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Development of lean body mass in off-season intercollegiate football players

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DEVELOPMENT OF LEAN BODY MASS IN OFF-SEASON INTERCOLLEGIATE FOOTBALL PLAYERS

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ABSTRACT

A NUTRITION PROGRAM TO INCREASE LEAN BODY MASS IN THE OFF-SEASON INTERCOLLEGIATE FOOTBALL PLAYER

by David Amacher

A nutrition program was created to provide information on how to increase lean body mass in off-season football players. The intent of the program is to provide a resource for football coaches, strength coaches, athletic trainers, and football players. The program has a special emphasis on football players, but could be used by any athlete who is trying to increase lean body mass. The program contains five topics: protein, fat, carbohydrates, post workout nutrition, and creatine. Five Division III football players, two Division III strength coaches, two certified athletic trainers, and one registered dietician evaluated the program. The results were supportive and the evaluators would recommend the program to football players attempting to increase lean body mass in the off-season.

DEDICATION

I dedicate this document to the late Dan Duchaine. Duchaine's ideas and rantings forced me to think for myself and question authority on performance enhancement and bodybuilding. Dan, wherever you are, I hope you look at this manual and smile.

Special thanks and love go to my mother and father. You always supported me in my crazy nutrition endeavors. You started it all with that copy of Muscle & Fitness and amino acids. I cannot state how much you two mean to me.

Another shout out goes to Shauna. You put up with research articles, books, and drafts scattered throughout the living room. Thank you for all your love and support.

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CHAPTER 1

Introduction

Bench pressing 500 lb, squatting 800 lb, running a 4.6 s forty yard dash, and weighing in at 250 lb while playing middle linebacker are numbers that football players strive to achieve because the game of football is a sport requiring maximum power, strength, and lean body mass (Baker, 1998). When two football players of equal skill level compete against each other, the bigger, faster, and stronger player will win (Pearson & Gehlsen, 1998). Many football players spend countless hours performing squats, bench presses, and power cleans in the weight room and numerous sprints and agility workouts to become bigger, faster, and stronger. At the same time, many football players often undermine their hard work by neglecting one area - a proper nutrition program (Phillips, 1997).

Maintaining optimum nutrition is essential to maximize the off-season strength and conditioning program (Voris, 1997). When creatine supplementation is added to a proper nutritional program, football players may experience significantly greater gains in lean body mass (Kreider, Ferreira, Wilson, Grindstaff, Plisk, Reinardy, Cantler, & Almada, 1998). Without proper nutrition, the football player derails even the greatest physical training efforts. While following a strength and conditioning program, adequate nutritional support will help football players reach their goals of becoming bigger, faster, and stronger (Parillo, 1997; Vinci, 1998).

A high carbohydrate, low fat diet is sometimes recommended for football players (Economos, Bortz, & Nelson, 1993). The high carbohydrate, low fat diet is from the

U.S. Department of Agriculture's food guide pyramid, with carbohydrates at the base of the pyramid and fats at the apex. Many football players take the high carbohydrate, low fat diet to the extreme, eating only foods such as rice cakes, pasta, and bread. Such a diet high in carbohydrates may cause a roller coaster of energy levels every day (Luoma, 1996). By placing such a high value on carbohydrates, many strength training football players may not consume enough protein to remain in anabolic or positive nitrogen balance (Brink, 1996; Lemon, 1991).

An often heard expression in nutrition is that nothing should be taken to the extreme, but balance and moderation are key factors (Duchaine, 1996). Should the moderation notion apply to a football player's nutritional program? In recent years, the effects of different ratios of protein, carbohydrates, and fat in football players' diets have been examined (Celejowa & Homa, 1970; Liu, Baracos, Quinney, & Clandinin, 1994).

Statement of problem

Many football players receive conflicting information on how to effectively increase lean body mass during the off-season, thus players do not understand the importance of nutrition (Brink, 1996). Football players are often misinformed on how to effectively increase lean body mass (Duchaine, 1996). The players are told to eat a lot of ice cream and ingest large portions of carbohydrates. Players are also told that supplements are useless and the body can only utilize 30 g of protein during one feeding (Brink, 1996; Luoma, 1997). The advice is given to the players by a variety of sources: coaches, teachers, athletic trainers, and friends (Luoma, 1997). Often an athlete will question a strength coach or athletic trainer for advice (Bentivegna, Kelley, & Kalenak, 1979). Unfortunately, if the strength coach or athletic trainer does not pursue nutrition and supplementation information on their own initiative, they may not have the proper answer from specific job experience or traditional course work in their chosen fields (Duchaine, 1996). If an individual does have nutrition education and knowledge, the individual may not be confident in giving advice about nutrition or may not be current in new nutritional theories or ergogenic aids (Corley, Demarest-Litchford, & Bazzarre, 1990; Wolf, Wirth, & Lohman, 1979). To make matters worse, small colleges may not even employ a strength coach, full time athletic trainer, nutrition consultant, or other qualified individual with whom players may discuss nutritional issues.

The purpose of this project was to synthesize the literature on performance enhancement through nutrition ratios and creatine supplementation. After the research was performed, a comprehensive off-season nutrition program was written. The resulting program is a guide for the off-season football player to increase lean body mass while following a strength and conditioning program. The program contains information on the following: ratios of carbohydrates, protein, and fat to be consumed, recommended food, when certain foods should be consumed, dispelling popular myths, creatine supplementation, and a sample diet.

Delimitation

For the purpose of this project the following delimitations were identified:

1. The search engines Yahoo, Webcrawler, Excite, Allinone and Snap were examined before 3-24-99.

2. The data bases Med-Line, Sports Discus, and Lexus-Nexus were examined before 3-24-99.

Limitation

The project outcomes were limited by:

1. The previous nutritional experiences of the reviewers.

2. The studies involving human participants might have failed to detect the use of illegal ergogenic aids.

3. A lack of objectivity with the survey.

Definition of terms

Anabolic State. An anabolic state is a condition in which muscle tissue can be synthesized.

Creatine. Creatine is a substance that is found naturally in red meat. Creatine is also produced in the pancreas and kidneys. Creatine is stored in the body as phosphocreatine, which replenishes adenosine triphosphate. Adenosine triphosphate is the source of energy used for muscular activity during short bursts of high-intensity exercise.

Intercollegiate Athlete. Intercollegiate athletes are enrolled in college courses full-time while playing a school sponsored sport.

Nitrogen Balance. Nitrogen balance is a state in which the daily intake of nitrogen from proteins equals the daily excretion of nitrogen. A negative balance is usually associated with a catabolic state, while a positive balance is usually associated with an anabolic state.

Justification of nutrition program

Football players receive conflicting and ineffective information from coaches, teachers, and athletic trainers on how to increase lean body mass in the off-season (Corley et al., 1990; Duchaine, 1996). Players are told that the human body can only utilize 30 g of protein during one feeding and that any additional protein will damage the human liver (Brink, 1996; Lemon, 1991). Players may also be told that all supplements, including creatine, are useless and dangerous (Luoma, 1991).

Wolf et al. (1979) surveyed 137 coaches in the Big Ten conference on nutrition information. The results indicated that 69% of the surveyed coaches responded that they rarely read about nutrition, while 78% felt the need for more knowledge about sports nutrition. The coaches reported that they relied on physicians, coaches, players, and popular literature for nutrition information.

Luoma (1991) investigated the responses to nutrition and supplement questions from an endocrinologist, sports medicine specialist, and general practitioner. The report demonstrated that the individuals interviewed had nutrition information from the 1960's and were extremely biased against supplements, including creatine. The endocrinologist had outdated nutritional information and no knowledge of ergogenic aids. The sports medicine specialist advocated eating sugar for energy and had a negative view of supplements both before and after being presented with research articles. The general practitioner also had a negative view of supplementation, stating that no double blind, placebo studies on creatine supplementation existed.

Sometimes players have no qualified individual with whom to discuss nutritional issues. They are left confused and alone in regards to nutrition.

The More Mass Nutrition Program (Appendix A) serves as a nutrition guide for the off-season football player to effectively increase lean body mass. The off-season football player must be engaged in an off-season strength and conditioning program for the ideas of the manual to be effective tools for promotion of lean body mass.

CHAPTER 2

Review of Literature

The game of football requires power, speed, strength, and large amounts of body mass. The body mass component should preferably be a high percentage of lean body mass (Baker, 1998). To achieve strength, power, and speed, most successful football programs have an off-season strength and conditioning program (Voris, 1996). Some football programs do not have a nutrition and creatine supplementation program to complement the strength and conditioning program. In this chapter information on using nutrition and creatine supplementation to accompany a strength and conditioning program is reviewed.

Protein

For the past 20 years dietary protein has been a disputed subject between researchers, doctors, athletes, and coaches (Brink, 1996). The idea that strength training individuals need more protein than the average person has been the main issue of debate (Lemon, 1991).

Tarnopolsky, Atkinson, MacDougall, Chesley, Phillips, and Schwarcz (1992) examined the issue of protein requirements for strength trained athletes. Nitrogen balance and leucine kinetic methods were used to determine if strength trained athletes needed more protein than sedentary participants. Participants were randomly assigned to one of three different groups with a relative ingested protein intake: low protein = 0.86 g of protein per kg bodyweight, moderate protein = 1.40 g of protein per kg of bodyweight, or high protein = 2.40 g of protein per kg of bodyweight for 13 days for each protein intake.

Caloric intake was matched with the participant's habitual diet. The low protein diet provided the sedentary participants with adequate protein intake, while increasing the protein levels did not increase whole body synthesis, but caused protein to be excreted at a higher rate. The strength trained athletes in the low protein diet group were found to be in a negative nitrogen balance, signifying a catabolic environment and inadequate protein intake. The medium and high protein groups were not in a negative nitrogen balance. The finding from the Tarnopolsky et al. study supports the idea that higher levels of protein intake may be necessary for strength training athletes.

Protein requirements and muscle mass/strength changes during intensive training in novice bodybuilders were examined by Lemon, Tarnopolsky, MacDougall, and Atkinson (1992). The double blind, cross-over study used 12 participants assigned to a relative ingested protein intake of 2.63 g per kg of bodyweight (PRO) or a protein intake of 1.35 g per kg of bodyweight (CHO) for 1 month during intensive training, 1.5 hours a day, 6 days a week. Both groups consumed an equal amount of calories. Nitrogen balance was taken after 3.5 weeks on each treatment. No differences in strength or muscle mass were found between the 2 protein groups. The CHO group demonstrated a negative nitrogen balance, while the PRO group was in a positive nitrogen balance, which is favorable for muscle and strength gains. Lemon et al. concluded that if the study lasted longer than 1 month, the PRO group would have experienced greater muscle and strength gains. The greater gains were attributed to the PRO group achieving a positive nitrogen balance. Lemon et al. suggested that if an individual trains intensively with weights for more than a 1 month period and wishes to increase strength and muscle mass, then the individual should consume 1.7-2.63 g of protein per kg of body weight. The 1.7-2.63 g of protein is 100% more protein than current recommendations.

Fern, Belinski, and Schutz (1991) assessed changes in lean body mass from differences in the level of protein intake during weight training. Twelve young men were randomly assigned to 2 relative protein groups. A protein supplemented group consumed 3.3 g of protein per kg of bodyweight. The control group received a placebo of wheat bran and consumed 1.3 g of protein per kg of bodyweight. The groups consumed an equal amount of calories. Both groups engaged in progressive weight training for 3 times a week for 1 month. Bodyweight was measured daily. Body fat was measured weekly by skinfold thickness and underwater weighing. Nitrogen balance was also tested weekly. At the end of the study, the placebo group demonstrated a weight gain of 1.5 kg, while the protein supplement group gained 2.8 kg. The protein group demonstrated greater gains in lean body mass than the placebo group. The study demonstrated that 3.3 g of protein per kg of bodyweight benefited the strength training athlete more than 1.3 g of protein per kg bodyweight.

Celejowa et al. (1970) evaluated the effects of protein levels on nitrogen balance in 10 competitive weightlifters. The weightlifters were divided into three absolute protein groups for 11 days. Group I consumed 130 g of protein a day, Group II consumed 143 grams of protein a day, and Group III consumed 159 g of protein a day. All groups weight trained for an average of 96 min a day. At the end of the 11 days, Group I demonstrated a negative nitrogen balance of 0.47. Group II had a positive nitrogen balance of 0.38. Group III demonstrated a positive nitrogen balance of 1.30. The authors concluded that to remain in a positive nitrogen balance while weight training, one needs to consume at least 2.0 - 2.2 g of protein per kg of bodyweight.

The research on protein and weight training supports higher levels of protein intake than the recommended daily allowance of 0.9 g per kg of body weight. If a strength training athlete wishes to optimize muscular growth, the athlete must remain in a positive nitrogen balance. If a strength training athlete is not in a positive nitrogen balance, muscle tissue cannot be synthesized (Lemon, 1991). To remain in a positive nitrogen balance, the athlete should consume 2.0 - 3.3 g of protein per kg of bodyweight (Fern et al., 1991). The 2.0 - 3.3 g of protein per kg of bodyweight is what body enhancement coaches have been recommending successfully for several years (Duchaine, Brink, & Kneller, 1996).

Fat

Throughout the 1980's, fat was the opponent of mainstream nutritionists (Brink, 1996). The main outcome of this reasoning was a diet high in carbohydrate, 65% - 70%, and low in fat. This high carbohydrate diet is often responsible for energy crashes and increased body fat (Duchaine, 1996; Luoma, 1996). It is now thought that a low fat diet may not be the most conducive diet for the weight training football player (Duchaine et al., 1996). Dietary fat is responsible for healthy skin, mediation of the productions of eicosanoids, regulation of cholesterol, lowering the glycemix index of carbohydrates, and improving insulin resistance (Luoma, 1996).

Insulin secretion and insulin action related to the serum phospholipid fatty acid pattern in healthy men was the subject of a study performed by Pelikanova, Kohout, Valek, Base, and Kazdova (1989). Eleven men with normal glucose tolerance and serum lipids participated in the study. The proportions of individual fatty acids in serum phospholipids and insulin secretion were examined by fasting and postglucose plasma insulin levels. The results demonstrated that both insulin secretion and insulin action are significantly related to the ratio of omega-6 class essential fatty acids to saturated fatty acids in serum phospholipids. An increase of this ratio is associated with a decrease in total insulin response, while a decrease of the ratio demonstrated an increase of insulin response. The researchers concluded that the fatty acid component in one's diet may play a role in blood glucose regulation, thereby affecting energy levels.

The relation between insulin sensitivity and the fatty-acid composition of skeletal-muscle phospholipids was investigated by Borkman, Storlein, Jenkins, Chisholm, and Campbell (1993). The study involved 2 groups. One group was composed of 27 participants undergoing coronary artery surgery, while the other was composed of 13 healthy men. Blood samples, for insulin sensitivity, and biopsies of the rectus abdominis were taken from the surgery group. A biopsy of the vastus lateralis was performed in the second group, while insulin sensitivity was also examined. An inverse correlation between serum insulin concentration, a measurement of insulin resistance, and the percentages of individual long-chain polyunsaturated fatty acids was found in the coronary group. The healthy group demonstrated a positive correlation between insulin resistance and total percentage of polyunsaturated fatty acids. The study supported the theory that polyunsaturated fat regulates the action of insulin, which affects energy levels.

Liu et al. (1994) investigated insulin and fat. The study was performed to examine the mechanism of the polyunsaturated/saturated (P/S) fat ratio on insulin resistance in rats. Rats were fed a 20% fat diet for 6 weeks. To study the effects of saturated fat, the rats were fed diets containing P/S ratios of 0.25, low P/S diet, and 1.0, high P/S diet. To study the effects of polyunsaturated fats, specifically omega-3 fatty acids, the rats were fed a P/S ratio of 0, low omega diet, or 3.3%, high omega diet from fish oil. The results demonstrated that the rats fed the high P/S and high omega diets bound more insulin at the skeletal-muscle sarcolemma than the low groups. The researchers suggested that dietary omega-3 and polyunsaturated fatty acids increase insulin binding to the sarcolemma by changing the fatty acyl composition of phospholipid surrounding the insulin receptor, thus modifying insulin reaction.

A side effect of the high carbohydrate, low fat diet is the finding of lower testosterone levels (Hamalainen, Aldercreutz, Puska, & Pietinen, 1984). Hamalainen et al. examined the serum total and free testosterone concentrations in 30 adult males. The male subjects were fed an experimental diet containing less fat and more fiber than their normal diets. The results indicated a decrease in serum total testosterone concentrations and serum free unbound testosterone when fat levels were lowered. The effects were reversible when fat was added back into the diet.

<u>Carbohydrates</u>

When research on fat, specifically the result of fatty acid intake on insulin action, is examined, it was found that a low fat, high carbohydrate diet may not be ideal for a strength training football player (Brink, 1996). If a strength training football player has been following a high carbohydrate, low fat diet, the carbohydrate percentage of the daily intake must be lowered to make up for the additional calories added by the now increased fat and protein levels (Duchaine, 1996).

Many football players may be concerned about lowering their carbohydrate intake and decreasing their athletic performance. The influence of dietary carbohydrate (CHO) on the performance of supramaximal intermittent exercise was investigated by Jenkins, Palmer, and Spillman (1993). The participants included 14 trained male students who took a maximal oxygen consumption test and 2 maximal interval tests, which consisted of five 60 s maximal cycling periods, with a 5 min passive recovery between periods. The subjects consumed a moderate CHO diet, 55.3% of caloric intake as CHO, for three days before maximal interval test one. Before maximal interval test two, participants were randomly assigned to either a high CHO, 83%, or low CHO, 12%, diet for three days. During the study, all food and drink were weighed and recorded for analysis. Measurements of work done, venous blood pH, plasma lactate, exercise oxygen consumption, and plasma glucose concentrations were compared between the high, moderate, and low CHO MIT. They found the low CHO group had decreased performance in work output. No significant differences of work output were seen between the high and moderate CHO groups. The study demonstrated that a moderate CHO diet did not decrease performance in supramaximal exercise.

Mitchell, DiLauro, and Cavendar (1997) studied carbohydrate intake and exercise performance. A high and low pre-exercise relative carbohydrate (CHO) diet was used to determine if diet influenced performance during multiple sets of resistance exercise. The participants consisted of 11 resistance-trained males who performed exhaustive cycle ergometry to deplete muscle glycogen. The participants were assigned to a high CHO, 7.66 g CHO per kg of bodyweight, or low CHO, 0.37 g CHO per kg of bodyweight, group for 48 hr. After the 48 hr were over, both groups performed 5 sets each of squats, leg presses, and knee extensions to muscular failure. Blood samples were taken both pre and during exercise to measure glucose and lactate. The results demonstrated that no differences in exercise performance or blood lactate existed between the high and low CHO groups. They concluded that a low CHO intake does not negatively effect resistance exercise performance.

The additive effects of training and high fat diet on energy metabolism during exercise were investigated by Simi, Sempore, Mayet, and Favier (1991). They studied 80 rats randomly assigned to a 12 week high carbohydrate, CHO, diet or a high fat diet, HFD, which was free of dietary carbohydrate. The 2 diet groups were then further divided into a progressive endurance training and sedentary group. During the 12 week period, maximal oxygen uptake and submaximal running endurance were measured. At the end of the 12 week period, the rats were sacrificed before blood samples and muscle dissection took place. The sedentary HFD rats demonstrated an increase of 15% in maximal oxygen uptake over the sedentary CHO group. The endurance HFD rats demonstrated an enhanced maximal oxygen uptake of 35% when compared to the endurance CHO rats. The endurance HFD rats' submaximal running times were longer than the endurance CHO rats, while the sedentary HFD rats ran longer than their CHO counterparts. A football off-season strength and conditioning program would not deplete muscle glycogen as much as an endurance protocol such as this study would. Since the HFD rats demonstrated a longer running time than the CHO rats, it may be deduced that an off-season football player's performance would no suffer by ingesting fewer carbohydrates.

Phinney, Bistrian, Evans, Gervino, and Blackburn (1983) conducted a study to examine the exercise capabilities of 5 trained endurance bicyclists. The participants followed a 85% fat and 15% protein diet for 4 weeks. Pedal ergometer testing of maximal oxygen uptake and submaximal endurance was measured before and after the dietary period. The results demonstrated no significant differences between maximal oxygen uptake and submaximal endurance while on a high fat diet compared to a regular diet. Endurance athletes generally use the carbohydrate dependent glycogen and aerobic energy systems. It may be deduced that a weight training football player, who is using the ATP and glycogen energy systems, would also demonstrate no significant differences in performance.

Symons and Jacobs (1989) conducted a study to investigate if high-intensity exercise performance was impaired by low intramuscular glycogen. The participants included 8 males who performed a series of tests to evaluate isokinetic strength and endurance, isometric strength, and electrical stimulation evoked movements of the knee extensors on two different days. The participants were divided into two groups. Group C ate a mixed diet between the two tests. Group E ate a low carbohydrate diet, 37% of total calories, between tests. The participants performed glycogen depleting endurance and strength exercises after Test 1. The participants then consumed the assigned diets for 3 days and were tested again, Test 2. No performance differences were found between Tests 1 or 2 in either dietary group. Group E demonstrated lower glycogen stores than Group C prior to Test 2. The researchers concluded that low intramuscular glycogen does not impair high-intensity exercise performance.

Post workout nutrition

Many football players wonder if certain foods should be consumed after a weight workout and at what times these items should be consumed. Several studies have dealt with this very issue. The effect of the timing of amino acids and glucose administration after exercise on protein kinetics has been researched by Okamura, Doi, Hamada, Sakurai, Matsumoto, Imaizumi, Yoshioka, Shimizu, and Suzuki (1997). The participants were 10 beagle dogs that ran 150 minutes on a treadmill inclined 12%. After running, the dogs were placed into one of two groups and infused with amino acids and glucose immediately after exercise or 1 hour after exercise. The protein kinetics were negative in both groups after exercise. The immediately after exercise group entered positive protein kinetics within 15 minutes after the start of the infusion, while the 1 hour after exercise group remained negative until infusion. The immediately after exercise group also had higher protein synthesis during infusion than the 1 hour after exercise group.

Zawadzki, Yaspelkis, and Ivy (1992) investigated if a carbohydrate-protein supplement ingested after prolonged endurance exercise would effect the rate of muscle glycogen storage. The participants included 9 male cyclists who rode for 2 h on three separate locations to deplete muscle glycogen storage. Immediately following and 2 hr after each cycling bout the participants ingested an absolute number of 112 g of carbohydrates, CHO, 40.7 g of protein, PRO, or a 112 g of carbohydrate and 40.7 g protein, CHO-PRO, solution. Blood samples were taken before exercise, after exercise, and throughout recovery. Muscle biopsies were taken from the vastus lateralis immediately and 4 hr after exercise. The CHO-PRO group demonstrated a faster rate of muscle glycogen storage and elevated plasma insulin levels than the CHO and PRO groups.

In another study Chandler, Byrne, Patterson, and Ivy (1994) examined the effect of carbohydrate and/or protein supplements on the hormonal state of the body after weight training exercise. The study included 9 male weight lifters, with at least 2 years of training experience. The participants ingested a supplement immediately after and at 2 hr after a 2 hr weight training workout. The participants ingested water (control), an isocaloric relative carbohydrate (CHO), 1.5 g of carbohydrate per kg of bodyweight, solution, a relative protein (PRO), 1.38 g of protein per kg of bodyweight, solution, or a relative carbohydrate-protein solution (CHO-PRO), 1.06 g carbohydrate and 0.41 g of protein per kg of bodyweight. Blood samples were taken before exercise, after exercise, and during 8 hr of recovery. CHO-PRO and CHO stimulated higher insulin concentrations than the PRO and control groups. The CHO-PRO group had higher elevated growth hormone levels 6 hr after exercise than the other groups. The study demonstrated that nutritive supplements especially a CHO-PRO solution, after weight training exercise can produce a muscle favorable hormonal anti-catabolic effect, reducing cortisol and stimulating the elevation of insulin and growth hormone concentrations.

Creatine

Creatine's use has become popular since it was introduced to the supplement market in 1993 (Maughan, 1995). Creatine is currently recognized as the most effective supplement to increase strength and body mass (Phillips, 1997). Creatine allows high rates of adenosine triphosphate resynthesis to occur in muscles and therefore plays a role in the performance of high-intensity exercise. Creatine supplementation may improve athletic performance in sports that require repeated maximal or submaximal bouts of effort, separated by short rest periods.

Creatine's Effects on Muscular Strength

Volek, Kramer, Bush, Boetes, Incledon, Clark, and Lynch (1997) studied the influence of oral creatine monohydrate supplementation on muscular performance during repeated set of high-intensity resistance exercise. The participants included 14 resistance-trained men who were assigned in a double-blind manner to either a creatine or placebo group. Both groups performed a bench press, 5 sets to failure at 30% max bench, and a jump squat, 5 sets of 10 repetitions on three occasions (T1, T2, and T3), separated by 6 days. Before T1, neither group received supplementation. From T1 to T2, each group consumed a placebo. From T2 to T3, the control group consumed a placebo and the creatine group consumed 25 g of creatine equally divided throughout the day. From T2 to T3, the creatine group increased body mass by 1.4 kg. The creatine group also demonstrated a significant improvement in repetitions performed during the bench press and an increase in peak power output during jump squats during T2 to T3. The study demonstrated that creatine supplementation allows an athlete to workout at higher intensities and increase body mass.

Krieder et al. (1998) investigated the effects of creatine supplementation on body composition, strength, and sprint performance. The participants included 25 NCAA Division I football players who were assigned in a double-blind and randomized manner to supplement their diet with either 15.75 g of creatine daily or an equivalent amount of placebo. Both groups followed a 28 day off-season strength and agility program while ingesting the supplements. At the end of 28 days, both groups performed maximal repetitions on the bench press, squat, and power clean. Both groups performed twelve 6 s cycle ergometer sprint tests. The creatine group increased fat-free mass by 2.5 kg. The creatine group also demonstrated significantly greater gains in bench press lifting volume, sum of the bench press, squat, and power clean lifting volume, and total work performed during the first five 6 s sprints when compared to the placebo group. No increased incidence of gastrointestinal distress or muscular cramping was reported during the 28 day period. The study demonstrated that creatine supplementation promoted greater gains in fat-free mass, lifting volume, and sprint performance when accompanied by intense resistance and agility training.

Vandenburghe, Goris, Van Hecke, Van Leemputte, Vangerven, and Hespel (1997) conducted a double-blind study to investigate if long-term creatine intake is beneficial to muscle performance during resistance training. The participants, 10 females, average age of 19 years, supplemented with creatine or a placebo during 10 weeks of resistance training. The creatine group ingested 20 g of creatine for 4 days. The creatine group demonstrated a phosphocreatine concentration increase of 6% during the 4 days. This increase in phosphocreatine stores was maintained for the duration of the study by ingesting 5 g of creatine a day. Compared with the placebo group, the creatine's group maximal strength of the muscle groups trained increased by 20-25%, maximal intermittent exercise capacity of the arm flexors increased 10-25%, and fat free mass of the arm flexors increased 60%. When creatine supplementation was stopped, muscle phosphocreatine levels returned to pre-supplementation level within 4 weeks. No side effects of creatine supplementation were noted by researchers. The results indicated that oral creatine supplementation increases the effect of resistance training on maximal muscle strength, fat-free mass, and capacity to perform high-intensity intermittent exercise.

Creatine's Effects on Muscular Endurance

Bosco, Tihanyi, Pucspk, Kovacs, Gabossy, Colli, Pulvirenti, Tranguilli, Foti, and Viru (1997) examined the effects of creatine, 20 g daily for 5 days, or placebo ingestion on performance in a 45 s maximal continuos jumping test and all-out treadmill running for 60 s at a 5% incline. The participants included 14 males; all were jumpers and sprinters. The participants were tested 2 day prior and after supplementation. The creatine group increased performance capacity in the jumping test by 7% during the first 15 s and by 12% during the second 15 s of the test. The last 15 s of the jumping test showed no improvement by the creatine group, which was attributed to decreasing anaerobic metabolism. The creatine group improved 13% in the running to exhaustion test. Oral creatine supplementation increased the duration in which maximal rate of power could be maintained.

Balsom, Soderlund, and Ekbolm (1995) studied the effect of creatine supplementation on muscle metabolism. Repeated bouts of high-intensity ergometer cycling were performed by 7 male subjects before and after six days of creatine supplementation. The participants consumed 20 g of creatine daily between tests. The ergometer cycling consisted of five 6 s cycling periods at a fixed intensity level, with 30 s recovery periods between periods. The periods were followed 40 s later by one 10 s cycling period where power output was evaluated. The participants also performed a series of jumps, a counter movement jump without arm swing (CMJ) and squat jump (SJ) before and after creatine supplementation. Blood samples were taken prior to and 3 minutes after exercise. Muscle biopsies were taken from the vastus lateralis before testing, after the 6 s cycling tests, and after the 10 s cycling test. After the 6 day supplementation period, the participants increased body mass by 1 kg. The biopsies indicated that creatine concentrations at rest increased by 35%. After the fifth cycling period, creatine concentrations were 60% in the vastus lateralis than during the first day of testing. The participants were better able to maintain power output during the 10 s cycling period after supplementation.

Studies on the effect of creatine supplementation and muscular endurance have provided equivocal findings. Odland, MacDougall, Tarnoplsky, Elorriaga, and Borgmann (1997) examined the effect of creatine supplementation on power output during 1 bout of 30 s maximal cycling. The participants consisted of 9 males. The participants performed three cycling tests, 14 days apart, after random ingestion of creatine, 3 days at a rate of 20 g a day, placebo, or control. Biopsies were taken from the vastus lateralis before each cycling test. No differences were found between power output, percent fatigue, or post-exercise blood lactate concentrations. Odland et al. concluded that 3 days of oral creatine supplementation does not increase performance during a single short-term maximal cycling test.

Creatine supplementation studies indicate that creatine had effects on exercise performance when used in movements of repeated bouts of effort, separated by a short rest period, and maximal power, less than 20 s duration, or submaximal power, 20 s to five minutes of duration (Balsom et al., 1995; Kreider et al., 1998; Bosco et al., 1997). Applying these results, football players should benefit from the supplementation of creatine in the off-season and in-season. Creatine studies also indicated that creatine supplementation increased the intensity of weight training programs (Balsom et al., 1995; Vandenberghe et al., 1997). Football players who engage in a strength and conditioning program should benefit from this aspect of creatine supplementation.

<u>Creatine's Effect on Body Composition</u>

Two of the above studies demonstrated that creatine supplementation increased body mass (Kreider et al., 1998; Volek et al., 1997). One study was found focusing on this issue. Kreider, Klesges, Harmon, Grindstaff, Ramsey, Bullen, Wood, Li, and Almada (1996) investigated the effects of supplements designed to promote lean tissue gains during resistance training. In this double blind study, 28 resistance trained males supplemented their diets with maltodextrin, <u>Gainers Fuel 1000</u>, or <u>Phosphagain</u>, a product that contains 5 g of creatine, while following a resistance training program. No significant differences were observed in relative or absolute total body water among groups. Body mass significantly increased in each group throughout the study with greater gains observed in the Gainers Fuel and Phosphagain groups. The Phosphagain group demonstrated a significantly greater gain in lean mass, while the Gainers Fuel group significantly increased body fat.

Creatine's Effects on Phosphocreatine Concentrations

Some of the studies reported that phosphocreatine stores increased when creatine was digested (Vandenberghe et al., 1997; Bosco et al., 1997). Studies have been conducted to examine this issue.

The effect of creatine loading in men was the subject of one such study (Hultman, Soderlund, Timmons, Cederbald, & Greenhaff, 1996). Participants included 31 males who were assigned to 4 different groups. Group 1 ingested 20g of creatine a day for 6 days. Group 2 ingested 20 g of creatine a day for 6 days, then 2 g a day for the next 28 days. Group 3 ingested 3 g of creatine a day for 28 days. Group 4 ingested 20 g of placebo a day for 6 days. Groups 1 and 2 increased total muscle creatine concentration by 20% after 6 days of creatine supplementation. Group 2 maintained the elevated levels for the next 28 days. Groups 1 and 2 had declining concentration levels when supplementation ceased. Group 3 showed a 20% increases in total muscle concentration, but took the final 14 days of supplementation to reach this level. No changes were observed in Group 4. The results indicate that for optimal creatine elevation and maintenance, a loading phase should be used, 20 g of creatine a day for 6 days, then a maintenance phase, 2 g of creatine a day.

Harris, Soderlund, and Hultman (1992) examined the amount of creatine absorbed with supplementation and if supplementation increased creatine concentration pools in the muscles. Seventeen resistance trained subjects ingested different levels of creatine throughout the study. The results indicated that consuming 1 g of creatine produced a small rise in plasma creatine concentration, while consuming 5 g resulted in a mean peak of 795 mumol/l in the plasma creatine concentration after 1 hr. Repeated doses of 5 g every 2 hr sustained the concentration.

Whether carbohydrate ingestion augments creatine retention was studied by Green, Simpson, Littlewood, Macdonald, and Greenhaff (1996). The participants included 22 men who had their blood and urine tested for creatine concentrations before and after different creatine protocols. The groups were divided into the following: Group 1, supplemented with 5 g of creatine solution, while Groups 2 and 3 ingested 5 g of creatine and 93 g of a simple carbohydrate in solution. Participants ingested the solutions every 4 hr over the next 2 days. During the 2 days, Group 3 also cycled for 1 hr at their maximal oxygen consumption. Participants in Group 2 and 3 demonstrated a higher serum insulin concentration than Group 1. Groups 2 and 3 demonstrated a lower peak plasma creatine concentration than Group 1. No differences were found between Groups 2 and 3. The researchers suggest that creatine and simple carbohydrate ingestion increases creatine retention.

The results from the research performed on creatine demonstrate that to elevate phosphocreatine concentrations in the least amount of time, the athlete should “load” creatine (Hultman et al., 1996). During the “load” phase, the athlete consumes 5 g of creatine at a rate of five times a day for five consecutive days. The athlete should then perform a "maintenance phase" to sustain the elevated phosphocreatine concentration (Vandenberghe et al., 1997). During the "maintenance phase," the athlete consumes 5 g of creatine at a rate of one time a day.

<u>Summary</u>

To excel in the sport of football, it is required for a player to be the biggest, strongest, and fastest the player can be (Pearson et al., 1998). To achieve these characteristics, the player must lift weights and perform speed and agility work. When a nutrition and creatine supplementation program is added to the strength and conditioning program, football players are more capable of reaching their full potential (Brink, 1996). When a football player is considering a nutrition and creatine supplementation program certain points need to be considered: (1) Adequate protein must be present in the diet to achieve a positive nitrogen balance, with the optimum amount being 2 - 3.3 g per kg of bodyweight (Fern et al., 1991); (2) Fat percentage of the diet should be moderate to manage insulin levels (Borkman et al., 1993); (3) The majority of the fat content in the diet should come from omega-3 and omega-6 fatty acids (Pelikanova et al., 1989); (4) Decreased dietary carbohydrate intake in the diet will not decrease athletic performance (Jenkins et al., 1993); (5) A carbohydrate and protein supplement should be consumed immediately after an intense weight workout to increase muscle glycogen storage and increase protein synthesis (Chandler et al., 1994); (6) Creatine can be used to increase body mass, muscular strength, and muscular endurance (Kreider et al., 1998; Bosco et al., 1997), and (7) Creatine should be ingested in a loading phase, then a maintenance phase to increase athletic performance and achieve increased muscle creatine stores in the quickest time possible (Hultman et al., 1996).

CHAPTER 3

Methods

Football players may receive conflicting or incorrect information on how to increase lean body mass during the off-season through nutrition (Duchaine, 1996). The purpose of the More Mass Nutrition Program (Appendix A) is to provide an off-season football player with information on ratios of carbohydrates, protein, and fat to be consumed, dispelling popular myths, and creatine supplementation. The information can be combined with an off-season strength and conditioning program so that optimal results may be achieved.

Procedures

Using the terms protein, weight lifting, bodybuilding, creatine, supplements, resistance and athletes, protein and overfeeding, protein and synthesis, insulin and secretion, monounsaturated and fat, omega-3, dietary and carbohydrate, blood and glucose, amino acids, and creatine and supplementation research was performed on Med-Line, Sports Discus, and Lexus-Nexus. Popular literature, MuscleMedia, MuscleMag, and ACE Trainer's Newsletter, were examined for information on nutrition and creatine. The Internet was searched, via yahoo, snap, excite, and webcrawler with the following terms: creatine, bodybuilding, nutrition, fat, carbohydrate, protein, and weight lifting.

When research was concluded, the manual was written and entitled the More Mass Nutrition Program (Appendix A). The manual was printed on white standard printing paper.

The More Mass Questionnaire (Appendix B) was submitted to San Jose State Human Subject's for approval (Appendix C). All questionnaires were anonymous and confidential. Completed questionnaires were stored in a locked filing cabinet.

Reviewers

The manual was distributed to 5 Division III football players, 2 Division III certified athletic trainers, 2 Division III strength and conditioning coaches, and 1 registered dietician. All reviewers had 4 years previous experience with a football program. The reviewers were chosen by word of mouth and public lists.

Evaluation of manual

The manual was distributed to football players, strength coaches, and certified athletic trainers, accompanied by a cover letter (Appendix D) and the More Mass Questionnaire (Appendix B). The More Mass Questionnaire (Appendix B) used values 1 (strongly agree) through 5 (strongly disagree), to evaluate the More Mass Nutrition Program (Appendix A). The More Mass Questionnaire (Appendix B) also contained an open ended questionnaire for additional comments. The manual was sent with a self-addressed stamped envelope so that the evaluator could return the More Mass Questionnaire (Appendix B) when completed.

Statistical Analyses

The More Mass Questionnaire (Appendix B) was evaluated by the reviewers and then compared to all other answers given by the other evaluators. All comments were reviewed and then categorized for changes to the manual. A descriptive analysis of each question was conducted. The interpretation of the reviewers' comments and scores are provided in Chapter 4.

CHAPTER 4

Results

Many football players receive conflicting information on how to effectively increase lean body mass during the off-season (Brink, 1996). Football players receive conflicting and ineffective information from coaches, teachers, and athletic trainers on how to increase lean body mass in the off-season (Corley et al., 1990; Duchaine, 1996). Players are told that the human body can only utilize 30 g of protein during one feeding and that any additional protein will damage the human liver (Brink, 1996; Lemon, 1991). Players may also be told that all supplements, including creatine, are useless and dangerous (Luoma, 1991).

Wolf et al. (1979) surveyed 137 coaches in the Big Ten conference on nutrition information. The results indicated that 69% of the surveyed coaches responded that they rarely read about nutrition, while 78% felt the need for more knowledge about sports nutrition. The coaches reported that they relied on physicians, coaches, players, and popular literature for nutrition information.

Luoma (1991) investigated the responses to nutrition and supplement questions from an endocrinologist, sports medicine specialist, and general practitioner. The report demonstrated that the individuals interviewed had nutrition information from the 1960's and had a negative view towards supplements, including creatine. The endocrinologist had outdated nutritional information and no knowledge of ergogenic aids. The sports medicine specialist advocated eating sugar for energy and had a negative view of supplements both before and after being presented with research articles. The general practitioner also had a negative view towards supplementation, stating that there were no double blind, placebo studies on creatine supplementation.

Sometimes the player will have no qualified individual with whom to discuss nutritional issues. The player may be left confused and alone in regards to nutrition.

The purpose of this project was to synthesize the literature on performance enhancement through nutrition ratios and creatine supplementation. After a thorough review of the scholarly literature was performed, a comprehensive off-season nutrition manual was written, entitled the More Mass Nutrition Program (Appendix A). The manual was designed to serve the off-season intercollegiate football player as a guide to increase lean body mass while following a strength and conditioning program. The manual contained the following information: ratios of carbohydrates, protein, and fat to be consumed, recommended food, when certain foods should be consumed, dispelling popular myths, creatine supplementation, and a sample diet.

Ten envelopes containing the More Mass Nutrition Program (Appendix A) were distributed with cover letters, self-addressed stamped envelopes, and the More Mass Questionnaire (Appendix B) to 5 Division III football players, 2 Division III certified athletic trainers, 2 Division III strength and conditioning coaches, and 1 registered dietician. All reviewers had 4 years previous experience with a football program. The reviewers were chosen by word of mouth and public lists. All questionnaires were returned and used for analysis.

Evaluation of the More Mass Questionnaire

The questionnaire was comprised of six questions with room for comments after each (Appendix B). The frequencies of the evaluator's scores are reported in Table 1.

Table 1

Responses to the More Mass Questionnaire

Question	Total N	SA	A	U	D	SD
Do you think the program was easy to understand?	10	6	3	1	0	0
Do you think a football player can easily consume the ratio of fats, protein, and carbohydrates contained in the program?	10	5	4	1	0	0
Do you feel that the information in the program is beneficial to a football player who is trying to increase lean body mass?	10	7	3	0	0	0
Would you advise football players to follow the nutrition information contained in the program?	10	6	3	1	0	0
Would you advise football players						

to follow the creatine information						
contained in the program?	10	8	1	1	0	0

Question one: Do you think the program was easy to understand? The number of evaluators who chose 'strongly agree' was 6. Three evaluators responded 'agree,' while 1 evaluator chose 'undecided.' A football player commented that the program was straight to the point. Another football player wrote that the program was easy to comprehend. The other evaluators chose not to respond.

Question two: Do you think a football player can easily consume the ratio of fats, protein, and carbohydrates contained in the program? Five evaluators responded 'strongly agree,' 4 chose 'agree,' and 1 chose 'undecided.' A strength coach responded that it would take some planning and dedication by the athlete to follow the nutrition program. A football player commented that it would be harder, but not impossible, for a player living in a dormitory to follow the program. No other evaluator commented on this question.

Question three: Do you feel that the information in the program is beneficial to a football player who is trying to increase lean body mass? Seven evaluators chose 'strongly agree' and 3 responded 'agree.' No evaluator wrote additional comments for this question.

Question four: Would you advise football players to follow the nutrition information contained in the program? Six evaluators chose 'strongly agree,' 3 evaluators chose 'agree,' and 1 evaluator responded 'undecided.' No additional comments were written for this question.

Question five: Would you advise football players to follow the creatine information contained in the program? Eight evaluators chose 'strongly agree,' 1 evaluator responded 'agree,' and 1 evaluator registered 'undecided.' An athletic trainer, not familiar enough with creatine to recommend it, responded undecided. A football player commented that the player previously had good results with creatine. The other evaluators chose not to respond to this question.

Question six: What, if anything, would you add or change about the program to better aid a football player who is trying to increase lean body mass? A football player responded that a good diet is a very important part of a football player's program. The player would change nothing. Two different players stated that a workout program and supplement recommendations would benefit the program. Another player felt that the manual was very beneficial and wished that the player had the program at the beginning of the player's collegiate career. The athletic trainers felt that a supplementation rating system should be added. The coaches commented that more sample diets and a list of foods to eat and not to eat would be helpful. One coach responded that a section on alcohol and drug use and their effects on the human body would be beneficial. The dietician would like a training program added to the program.

CHAPTER 5

Discussion, Conclusions, and Recommendations for Future Study

Discussion

The More Mass Nutrition Program (Appendix A) was mailed to 10 evaluators for an analysis of content and purpose. All 10 evaluator returned the More Mass Questionnaire (Appendix B) that accompanied the manual. The program contains sections on: food ratios of carbohydrates, fat, and protein to be consumed, post workout meal, creatine, sample diet, and individual profiles. The overall responses from the evaluators regarding the content and purpose of the program were positive. The majority of the answers were 'strongly agree' (n=32) or agree (n=14). Questions 1,2,4 and 5 each had one 'undecided' response. No evaluator responded 'disagree' or 'strongly disagree.' Additional comments, reported in chapter 4, were written for questions 1,2,5,and 6. No evaluator wrote additional comments for questions 3 and 4. The overall mean of all the scores was 1.44. The overall median of all the scores was 1. The most highly rated question was (question 5) would you advise football players to follow the creatine information contained in the program?

The evaluators consisted of 5 football players, 2 certified athletic trainers, 2 strength coaches, and 1 dietician. The football players represented the group that responded most favorably. The certified athletic trainers indicated, through question 6, that a comprehensive supplement section would benefit the program. The strength coaches responded that further sample diets be included. Many evaluators commented that a training program would benefit the program.

Conclusion

Through the responses from the More Mass Nutrition Questionnaire (Appendix B), the manual was easy to comprehend and looked upon favorably. Similar nutritional programs have been successfully suggested by other nutritional theorists (Brink, 1996). In the author's opinion and from the responses from the More Mass Questionnaire (Appendix B) located in chapter 4, the program does not need many changes. Feedback from question 6 asked for a suggested strength and conditioning program with the program. The intent of the More Mass Nutrition Program (Appendix A) was to serve an off-season football player who is already following a strength and conditioning program. It was beyond the scope of this project to include a strength and conditioning program. Another suggestion from question 6 was to include information on all supplements. Although this may be beneficial to those reading the program, it was beyond the scope of this project to include a complete supplementation section on every supplement. Perhaps a More Mass Supplement Program could be a future project.

Recommendations for future study

In the future, authors of projects of this type may consider the following: (1) The program should either be targeted towards a football player or someone who is going to work with a football player, not both groups; (2) A supplement or ergogenic aid section may be beneficial for informational purposes; (3) The purpose should be clearly defined to the evaluators; (4) The author may wish to include a table of suggested foods for a football player choose from; and (5) A strength and conditioning program may be beneficial for informational purposes.

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APPENDIX A. More Mass Nutrition Program

INTRODUCTION

Football is a sport that requires power, strength, speed, and large amounts of body mass. To become bigger, faster, and stronger many intercollegiate football players perform an off-season strength and conditioning program. These players spend countless hours in the weight room and on the track, but they may undermine their hard work by neglecting a nutrition program.

Nutrition programs are designed to complement a strength and conditioning program so that a football player may better be able to reach optimum potential. The program will progress as follows: nutrition, creatine supplementation, sample diets, and individual profiles.

If you are currently frustrated with your progress in your strength and conditioning program, increase your training intensity and follow this nutrition program. You may find that you will become bigger, faster, and stronger - dominating the opposition during your next season.

WHO AM I

I am a graduate student in kinesiology at San Jose State University. My Bachelor's of Arts is in Health and Human performance. I have studied weight training, nutrition, and ergogenic aids for the past 11 years. During that time, I played football at the collegiate level and trained several college football players who received post-season honors. I am a certified athletic trainer and certified personal trainer.

DISCLAIMER

The following nutrition program is for educational purposes only. The following information is not intended to replace medical advice. Users of the More Mass Nutrition Program do so at their own risk. It is not the author's intent to diagnose or prescribe. Use of any of the information contained in the manual is at the risk and choice of the reader. The information contained in the manual is intended for a legal adult, 18 years of age or older.

At the time this manual was developed in the Spring 1999, creatine is a legal substance. It is not advised to exceed the recommended creatine dosages recommended here. At the time of this manual, Spring1999, creatine supplementation has no known side effects, if used as recommended.

WHO IS THE PROGRAM FOR

The nutrition program is designed for you, an intercollegiate football player who is trying to gain body mass, preferably lean body mass, strength, and power. You should be following a strength and conditioning program while following the nutrition program.

FUNDAMENTALS OF THE PROGRAM

1. Eat 1.5 – 3.3 grams of protein per kg of bodyweight
2. Try to eat no carbohydrates by themselves
3. Drink a carbohydrate and protein solution immediately after a weight workout
4. Supplement your diet with high quality creatine monohydrate if desired

FOOD RATIOS OF THE NUTRITION PROGRAM

You have probably been told to eat a diet that is high in carbohydrates and low in fat and protein. This is the traditional diet of the US Department of Agriculture with carbohydrates at the bottom of a pyramid and fat at the apex. Research indicates that this may not be the ideal diet for a strength training athlete (Tarnopolsky, et al., 1992; Simi, et al., 1991). The diet in this nutritional program will have you eating a balanced diet of 40% carbohydrate, 30% protein, and 30% fat. This nutritional program is not to be confused with the 40,30,30 or "Zone" diet which is primarily a weight loss diet that is not designed to increase lean body mass.

The amount of calories in your diet should vary from individual to individual. One key component for you, who is trying to increase lean body mass, exists. The component is that the you must be consuming more calories than your maintenance caloric intake. The maintenance caloric intake is the point in which the caloric intake is at number where weight is neither gained nor lost. The amount of calories consumed above your maintenance caloric intake will depend on how much lean or overall body mass you wish to gain. This issue should be discussed with your position coach. You should divide this caloric intake into 5-6 meals a day. By dividing your meals you will insure that all food will be utilized maximally and your muscles will be constantly supplied with the nutrients they need to get bigger and stronger. You may wish to adjust your caloric intake slightly every two days so your body will not adjust to a set caloric intake.

It is important to remember that the ratios of the program are not written in stone. You may find that your body responds better when the ratios are adjusted slightly. You must find out what works best for you, as everyone's body is slightly different.

CARBOHYDRATES

40% of your caloric intake should be from carbohydrates. Carbohydrate ingestion is related to insulin secretion, which you want to control. To roughly gauge carbohydrate quality, the glycemic index (GI) is used. The higher a carbohydrate is on the GI scale, the more of an insulin spike it will cause. The insulin spike leads to fluctuations in energy levels and the storage of body fat. The lower the carbohydrate is on the scale; less insulin is secreted when that carbohydrate is ingested.

As far as carbohydrates go, try to stick to complex, high fiber carbohydrates such as sweet potatoes, brown rice, beans, and raw vegetables. All of these carbohydrates are low on the GI scale. In general, try to ingest your carbohydrates in their most natural state. Stay clear of highly processed or refined carbohydrates such as low fiber cereal, rice cakes, white bread, chips, and doughnuts. One gram of carbohydrate has four calories.

You may be concerned that decreasing your carbohydrate intake will affect your energy level negatively. Research indicates that athletes in anaerobic sports, such as football, suffer no adverse effects from ingesting moderate carbohydrate levels (Mitchell, et al., 1997). In fact, you may find that your energy levels are steadier due to your now managed insulin levels.

FAT

A diet that is 30% fat may be ideal for a weight-training athlete, which you are. The highly successful Bulgarian power lifting team has followed a 30% fat diet for years. By consuming a diet that is 30% fat, you will be influencing several key issues. The first issue is that fat lowers the glycemic index of carbohydrates, which will make your body produce less insulin. This means that you will be less likely to experience fluctuations in energy levels. The second is that certain fats improve insulin resistance. This means that you will be less likely to store carbohydrates as fat. The last issue is that you will maximize your testosterone levels, as a moderate fat diet has demonstrated a positive effect on testosterone levels (Hamalainen, et al., 1983).

You probably have some familiarity with saturated and unsaturated fats. If a fatty acid is full of hydrogen, it is said to be saturated, and is generally solid at room temperature. Saturated fats are primarily found in animal fat.

If a fatty acid can carry other hydrogen atoms, it is unsaturated. Unsaturated fats are either polyunsaturated (corn, safflower, or sesame) or monounsaturated (olive, canola, peanut, avocado). These fats are generally liquid at room temperature and spoil quickly.

The third type of fat is hydrogenated fat. This is synthetic fat that extends the shelf life of fats and products. Hydrogenation changes the shape of the unsaturated fat molecules. When these fat molecules are changed, your body cannot use the fats properly. The hydrogenated fats cause abnormal cell function in your body. It is wise to avoid hydrogenated fats if at all possible.

Humans have dietary fat requirements, which consists of essential fatty acids. These essential fatty acids are polyunsaturated fats that our bodies cannot make from other dietary fats. There are two of these fats: linoleic (Omega 6) and linolenic (Omega 3) acids. Linoleic acid is present in cooking and salad oils. It is usually not a problem to ingest linoleic acid. Linolenic acid is harder to ingest. To fulfill the essential fatty acids of linolenic acid, it is wise to supplement the diet with flaxseed oil.

Flaxseed oil can be purchased at better health food stores. Ingesting two tablespoons a day should be sufficient for your needs. Flaxseed oil must be refrigerated at all times.

You should ingest around 20% of your 30% fat allowance from the essential fatty acids. The other 10% of your fat allowance will come from saturated fats from meat and nonessential fats from grain. Remember that one gram of fat has nine calories.

PROTEIN

Protein will consist of 30% of your daily caloric intake. The first issue that must be said about protein is that protein alone will not give you larger or stronger muscles, only intense weight training will due this. Intense training stimulates muscle growth, which in turn requires adequate protein intake. Current research indicates that a weight training individual should consume 1.5 – 3.3 grams of protein per kg of bodyweight to stay in an anabolic (growth) state (Fern, et al., 1991).

The 1.5 – 3.3 grams per kg should be spread out equally amongst your meals throughout the day. The most important time to eat protein is at the first meal of the day, immediately after a workout, and at the last meal of the day. You may have been previously told that the human body cannot digest more than 30 grams of protein at a time. This is an unfounded claim that can be disregarded. It has been said that additional protein can stress the kidneys. This is yet another unfounded claim that has been largely overstated (Lemon, 1998).

Good choices of protein are eggs (whites and whole), skinless chicken, fish, turkey, and lean cuts of red meat. If you can reach your protein intake by consuming whole foods, then do so. In reality, this is inconvenient and practically impossible unless you carry a microwave and refrigerator around with you all day. Keeping this in mind, you may need to consume a protein powder or meal replacement powder for convenience and to reach your daily protein intake level. When increasing your protein intake, make sure that you are adequately hydrated. Remember that a gram of protein had four calories.

POST WORKOUT MEAL

After your weight workouts, your muscles are ready for carbohydrates and protein, which will favorably effect your recovery time. At this time, an insulin surge is actually beneficial to you. Due to these facts, you should ingest a carbohydrate and protein mixture immediately after your workout. It should contain around 1.5 - 2 grams of carbohydrates for every 2.2 lb. of bodyweight and a moderate level of protein powder (40-50 grams). The carbohydrate should be some sort of fruit juice, as fruit juices are high on the GI scale, which will cause an insulin surge. Fruit could also be ingested at this time, due to the desired insulin spike.

CREATINE

Creatine is a substance that is naturally found in red meat. Creatine is stored in the body as phosphocreatine, which replenishes adenosine triphosphate. Your body uses adenosine triphosphate as an immediate energy source. By supplementing your diet with creatine, you may increase your phosphocreatine levels. The increased phosphocreatine levels may allow you to gain additional lean body mass, muscular strength, and muscular endurance.

To elevate your phosphocreatine levels in the shortest time possible, you should perform a "load" phase. During this time, you should consume 5 grams of creatine at a rate of 5-6 times a day for 5 days. After this period, you perform a "maintenance" phase, consuming 5 grams of creatine a day. You should always consume one serving of creatine in your post workout drink, as an insulin surge is beneficial to creatine uptake.

Muscle cramping and strains are anecdotal claims against creatine supplementation. None of these claims have been reported in controlled settings (Krieder, et al., 1998). If you are adequately hydrated, creatine supplementation should not cause cramping.

PURCHASING CREATINE AND/OR PROTEIN POWDER

The best place to purchase creatine and protein powder is directly from supplement companies. Try to order from reputable companies. Many companies offer special wholesale university price lists. Discuss university pricing with your coach or athletic trainer.

SAMPLE DIET

Meal One	**Protein(g)**	**Carbs(g)**	**Fat(g)**	**Calories**
2 cups (dry) Quaker Quick Oats	10g	56g	6g	300
2 scoops ProScore Whey Protein	32g	4g	2g	160
16 oz skim milk	17.25g	25g	.4g	174
1 Tablespoon Flaxseed Oil	0	0	14g	120
Total	**62.25**	**86**	**22.4**	**764**
Meal Two				
8 oz ground beef sirloin	50g	0	40g	560
1 large tortilla	4g	28g	3g	160
lettuce and salsa	not a significant source			
Total	**54g**	**28g**	**43g**	**720**
Meal Three				
1 scoop ProScore Whey Protein	16g	2g	1g	81
8 oz skim milk	8.75g	12.5g	.2g	87
1 bagel	6g	34g	1g	160
½ Tablespoon all natural peanut butter	2.25g	2g	4g	53g
Total	**33g**	**50.5g**	**6.2g**	**381**
Workout				
Meal Four				
2 1/2 scoops ProScore Whey Protein	40g	5g	2.5g	200
16 oz Grape Juice	0g	100g	0g	400
Total	**40g**	**105g**	**2.5g**	**600**
Meal Five				
8 oz Flank Steak	50g	0g	42g	578
½ cup Brown Rice	4g	34g	1.5g	170
Total	**54g**	**34g**	**43.5g**	**748**

Meal Six	**Protein(g)**	**Carb(g)**	**Fat(g)**	**Calories**
2 Scoops ProScore Whey Protein	32g	4g	2g	160
16 oz Skim Milk	17.25g	25g	.4g	174
1 Tablespoon Flaxseed Oil	0	0	14g	126
Total	**49.25g**	**29g**	**16.4g**	**460**
GRAND TOTAL	**292.5**	**332.5**	**134**	**3673**

The grand total for the daily caloric intake is 3673. These calories break down as follows: 1170 calories from protein, 1330 calories from carbohydrates, and 1206 from fat. The sample diet illustrates how the ratios of the program can be slightly skewed. In the sample diet, the protein intake is 32%, the carbohydrate is 36%, and the fat is 32% of daily caloric intake. Remember, you may adjust the ratios or food to fit your individual ratio and caloric needs.

INDIVIDUAL PROFILES

A 21-year-old junior linebacker used a similar nutrition and creatine supplementation program during an off-season strength and conditioning program.

	Spring	Fall
Bodyweight	200 lb.	215 lb.
Bench Press	310 lb.	340 lb.
Bodyweight Bench Reps	15	17
Squat	500 lb.	550 lb.
Vertical Jump	29 inches	31 inches
400	58 seconds	58 seconds

A 20-year-old sophomore linebacker used a similar nutrition and creatine supplementation program during an off-season strength and conditioning program.

	Spring	Fall
Bodyweight	215 lb.	230 lb.
Bench Press	290 lb.	300 lb.
Bodyweight Bench Reps	10	14
Squat	350 lb.	400 lb.
Vertical Jump	25 inches	28 inches
40 Yard Dash	4.9 seconds	4.8 seconds

APPENDIX B. Questionnaire

The More Mass Questionnaire was designed to evaluate the More Mass Nutrition Program.

Please circle what group best describes you:

Football Player   Strength Coach   Certified Athletic Trainer   Dietician

Please respond to the following questions as directly as possible. Circle the number that best describes your answer. You are encouraged to write comments in the space provided below. If more room is needed for comments, please use the back of the sheet.

After reviewing the manual:

1. Do you think the manual was easy to understand?

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

Comments:

2. Do you think the ratio of fats, protein, and carbohydrates contained in the manual can be easily consumed by a football player?

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

Comments:

3. Do you feel that the information in the manual is beneficial to a football player who is trying to increase lean body mass?

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

Comments:

4. I would advise football players to follow the nutrition information contained in the manual.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

Comments:

5. I would advise football players to follow the creatine information contained in the manual.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

Comments:

6. **What, if anything, would you add to the manual to better aid a football player who is trying to increase lean body mass?**

Thank you for your time and effort. Your answers and comments are greatly appreciated. David

San José State
UNIVERSITY

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Vice President

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APPENDIX C. Approval Letter

TO: David Amacher
20112 Northcrest Square
Cupertino, CA 95014

FROM: Nabil Ibrahim,
Acting AVP, Graduate Studies & Research

DATE: May 4, 1999

The Human Subjects-Institutional Review Board has approved your request to use human subjects in the study entitled:

"Development of Lean Body Mass in the Off-Season Intercollegiate Football Player"

This approval is contingent upon the subjects participating in your research project being appropriately protected from risk. This includes the protection of the anonymity of the subjects' identity when they participate in your research project, and with regard to any and all data that may be collected from the subjects. The Board's approval includes continued monitoring of your research by the Board to assure that the subjects are being adequately and properly protected from such risks. If at any time a subject becomes injured or complains of injury, you must notify Nabil Ibrahim, Ph.D., immediately. Injury includes but is not limited to bodily harm, psychological trauma and release of potentially damaging personal information.

Please also be advised that all subjects need to be fully informed and aware that their participation in your research project is voluntary, and that he or she may withdraw from the project at any time. Further, a subject's participation, refusal to participate, or withdrawal will not affect any services the subject is receiving or will receive at the institution in which the research is being conducted.

If you have any questions, please contact me at (408) 924-2480.

APPENDIX D. Evaluator's Letter

San José State
UNIVERSITY

College of Applied Sciences and Arts
Department of Human Performance
One Washington Square
San Jose, CA 95192-0054
Voice: 408-924-3010
Fax: 408-924-3053

April 30, 1999

Evaluator X
Any Street
Anywhere, USA

Dear Evaluator X,

Thank you for taking the time to read my manual.

After reading the manual, please complete the questionnaire. Return it to me in the self-addressed stamped envelope or fax it to 650-949-7114. You may keep the manual. I hope you find the manual will be helpful in the future.

For reasons of anonymity, please do not put your name on the questionnaire. You should understand that your participation is voluntary. There are no risks or benefits associated with the completion of the questionnaire.

If you have any questions about the manual, I will be happy to talk to you. I can be reached at (408) 777-0208. If you have any questions or complaints about evaluator's rights, please contact Nabil Ibrahin, Graduate Studies and Research, at (408) 924-2480.

Please mail or fax the questionnaire to me by May 16, 1999.

Thank you in advance for you time and consideration.

Sincerely,

David Amacher