83.
60. Steen, S.N. Precontest strategies of a male bodybuilder. Inter. J. Sport Nutr. 1: 69-78. 1991.
61. Stewart, K.J., M.H. Kelemen, C.K. Ewart. Relationships between self-efficacy and mood before and after exercise training. J. Cardio. Rehabil. 14: 35-42. 1994.
62. Stunkard, A.J., J. Rush. Dieting and depression re-examine. Ann. Intern. Med. 81: 526-533. 1974.
63. Tabata, I., A. Kawakami. Effects of blood glucose concentration on ratings of perceived exertion during prolonged low-intensity physical exercise. Jap. J. Physiol. 41: 203-215. 1991.
64. Thayer, R.W. Energy, tiredness, and tension effects of a sugar snack versus moderate exercise. J. Personality and Social Psychology. 52: 119-125, 1987.
65. Thomson, J., H. Rankin, G.W. Ashcroft, C.M. Yates, J.K. McQueen, and S.W. Cummings. The treatment of depression in general practice: a comparison of l-tryptophan, amitriptyline, and a combination of l-tryptophan and amitriptyline with placebo. Psychol. Med. 2: 741-51. 1982.

66. Van Handel, P.J., W.J. Fink, G. Branam, and D.L. Costill. Fate of C glucose ingested during exercise. Int. J. Sports Med. 1: 127-131. 1980.
67. van Praag, H., Neurotransmitters and CNS disease: depression. Lancet. ii: 1257-1264. 1982.
68. Wadden, T.A., A.J. Stunkard, and J.W. Smoller. Dieting and depression: A methodological study. J. Consult. Clin. Psych. 54: 869-871. 1986.
69. Walberg-Rankin, J., C.E. Edmonds, F.C. Gwazdauskas. Detailed analysis of the diets and body weights of six female bodybuilders before and after competition. Int. J. Sport Nutr. 3(1): 87-102. 1993.
70. Watt, B., R. Grove. Perceived exertion: antecedents and applications. Sports Medicine. 15(4): 225-241 . 1993.
71. Wifely, D., and J. Kuncze. Differential physical and psychological effects of exercise. J. of Counseling Psychology. 33: 337-342, 1986.
72. Wise, T.N., and J.N. Cooper. Psychiatric Casualties of the Supplemented Fast Diet. Obesity and Metabolism. 1 (4): 241-246. 1981.
73. Zervas, Y., A. Danis, V. Klissouras. Influence of physical exertion on mental performance with reference to training. Percept. Motor Skills. 72: 1215-1211. 1991.

Appendix A
METHODOLOGY

METHODS

Subjects

Apparently healthy college aged male (n=17) volunteers who had been training for a period of at least one year were used for this investigation. (The subject pool started at n=24; however two subjects were dropped due to lack of compliance to the diet and exercise prescriptions.) Training was defined as having consistently lifted for at least sixty minutes four times a week. Subjects were recruited from the Virginia Tech campus and surrounding areas. Subjects were not included in the study if they had any health problems that might have put them at risk during this study or if they would be unable to complete any portion of the study.

General Protocol

The study began with a day designated to perform 1-repetition maximums (1-RM) of several different weightlifting exercises. These 1-RM's were used to prescribe weightlifting exercises to be performed during the study. Two different days were designated for practice sessions of the bench press test. These sessions were to help reduce any learning effect. The subjects then went on a three day maintenance diet to get all subjects to

approximately the same eating patterns and carbohydrate consumption prior to the start of the low calorie dieting phase. The subjects were brought in on the first morning of their low energy diet to consume a supplement, fill out questionnaires, and perform a bench press exercise (this was called the Pre-Diet Test). The low energy diet was followed for four days and on the fifth morning subjects were brought in for the final time to perform a Post-Diet Test which was exactly the same as the Pre-Diet Test.

Timeline of Study

DAY										
1	2	3	4	5	6	7	8	9	10	11
I	---	I	---	I	---	I	---	I	---	I
1-RM		P-2				PRT				PST
	P-1		I	---	MD	---	I			
							I	---	LC	---
										I

1-RM = 1-Repetition Maximum Testing

P-1 = Practice Session 1

P-2 = Practice Session 2

MD = Three Day Maintenance Diet

PRT = Pre-Diet Test (7-9a.m.)

LC = Four Day Low-Calorie Diet

PST = Post-Diet Test (7-9a.m.)

1-Repetition Maximums - Day 1

1-RM's were performed for each exercise the subjects would be using in their prescribed exercise workout. Subjects were allowed to warm-up on their own for each exercise. Subjects were asked to think about what weight their maximum lift might be and to lower that to a weight they knew they could perform. Subjects increased the weight according to how difficult the previous lift was and continued on until no heavier lift could be attained. Subjects had to obtain their maximum lift in four to five sets of one repetition per set. The subjects were allowed to rest between sets until they felt comfortable to continue. The maximum weight lifted was noted.

Three exercises utilized a five repetition maximum (5-RM). The exercises that used a 5-RM were shrugs, squats, and standing calf raises. These were determined in the same manner as the 1-RMs. The subject was instructed to think about a weight he could lift five times, but no more than five times. He then lowered this weight to a weight he knew he could lift 5 times. He increased this weight until he could lift the weight five times and no more. The maximum weight lifted was noted.

Practice Session 1 - Day 2

The first practice session started with some general subject measurements. Each subjects' height (in centimeters and inches), weight (in kilograms and pounds), and percent body fat was obtained. Percent body fat was determined using John Bull (British Indicators, Inc.) skin fold calipers. The skin fold sites included the chest, abdomen, and thigh. The average across three measurements at each site was determined. The sum of these three numbers was determined and looked up on a chart based on age. The percent fat was noted.

Subjects then perform the bench press exercise. Subjects were not allowed any warm-up period. This exercise consisted of lifting seven sets at 60% of their flat bench 1-RM. The repetitions decreased with each set. On set one the subjected lifted 18 repetitions, on the second set he lifted 15, the third he lifted 12, the fourth he lifted 10, the fifth, he lifted 8, and the sixth he lifted 6. On the seventh set the subject was asked to perform as many repetitions as he could until volitional fatigue was attained. Each set had a two minute and 30 second rest period following it before the next set was begun.

Ratings of Perceived Exertion (RPE) were reported by the subject between each set immediately upon completion of

the previous set. Borg's 6-20 RPE scale was utilized. Subject's were instructed how to use the scale before the test was begun. Subjects were told to concentrate on their total, inner feeling of exertion combining all sensations of physical stress, effort, and fatigue. Subjects were given the reference points of six being sitting at home watching television and 20 being chased by a man with a gun and running for your life.

Subjects were instructed that examiners would not be encouraging them during the bench test to assure consistent treatment between subjects. The examiners explained to each subject that even though they did not encourage them, they wanted the subject to performed as well as possible each time the bench test was performed.

Practice Session 2 - Day 3

The second practice session started with education regarding the maintenance diet the subject's were going to be following for the next three days. Subjects were instructed as to the use of the Diabetic Exchange diet and how many exchanges they were allowed per food group. They were shown samples of the different sizes of the portions for each exchange. Subjects were also given forms to be filled out regarding their adherence to both the diet and

their weightlifting routine. Subjects then performed the bench press exercise exactly as was done during practice session one.

Three Day Maintenance Diet - Days 4 through 6

Diet - The diet to be followed for three days was the Diabetic Exchange diet. Fat was set to be 30% of the diet, protein at 15%, and carbohydrate at 55% with caloric consumption at 35kcal/kg of body weight. Exchanges were determined relative to body weight. Records were filled out regarding the consumption of these exchanges to ensure that all exchanges were consumed but no more than the allotted amount was consumed. Subjects were free to call the investigator with any questions regarding the diet. No dietary supplements or alcohol were allowed to be consumed during these three days.

Exercise - The exercises performed during days 4 through 6 were determined via the 1-RM's performed earlier. On day one subject's lifted exercises for the legs, calves, biceps, and abdominals; on day two they lifted exercises for the chest, back, and abdominals; and on day three they lifted exercises for shoulders, triceps, and abdominals. Subjects also performed 30 minutes of aerobic exercise on a stationary bicycle convenient for them. Subject's could put

the bicycle workload on what they felt most comfortable with; however, subject's were instructed to keep their heart rate between 65-75% of their age-adjusted maximum. These values were given to them along with instructions how to take their heart rate. Subjects were instructed to take their heart rate within the first 10 minutes of their bicycling to assure that they were in their heart rate range for the majority of the session. Subjects were encourage to call the investigator with any problems regarding the exercises prescribed to them.

Four Day Low Energy Diet - Days 7 - 11

Diet - The diet for four days was set at 21 kcal/kg body weight. The diet consisted of 15% fat, 30% protein, and 55% carbohydrate. The diet was provided to the subjects each day and consisted of spaghetti, tomato sauce, rice cakes, peanut butter, rice, tuna fish, and oatmeal (Appendix D). Food was packaged in individual zip-lock baggies and was measured to within 0.5g. Subject's were to report each morning of this diet between the hours of 7-9a.m. to pick up their daily food, be weighed, and fill out a brief report of any unusual problems arising from the diet (Appendix C). Subjects were provided with check off sheets listing all food provided to them to record that all food was consumed

and that nothing extra was eaten. Subjects returned these sheets when they came in for the posttest. Subject's were allowed to flavor their food with items not containing calories. The unlimited items allowed to be consumed included herbs and spices, water, diet pop, sugarless gum (three sticks per day), and lemon juice. The subjects were not allowed to consume any dietary supplements or alcohol during these four days.

Exercise - The subjects did not do any exercise the first day of their low calorie diet. The subjects followed the exact same exercise routine that they followed during the three day maintenance diet during the remaining three days.

Pre-Diet Test (Day 7) and Post-Diet Test (Day 10) - Subjects were instructed to come in on the morning of each test having fasted for 12 hours, not exercising for 18 hours, and not consuming caffeine or tobacco products for 4 hours prior to their testing time. Subjects were given either a carbohydrate beverage or a protein beverage (the placebo). The carbohydrate beverage was "Sports Shot" and consisted of a blend of sugar, dextrose, fructose, and preservatives. "Sport Shot" has 1.25g/serving. The placebo drink was an instant 85% isolated soy protein shake. It contained Supro (isolated soy protein), lecithin, and

sweeteners and was 95% protein and 5% fat. The concentration of each supplement was relative to body weight. Subjects were required to consume the beverage within 10 minutes. The time was noted when the subject had completely consumed his beverage. The subject was then instructed to fill out a Profile of Mood States questionnaire as to how he was feeling at that moment. Fifteen minutes after the consumption of the beverage the subject started the bench press exercise. The bench press exercise was exactly the same as the one followed during practice sessions 1 & 2. Within five to 10 minutes of the completion of the bench press exercise subjects completed a second Profile of Mood States questionnaire.

Following the completion of the Post-test subjects filled out a brief questionnaire. Subjects were asked a yes/no question whether or not they felt they complied with the diet and exercise prescriptions. Subjects were also asked as to whether they could tell what kind of beverage they were consuming and if they felt it helped them either psychologically, physically, or both.

Appendix B
SUBJECT PERSONAL DATA SHEETS

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Informed Consent for Participants
of Investigative Projects

Title of Project: Bodybuilders and Low Calorie Diets: The Effects of Dietary Supplementation on Muscle Endurance and Perception of Fatigue

Principle Investigators: Lynette Poland and Tina Randall, masters student directors; Janet Walberg-Rankin, faculty director

I. THE PURPOSE OF THIS RESEARCH/PROJECT

You are invited to participate in a study about the effects of dietary supplementation on the quality of a training session while an athlete is consuming a low calorie diet. This study involves experimentation for the purpose of:

1. determining if dietary supplements can affect muscle performance during weight lifting sessions.
2. determining if dietary supplements affect psychological status during training sessions.

This study involves 24 subjects.

II. PROCEDURES

The procedures to be used in this research are as follows:

1. You will be asked to consume a weight maintenance diet for 3 days. You will be asked to eat certain foods you provide for yourself. This will be based on foods you typically consume. It's purpose is to ensure that you are not gaining or losing body weight and that all subjects are consuming similar diets prior to the treatment.
2. Then, you will be asked to consume a low calorie diet for 4 days during which time food for your consumption will be provided to you each morning by the experimenters with specific directions for preparation. You will be requested to fill out food intake records during these four days. No other food can be consumed during this period.
3. A weight-lifting routine will be prescribed for you based on your strength and must be followed for a total of seven days (three days maintenance and four days of low calorie consumption). Required aerobic activities will consist of 30 minutes of stationary bicycling within 65-75% of your maximum heart rate each day of this study. You will be requested to fill out records of your workouts.
4. You will perform four total multiple-bout resistance exercises tests--two practice sessions, one test after the maintenance period, and one test after the diet treatment

- period. The performance session will consist of a bench press test. You will lift seven sets on the bench press at 60% of your maximum strength. The first set will have 18 repetitions, the second will have 15, the third 12, the fourth 10, the fifth 8, the sixth 6, and the final set you will do repetitions until you cannot complete a full lift.
5. You will be given a liquid dietary supplement 15 minutes prior to each performance measurement.
 6. You will fill out a mood questionnaire consisting of 65 questions (approximately 10-15 minutes required to complete) before and after each exercise performance measurement.
 7. You will be asked to report your perception of effort sporadically throughout each performance measurement.

The time and conditions required for you to participate in this project are as follows:

1. Initial meeting for orientation and health screening; lasting approximately 60 - 90 minutes.
2. Daily recording of food intake and weightlifting routines.
3. Daily food pickup during the four day diet treatment period.
4. Two to three hours designed to determine maximum strengths of major muscle groups used for prescribing

weightlifting routines.

5. Choosing pre-specified time for your workout (your own discretion) so that the investigators can do sporadic check-ins.
6. Four mornings--two practice sessions, one after the maintenance period, and one after the diet treatment period--during which time you will be asked to fill out questionnaires and perform your bench press test. These sessions will last approximately 1 hour each.
7. Before each of the mornings discussed in #6, consumption of a supplement 15 minutes prior to performance measures.
8. Your guarantee that you have not used any form of steroids within the past six months.

The possible risks or discomforts to you as a participant may be:

1. Hunger, fatigue, and irritability while on the four day low calorie diet.
2. Muscle soreness and fatigue from the muscle performance tests and strength tests. There is a slight risk of strains, sprains, tendonitis, and bursitis from the muscle performance tests, strength tests, and prescribed lifting workouts.

Safeguards that will be used to minimize your risk or discomfort include:

1. A telephone is available which would be used to call the hospital for emergency service.
2. The investigators are trained in basic first aid and CPR.

III. BENEFITS OF THIS PROJECT

Your participation in the project will provide the following information that may be helpful:

1. Knowledge of benefits of dietary supplementation on your performance while eating low calorie diets.
2. Having your body fat percentage and body weight calculated.

No guarantee of benefits has been made to encourage you to participate.

You may receive a synopsis or summary of this research when completed.

IV. EXTENT OF ANONYMITY AND CONFIDENTIALITY

The results of this study will be kept strictly confidential. At no time will the researcher release the results of the study to anyone other than individuals working on the projects without your written consent. The information you provide will have your name removed and only

a subject number will identify you during analyses and any written reports of the research.

V. FREEDOM TO WITHDRAWAL

Your are free to withdrawal from this study at any time without penalty.

There may be the following circumstances under which the investigator may determine that you should not continue as a subject of this project:

1. Failure to comply with prescribed lifting sessions and/or diet regimens.
2. Illness.

VI. APPROVAL OF RESEARCH

This project has been approved, as required, by the Institutional Review Board for projects involving human subjects at Virginia Polytechnic Institute and State University.

VII. SUBJECT'S RESPONSIBILITIES

I know of no reason I cannot participate in this study. I have the following responsibilities:

1. To advise the researchers of any pre-existing medical problems that may affect my participation, such as, but not limited to, diabetes, heart conditions, muscle, bone, or joint problems, and major organ malfunctions. Should you have any questions regarding a particular condition, please feel free to ask any investigator.
2. To advise the researchers of any medical problems that might arise in the course of this experiment, such as signs of strains, sprains, tendonitis, or bursitis; or any signs and/or symptoms of illness.
3. To refrain from the consumption of alcoholic beverages throughout the entire duration of the study.
4. To refrain from the consumption of caffeine and use of tobacco at least 4 hours prior to each muscle performance test.

5. To refrain from exercise 18 hours prior to each performance measure.
6. To adhere to the prescribed diets and workouts.
7. To refrain from any other dietary supplements and steroid use throughout the duration of this study.

VIII. SUBJECT'S PERMISSION

I have read and understand the informed consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project.

If I participate, I am free to withdraw at any time without penalty. I agree to abide by the rules of this project.

Signature of Participant:

Signature of Investigator:

Date:

Should I have any questions about this research or its conduct, I will contact:

Lynette Poland	961-0332
Investigator	
Tina Randall	552-7649
Investigator	
Janet Walberg-Rankin, Ph.D.	231-6355
Faculty Advisor	
Ernest Stout	231-9359
Chairman of the University Review Board	

GENERAL DATA SHEET
Poland/Randall Thesis

Name: _____

Address: _____

Home Phone Number: _____

Work Phone Number (if appropriate): _____

In an emergency, please contact: _____

Relationship: _____

Phone Number: _____

Please list your class schedule:

Monday Tuesday Wednesday Thursday Friday

Please list your work schedule (if appropriate):

Monday Tuesday Wednesday Thursday Friday Satur

Are there any other times during the week that you are unavailable?

Monday Tuesday Wednesday Thursday Friday Satur

Do you foresee leaving town any time during February or March?

Yes _____ No _____

If yes, please state dates:

MEDICAL HISTORY
Poland/Randall Thesis

** All information is private and confidential **

Name: _____

Address: _____

Home Phone: _____

Social Security Number: _____

Date of Birth: _____

Family Physician: _____

Physician's Address: _____

Physician's Phone Number: _____

Sex: Male Female

I. Have you ever been diagnosed with or suffer from problems related to the heart, lungs, or circulatory system (i.e. - chest pain, shortness of breath, heart disease, hypertension, asthma)

YES NO

If yes, please explain:

II. Have you ever been diagnosed with or suffer from problems

relating to the skeletal/muscular system (i.e. - broken bones, bursitis, tendonitis, sprains, strains)

YES NO

If yes, please explain:

III. Have you been treated by a physician for anything other than

the common cold in the past six months?

YES NO

If yes, please explain:

Do you have or have you been diagnosed with

Diabetes YES NO

Anemia YES NO

Periods of dizziness or fainting spells
YES NO

List any medications (prescription and/or over-the-counter) you are now taking and their use:

List any allergies (including drugs):

Do you currently use any tobacco products (including smokeless)?

YES NO

If yes, please describe:

Are you currently taking steroids? yes no

Have you ever taken steroids? yes no

If yes, please give dates and duration:

Have you been under more stress than normal during the past six

months (i.e. - death in the family, moving homes)

YES NO

If yes, please explain:

Please explain any other medical conditions that you consider important for us to know:

EXERCISE HISTORY/HABITS
Poland/Randall Thesis

Are you currently weightlifting? Yes ___ No ___

How many years: _____

How many days per week: _____

How many minutes does each lifting session typically last:

Please describe your rotation schedule:

On the back of this page please describe what exercises you perform for each rotation in your cycle.

Where do you workout? _____

What type of equipment do you generally use?

Have you ever participated in a bodybuilding competition?

Yes ___ No ___

If yes, please list them below:

<u>Name</u>	<u>Dates</u>	<u>Finishing Place</u>
-------------	--------------	------------------------

Do you do any type of aerobic exercise? Yes ___ No ___

Please list the aerobic activities (e.g. - running, biking, swimming) you participate in and the frequency and duration of each:

Do you participate in any other forms of exercise?

Yes No

If yes, please list with the frequency and duration of each:

Do you ever feel faint, dizzy, or nauseous while working out?

Yes No

If yes, please explain circumstances and frequency:

Do you have any conditions that would limit your participation in either the weightlifting or aerobic portion of this study (i.e. - orthopedic injuries, time constraints, etc...)

Have you ever been advised by a doctor not to engage in either weightlifting or aerobic activities? Yes No

If yes, please explain:

Do you see any reasons other than those listed above for which you should not participate in this study?

Yes No

If yes, please explain:

Do you have access to a stationary bicycle? Yes No

DIET HISTORY
Poland/Randall Thesis

Name: _____

Current Weight: _____

How long have you been at this weight? _____

Are you currently trying to gain/lose weight?

Yes ___ No ___

If so, state reason and duration:

If you have had a weight fluctuation within the past year, explain how and why it occurred:

Number of meals you usually eat per day: _____

Do you ever drink alcoholic beverages? Yes ___ No ___

If yes, how many drinks per week? _____

Briefly explain your current diet regimen (i.e. - types of food you most commonly eat and drink):

Do you have any food allergies, please explain (BE SPECIFIC!):

Are you currently taking any dietary supplements?

Yes ___ No ___

If yes, list and explain their use:

Have you taken any dietary supplements within the last six months? Yes ___ No ___

If yes, list and explain their use:

Do you ever feel weak or faint when you haven't consumed an adequate amount of food? Yes ___ No ___

Do you feel you can complete this study knowing that you will probably not be consuming your usual amount of food?
Yes ___ No ___

Do you think you will have problems complying with the dietary regimen prescribed to you? Yes ___ No ___

Do you have a refrigerator to store any foods that may require refrigeration? Yes ___ No ___

Appendix C
DATA COLLECTION SHEETS

DATA FOR 1RM LIFTS

Subject: _____

Date: _____

	<u>1 RM</u>	<u>%</u>
SUPINE BENCH PRESS		60% =
INCLINE BENCH PRESS		65% =
DIPS	BW	
CABLE PUSHDOWN		65% =
KICKBACKS R)		65% =
L)		65% =
SUPINE TRICEP EXTENSION		65% =
PULL-UPS	BW	
LAT PULLDOWNS		70% =
BENT-OVER ROWS		70% =
LEG CURL		70% =
SQUATS (5 RM)		75% (cal 1RM) =
LEG PRESS		70% =
LEG EXTENSION		70% =
CALF RAISES (5 RM)		70% (cal 1RM) =
MILITARY PRESS		65% =
SIDE LATERAL RAISE		65% =
FRONT LATERAL RAISE		65% =
REAR LATERAL RAISE		65% =
SHRUGS (5 RM)		65% (cal 1RM) =
PREACHER CURL		65% =
CONC. DUMBBELL CURL R)		65% =
L)		65% =

DATA SHEET

Name: _____

Date:

Time:

Technician:

Body Weight: _____ kg _____ lbs.

Body Height: _____ cm. _____ inches

Age:

Training Target Heart Rate: _____ bpm

Skinfold Measurements:

Chest: _____, _____,
Abdomen: _____, _____,
Thigh: _____, _____,

Sum of measurements: _____ mm

% of bodyfat

FLAT BENCH PRESS TEST

Name: _____ Test: Pract1/Pract2/Pre/Post

Date:

Time:

Flat Bench Press 1RM: _____ lbs.

Weight at 60% 1RM _____ lbs.

SET 1: 18 Reps. _____ RPE

SET 2: 15 Reps. _____ RPE

SET 3: 12 Reps. _____ RPE


SET 4: 10 Reps. _____ RPE

SET 5: 8 Reps. _____ RPE

SET 6: 6 Reps. _____ RPE

SET 7: _____ Reps. at _____ lbs. _____ RPE

Comments:

NAME _____ DATE _____ SEX: Male <input type="checkbox"/> Female <input type="checkbox"/>		IDENTIFICATION	0	1	2	3	4
Below is a list of words that describe feelings people have. Please read each one carefully. Then fill in ONE circle under the answer to the right which best describes HOW YOU HAVE BEEN FEELING DURING THE PAST WEEK INCLUDING TODAY.			0	1	2	3	4
The numbers refer to these phrases. 0 = Not at all 1 = A little 2 = Moderately 3 = Quite a bit 4 = Extremely			0	1	2	3	4
Col <input type="checkbox"/>	O.P. <input type="checkbox"/>		0	1	2	3	4
1. Friendly	0 1 2 3 4		0	1	2	3	4
2. Tense	0 1 2 3 4		0	1	2	3	4
3. Angry	0 1 2 3 4		0	1	2	3	4
4. Worn out	0 1 2 3 4		0	1	2	3	4
5. Unhappy	0 1 2 3 4		0	1	2	3	4
6. Clear-headed	0 1 2 3 4		0	1	2	3	4
7. Lively	0 1 2 3 4	0	1	2	3	4	
8. Confused	0 1 2 3 4	0	1	2	3	4	
9. Sorry for things done	0 1 2 3 4	0	1	2	3	4	
10. Shaky	0 1 2 3 4	0	1	2	3	4	
11. Listless	0 1 2 3 4	0	1	2	3	4	
12. Peeved	0 1 2 3 4	0	1	2	3	4	
13. Considerate	0 1 2 3 4	0	1	2	3	4	
14. Sad	0 1 2 3 4	0	1	2	3	4	
15. Active	0 1 2 3 4	0	1	2	3	4	
16. On edge	0 1 2 3 4	0	1	2	3	4	
17. Grouchy	0 1 2 3 4	0	1	2	3	4	
18. Blue	0 1 2 3 4	0	1	2	3	4	
19. Energetic	0 1 2 3 4	0	1	2	3	4	
20. Panicky	0 1 2 3 4	0	1	2	3	4	
21. Hopeless	0 1 2 3 4	0	1	2	3	4	
22. Relaxed	0 1 2 3 4	0	1	2	3	4	
23. Unworthy	0 1 2 3 4	0	1	2	3	4	
24. Spiteful	0 1 2 3 4	0	1	2	3	4	
25. Sympathetic	0 1 2 3 4	0	1	2	3	4	
26. Uneasy	0 1 2 3 4	0	1	2	3	4	
27. Restless	0 1 2 3 4	0	1	2	3	4	
28. Unable to concentrate	0 1 2 3 4	0	1	2	3	4	
29. Fatigued	0 1 2 3 4	0	1	2	3	4	
30. Helpful	0 1 2 3 4	0	1	2	3	4	
31. Annoyed	0 1 2 3 4	0	1	2	3	4	
32. Discouraged	0 1 2 3 4	0	1	2	3	4	
33. Resentful	0 1 2 3 4	0	1	2	3	4	
34. Nervous	0 1 2 3 4	0	1	2	3	4	
35. Lonely	0 1 2 3 4	0	1	2	3	4	
36. Miserable	0 1 2 3 4	0	1	2	3	4	
37. Muddled	0 1 2 3 4	0	1	2	3	4	
38. Cheerful	0 1 2 3 4	0	1	2	3	4	
39. Bitter	0 1 2 3 4	0	1	2	3	4	
40. Exhausted	0 1 2 3 4	0	1	2	3	4	
41. Anxious	0 1 2 3 4	0	1	2	3	4	
42. Ready to fight	0 1 2 3 4	0	1	2	3	4	
43. Good natured	0 1 2 3 4	0	1	2	3	4	
44. Gloomy	0 1 2 3 4	0	1	2	3	4	
45. Desperate	0 1 2 3 4	0	1	2	3	4	
46. Sluggish	0 1 2 3 4	0	1	2	3	4	
47. Rebellious	0 1 2 3 4	0	1	2	3	4	
48. Helpless	0 1 2 3 4	0	1	2	3	4	
49. Weary	0 1 2 3 4	0	1	2	3	4	
50. Bewildered	0 1 2 3 4	0	1	2	3	4	
51. Alert	0 1 2 3 4	0	1	2	3	4	
52. Deceived	0 1 2 3 4	0	1	2	3	4	
53. Furious	0 1 2 3 4	0	1	2	3	4	
54. Efficient	0 1 2 3 4	0	1	2	3	4	
55. Trusting	0 1 2 3 4	0	1	2	3	4	
56. Full of pep	0 1 2 3 4	0	1	2	3	4	
57. Bad-tempered	0 1 2 3 4	0	1	2	3	4	
58. Worthless	0 1 2 3 4	0	1	2	3	4	
59. Forgetful	0 1 2 3 4	0	1	2	3	4	
60. Carefree	0 1 2 3 4	0	1	2	3	4	
61. Terrified	0 1 2 3 4	0	1	2	3	4	
62. Guilty	0 1 2 3 4	0	1	2	3	4	
63. Vigorous	0 1 2 3 4	0	1	2	3	4	
64. Uncertain about things	0 1 2 3 4	0	1	2	3	4	
65. Bused	0 1 2 3 4	0	1	2	3	4	
MAKE SURE YOU HAVE ANSWERED EVERY ITEM.							
 POM 021							

DAILY CHECK-IN SHEETS
Poland/Randall Thesis

Name: _____

Date: _____ Day of Study: _____

Body Weight: _____

ON A SCALE OF 1 TO 5 PLEASE RATE HOW YOU ARE FEELING TODAY
(1 = very poor 2 = below average 3 = average 4 = good
5 = great)

1) Have you experienced any problems staying on the diet?

2) Are you experiencing any unusual symptoms or physical problems?

FOLLOW-UP QUESTIONNAIRE
Poland/Randall Thesis

Name: _____

Were you able to tell which supplement you were consuming?

Yes ___ No ___

If yes, please state: _____

Do you feel this supplement improved your weightlifting sessions? Yes ___ No ___

If yes, was it Physical ___ Psychological ___
Both ___

Do you feel you complied completely with this study?

Yes ___ No ___

Are you interested in finding out the results of this study?

Yes ___ No ___

(If yes we will send you a copy upon its final completion.)

EXPLANATION OF STUDY

During the next few days we will ask that you come in to perform a flat bench press test. This is the same test that you will perform during the experiment week. We want you to give your maximum effort for each test in order to get the best results from the study.

During the 8 days of the study we will ask you to record EVERYTHING you eat and drink on the provided forms. This includes supplements, tea, coffee, etc. Also, we will ask you to record any exercise that you perform during this time, from running to any weight lifting that you do. We do ask, that you limit your aerobic activity (i.e. running, cycling, etc.) to no more than 30 minutes, 3-4 times/week. This is to ensure that all subjects stay basically at the same activity level. Again we will provide you with the forms to record these activities. During the experiment week, you will be asked to come in two separate mornings for the flat bench press test. We ask that before you come in to be tested that you DON'T EAT ANYTHING FOR 12 HOURS BEFORE YOUR APPOINTMENT AND THAT YOU DON'T EXERCISE FOR 18 HOURS BEFORE YOUR APPOINTMENT. The times of these tests are listed on your schedule sheet. Your dietary and exercise logs will be collected on the last day you come in to be tested.

If you have any questions or concerns during the study, please contact one of the examiners.

INSTRUCTIONS FOR FILLING OUT WORKOUT
AND DIETARY DAILY LOG

Workout Log

- 1) Make sure specify which exercise you are performing and at what amount of weight and the number of repetitions you perform at that set.
- 2) Please fill out name, time, and muscle groups exercising during workout.
- 3) Don't forget to list any aerobic activity you engage in (i.e. running, swimming, biking, etc.). Make sure to include the duration and intensities of these activities. Also, please remember to limit this time to 30 min. 3-4 times/week.
- 4) If you experience any abnormal discomforts or changes while exercising, then list these on the log page.
- 4) Turn in workouts for Days 1-3 on
Turn in workout sheets for day 4-7 on

Dietary Log

- 1) Make sure to list amounts of food (i.e. 1/2 cup, 8 oz., 2 g, etc.), as well as type or style of preparation (i.e. creamed corn, baked potato, steamed broccoli, etc.).
- 2) Don't forget to include any supplements you may be taking as well as all beverages you consume.
- 3) If you have any comments to make on your diet, please do so on the back of the provided log pages.
- 4) Turn in dietary logs for days 1-3 on
Turn in dietary logs for days 4-7 on

WORKOUT LOG

Please be sure to include any aerobic act. in log, but limit it to 30 min.

NAME:

DAY 1:

TIME OF WORKOUT:

BODY PART(S) LIFTING:

<u>Exercises</u>	<u>wt/rep</u>	<u>wt/rep</u>	<u>wt/rep</u>	<u>wt/rep</u>	<u>wt/rep</u>
------------------	---------------	---------------	---------------	---------------	---------------

COMMENTS:

DAY 2:

TIME OF WORKOUT:

BODY PART(S) LIFTING:

<u>Exercise</u>	<u>wt/rep</u>	<u>wt/rep</u>	<u>wt/rep</u>	<u>wt/rep</u>	<u>wt/rep</u>
-----------------	---------------	---------------	---------------	---------------	---------------

COMMENTS:

***Turn in workout log and diet log for days 4 to 7 on
when you come in for testing*

WORKOUT LOG (CON'T)

NAME:

DAY 4:

REPORT TO WMH 239 AT _____ FOR TESTING... Don't
Workout For 18 Hours Before The Test & don't eat
anything for 12 hours before your appointment

TIME OF WORKOUT:

BODY PART(S) LIFTING:

Exercises wt/rep wt/rep wt/rep wt/rep wt/rep

**DON'T FORGET TO LIST ANY AEROBIC ACTIVITY (RUNNING,
CYCLING, ETC.) BUT, PLEASE LIMIT THIS AMOUNT OF
EXERCISE TO 30 MINUTES A DAY

COMMENTS:

NAME: **Please be sure to list
any aerobic activity, but
limit time to 30 minutes**

DAY 7:
TIME OF WORKOUT:
BODY PART(S) LIFTING:

Exercises wt/rep wt/rep wt/rep wt/rep wt/rep

COMMENTS:

DAY 8:
REPORT TO WMH 230 AT _____ FOR TESTING... Don't
Workout For 18 Hours Before The Test & don't eat
anything for 12 hours before your appointment

DIETARY LOG

NAME:
DAY 1

BREAKFAST:
Food

Amount

Way
Prepared

LUNCH:
Food

Amount

Way
Prepared

DINNER:
Food

Amount

Way
Prepared

SNACKS:
Food

Amount

Way
Prepared

*****TURN IN DIETARY LOGS FOR DAYS 1 THROUGH 3 ON
WHEN YOU COME INTO BE TESTED.*****

EXPLANATION OF STUDY

This study demands an intense amount of your concentration and time for a very brief period. During the next few days, we will ask you to come in and perform what is known as "One Repetition Maximum" test or 1 RM for all the exercises you will be performing during this study. After this information is gathered you will receive a prescribed workout telling you EXACTLY what exercise to do and how to do it.

The experiment phase of the study will be divided into a "maintenance" phase and an dieting phase. The maintenance phase will last three days. The dieting phase will last 4 days. Detailed explanations of each phase is included below.

MAINTENANCE DAYS

The purpose of the three maintenance days are to:

- 1) ensure that you don't gain or loose weight
- 2) start everybody on the same type of diet

The exercises you are to perform during these three days is listed in your packet under Exercise Protocol (days 1-3). Please perform these exercises in the order listed and check off exercises performed on the exercise protocol sheet. Please DO NOT delete or add any exercises to this list. If you have problems with one of the exercises or feel that your workout needs adjustment, call Lynette (961-0332). These completed sheets will be collected on day 4, when you come in for your flat bench test. It is important that you DO NOT EXERCISE FOR 18 HOURS, AND NOT EAT FOR 12 HOURS BEFORE THE TEST.

The diet you will be following during these three days is based on a diabetic exchange system. This type of system functions on a per serving basis rather than amount of calories. Please follow the prescribed exchange diet given to you for the three maintenance days and record what you eat on the provided form. These forms will be collected at the *end of your three maintenance days*, before you start the dieting phase(day 4). You may refer to the enclosed memiographed sheets on determining an exchange or ask one of the examiners if you have any problems or questions concerning the diet.

EXERCISE PROTOCOL

NAME _____
 DAY 1 _____

**Please don't
 add or delete
 any reps, wt.
 or ex.***

Legs/calves/Biceps

				<i>Actual</i>
	<u>Weight (lbs)</u>	<u>Sets</u>	<u>Reps.</u>	<u>Reps Perf.</u>
Squats		4	10-12	
Leg Press		3	12-15	
Leg Extension		4	8-15	
Leg Curls		4	8-15	
Donkey Calf Raises		4	12-20	
Preacher Curl		3	12-20	
Dumbbell Curls	2(each arm)		12-15	
Crunches		4	50+	
Stationary Cycling for 30 min. at heart rate of bpm				

COMMENTS:

Day 2:

<u>Back/Chest</u>	<u>Weight (lbs)</u>	<u>Sets</u>	<u>Reps</u>	<i>Actual</i> <u>Reps. Perf.</u>
Pull-Ups	body weight	3	failure	
Lat Pull-downs		4	8-15	
Bent-over Rows		4	8-15	
Incline Bench Press		3	12-15	
Dips	body weight	2	12-15	
Crunches		3	50+	
Stationary Cycling for 30 min. at heart rate of bpm				

Day 3: _____ ***Please don't
 add/delete any
 NAME: _____ sets, reps, wt., or ex.**
Shoulders/Triceps

	<u>Weight (lbs)</u>	<u>Sets</u>	<u>Reps.</u>	<u>Actual Reps. Perf.</u>
Military Press		3	8-12	
Side Lateral Raises (shoulders)		2	12-15	
Front Lateral Raises		2	12-15	
Rear Lateral Raises (sitting)		2	12-15	
Shrugs		2	12-15	
Tricep Cable Pushdowns		2	20-15	
Tricep Kickbacks (dumbbell)	2 (each arm)		12-15	
Tricep Extensions (lying using E-Z curl bar)		2	12-15	
Crunches		4	50+	
Stationary Cycling for 30 min. at heart rate of bpm				

COMMENTS:

Day 4:

DO NOT EXERCISE FOR 18 HOURS BEFORE YOUR APPT. TIME,
 REPORT TO LAB FOR FLAT BENCH PRESS TESTING.
 (MAKE SURE YOU DON'T EAT ANYTHING FOR 12 HOURS BEFORE
 TESTING)

MAINTENANCE

Your Diet Prescription is:

_____ meat	_____ milk
_____ bread	_____ fruit
_____ vegetable	_____ fat

Please note the following guidelines of exchanges:

1 bread exchange= 1/2 cup of cereal, grain, or pasta
1 ounce of a bread product

1 meat exchange= 1 oz. meat
1 oz. cheese
1/4 cup canned tuna

1 vegetable exchange= 1/2 cup cooked vegetables or
vegetable juice
1 cup of raw vegetables

1 fruit exchange= 1/2 cup of fresh fruit or fruit
juice
1/4 cup of dried fruit

1 milk exchange= 1 cup milk
8 ounces of nonfat/plain yogurt

1 fat exchange= 1 tsp. oil, butter, margarine or
mayonnaise
1 tablespoon diet margarine or diet
mayonnaise
2 tablespoons of sour cream
1 tablespoon salad dressing

free foods= unlimited amounts
herb seasonings, sugar sub., mustard,
vinegar diet sodas, coffee, tea
pickles, lemon/lime juice
nonstick pan spray

If you have a question about a food category, please follow your enclosed memiographed sheets, or contact one of the examiners.

MAINTENANCE DIET RECORD

DAY 1: _____ NAME:

Breakfast

FOOD

SERVINGS

EXCHANGE:

Lunch

FOOD

SERVINGS

EXCHANGE:

Dinner

FOOD

SERVINGS

EXCHANGE:

Snack

FOOD

SERVINGS

EXCHANGE

LOW CALORIE DIETING PHASE

The purpose of this phase is to mimic the type of diet a bodybuilder would consume in preparation for competition. This phase will last 4 days during which you will be asked to come in EVERY morning to receive your daily food. We asked that you follow our instructions in preparing and eating this food and that you consume only the food that is given to you.

The workout during this time correlates to days 4 through 8 in your exercise protocol sheets. You will notice that on days 4 and 8 you don't have to workout but instead are asked to come into the lab to perform the flat bench press test. On these days please DON'T EAT ANYTHING FOR 12 HOURS before your appointment time, and DO NOT WORKOUT FOR 18 HOURS BEFORE the test. Instructions for the test itself will be given to you on testing day.

If you experience and pain or discomfort during this study please don't hesitate to alert one of the examiners of your problem.

LOW CALORIE DIET

The food given to you in this bag contains EVERYTHING you should eat for one day (except non-caloric beverages). Please follow instructions in food preparation and DO NOT delete or add any other foods. If you experience any abnormal symptoms or discomforts while on this diet, please contact one of the examiners.

Your diet basically consists of:

BREAKFAST

2 cups of oatmeal

LUNCH

10 ounces of tuna fish
1 cup of rice

DINNER

1.5 cups of spaghetti
1 cup of tomato sauce

SNACK

1.333 tablespoons of peanut butter
4 rice cakes

-The exact amount might differ for you because the amount of food given is based on body weight. Please try to eat your food as designed above (3 meals and 1 snack), and remember to eat only the food you are given.

FOOD/BEVERAGES YOU CAN CONSUME

lemon juice, dry herbs (oregano, basil, cinnamon) water (unlimited amount)
diet soft drinks
coffee (no cream, artificial sweeteners only)
tea (artificial sweeteners only)
sugarless gum (no more than 3 sticks/day)

-If there is something else that you think would be okay to eat during this week, please check with the examiners first.

-Please don't consume any supplements during these four days and make sure to DRINK LOTS OF WATER (at least 6 glasses/day). Staying hydrated will help you from feeling tired and dizzy.

-You might feel fatigue from the diet but let us know if you experience any UNUSUAL SYMPTOMS.

COOKING OATMEAL

Stovetop

- 1) Stir the package of oats into cups of briskly boiling water.
- 2) Cook this mixture for 1 minute, stirring occasionally.
- 3) Cover; remove from heat. Let stand until desired consistency.

Microwave

- 1) Combine cups of water with the oatmeal in a microwavable dish.
 - 2) Microwave on high for 1 1/2 - 2 minutes
 - 3) Remove and mix well
- PLEASE DO NOT ADD ANY EXTRAS TO YOUR OATMEAL SUCH AS SUGAR, RAISINS, ETC.. CINNAMON IS OKAY, AND YOU CAN ADD ARTIFICIAL SWEETENER IF YOU WANT, BUT NO SUGAR.

COOKING RICE

Stovetop

- 1) Measure cups of water; bring to a boil
- 2) Stir rice into water; remove from heat
- 3) Let rice stand until all water is absorbed, (around 5 minutes)

Microwave

- 1) Combine cups of water and rice in microwavable dish.
 - 2) Microwave on high for 2-3 min. or until water boils.
- DO NOT ADD ANY EXTRAS TO RICE (Such as Butter), EXCEPT DRY SPICES SUCH AS PEPPER, BASIL, ETC.

COOKING SPAGHETTI

Stovetop

- 1) Bring 2-3 quarts of water to boil.
 - 2) Add spaghetti; stir to separate
 - 3) Boil spaghetti uncovered for about (9-13 minutes)
 - 4) Drain and serve immediately.
- DO NOT ADD ANY EXTRAS TO THE SPAGHETTI EXCEPT FOR THE PROVIDED TOMATO SAUCE. YOU MAY ADD DRY SPICES (Basil, Tarragon, Pepper) BUT NO CHEESES OR OTHER EXTRAS.

!!!!!!!!!!!!!!!!!!!!!!IMPORTANT!!!!!!!!!!!!!!!!!!!!!!
 TUNA FISH AND TOMATO SAUCE ARE PERISHABLE FOODS. THEY
 NEED TO BE REFRIGERATED IMMEDIATELY AFTER RECEIVING
 THEM. DO NOT EAT THEM IF THEY HAVE BEEN OUT FOR
 LONGER THAN ONE HOUR.

LOW CALORIE DIET CHECK-OFF

Please check off the food after you have eaten
 them. Also, add any beverages, seasonings, or
 permitted food that you consumed with that meal.

DAY

BREAKFAST

_____ Oatmeal
 _____ Beverage (Specify)
 _____ Other (Specify)

LUNCH

_____ Tuna Fish
 _____ Rice
 _____ Beverage (Specify)
 _____ Other (Specify)

DINNER

_____ Spaghetti
 _____ Tomato sauce
 _____ Beverage (Specify)
 _____ Other (Specify)

SNACK

_____ Peanut Butter
 _____ Rice Cakes
 _____ Beverage (Specify)
 _____ Other (Specify)

COMMENTS

Day 5: _____
 NAME: _____

**Please do not
 add/delete any
 reps, sets, wts.,
 or ex.****

Legs/Calves/Biceps

	<u>Weight (lbs)</u>	<u>Sets</u>	<u>Reps</u>	<u>Actual Reps. Perf.</u>
Squats		4	10-12	
Leg Press		3	12-15	
Leg Extension		4	8-15	
Leg Curls		4	8-15	
Donkey Calf Raises		4	12-20	
Preacher Curl		3	12-20	
Dumbbell Curls	2(each arm)		12-20	
Crunches		4	50+	
Stationary Cycling for 30 min. at heart rate of bpm				

COMMENTS:

Day 6:

Back/Chest

	<u>Weight (lbs)</u>	<u>Sets</u>	<u>Reps</u>	<u>Actual Reps. Perf.</u>
Pull-Ups	body weight	3	failure	
Lat Pull-downs		4	8-15	
Bent-over Rows		4	8-15	
Incline Bench Press		3	12-15	
Dips	body weight	2	12-15	
Crunches		3	50+	
Stationary Cycling for 30 min. at heart rate of bpm				

Day 7: _____ **Please do not
 NAME: _____ add/delete any reps.,
 wt., sets, or ex.**

Shoulders/Triceps

	<i>Weight (lbs)</i>	<i>Set</i>	<i>Reps</i>	<i>Actual Reps. Perf.</i>
Military Press		3	8-12	
Side Lateral Raises (shoulders)		2	12-15	
Front Lateral Raises		2	12-15	
Rear Lateral Raises (sitting)		2	12-15	
Shrugs		2	12-15	
Tricep Cable Pushdowns		2	20-15	
Tricep Kickbacks (dumbbell)	2(each arm)		12-15	
Tricep Extensions (lying using E-Z curl bar)		2	12-15	
Crunches		4	50+	
Stationary Cycling for 30 min. at heart rate of bpm				

COMMENTS:

Day 8:

DO NOT EXERCISE (for 18 hours before your appt. time),
 REPORT TO LAB FOR FLAT BENCH PRESS TESTING.
 (MAKE SURE YOU DON'T EAT ANYTHING 12 HOURS BEFORE
 TESTING)

*****It is important that you follow this
 workout and document this workout on the sheets
 provided until the end of the study. PLEASE DO NOT DO
 ANY ADDITIONAL EXERCISES OR DELETE ANY OF THE
 PRESCRIBED EXERCISES LISTED ABOVE. For some reason if
 you do not do the exact repetition or set listed
 above, please explain why in the space provided at the
 end of each workouts. *****

Appendix D

DIET AND SUPPLEMENT PORTIONS

CARBOHYDRATE SUPPLEMENT MEASUREMENTS

Ingredients -- 5 kcal/kg body weight

1.15 g carbohydrate/kg body weight

0.0 g protein/kg body weight

0.0 g fat/kg body weight

<u>Body weight (kg)</u>	<u>Mix (g)</u>
60	69.9
62.5	72.8
65	75.7
67.5	78.6
70	81.5
72.5	84.4
75	87.3
77.5	90.2
80	93.1
82.5	96.0
85	98.9
87.5	101.9
90	104.8
92.5	107.7
95	110.6

PROTEIN SUPPLEMENT MEASUREMENT

Ingredients -- 5 kcal/kg body weight

1.02 g protein/kg body weight

0.0 g carbohydrate/kg body weight

0.0 g fat/kg body weight

<u>Body Weight (kg)</u>	<u>Mix (g)</u>
60	85.2
62.5	88.8
65	92.3
67.5	95.9
70	99.4
72.5	102.9
75	106.5
77.5	110.1
80	113.6
82.5	117.2
85	120.7
87.5	124.7
90	127.8
92.5	131.4
95	134.9

LOW-CALORIE DIET FOOD MEASUREMENTS

Body Weight	Rolled Oats	Rice Cake	Tuna	Rice	Spaghetti	Tomato Sauce	PB
60	73.2	30.6	244.2	44.4	97.8	195.6	18.6
62.5	76.3	31.9	254.4	46.3	101.9	203.8	19.4
65	79.3	33.2	264.6	48.1	105.9	211.9	20.2
67.5	82.4	34.4	274.7	49.9	110	220	20.9
70	85.5	36	285	52	114	228	21.4
72.5	88.5	36.9	295	53.7	118.2	236	22.5
75	91.5	38.3	205.3	55.	122.3	244.5	23.3
77.5	94.6	39.5	315.4	57.4	126.3	252.6	24
80	97.6	40.8	325.6	59.2	130.4	260.8	24.8
82.5	100.7	42.1	335.8	61.1	134.5	268.9	25.6
85	103.7	43.4	345.9	62.9	138.6	277.1	26.4
87.5	106.8	44.6	356.1	64.8	142.6	285.3	27.1
90	109.8	45.9	366.3	66.6	146.7	293	27.9
92.5	112.9	47.2	376.5	68.5	150.8	301.6	28.7
95	115.9	48.5	386.7	70.3	154.9	309.7	29.5

Body Weight was measured in kilograms.

All food was measured in grams.

MAINTENANCE DIET EXCHANGES

BW	Bread	Meat	Vegetable	Fruit	Milk	Fat
60	8	3	7	6	3	6
62.5	9	4	7	6	3	6
65	9	4	7	6	3	6
67.5	10	4	8	7	3	7
70	10	4	8	7	3	7
72.5	10	4	8	7	3	7
75	11	4	9	8	3	8
77.5	11	4	9	8	3	8
80	11	5	9	8	3	8
82.5	12	5	10	8	4	8
85	12	5	10	9	4	9
87.5	12	5	10	9	4	9
90	13	5	10	9	4	9
92.5	13	5	11	9	4	9
95	13	5	11	10	4	10

Body Weight was measured in kilograms.

Exchanges are based on the Diabetic Exchange Diet.
Each exchange constitutes a serving.

Appendix E
RESULTS OF STATISTICAL ANALYSIS

Analysis of Variance for Subject Body Weight Across Time

Source	DF	Sum of Squares	Mean Square	Mean Ratio	Prob>F
A	2	47.79	23.89	.09	.912
B	2	27.49	13.75	.15	.862
A*B	4	175.22	43.81	.27	.984

A=Group (Carb, Protein, Control)
B=Pre-Diet Test and Post-Diet Test

ANALYSIS OF VARIANCE

TOTAL PROFILE OF MOOD STATES (POMS) SCORE

Source	DF	Anova SS	F Value	Pr > F	Adj G	Pr > F	H	F
DIET	2	4354.9259216	3.75	0.0498	.	.	.	.
Error	14	3138.5416667						
Source: TRIAL								
DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	F
1	919.117647	919.117647	3.53	0.0813	.	.	.	.
Source: TRIAL#DIET								
DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	F
2	253.974020	126.987010	0.49	0.6241	.	.	.	.
Source: Error(TRIAL)								
DF	Anova SS	Mean Square						
14	3545.908333	260.422024						
Source: TIME								
DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	F
1	39.7547059	39.7547059	1.57	1.4629	.	.	.	.
Source: TIME#DIET								
DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	F
2	60.3936275	30.1968137	0.43	0.6571	.	.	.	.
Source: Error(TIME)								
DF	Anova SS	Mean Square						
14	976.8416667	69.7744043						
Source: TRIAL*TIME								
DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	F
1	11.5294119	11.5294119	0.41	1.5308	.	.	.	.
Source: TRIAL*TIME#DIET								
DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	F
2	49.7289216	24.8644608	0.99	0.4323	.	.	.	.
Source: Error(TRIAL*TIME)								
DF	Anova SS	Mean Square						
14	390.7416667	27.9101190						

Diet=Group (Carb, Protein, Control)
 Trial=Pre-Diet Test 1&2 and Post Diet Test 1&2
 Time=Pre-Diet Test and Post Diet Test

ANALYSIS OF VARIANCE
TOTAL POMS ANGER SCORE

Source	DF	Anova SS	F Value	Pr > F	Adj G	Pr > H	F
DIET	2	421.81274510	1.39	0.1381	.	.	.
Error	14	1564.71666667					
Source: TRIAL							
DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > H	F
1	141.2352941	141.2352941	2.00	0.1737	.	.	.
Source: TRIAL*DIET							
DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > H	F
2	196.317059	98.1573529	0.75	0.4885	.	.	.
Source: Error(TRIAL)							
DF	Anova SS	Mean Square					
14	936.4500000	70.4607143					
Source: TIME							
DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > H	F
1	58.0000000	58.0000000	4.91	0.0439	.	.	.
Source: TIME*DIET							
DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > H	F
2	16.9500000	8.4750000	0.51	0.5564	.	.	.
Source: Error(TIME)							
DF	Anova SS	Mean Square					
14	194.0500000	13.8607143					
Source: TRIAL*TIME							
DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > H	F
1	0.9411765	0.9411765	0.08	0.7699	.	.	.
Source: TRIAL*TIME*DIET							
DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > H	F
2	0.2754902	0.1377451	0.01	0.9367	.	.	.
Source: Error(TRIAL*TIME)							
DF	Anova SS	Mean Square					
14	143.7833333	10.2702381					

Diet=Groups (Carb, Protein, Control)
 Trial=Pre-Diet Test 1&2 and Post-Diet Test 1&2
 Time=Pre-Diet Test and Post Diet TEST

ANALYSIS OF VARIANCE
TOTAL POMS VIGOR SCORE

Source	DF	Anova SS	F Value	Pr > F
DIET	2	152.02107843	1.64	0.2299
Error	14	650.50833333		

Source: TRIAL

DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	I	F
1	19.0588235	19.0588235	1.75	0.2029	.	.	.	.	.

Source: TRIAL*DIET

DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	I	F
2	56.3995098	28.1997549	2.54	0.1064	.	.	.	.	.

Source: Error(TRIAL)

DF	Anova SS	Mean Square
14	149.5416667	10.6819476

Source: TIME

DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	I	F
1	108.7647059	108.7647059	4.20	0.0596	.	.	.	.	.

Source: TIME*DIET

DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	I	F
2	1.6936275	0.8468137	0.03	0.9679	.	.	.	.	.

Source: Error(TIME)

DF	Anova SS	Mean Square
14	362.5416667	25.8958333

Source: TRIAL*TIME

DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	I	F
1	25.9411755	25.9411755	2.41	0.126	.	.	.	.	.

Source: TRIAL#TIME*DIET

DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	I	F
2	2.5504902	1.2752451	0.12	0.3890	.	.	.	.	.

Source: Error(TRIAL#TIME)

DF	Anova SS	Mean Square
14	150.5083333	10.7505952

Diet=Group (Carb, Protein, Control)
 Trial=Pre-Diet Test 1&2 and Post-Diet Test 1&2
 Time=Pre-Diet Test and Post Diet Test

ANALYSIS OF VARIANCE
TOTAL POMS FATIGUE SCORE

Source	DF	Anova SS	F Value	Pr > F
DIET	2	65.24215626	1.54	0.2494
Error	14	305.11556567		

Source: TRIAL

DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	F
1	1.4705332	1.4705332	0.17	0.6932	.	.	.	.

Source: TRIAL#DIET

DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	F
2	21.9460734	10.9730367	1.30	0.3046	.	.	.	.

Source: Error(TRIAL)

DF	Anova SS	Mean Square
14	113.5833333	8.4702381

Source: TIME

DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	F
1	39.7647059	39.7647059	4.27	0.0575	.	.	.	.

Source: TIME#DIET

DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	F
2	33.8519618	16.9259809	1.82	0.1937	.	.	.	.

Source: Error(TIME)

DF	Anova SS	Mean Square
14	130.3833333	9.3130952

Source: TRIAL#TIME

DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	F
1	0.52941176	0.52941176	0.06	0.7751	.	.	.	.

Source: TRIAL#TIME#DIET

DF	Anova SS	Mean Square	F Value	Pr > F	Adj G	Pr > F	H	F
2	3.08725490	1.54362745	0.25	0.7642	.	.	.	.

Source: Error(TRIAL#TIME)

DF	Anova SS	Mean Square
14	37.3833333	6.24166567

Diet=Group (Carb, Protein, Control)
 Trial=Pre-Diet Test 1&2 and Post-Diet Test 1&2
 Time=Pre-Diet Test and Post-Diet Test

2 Way Analysis of Variance for combined RPE scores (Sets 1-6) for Pre-Test versus Post-Test

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob>F
A	2	481.9	240.97	1.952	0.1787
B(A)	14	1728.0	123.43		
C	1	20.9	20.86	0.735	0.4058
AC	2	12.7	6.37	0.224	0.8020
Error	14	397.5	28.39		
Total	33	2644.1	80.12		

A=Group
 B=Subject
 C=Test Time

2 Way Analysis of Variance for RPE scores across all sets 1
- 6 of the Post-Test

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob>F
A	2	65.7	32.87	3.78	0.0487
B(A)	14	121.8	8.70		
C	5	76.4	15.28	6.92	<0.0001
AC	10	83.4	8.34	3.77	0.0004
Error	70	154.7	2.21		
Total	101	511.8	5.07		

A=Group
B=Subject
C=Test Time

Appendix F

RAW DATA

GENERAL SUBJECT INFORMATION

<u>Subject</u> (kq)	<u>Age</u>	<u>Body Weight</u>	<u>Height</u> (cm)	<u>Years Lifted</u>	<u>Body Fat</u> (%)
Carbohydrate Group					
1	24	63.1	170.1	1.5	4.7
2	23	87	182.9	5	17.4
3	21	67.4	162.6	6	8.9
4	29	88	190.5	5	11.8
5	23	100	189.2	3	14.8
6	23	83	193	1.5	4.7
Average	23.8	81.4	181.4	3.7	10.4
Placebo Group					
7	20	75.2	180	3	13.4
8	22	80.8	177.8	7	16
9	19	74.2	180.3	2.5	9.8
10	21	110	186.7	2.5	14.3
11	33	74.6	177.8	14	10.5
12	20	90	190.5	2.5	13.4
Average	22.5	84.1	182.2	5.3	12.9
Control Group					
13	19	90.2	190.5	7	12.5
14	19	74	175.3	4	9.8
15	25	75.9	175	12	7.6
16	27	89.4	182.9	2	17.4
17	21	79.6	180.3	4	14.3
Average	22.2	81.8	180.8	6.6	10.3

PROFILE OF MOOD STATES - TOTAL SCORES

<u>Subject</u>	<u>Pre-Test 1</u>	<u>Pre-Test 2</u>	<u>Post-Test 1</u>	<u>Post-Test 2</u>
Carbohydrate				
1	28	32	23	27
2	37	37	37	36
3	37	41	21	17
4	26	26	29	27
5	29	32	21	20
6	38	36	27	26
Average	32.5	34	26.3	25.5
Placebo				
7	42	62	42	55
8	117	89	46	42
9	27	27	24	21
10	44	48	40	44
11	32	36	32	38
12	69	57	71	54
Average	48.5	53.1	42.5	42.3
Control				
13	73	53	51	54
14	35	39	24	34
15	44	38	39	39
16	53	38	37	35
17	30	30	58	41
Average	47	39.6	41.8	40.6

PROFILE OF MOOD STATES - FATIGUE

<u>Subject</u>	<u>Pre-Test 1</u>	<u>Pre-Test 2</u>	<u>Post-Test 1</u>	<u>Post-Test 2</u>
Carbohydrate				
1	1	2	1	3
2	7	8	6	4
3	8	5	6	1
4	2	4	5	7
5	4	6	6	3
6	6	6	4	4
Average	4.7	5.2	4.7	3.7
Placebo				
7	6	9	9	9
8	5	18	9	12
9	7	4	5	0
10	5	7	3	5
11	5	5	4	11
12	6	2	3	8
Average	5.6	7.5	5.5	7.5
Control				
13	5	7	15	15
14	6	12	4	13
15	5	2	4	8
16	3	7	3	5
17	2	8	4	6
Average	4.2	7.2	6	9.4

PROFILE OF MOOD STATES - VIGOR

<u>Subject</u>	<u>Pre-Test 1</u>	<u>Pre-Test 2</u>	<u>Post-Test 1</u>	<u>Post-Test 2</u>
Carbohydrate				
1	13	18	15	17
2	17	16	16	18
3	1	19	1	7
4	18	15	13	10
5	18	20	9	12
6	14	15	11	14
Average	13.5	17.1	10.8	13
Placebo				
7	18	28	17	21
8	14	13	9	19
9	10	20	14	18
10	16	14	26	16
11	15	16	17	14
12	13	18	18	16
Average	14.3	18.1	16.8	17.3
Control				
13	13	23	14	24
14	17	16	13	13
15	17	26	23	17
16	20	16	23	20
17	9	14	7	12
Average	15.2	19	16	17.2

PROFILE OF MOOD STATES - ANGER

<u>Subject</u>	<u>Pre-Test 1</u>	<u>Pre-Test 2</u>	<u>Post-Test 1</u>	<u>Post-Test 2</u>
Carbohydrate				
1	4	2	0	0
2	1	1	1	0
3	3	0	1	0
4	0	0	0	0
5	1	1	1	1
6	1	0	1	0
Average	1.6	.66	.66	.16
Placebo				
7	7	14	6	5
8	47	25	6	2
9	0	0	0	0
10	0	3	2	0
11	1	1	0	0
12	11	9	14	8
Average	9.2	8.6	4.6	2.5
Control				
13	20	11	6	4
14	2	0	0	0
15	2	0	0	0
16	4	1	1	0
17	5	3	17	6
Average	6.6	2.5	4.8	2

PROFILE OF MOOD STATES - TENSION

Subject Pre-Test 1 Pre-Test 2 Post-Test 1 Post-Test 2

Carbohydrate

1	7	8	5	5
2	8	10	10	10
3	15	14	8	6
4	3	4	5	4
5	4	3	2	2
6	5	6	4	5

Placebo

7	10	8	5	17
8	26	12	7	7
9	7	2	2	2
10	16	11	7	16
11	1	8	3	6
12	14	7	12	8

Control

13	18	11	3	6
14	5	9	5	5
15	11	4	8	10
16	16	10	6	5
17	8	3	12	7

PROFILE OF MOOD STATES - DEPRESSION

Subject Pre-Test 1 Pre-Test 2 Post-Test 1 Post-Test 2

Carbohydrate

1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	6	5	3	2

Placebo

7	5	1	1	0
8	19	8	7	0
9	1	0	0	0
10	1	3	0	1
11	3	1	1	1
12	16	13	16	9

Control

13	6	0	3	1
14	3	0	0	1
15	0	0	0	0
16	6	1	1	1
17	5	1	11	6

PROFILE OF MOOD STATES - CONFUSION

Subject Pre-Test 1 Pre-Test 2 Post-Test 1 Post-Test 2

Carbohydrate

1	3	2	2	2
2	4	2	4	4
3	10	3	5	3
4	3	3	6	6
5	2	2	3	2
6	6	4	4	3

Placebo

7	1	2	4	3
8	6	13	8	2
9	2	1	3	1
10	6	10	2	6
11	7	5	7	6
12	9	8	8	5

Control

13				
14	11	1	10	4
15	2	2	2	2
16	9	6	4	4
17	4	3	3	4
	1	1	7	4

RATINGS OF PERCEIVED EXERTION - PRE-DIET TEST

<u>Subject</u>	<u>Set 1</u>	<u>Set 2</u>	<u>Set 3</u>	<u>Set 4</u>	<u>Set 5</u>	<u>Set 6</u>	<u>Set 7</u>
Carbohydrate							
1	12	13	14	14	13	12	16
2	13	14	13	15	13	12	15
3	13	14	16	16	14	13	15
4	8	12	15	16	13	9	18
5	16	16	15	13	11	6	17
6	15	15	14	13	12	11	16
Placebo							
7	13	15	14	14	12	12	15
8	7	11	9	8	7	7	18
9	11	12	12	12	11	10	15
10	12	13.5	14.5	15.5	14	12	16
11	14	14	17	16	14	8	18
12	8	10	12	11	10	9	12
Control							
13	12	13	13	13	13	12	15
14	13	15	15	14	13	11	13
15	10	12	12	14	13	11	15
16	13	13	13	14	13	12	15
17	10	12	13	14	13	12	16

RATINGS OF PERCEIVED EXERTION - POST-DIET TEST

<u>Subject</u>	<u>Set 1</u>	<u>Set 2</u>	<u>Set 3</u>	<u>Set 4</u>	<u>Set 5</u>	<u>Set 6</u>
Carbohydrate						
1	12	13	14	14	13	11.5
2	12	13	15	15	13	13
3	15	15	16	16	15	12
4	10	16	17	15	13	11
5	16	17	15	13	8	7
6	15	15	15	14	13	12
Placebo						
7	13	14	14	15	13	12
8	13	14	12	11	9	9
9	11	11	10	10	9	8
10	12	13.5	14.5	15.5	14	12
11	12	15	15	16	13	7
12	9	12	10	10	9	8
Control						
13	13	15	16	14	13	13
14	11	13	14	13	12	10
15	13	13	14	13	13	11
16	12	13	13	12	11	11
17	11	12	13	14	13	11

RESPONSE TO FINAL QUESTIONNAIRE

<u>Subject</u>	<u>Able to tell Beverage</u>	<u>Helped Psych</u>	<u>Helped Physical</u>
Carbohydrate			
1	yes	yes	no
2	no	yes	no
3	yes	yes	yes
4	no	yes	yes
5	yes	no	no
6	no	yes	yes

50% knew what the beverage was

83% thought it helped them psychologically

50% thought it helped them physically

Placebo (Protein)

8	yes	no	no
9	no	no	no
10	yes	no	yes
11	no	no	no
12	no	no	no
13	no	no	no

33% knew what the beverage was

no one thought it helped them psychologically

16% thought it helped them physically

Control

no controls answered these questions since they were not applicable to their portion of the study

**The vita has been removed from
the scanned document**