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hereby submit this as part of the requirements for the degree of:

MASTERS OF EDUCATION

in Health Promotion and Education

It is entitled A Comparison Study of Male Collegiate, Division 1  
Soccer Players Macronutrient Intake the Day Before, the Day of,  
and the Day After Competition at a Large Midwestern University

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A COMPARISON STUDY OF MALE COLLEGIATE, DIVISION I SOCCER  
PLAYERS MACRONUTRIENT INTAKE THE DAY BEFORE, THE DAY OF, AND  
THE DAY AFTER COMPETITION AT A LARGE MIDWESTERN UNIVERSITY

A STUDY IN HEALTH

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by

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## Abstract

AN ABSTRACT OF THE THESIS FOR THE MASTER OF EDUCATION DEGREE IN HEALTH PROMOTION AND EDUCATION, PRESENTED ON NOVEMBER 18, 2003, AT THE UNIVERSITY OF CINCINNATI, OHIO.

TITLE: A Comparison Study of Male Collegiate, Division I Soccer Players Macronutrient Intake the day before, the day of, and the day after competition at a Large Midwestern University.

MASTERS COMMITTEE MEMBERS: Dr. Brad Wilson (Chair), Dr. Don Wagner, and Dr. Bonnie Brehm.

The purpose of this study was to examine male collegiate, Division I soccer players' diets to determine the extent to which their actual dietary intake reflected the recommended dietary intakes for calories, carbohydrates, protein and fat. Further this study sought to determine if male collegiate Division I soccer players' food selection for grains, fruits, and vegetables meet the recommendations from the USDA Food Guide Pyramid.

Participants of the study were 10 male collegiate, Division I soccer players from a large Midwest University. The athletes completed a three-day record of all food, beverages, and condiments consumed. Statistical analysis determined that there were no significant differences among the male collegiate Division I soccer players' actual dietary intake for calories, carbohydrate, protein, and fat the day before competition, the day of competition, or the day after competition. However, their intake for calories, carbohydrates, and protein were below current recommendations for high intensity sports. In addition, the results indicated that the Division I male soccer athletes are not consuming adequate servings from the grain, fruit, and vegetable groups for optimal performance and good health.

The results of this study may be used to help Division I male soccer athletes make dietary improvements which may enhance performance. Recommendations for future research are offered. Continuing research could aid Division I male soccer players with improving athletic performance.

## Acknowledgements

I would like to thank Dr. Brad Wilson, for initiating this project and facilitating the process. Without his presence my goal of completing this project would not have been accomplished.

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## Chapter One

### *The Problem*

Nutrition played a vital role in the health and well being of all individuals. Many chronic diseases today were attributed to lifestyle choices such as smoking, physical inactivity, and poor or inadequate nutrition. Poor dietary patterns were associated with four of the ten leading causes of death (heart disease, cancer, stroke and type 2 diabetes) in the United States today (U.S. Department of Health and Human Services [DHHS], 2000). A poor diet also affected athletic performance and researchers documented the positive and negative have an effect on of nutrition on athletic performance. It was recognized that a poor or inadequate diet may potentially cause fatigue, loss of muscle strength and size, suppressed immune system, insufficient bone maintenance, low weight, and impaired performance (American Dietetic Association, 2000).

Athletes faced the same challenges as the general population to consume a healthy diet. According to the 1999 Healthy Eating Index, 74% of most people's diets "need improvement, 16% of the population had a poor diet and 10% of the population had a "good diet" (Basiotis, Carlson, Gerrior, Juan, & Lino 2002). Seventy percent of males between the ages of 20 and 39 consumed six or more servings a day of grains; only 11% of those males selected three or more servings from whole grain products. Only 23% and 68% of males between the ages of 20 and 39 consumed two or more servings of fruits and three or more servings of vegetables a day respectively (U.S Department of Health and Human Services, [DHHS], Healthy People 2010, 2000).

It was recognized that “physical activity, athletic performance and recovery from exercise are enhanced by optimal nutrition” (American Dietetic Association, 2000, p. 1543). Currently, there are no sport specific dietary recommendations (Jonnalagadda, 2000). The dietary needs of athletes should have been based on energy demands of the sport, gender, and current nutritional status of the individual (Macedonio, 2000). It was advised that athletes follow the same basic principles of nutrition as the general population but athletes should consume additional fluids to account for sweat loss and additional energy to fuel physical activity (American Dietetic Association, 2000) It was also recommended that athletes incorporate the principles of the Dietary Guidelines for Americans and select foods for training and competition based on the US Food Guide Pyramid (American Dietetic Association, 2000).

Sports nutrition experts advocated for adequate energy consumption to help athletes enhance performance. Past studies suggest that athletes did not make appropriate food choices that met current recommendations to enhance performance (Kirkendall, 1993; Clark, Tobin & Ellis, 1992). Rico-Sanz (1998) found in a literature review of the dietary consumption of elite soccer players that they did not consume enough macronutrients, especially carbohydrates, for competition and training. In addition, many athletes, especially college athletes, did not have the necessary nutrition knowledge to make appropriate food choices for training and competition or have access to the services of a registered dietitian (Rosenbloom, Jonnalagadda, & Skinner, 2002). They relied on coaches or athletic trainers that typically did not have adequate nutrition knowledge or

education to help athletes enhance performance (Rockwell, Nickols-Richardson, & Thye, 2001). Without adequate macronutrient intakes (carbohydrates, proteins, and fats) athletic performance and the recovery from exercise was compromised (American Dietetic Association, 2000).

### *Purpose of the Study*

A comprehensive review of the literature revealed no published study which had specifically examined male collegiate, Division I soccer players' dietary intake the day before, the day of, and the day after competition. Therefore, the present study was conducted. The purpose of this study was to compare male collegiate, Division I soccer players' dietary intake the day before, the day of, and the day after competition for calories, carbohydrate, fat and protein. In addition, this study examined the food selection for grains, fruits, and vegetables and compared the findings to the current recommendations for food selection based on the USDA Food Guide Pyramid. The result of this study could be used to help Division I male soccer players make dietary improvements, which may enhance performance.

### *Research Questions*

The following research questions were examined in the present study:

1. What are the male collegiate, Division I soccer players' actual dietary intakes for calories, carbohydrates, proteins, and fats, the day before competition, the day of competition, and the day after competition?

2. Do male collegiate, Division I soccer players consume the recommended amounts of grains, fruits, and vegetables indicated by the USDA Food Guide Pyramid?

### *Hypotheses*

*Null Hypothesis 1.* There will be no significant differences in the actual dietary intake among the male collegiate, Division I soccer players in relation to: a) calories, b) carbohydrates, c) proteins, and d) fats the day before competition, the day of competition, and the day after competition.

*Hypothesis 1.* There will be significance differences in the actual dietary intake among the male collegiate, Division I soccer players in relation to: a) calories, b) carbohydrates, c) proteins, and d) fats the day before competition, the day of competition, and the day after competition.

### Delimitations

1. This study was delimited to male collegiate, Division I soccer players at a large Midwestern University and therefore may not be generalizable to other universities or athletic populations.

2. This study was delimited to the consumption of calories, carbohydrates, protein, and fat based on actual dietary intakes and therefore may not be generalizable to other nutrients.

3. This study was delimited to male collegiate, Division I soccer players aged 19-25.

### *Limitations*

1. This study was limited by the self-reporting and honesty of the athletes who submitted the three-day dietary records the day before competition, the day of competition, and the day after competition.
2. This study was limited by the athlete's ability to read, understand, and follow the directions to complete the three-day dietary records.
3. This study was limited by the athlete's ability to accurately determine amounts and serving sizes of food.

### *Assumptions*

1. It was assumed that the athletes who volunteered for this project were interested and took the time to fill out the three-day food log as it reflected their usual dietary intake the day before competition, the day of competition, and the day after competition.
2. It was assumed that the athletes understood how to fill out the document and were accurate and honest about recording their dietary intake.

### *Operational Definitions*

1. Actual dietary intake: The actual amounts of food and nutrient intake as measured by the three-day dietary records.
2. Calorie: Unit used for measuring the energy produced by food when metabolized in the body.
3. Collegiate Division I soccer player: A male or female athlete who



participated in soccer at a Division I level school. Division I status requires the school to offer at least seven sports for women and seven sports for men or eight sports for women and six sports for men with two team sports per gender. The Division I athletic programs are required to meet minimum financial aid awards and are not allowed to exceed maximum financial aid awards for each sport (National Collegiate Athletic Association, n.d.).

4. The Dietary Reference Intakes (DRI): the DRI is an umbrella group that includes the following other nutrient measures: RDAs, adequate intakes (AI), estimated average intakes (EAR), and tolerable upper intakes (UL).

5. Dietary Guidelines for Americans: A report published by the U.S. Department of Agriculture and U.S. Department of Health and Human Services that explains how to eat to maintain health. These guidelines for the national nutrition policy and are revised every 5 years.

6. Food Guide Pyramid: A graphic depiction of U.S. Department of Agriculture's current food guide that includes five major food groups including grains, vegetables, fruits, milk products, and meat. The tip of the pyramid is the fats and sweets, which depicts the small contribution that fat and added sugar should make to U.S. diets. The Food Guide Pyramid provides information on the choices within each food group and the recommended number of servings.

7. Recommended Daily Allowances (RDA): Recommended Dietary Allowances (RDAs) are the levels of intake of essential nutrients that, on the basis of scientific knowledge, are judged by the Food and Nutrition Board to be adequate to meet the known nutrient needs of practically all healthy persons.

8. Registered Dietitian: A food and nutrition expert who has met the minimum academic and professional requirements to receive the credential "RD." Many states and commonwealths also have licensing laws for dietitians and nutrition practitioners.

9. Three-day Food Log: An instrument used to measure actual dietary intakes. The athletes who participated in this study were required to complete a three-day record of all the foods, beverages, method of food preparation, and amounts consumed the day before competition, the day of competition, and the day after competition (24 hours for each day).

## Chapter Two

### *Review of Literature*

It was well documented that nutrition played a vital role in the health and well being of all individuals. Many chronic diseases were attributed to lifestyle choices such as smoking, physical inactivity and poor or inadequate nutrition. Poor dietary patterns were associated with four of the ten leading causes of death (heart disease, cancer, stroke and type 2 diabetes) in the United States today (U.S. Department of Health and Human Services [DHHS], 2000). A poor diet also affected athletic performance and researchers documented the positive and negative effects of nutrition on athletic performance. It was recognized that a poor or inadequate diet may potentially cause fatigue, loss of muscle strength and size, suppressed immune system, insufficient bone maintenance, low weight, and impaired performance (American Dietetic Association et al., 2000).

Past studies suggest that athletes did not make appropriate food choices that met current recommendations to enhance performance (Kirkendall, 1993; Clark, Tobin & Ellis, 1992). Rico-Sanz (1998) found in a literature review of the dietary consumption of elite soccer players that they did not consume enough macronutrients, especially carbohydrates, for competition and training. In addition, many athletes, especially college athletes, did not have the necessary nutrition knowledge about appropriate food choices for training and competition or access to the services of a registered dietitian (Rosenbloom, Jonnalagadda, & Skinner, 2002). They relied on coaches or athletic trainers that typically did not have adequate nutrition knowledge or education to help athletes enhance

performance (Rockwell, Nickols-Richardson, & Thye, 2001). Without adequate macronutrient intakes (carbohydrates, proteins, and fats) athletic performance and the recovery from exercise was compromised (American Dietetic Association, 2000).

The purpose of this study was to compare male collegiate, Division I soccer players' dietary intake the day before, the day of, and the day after competition for calories, carbohydrate, fat and protein. In addition, this study examined the food selection for grains, fruits, and vegetables and compared the findings to the current recommendations for food selection based on the U.S. Food Guide Pyramid. The results of this study could be used to help Division I male soccer players make dietary improvements, which may enhance performance.

#### *The Physiological Demands of Soccer*

It was important to understand the physical demands of soccer in order to address the nutritional needs of the players (Macedonio, 2000). Soccer was considered a high intensity intermittent exercise and players typically work at 70-80% of their VO<sub>2</sub> max with heart rates above 160 beats a minute (Rico-Sanz, 1998). According to Learmouth (1979), a soccer team consists of eleven players and the game is 90 minutes long, with two 45-minute halves and a 15-minute break.

There are four basic positions on a soccer team and the athlete's energy expenditure was based on the total running distance covered in a game

(Luxbacher, 1997). According to Macedonio (2000), first, there are the defenders, known as fullbacks or sweepers. They typically cover the least distance among all the positions. They average about 8,960 meters or 5.57 miles per game. Next, are the attackers, known as forwards, wings, or strikers. In this position the player is expected to make the most goals. They typically sprint most of the distance they cover. It is estimated that they cover approximately 10,000 meters or 6.2 miles per game. Third, is the midfielder, known as linkmen or halfbacks. Their job is to play both offense and defense and they keep the ball moving between the attackers and defenders. Midfielders are usually the most active players on the field. They cover more distance than other players and are required to jog most of the distance they cover. On average a midfielder can run between 11,040 and 12,069 meters or 6.86 to 7.5 miles in a 90-minute game (Nike Research Review, 1997). Finally, the goalkeeper or goalie is the least active person on the field. The job of this person is to defend their goal from the opposing team.

Rico-Sanz (1998) estimated that the energy expenditure during training was about 12 calories per minute, and increased to 16.7 calories per minute during a soccer game for outfield players and 4.8 calories per minute for goalkeepers. Macedonio (2000) explained that regardless of the position of the players, about two-thirds of the distance was covered at the moderate intensity level such as walking and jogging.

Bangsbo (1994) concluded from a study that the higher the level of performance, the more frequent and longer were the periods of high intensity

exercise. He compared Danish First and Second division players and determined that for elite male soccer players the total duration of high intensity exercise was about 7 minutes in length. This included 19 sprints, about 2 seconds per sprint, with high speed running occurring every 70 seconds. Clark (1994) reported that professional male soccer players who play at higher intensities for longer periods of time can use between 3,150 and 4,300 calories per day.

#### *General Nutrition Principles for Athletes*

According to the American Dietetic Association (2000), athletes should follow the same basic principles of nutrition as the general population. Athletes were advised to incorporate the concepts from the Dietary Guidelines for Americans and their food selection should be based on the 1992 USDA Food Guide Pyramid (U.S. Department of Agriculture [USDA], 1992). The Dietary Guidelines for Americans were established in 1980 by the United States Department of Agriculture and the US Department of Health and Human Services. The Dietary Guidelines were based on the most recent scientific and medical knowledge formulated by nutrition scientists and were revised very five years (U.S. Department of Agriculture and U.S. Department of Health and Human Services [DHHS], 2000).

There were three categories in the most recent edition, the 5<sup>th</sup> edition, of the 2000 Dietary Guidelines for Americans (U.S. Department of Agriculture and U.S. Department of Health and Human Services [DHHS], 2000). The first one

was “Aim for Fitness” with an emphasis on achieving a healthy weight and engaging in physical activity each day. The second category was “Build a Healthy Base” by using the food guide pyramid for food selection. It was emphasized to choose a variety of foods especially whole grains, fruits, and vegetables each day. The third category was “Choose Sensibly” by eating a diet low in saturated fat and cholesterol, moderating sugar consumption, using less salt and drinking alcohol in moderation.

The USDA Food Guide Pyramid translated the Dietary Guidelines for Americans into types and amounts of foods people can eat to have a healthy diet (American Dietetic Association, 2000). According to the American Dietetic Association (2000), the recommended number of servings and serving sizes from the six food groups depended on a person’s caloric requirement based on their physical activity, age, and gender. The food groups included: grains such as bread, cereal, rice and pasta; vegetables; fruits; milk, including yogurt and cheese; and meat such as poultry, fish beans, eggs and nuts. The sixth food group was fats, oils, and sweets, which supplied calories but had little or no nutritional value.

In order to provide the general population with nutritional guidelines to prevent disease and promote health the Recommended Dietary Allowances (RDA) were developed by the Food and Drug Board of the National Resource Council. The RDAs were published in 1943 and have been used as minimum dietary standards and served as guidelines for adequate nutritional intakes. The RDAs were revised in 1997 with the Canadian government. The revision was

called the Dietary Reference Intake (DRI) and it included additional selected nutrients. The RDAs and DRIs were based on scientific knowledge and provided the general population with recommended nutrient intakes (Committee on Dietary Intake, 1997; National Academy of Science, 1989).

### *Macronutrients*

*Carbohydrates for Fuel.* The nutritional goal of an athlete's diet should have been to consume enough carbohydrates to optimize muscle and liver glycogen stores (Burke, Collier, & Hargreaves 1998). It was necessary for athletes to consume adequate carbohydrate consumption on a daily basis to support training needs and maintain an ideal body weight. The total energy requirement of a soccer player was determined by the amount and quality of training and the distance traveled in a game (Clark, 1994). Total energy requirements for males should have been between 47-60 calories per kilogram of body weight per day (Macedonio, 2000). Macedonio (2000) explained that based on this criterion a male who weighs 165 pounds should consume approximately 3375-4500 calories a day in order to maximize muscle glycogen and glucose levels.

Current research recommended that athletes consume 8-10 grams of carbohydrate per kilogram of body weight or 60-70% of total calories a day to maintain muscle glycogen stores. The average American individual was advised to consume 4 grams of carbohydrates per kilogram of body weight or 50-55% of total calories a day. The American Dietetic Association, (2000) recommended



that athletes consume the maximum number of servings from the carbohydrate-based food groups. These carbohydrate-rich food groups include the grain group, such as bread, rice, cereal, and pasta. The other two groups are the fruit and vegetable group. According to the USDA Food Guide Pyramid, the recommended number of servings varied according to age and gender. Men between the ages of 19-24 years were advised to consume approximately 2900 calories per day. The maximum number of recommended servings from the grain group was 11 servings per day, 5 servings per day from the vegetable group and 4 servings per day from the fruit group. The American Dietetic Association, (2000) recognized that the energy requirements for athletes would far exceed the maximum number of servings. Athletes were advised to consume additional servings from these food groups as needed.

*Fat Intake.* Fats were considered a very important macronutrient in the diet of all individuals. Fat played a vital role in providing energy, absorbing fat soluble vitamins, providing essential fatty acids and essential elements for cell membranes, and protecting major organs (Jonnalagadda, 2000). The mix of carbohydrate and lipid substrates used during exercise is depended on the intensity and duration of the exercise (Macedonio, 2000). It was observed by Bangsbo (1994) that free fatty acid concentration increased more during the second half of a soccer game than in the first half. This was attributed to a slower pace during the second half and a greater blood flow to adipose tissue promoting a greater fatty acid release for energy.

The general recommendation for fat intake was 25 to 30% of a person's total caloric intake. The American Dietetic Association suggested that athletes follow the recommendations of the Dietary Guidelines for Americans to consume 30% of total calories as fat (10% saturated, 10% polyunsaturated and 10% monounsaturated) each day. Because athletes were required to eat large quantities of carbohydrates they were advised to decrease fat intake to accommodate the large carbohydrate requirements (Hargreaves, 1994 ). There are no performance benefits to consuming a diet with less than 15% fat compared to a diet with 20 to 25% fat (American Dietetic Association, 2000).

*Protein Requirements.* The Recommended Daily Allowance (RDA) for protein is 0.8 g/kg of body weight a day for an average individual. The RDAs set by the Food and Drug Board of the National Research Council did not recognize the need for increased dietary protein for active people. The RDAs were determined for sedentary people. The RDA provided for large allowances (twice the standard deviation of the mean) and may be adequate for many active people (Carroll, 2000). Protein typically should make up approximately 15-20% of an individuals' total caloric intake. Lemon (1994) reviewed the literature on protein consumption and concluded that soccer players needed more dietary protein than sedentary individuals and suggested a protein intake of 1.4 to 1.7 g/kg per day. This was approximately 175 to 212% of the RDA for protein for competitive soccer players. Lemon (1994) explained that data specific to soccer players was lacking but research from strength and endurance athletes could have been related to soccer players due to the fact that soccer players exercise

at high intensity for 90 minutes or more with heart rates above 160 beats per minute. The rationale behind Lemon's recommendation was based on the principle that the extra protein had the potential to increase strength and contributed to increased amino acid oxidation. In turn, the amino acid oxidation was related to muscle glycogen availability. The higher the intensity of exercise, the greater the muscle glycogen use and amino acid oxidation. Although extra protein may serve as an auxiliary fuel for exercise, it was important to understand that it typically would provide less than 5% energy.

Clark (1994) suggested that adequate protein needs were just as important as carbohydrate consumption and athletes should eat a variety of meats, dairy products, grains, and vegetables to obtain an adequate intake. Macedonio (2000) indicated that if an athlete was consuming appropriate calories to maintain a desirable weight and was eating from a variety of foods, the increased recommendations of 1.4-1.7 g/kg of protein per day was achievable. Lemon (1994) cautioned that more was not necessarily better in relation to protein. In his literature review, it was indicated that the dietary intake of 0.86 to 1.4g/kg of protein per day enhanced protein synthesis in strength athletes but there was no benefit at protein intakes about 2.4 g/kg per day. He suggested that a high protein intake (above 2 g/kg a day) provided no advantage to athletes and may have been hazardous to their health. Maughan et al. (1997) also found that a high protein, low carbohydrate diet would result in metabolic acidosis, which is related to fatigue.

*The Training Diet*

Over the last 30 years there has been a tremendous amount of research conducted about sports nutrition (American Dietetic Association, 2000). It was well documented that an optimal diet enhances sports performance. In their position statement the American Dietetic Association, (2000) stated, “physical activity, athletic performance and recovery from exercise are enhanced by optimal nutrition” (p.1543).

Meeting energy needs should be the first nutritional goal for athletes (American Dietetic Association, 2000). Achieving energy balance was essential for the maintenance of weight or lean tissue mass, immune function, and optimal athletic performance. Swinburn and Ravussin (1997) defined energy balance as “a state when energy intake (the sum of energy from foods, fluids and supplement products) equals energy expenditure (the sum of energy expended as basal metabolism, the thermic effect of food, and any voluntary physical activity)” (p. 767).

Carbohydrates were the main source of energy for athletes and energy requirements should have been based on the need of each individual player (Macedonio, 2000). The amount and quality of training are the two most important factors that influenced energy expenditure (Clark, 1994).

Carbohydrates were stored in the body as muscle glycogen, liver glycogen, and blood glucose. Both muscle glycogen and blood glucose were important fuels that provided energy for athletes. It was well known that muscle glycogen provided the greatest source of carbohydrate in the body (300-400

grams or 1,200-1,600 calories), followed by liver glycogen (75-100 grams or 300-400 calories) and lastly, blood glucose (25 grams or 100 calories) (Coleman, 2000).

Many studies have been conducted that indicate there is a direct correlation between the amount of carbohydrates stored as muscle glycogen and the length of time a person could exercise. It was determined that the greater amount of carbohydrates stored as muscle glycogen, the more endurance an athlete had in competition or training. Bergstrom, Hermansen and Saltin (1967) examined the effects of a low, moderate, and high carbohydrate diet had on the length of exercise time to fatigue. They provided three diets (low, moderate, and high carbohydrate) for three days of exercise at 75% of VO<sub>2</sub> max. He found that a high carbohydrate diet (>82% carbohydrate diet) provided 204 mmol/kg of muscle glycogen and enabled the subjects to exercise for 170 minutes before exhaustion. They found that the subjects who consumed the moderate carbohydrate diet (50% carbohydrate) produced a muscle glycogen content of 106mmol/kg and were able to exercise for 115 minutes before exhaustion and the subjects who consumed a low carbohydrate diet (< 5% carbohydrate diet) produced the smallest amount of muscle glycogen at 38 mmol/kg and were only able to exercise for one hour.

Balsom, Wood, Olsson, and Ekblom (1999) studied the effects of a high vs. low carbohydrate diet specific to soccer players. Six male soccer players and had each pair of subjects performed routine intermittent shuttle runs to lower their muscle glycogen levels 48 hours before competition. They were randomly

provided a high (65%) or low (30%) carbohydrate diet during the 48 hours before competition. They competed in a 90-minute game (4-a-side) on two occasions following the exercise and diet regimen. They determined that the subjects who consumed the high carbohydrate diet had higher pre-game muscle glycogen levels ( $395.6 \pm 78.3$  mmol  $\times$  kg<sup>-1</sup>) than the subjects who consumed the low carbohydrate diet ( $287.1 \pm 85.4$  mmol  $\times$  kg<sup>-1</sup>). The athletes who consumed the high carbohydrate diets were able to perform 33% more high intensity activity than the subjects who consumed the low carbohydrate diet.

Other studies indicated the effects of a low carbohydrate diet versus a high carbohydrate diet on performance of repeated sprints. These studies indicated there was a positive benefit toward consuming a high carbohydrate diet compared to a low carbohydrate diet. Smith, Walberg Rankin, Stevens, and Williams (2000) studied 8 trained cyclists who conducted 60-second repeated sprints at 125-135 VO<sub>2</sub> max to 30% fatigue. They found that the subjects who consumed a high carbohydrate diet (80-85%) cycled significantly longer (37% longer) before achieving the 30% fatigue than the cyclist who consumed a low carbohydrate diet (5-10%).

Casey, Short, Curtis, and Greenhaff (1996) studied 11 male cyclists who conducted 4 rounds of 30-second cycling with a 4-minute rest period between each round. The exercise protocol was conducted before and after dietary treatments. Their subjects either consumed a low carbohydrate diet of 7.8% or a high carbohydrate diet of 82% for three days prior to the exercise. They found that there was no change in work performed before or after dietary intake for the

high carbohydrate cyclist. The low carbohydrate diets contributed to an 8% decrease in the work during the first three sprints.

Finally, Jenkins, Palmer, and Spillman (1993) worked with 14 moderately trained males. They conducted five 60-second sprint cycles with five-minute rest periods between each cycle. The exercise protocol was conducted before and after dietary treatments. The subjects either consumed a high carbohydrate diet of 80% carbohydrates, a moderate carbohydrate diet of 55% carbohydrates, or a low carbohydrate diet of 12% carbohydrates. The results of the study indicated that the persons who consumed a high carbohydrate diet had a 5.6% increase in work performed during the sprints, the persons who consumed a moderate carbohydrate diet had a 2.3 percent increase in work performed during the sprints, and the persons who consumed the low carbohydrate diet had a -5.4% change in work performance during the sprints.

A concept that was used by some athletes to help them identify and select carbohydrate rich foods is called the glycemic index. Burke, Collier, and Hargreaves (1998) explained that the glycemic index indicated the actual effects of carbohydrate-rich food on blood glucose and insulin levels. Researchers have defined the glycemic index as the response of blood glucose to a 50-gram carbohydrate portion of food when compared to the same amount of carbohydrate from a standard comparison, usually white bread or glucose (Burke, Collier, & Hargreaves 1998). Foods are ranked according to the blood glucose response (rate of digestion and absorption) following their intake (Burke, Collier, & Hargreaves 1998).

Foods were categorized into three classifications: high, moderate, or low glycemic index rankings. High glycemic foods included: glucose, white potatoes, honey, most breads, cereals, and sport drinks. Moderate glycemic foods included: sucrose, soda, rice, oats, bananas, and orange juice. Low glycemic foods included: fructose, pasta, dairy foods, lentils, apples, and oranges (Foster-Powell, Holt & Brand-Miller, 2002). According to Clark (1994), the glycemic index could be used with soccer players with a positive effect towards selecting a high carbohydrate training diet. It was suggested that if athletes choose the recommended foods based on the glycemic index they may have been able to enhance carbohydrate availability and improve athletic performance (Burke, Collier, & Hargreaves 1998).

The literature indicated there were limitations to the glycemic index that athletes should be aware of. First, the glycemic index was based on grams of carbohydrates and not based on the average serving size for foods. Second, the glycemic index numbers were based on single foods. If an athlete ate a mixed meal (high and low glycemic foods) the low glycemic food may have interfered with the high glycemic food (Coleman, 2000). Burke, Collier, and Hargreaves (1998) explained that it could have been applied to mixed meals by taking the weighted mean of the glycemic index of the carbohydrate food that make up the meal. Third, the healthiness of a food cannot be based on the classification of its main carbohydrate. Athletes were advised not to use the glycemic index exclusively to provide guidelines for carbohydrate and food selection before, during and after competition or training (Coleman, 2000). It was encouraged to



keep in the mind the foods' nutritional content and issues of taste, cost, gastric comfort, and ease of preparation. It was advised that the tool may have helped athletes make better food selections but athletes needed to choose foods based on their exercise and nutritional goals (Coleman, 2000).

### *Eating For Competition*

*Pre-Competition Meal.* Athletes were advised to consume a high carbohydrate diet to build up and maintain muscle glycogen stores. When adequate amounts of carbohydrate were not consumed on a daily basis, the pre-exercise muscle glycogen storage declined and this was associated with fatigue and poor performance (Clark, 1994). The pre-exercise meal was important and provided energy when athletes exercised hard for one hour or longer (Burke, Collier, & Hargreaves 1998). Pre-competition meals were advised so athletes did not feel hungry, which may have impaired performance.

Pre-exercise meals were important for soccer players particularly during the second half of the game. Saltin (1973) demonstrated the negative impact of pre-exercise muscle glycogen on the running performance during a soccer match. He found low amounts of muscle glycogen after a soccer game and determined that the greater amount of muscle glycogen was used in the first half compared to the second half. Players who had low muscle glycogen stores experienced fatigue and a decrease in performance. He reported that players with low muscle glycogen stores covered 24% less distance and walking covered 50% of this distance.

Costill, Bowers, Branam, and Sparks (1971) examined muscle glycogen production on a moderate carbohydrate diet of 45% of total calories during 3 successive days of running 16.1 kilometers at 80% of  $\text{VO}_2$  max. Subjects' pre-exercise muscle glycogen levels started at 110 mmol/kg and fell to 88 mmol/kg on the second day and fell to 66 mmol/kg by the third day. By providing 525 to 648 grams of carbohydrates, muscle glycogen stores increased by 70 to 80 mmol/kg. Within a 24-hour period, muscle glycogen stores reached maximal repletion.

The literature indicated that the timing of meals was very important for optimal exercise performance. Hargreaves (1994) explained that a high carbohydrate meal greater than 200 grams was recommended 3 to 4 hours before competition to insure there was sufficient carbohydrate available and to enhance performance. Clark (1994) recommended consuming 30 to 60 grams of carbohydrates as solid or liquid up to one hour before competition for athletes that were hungry before competition.

The glycemic index of foods had been used as a tool for pre-exercise meals but current data was mixed as to whether high or low glycemic foods effected performance. Thomas, Brotherhood, and Brand (1991) compared the consumption of 1 gram of carbohydrates per kilogram of lentils (low glycemic food), potatoes (high glycemic food), glucose (high glycemic food), and water 1 hour before exercise. The subjects cycled at 65-70%  $\text{VO}_2$  max to exhaustion. The lentil feeding provided a more gradual rise and fall in blood glucose compared to the other foods and water. They found that the endurance time for

the low glycemic index lentils was 20 minutes longer than for all other foods, which were not different from each other.

Neufer et al., (1987) found that endurance increased in cyclists by providing 200 grams of high glycemic foods (bread, cereal and milk, fruit juice) 3 to 4 hours before competition. He provided a candy bar containing 43 grams of sucrose five minutes before cycling. He found that the cyclist had a 22% increase in cycling power after their meal.

Sherman, Peden, and Wright (1991) compared the ingestion of 1.1 grams and 2.2 grams per kilogram of bodyweight a carbohydrate (high glycemic) drink consumed 1 hour before (90 minutes of VO<sub>2</sub> max cycling) exercise. It was found that the drink caused a rise in insulin levels at the start and during exercise and initially decreased blood glucose. By the end of the time trial, the cyclist's performance increased by 12.5%. It was recommended that athletes examine their glucose and insulin responses with both high and low glycemic foods to determine which provided the best results.

The general guidelines for using the glycemic index include: 1) high glycemic foods were recommended before exercise if athletes were not sensitive to having their blood glucose lowered, 2) low glycemic foods are recommended before exercise for athletes who were sensitive to having their blood glucose lowered and experienced symptoms of fatigue or hypoglycemia, 3) high glycemic foods were recommended during exercise to raise blood glucose and promote carbohydrate oxidation, 4) high glycemic foods were recommended following exercise to enhance muscle glycogen stores (Coleman, 2000, p. 20).

Other recommendations for pre-exercise meals include avoiding high fat and fried foods, and high fiber foods that may have caused gastrointestinal discomfort. The American College of Sports Medicine (1996) provided guidelines for fluid consumption and replacement. In their position stand on exercise and fluid replacement, the American College of Sports Medicine, (1996) recommended that individuals drink about 17 ounces of fluid 2 hours before exercise to promote adequate hydration and allow time for excretion of excess ingested water (ACSM, 1996). Extra fluid should be consumed 10 to 15 minutes before the competition began. Caffeine and alcohol should have been avoided for 72 hours before a game (Macedonio, 2000).

*During Competition.* Clark (1994) identified the depletion of muscle glycogen and dehydration as the major causes of fatigue during high-intensity intermittent exercise. The American College of Sports Medicine (1996) acknowledged that the primary role of carbohydrates during exercise was to maintain blood glucose concentration and enhance carbohydrate oxidation. The American Dietetic Association (2000) advocated for the use of carbohydrates during exercise and explained that it was even more important "when athletes have not carbohydrate loaded, consumed pre-exercise meals or restricted energy intake for weight loss" (p. 1553). There was evidence that carbohydrates were beneficial during exercise in either a liquid or solid form. It was suggested as a general rule if the same amount of carbohydrate was consumed, the form of the carbohydrate did not matter. However, the literature indicated that there were advantages and disadvantages to both. Some of the advantages of liquid

carbohydrates were that they replaced sweat loss and emptied rapidly from the stomach. The disadvantages were that they contained large volumes and could be difficult to carry, there is limited the variety, and they are not as satisfying as other (solid) carbohydrates. Solid carbohydrate replacements are easy to carry, there are many choices and could be very satisfying. On the other hand they did not replace sweat loss and require additional water for digestion (Coleman, 1994).

The American College of Sports Medicine (1996) recommended that athletes drink fluids before exercise and at regular intervals in an attempt to replace all the water lost through sweating, or consume the maximal amount that can be tolerated. This recommendation was to support the need for adequate fluid intake during competition and training to prevent dehydration. Maughan and Leiper (1994) explained that carbohydrates played an important part of fluid replacement because it provided a source of fuel for muscles, helped with absorption from the intestines and improved taste by adding sweetness. The recommendation for consuming carbohydrates and for fluid replacement during competition was to consume between 30 to 60 grams or 20-40 ounces of carbohydrate every hour. For a liquid carbohydrate beverage the solution should have been between 6 and 8% carbohydrate. It was recommended that athletes start drinking 10-15 minutes after initiation of the competition and continue drinking throughout the game.

Sodium and potassium replacement was also important in relation to fluid replacement. Sodium and potassium helped increase voluntary fluid intake and

maintained both plasma volume and total body fluid balance. Burke, Collier, and Hargreaves (1998) recommended drinking a carbohydrate solution with 4 to 8% carbohydrate, 110-165 mg of sodium and 19-46 mg of potassium per 8 oz serving before and after competition. The American College of Sports Medicine (1996) recommended consuming 600 to 1,200 mL per hour (20 to 40 oz) of sport beverages containing between 4 and 8% carbohydrate to meet both fluid and carbohydrate requirements.

*Post-Competition Meal.* Fallowfield and Williams (1993) studied the importance of a high carbohydrate diet on muscle glycogen recovery after prolonged exercise. The subjects ran at 70% of their VO<sub>2</sub> max for 90 minutes or exhaustion whichever came first. Over the next 22.5 hours, the runners either consumed 5.8 grams of carbohydrate or 8.8 grams of carbohydrate per kilogram of body weight. After this rest period, the runners ran at the same 70% of VO<sub>2</sub> max for 90 minutes. They found that the subjects who consumed 8.8 grams of carbohydrates per kilogram were able to match their running time from the first race. The subjects who ate 5.8 grams of carbohydrate per kilogram decreased their time by more than 15 minutes.

The primary goal of the post-competition meal was to replenish muscle and liver glycogen stores. The timing of this meal was of utmost importance. It was well documented that when carbohydrates were consumed immediately after exercise it produced higher muscle glycogen levels. Ivy, Lee, Broznick, and Reed (1988) examined the muscle glycogen repletion of cyclists after 2 hours of hard cycling, which depleted glycogen stores. They provided 2 grams of

carbohydrates per kilogram immediately after exercise and the glycogen synthesis was 24 mmol/kg. When the same carbohydrate feeding was consumed 2 hours after exercise glycogen stores were 15.4 mmol/kg and after four hours it was 13.2 mmol/kg. Muscle glycogen synthesis was reduced by 66% and 45% respectively. The literature recommended either a liquid or solid; or simple or complex forms of carbohydrates after exercise to replenish muscle glycogen stores.

There was evidence that a high glycemic carbohydrate diet following the first 24 hours after exercise may increase muscle glycogen stores. Burke, Collier, and Hargreaves (1993) had subjects cycle for 2 hours at 75%  $\text{VO}_2$  max to deplete muscle glycogen stores. Subjects consumed either a high or low glycemic index food. Subjects consumed 10 grams of carbohydrate per kilogram of body weight immediately after exercise, and 4, 8, and 21 hours after exercise. It was determined that in muscle glycogen after the 24 hours increased more with the high glycemic index food (106 mmol/kg) than with the low glycemic food (71.5 mmol/kg).

Coyle (1991) also recommended ingesting 50 grams per 2 hours of moderate and high glycemic foods to reach a total of 600 grams within the first 24 hours after competition. It was concluded that post-exercise nutrition is important to replenish muscle glycogen stores and hydrate from sweat loss. The general carbohydrate guidelines for males for post-exercise lasting 90 minutes or longer (such as soccer) was to consume 1.5 to 2 grams per kilogram of body weight of high glycemic food or a liquid carbohydrate beverage 30 minutes after

exercise and again 2 hours later. Athletes were also advised to consume at least one pint of fluid for every pound of body weight lost during activity. It was advised that athletes weigh in nude before and after competition to analyze fluid loss and to insure proper fluid replacement. Maughan and Leiper (1996) emphasized the importance of drinking fluids in excess of the deficit in body weight. They recommended "drinking at least a pint of fluid for every pound of body weight deficient" (p.31). It was suggested that further research was needed for more precise recommendations about the quantity of fluid needed after competition. Recommendations were to consume 24 ounces per pound of weight loss within 24 hours after exercise.

#### *Nutrition Knowledge and Dietary Intake of Athletes*

There have been many studies that have investigated the physical characteristics, daily energy expenditures, diet intake, and effects of nutritional supplements in relation to elite soccer players. After a review of the literature, Rico-Sanz (1998) found that the carbohydrate intake of elite male soccer players was about 53% of their total energy intake. Carbohydrate consumption ranged from 46.3% of total calories to 56%. Protein intake averaged 15% (range 13.6-15.9) and fat intake averaged 30% (range 28%-39%). He found that alcohol consumption made up the additional percentage of calories. He concluded that the carbohydrate intake was generally below the recommended requirements for competition and training for elite male soccer players.



Several studies have been completed assessing the nutrition knowledge of athletes, coaches, and athletic trainers at Division I Universities. Rosenbloom, Jonnalagadda, and Skinner (2002) provided a nutrition knowledge questionnaire to 237 males and 91 females during their yearly physical. Thirty percent of the athletes were freshmen, 25% were sophomores, 23% were juniors, and 25% were seniors. Only 63% (n=149) of males and 54%(n=49) of females knew that carbohydrates and fat were the main energy sources for activity. Seventy four percent of males (n=175) and 75% of females (n=68) knew that carbohydrates would not make them fat. Sixty-three percent of males (n=149) and 71% of females (n=65) believed that sugar eaten before an event would adversely affect performance. Forty-seven percent of males (n=111) and 43% of females (n=39) believed that protein was the main source of energy for the muscle. Thirty-five percent of males (n=83) and 34% of females (n=31) believed that protein supplements were necessary. Jacobson, Sobonya, and Ransone (2001) found that 21% college athletes thought protein was an immediate energy source and 13% of the respondents thought protein increased muscle size. Most athletes knew that dehydration decreased performance and that fluids should be replaced before, during, and after exercise. Sixty-seven percent of males (n=159) and 53% of females believe vitamin and mineral supplements increased energy. Jacobson and Aladana (1992) found that 77% of college athletes believed vitamin supplements provided energy. Rosenbloom, Jonnalagadda, and Skinner (2002) concluded "the results suggest that both males and female athletes need

to be targeted for nutrition education to assist them in making proper dietary decisions” (p. 420).

Many Division I Universities did not employ registered dietitians as a part of the athletic department. Athletes often viewed coaches, athletic trainers, doctors and other teammates as their primary sources of nutrition information (Parr, Porter, & Hodgson 1984). Rockwell, Nickols-Richardson and Thye (2001) conducted a study to assess nutritional knowledge, opinions, and practices of coaches and athletic trainers at a Division I Universities. They surveyed 35 coaches (including head coaches, assistant coaches, and graduate assistants, and strength and conditioning staff members) and 18 athletic trainers from 14 different sports. Twenty-five participants were male and 28 participants were female. Sixty-seven percent of the participants answered all the questions correctly. They found that strength and conditioning coaches gave significantly more correct answers (80%) compared to team coaches and athletic trainers (66%). There were no differences between the nutrition knowledge among the participants from different sports; however, they found that there was a tendency among participants who coached or trained female athletes (n=16) or both male and female athletes (n=11) to give more correct responses (74% vs. 68% respectively) compared to participants who only worked with male athletes (n=10) 62%. The more experience a participant had, the higher they scored. They found no difference in knowledge for age or gender. In regard to nutrition opinions and practices, most participants (94%) said that water and sport beverages were provided to the athletes during competition and training. Forty

percent of the participants recommended vitamin and mineral supplements to their athletes. The majority of participants rated body weight as more important than body composition. Fifty percent of the participants weighed their athletes less than once a week, 11% weighed more than once a week, and 10% had body fat measurements taken more than once a week. Fifteen percent of participants recommended athletes "go on a diet" (p.176). There were unclear roles between athletic trainers and coaches about who was responsible for monitoring body weight and composition. Eighty-two percent of the team coaches identified athletic trainers as responsible for body weight and composition monitoring while 68% of athletic trainers indicated that coaches were responsible for these activities. Fifty-three percent of the participants said athletes could eat more nutritious meals if they had more money but only 27% actually thought that they would do so. The majority of participants obtained nutrition information from magazines, doctors, books, and scientific journals. Thirty percent of the participants had dietitians available to them for nutrition information and 100% of those participants utilized those services. Researchers concluded that there might be a "disparity between scientific sports nutrition knowledge and nutritional practices of college athletes" (p. 183).

### *Summary*

Dietary guidelines were established to help individuals make adequate food selections. However, many individuals were consuming appropriate recommendations for age, gender, and physical activity level. This may have

placed individuals at risk for certain chronic diseases and kept them from achieving an optimal quality of life. Athletes faced the same challenges as the general population to achieve optimal nutritional goals. The results of inadequate diets for athletes resulted in fatigue, and impaired athletic performance as well as health complications. The literature indicated that elite soccer players were not consuming adequate amounts of carbohydrates for competition and training. The literature on nutrition and sports performance provided athletes with the current recommendations on energy needs, protein and fat requirements to enhance athletic performance. It was well established that adequate food consumption during training and competition improved athletic performance and assisted in the recovery from exercise. Many studies had been conducted on energy requirements, dietary intakes, and supplements for elite male soccer players. Additional studies may be beneficial for female soccer players and for high school and university players.

## Chapter Three

### *Methods*

Nutrition played a vital role in the health and well-being of all individuals. Many chronic diseases were attributed to lifestyle choices such as smoking, physical inactivity and poor or inadequate nutrition. Poor dietary patterns were associated with four of the ten leading causes of death (heart disease, cancer, stroke and type 2 diabetes) in the United States today (U.S. Department of Health and Human Services [DHHS], 2000). Researchers have documented the positive and negative affects of nutrition on athletic performance. It was recognized that a poor or inadequate diet may potentially cause fatigue, loss of muscle strength and size, suppressed immune system, insufficient bone maintenance, low weight, and impaired performance (American Dietetic Association, 2000). Sports nutrition experts advocate for adequate energy consumption to help athletes enhance performance. Past studies suggest that athletes do not make appropriate food choices that meet current recommendations to enhance performance (Kirkendall, 1993; Clark, Tobin & Ellis, 1992).

The purpose of this study was to compare male collegiate, Division I soccer players' dietary intakes the day before, the day of, and the day after competition for calories, carbohydrate, protein, and fat. In addition, this study examined the food selection for grains, fruits, and vegetables and compares the findings to the current recommendations for food selection based on the USDA Food Guide Pyramid. The results of this study could be used to help Division I

male soccer players make dietary improvements which may enhance performance.

### *Participants*

The participants of the study consisted of ten male collegiate, Division I soccer players from a large Midwestern University. Ten athletes voluntarily participated in the study and all male soccer players were given equal opportunity to participate. The criteria for inclusion in the study was that the athlete was a collegiate, Division I soccer player at a large Midwestern university.

### *Instrumentation*

A food log was used to record the food consumption for each athlete who participated in the study. The food log consisted of multiple rows and four columns which included the time of consumption; type of food, beverage, and condiment consumed; the amount of food, beverage, and condiment consumed; and the method of food preparation. The athletes completed the three-day food logs by hand on a Saturday, Sunday, and Monday day (Appendix A). Saturday was the pre-game day, Sunday was game day, and Monday was the post-game day. A handout was provided to help the athletes determine serving sizes and portions of foods consumed (Appendix B). Basiotis, Welsh, Cronin, Kelsay, and Mertz (1987) found that a three-day dietary intake was needed to accurately estimate average energy consumption for a group.

A computer software program called Nutritionist Pro was used to analyze the nutritional data for this study. The Nutritionist Pro software database included over 17,000 foods and ingredients, 500 brand names, 600 quantity and consumer recipes, and over 80 nutrients and nutrient factors. The nutritional intakes were analyzed for each player's pre-game, game day, and post-game day consumption.

### *Procedures*

The researcher met with the soccer coaching staff to explain the procedures of the study and trained the coaches on how to effectively instruct the athletes on accurately recording dietary intakes. During the study the researcher was available in the event that a question or concern arose that the coaches were unable to address.

The researcher received approval from the Human Subjects Committee and the soccer coaching staff prior to initiating the study. The study was conducted during the fall soccer season in which soccer athletes compete with other universities. Team coaches encouraged players to participate in the study and explained that the study provided the team with important nutrition information for improved performance. The coaching staff met with the soccer team to explain aspects of the study. The coaching staff provided the athletes with an informed consent letter from the researcher that clarified who was administering the study, the purpose of the study, and the method of collection (Appendix C). The letter included the risks and benefits of the study. It was

explained that the results could be used by the athletic department to help the athletes make diet modifications which may improve health and/or performance. The coaches explained that the results would be confidential and would be provided only to the athlete himself. No individual data were shared. Only group data were provided to coaches and used in publications of the data.

The informed consent letter required the athletes' signatures in order to confirm their approval to participate in the study. Each person who was interested in participating in the study signed and returned the consent form to the coaching staff. It was explained that participants had the right to withdraw from the study at any time without penalty or loss of benefits. The coaching staff provided the athletes with three food logs (Appendix A), a food log directions sheet (Appendix D), and a serving size indicator handout (Appendix B). The serving size indicator handout was designed to help the athlete in estimating food amounts. Coaches and administrative staff did not have access to nutritional data related to a specific athlete. Only the athlete and researcher had access to the nutritional information for each athlete. All data were recorded by a subject number on the upper right hand corner of the first food log sheet for each participant to assure confidentiality.

Dietary intake recording began Saturday, October 27<sup>th</sup> at 12:00 am and ended at Monday, October 29<sup>th</sup> at midnight. Participants were asked to maintain a typical intake pattern during the recording period. Participants were asked to keep a record of the amount of food, beverage, and condiment consumed. The food log directions requested that participants record all food, beverage, fluid,



and condiment consumption with as much accuracy and detail as possible. Details included such information as the brand name of the food; restaurant in which the food was prepared; ethnicity of the food and ingredients. To help the athletes determine serving sizes of foods, they were given a serving size indicator handout and told to draw the size of the food on the back of the food logs to more clearly convey serving sizes. They were encouraged to estimate serving sizes by using cups and ounces to maintain accuracy. Lastly, participants were asked to indicate the method of food preparation such as broiled, baked, fried, boiled, steamed, or any other options for preparation.

At the completion of the food logs, athletes placed their completed food logs into an envelope and gave them to the soccer coaches who hand-delivered returned them to the researcher.

### *Data Analysis*

The food log data were collected from the athletes and hand-delivered to the researcher who input all food log data into the computer for analysis. The participant's number, age, gender, and food log data were input into the computer. The Nutritionist Pro software generated a nutritional analysis for each athlete in regard to gender and age. The analysis consisted of the average amount of intake for calories, macronutrients, the goal of intake, and percentage of the goal met per nutrient. Nutrients examined specific to the study were as follows: calories, carbohydrate, protein, and fat for pre-game, game day, and post-game day. In addition, the number of servings for bread, fruits, and

vegetables were examined for each day. Data obtained from the Nutritionist Pro software were input into the SPSS program in order to generate statistical tests. A One-way Analysis of Variance (ANOVA) and T-test were performed to compare data. An alpha level of .05 was used to determine significance.

## Chapter Four

### *Results and Discussion*

Athletes were advised to consume the recommended dietary intakes through a balanced diet (American Dietetic Association, 2000). An adequate dietary intake was imperative for athletes to optimize performance, maintain muscle fitness, healthy bones, and decrease the risk of health complications. The Recommended Dietary Allowances (RDA) (National Academy of Sciences, 1989) and Dietary Reference Intakes (DRI) (Committee on Dietary Intake, 1997) were the guidelines used for adequate nutritional intake for general populations as well as athletes. Researchers agreed that athletes participating in high endurance sports, such as soccer, required high energy carbohydrate diets to maintain glycogen stores throughout the competition (Luxbacher, 1997; Pearson, 1998). Rico-Sanz (1998) concluded that the carbohydrate intake was generally below the recommended requirements for competition and training for elite male soccer players. The potential consequences of an inadequate diet were fatigue, loss of muscle size and strength, suppressed immune system, insufficient bone maintenance, low weight, and impaired performance (American Dietetic Association, 2000).

The purpose of this study was to compare male collegiate, Division I soccer players' actual dietary intake the day before, the day of, and the day after competition for calories, carbohydrate, fat, and protein. In addition, this study examined the food selection for grains, fruits, and vegetables and compared the findings to the current recommendations for food selection based on the USDA

Food Guide Pyramid. The results of this study could be used to help Division I male soccer players make dietary improvements, which may enhance performance.

### *Participants*

The participants of the study consisted of ten male collegiate, Division I soccer players from a large Midwestern University. Ten athletes voluntarily participated in the study and all male soccer players were given equal opportunity to participate. The total number of soccer players on the team was 20. There was an overall response rate of 50% (10/20). The criteria for inclusion in the study was that the athlete was a collegiate, Division I soccer player at a large Midwestern university. The food logs from 10 male collegiate, Division I soccer athletes were completed the day before competition, the day of competition, and the day after competition.

### *Results*

The null hypothesis for this study was "There will be no significant differences of the actual dietary intake among the male collegiate, Division I soccer players in relation to: a) calories, b) carbohydrates, c) proteins, and d) fats the day before, the day of, and the day after competition". A One-way Analysis of Variance (ANOVA) was performed to compare the means among the players' actual dietary intake of calories, carbohydrates, proteins, and fats the day before, the day of, and the day after competition.

*Calories.* Mean caloric intake among the players did not differ on the day before, the day of, and the day after competition ( $F(2,29)=.367$ ,  $p=.696$ ). The caloric intakes decreased slightly the day before competition ( $M=2685$ ), to the day after competition ( $M=2657$ ), with the lowest caloric intake being the day after competition ( $M=2177$ ) (Table 4.1). The results failed to reject the null hypothesis.

*Carbohydrate.* The grams of carbohydrates consumed among the players were not significantly different on the day before competition ( $M=337$ ), the day of competition ( $M=343$ ), and the day after competition ( $M=298$ ), ( $F(2,29) =.160$ ,  $p=.853$ ) (Table 4.1). The results failed to reject the null hypothesis.

*Protein.* The mean protein intake was not significantly different on the day before ( $M=121$ ), the day of competition ( $M=101$ ), and the day after competition ( $M=90$ ), ( $F(2,29)=.490$ ,  $p=.618$ ) (Table 4.1). The results failed to reject the null hypothesis.

*Fat.* The mean fat consumption among the players was not significantly different on the day before ( $M=96$ ), the day of competition ( $M=95$ ), and the day after competition ( $M=58$ ), ( $F(2,29)=.1.188$ ,  $p=.320$ ) (Table 4.1). The results failed to reject the null hypothesis

*Percent of Macronutrients.* The differences between the means were not statistically significant for the percentages of carbohydrate ( $F(2,29)=.765$ ,  $p=.475$ ), protein ( $F(2,29)= 1.045$ ,  $p=.366$ ), and fat ( $F(2,29)=.1.338$ ,  $p=.279$ ), consumed among players the day before competition, the day of competition and the day after competition. The percentage of total calories from carbohydrates

Table 4.1: Means for Calories, Carbohydrates, Protein and Fat consumption the day before, the day of, and the day after competition

<b>Nutrient</b>	<b>Day 1</b>	<b>Day 2</b>	<b>Day 3</b>
	<b>Before Competition</b>	<b>Competition Day</b>	<b>After Competition</b>
Calories	2685	2657	2177
Carbohydrates (gm)	337	343	298
Protein (gm)	121	101	90
Fat (gm)	96	95	58

among the players the day before competition was 51 percent, the day of competition was 52 percent, and the day after competition was 58 percent respectively. The percent of protein was 18 percent, 15 percent and 17 percent. And the fat intake among the players' was 31 percent the day before and the day of competition and 24 percent the day after competition (Figure 4.1). The results failed to reject the null hypothesis.

*Food Selection.* This study also examined the food selection for grains, fruits, and vegetables based on the USDA Food Guide Pyramid. The USDA Food Guide Pyramid recommends 6 to 11 servings from the bread and grains daily. Data indicated that 50% of the male collegiate, Division I soccer players consumed more than the recommended eleven servings from the grain group. However, sixteen percent consumed less than 6 servings from the same food group. Two to 4 servings of fruits and 3 to 5 servings of vegetables are recommended each day for health. Fifty-three percent of the male collegiate Division I soccer players ate less than 2 fruits a day and eighty percent ate less than 3 vegetables a day.

## Discussion

As a team, the male collegiate, Division I soccer player's three-day dietary intake indicated no significant differences among the players for calories, carbohydrate, protein and fat consumption the day before, the day of, and the day after competition. Also, the percentages of carbohydrates, protein and fat consumed the day before, the day of, and the day after competition indicated no

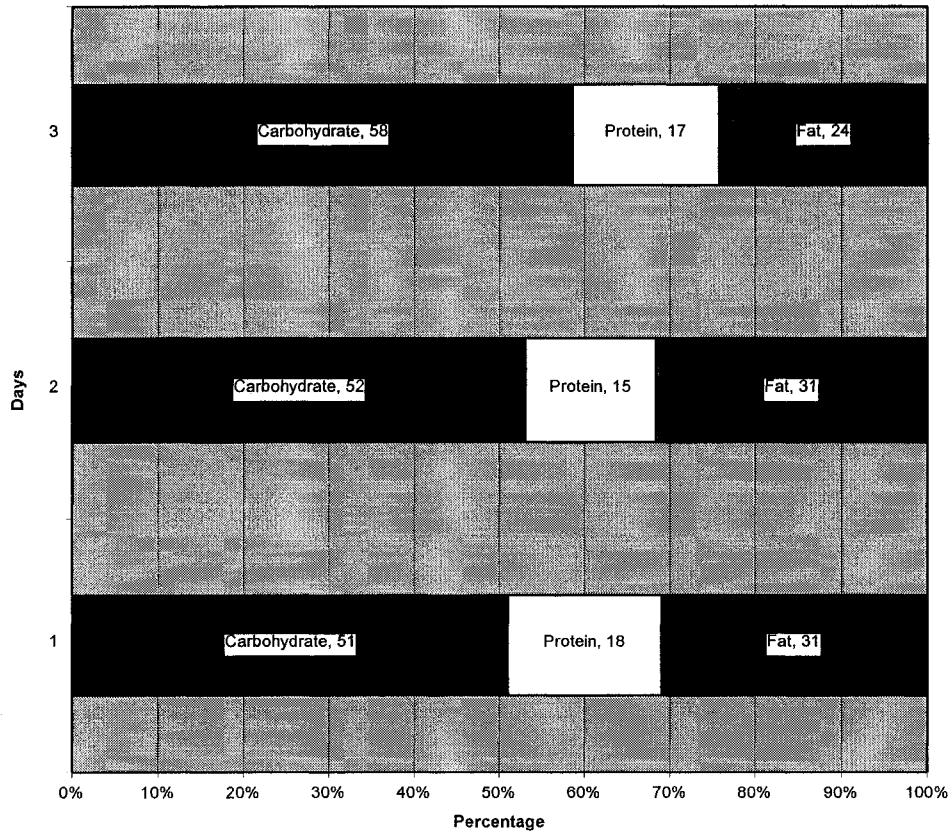


Figure 4.1: Percentage of Carbohydrate, Protein, and Fat the day before, the day of, and the day after competition



significant differences among the players. However, their total calories, carbohydrate, and protein intakes were below the recommended amount for athletes engaging in high intensity sports. According to the USDA Food Guide Pyramid the number of recommended servings varies according to a person's age, gender, and activity level. Men between the ages of 19-24 years were advised to consume 2900 calories per day. In addition, Macedonio (2000) recommended total energy requirements for male soccer players to be between 47-60 calories per kilogram of body weight. A male who weighs 165 pounds should consume approximately 3375-4500 calories a day in order to maximize muscle glycogen and glucose levels (Macedonio, 2000). Clark (1994) also reported similar findings. She reported that professional male soccer players who play at high intensities for long periods of time can use between 3150 to 4300 calories per day. The mean calorie consumption among the players was 2685 the day before competition, 2657 the day of competition, and 2177 the day after competition. According to the current recommendations the players total calorie consumption were below recommendations.

Researchers agreed that athletes participating in high endurance sports, such as soccer, required a high energy carbohydrate diet to maintain glycogen stores throughout the competition (Luxbacher, 1997; Pearson, 1998). Current research recommended that athletes consume 8-10 grams of carbohydrate per kilogram of body weight or 60-70% of total calories a day to maintain muscle glycogen stores (American Dietetic Association, 2000). Rico-Sanz (1998) concluded that the carbohydrate intake was generally below the recommended

requirements for competition and training for elite male soccer players typically around 50-53%. The total carbohydrate intake among the players was consistent with Rico-Sanz findings of being below the recommended guidelines for competition and training. The total carbohydrate consumption among the players the day before competition was 57 percent, the day of competition was 52 percent and the day after competition 51 percent of their total calories. The potential consequences of an inadequate carbohydrate intake were fatigue, loss of muscle size and strength, suppressed immune system, insufficient bone maintenance, low weight, and impaired performance (American Dietetic Association, 2000).

The Recommended Daily Allowances (RDA) for protein is 0.8 g/kg for an average individual or 15-20% of an individual's total caloric intake. According to Lemon (1994) soccer players need more protein than sedentary individuals and suggest a protein intake of 1.4 to 1.7 g/kg per day. Macedonio (2000) indicated that if an athlete is consuming appropriate calories to maintain a desirable weight and is eating from a variety of foods the increased recommendations of 1.4 to 1.7 g/kg of protein per day is achievable. The protein intake among the players was not significantly different but the total intake was lower than recommended for soccer athletes. Their protein intake the day before competition was 18 percent, the day of competition was 17 percent and the day after was 15 percent of their total caloric intake

The general recommendation for fat intake was 25-30% of a person's total caloric intake. The American Dietetic Association recommends athletes follow

the Dietary Guidelines for American of 30% fat (10% saturated, 10% polyunsaturated and 10% monounsaturated each day. It was also suggested that athletes decrease their fat intake to accommodate for the large quantities of carbohydrates. However, the American Dietetic Association (2000) suggested that there were no performance benefits to consuming a diet with less than 15% fat compared to a diet with 20 to 25% fat. The percentage of fat intake among the players was consistent with the recommendations for soccer players. The percentage of fat the day before competition and the day of competition was 31 percent and the day after competition was 24 percent of their total calories.

The data also indicated that the male collegiate, Division I male soccer players were not consuming adequate servings carbohydrates from the bread, fruit, and vegetable group for optimal performance and good health. The American Dietetic Association (2000) recommended that athletes consume the maximum number of servings from these carbohydrate based food groups. These carbohydrate rich food groups include the grain group, which includes foods such as bread, rice, cereals, and pasta. The other two groups are the fruit and vegetable group. According to the Food Guide Pyramid the maximum number of recommended servings from the grain group is 11 servings a day, 5 servings per day from the vegetable group and 4 servings per day from the fruit group. The American Dietetic Association (2000) recognized that the energy requirements for athletes would far exceed the maximum number of servings. Athletes were advised to consume additional servings from these food groups as needed.

Fifty percent of the soccer players ate more than 11 servings from the bread group, and 16.7% ate less than six servings. Fifty-three percent of the soccer players ate less than 2 servings of fruit each day and eighty percent ate less than 3 servings of vegetables each day.

Athletes could increase their grain, fruit, and vegetable intake to meet the daily recommendations by eating a consistent meal plan. This would include eating breakfast, lunch, dinner and snacks everyday. Food selection is of utmost importance to get the recommended servings and nutrients required for good health and athletic performance. Suggestions for increasing these carbohydrate-rich foods include choosing; cereal, toast, bagels, muffins, pancakes, french toast, waffles, or english muffins, from the grain group for breakfast. Lunch or dinner choices may include; rice, pasta, pizza, sandwiches, macaroni, burritos, spaghetti, cornbread or biscuits. Fruit and vegetable choices should be eaten at each meal. Fresh or dried fruits can be added to cereal, yogurt, or salads. Fruit is easily transported and can be eaten at meals, snacks or on the run. Vegetables can be eaten raw or cooked and can be added to casseroles, salads, sandwiches or pasta. Vegetable juice or tomato juice can be eaten at meals as well as snacks. It is important for athletes to follow the USDA Food Guide Pyramid in making food selections that contribute to good health and optimal athletic performance.

## Chapter Five

### *Conclusions and Recommendations*

Adequate nutritional intake was imperative for athletes to optimize performance, maintain muscle fitness and healthy bones, and decrease the risk of health complications. It was agreed that achieving energy balance was essential for the maintenance of weight or lean tissue mass, immune function, and optimal athletic performance. Meeting energy needs should have been the first nutritional goal for athletes (American Dietetic Association, 2000). Researchers found that the daily nutritional consumption of many athletes was below recommended dietary intakes resulting in deficiencies in macronutrients and micronutrients (Jonnalagadda, 2001). The potential consequences of an inadequate diet were fatigue, loss of muscle size and strength, suppressed immune system, insufficient bone maintenance, and low weight (American Dietetic Association et al., 2000). Also, without adequate macronutrient intakes (carbohydrates, proteins, and fats), athletic performance and the recovery from exercise are compromised (American Dietetic Association, 2000).

The purpose of this study was to compare male collegiate, Division I soccer players' dietary intake on the day before, the day of, and the day after competition for calories, carbohydrate, fat and protein. In addition, this study examined the food selection for grains, fruits, and vegetables and compared the findings to the current recommendations for food selection based on the USDA Food Guide Pyramid. The results of this study could be used to help Division I

male soccer players make dietary improvements, which may enhance performance.

### *Conclusion*

The male Division I soccer players' actual dietary intake was analyzed and compared among the players for calories, carbohydrate, protein and fat consumption on the day before, the day of, and the day after competition. The results indicated that there were no significant differences among the players for calories, carbohydrate, protein or fat consumption the day before, the day of, and the day after competition.

### *Discussion*

The current study included 10 male collegiate, Division I soccer players at a large Midwest university. The study analyzed and compared data among the players for their nutrient intake the day before, the day of, and the day after competition. No other study was found to compare athletes' food and beverage consumption on the day before, the day of, and the day after competition. The results of this study indicated that there were no significant differences among the players for the consumption of calories, carbohydrate, protein or fat the day before, the day of, or the day after competition.

Although there were not significant differences among the players on the three days, their total calorie, carbohydrate, and protein intake were below the recommended amounts for athletes engaging in high intensity sports. Experts

agreed that meeting energy needs should be the first nutritional goal for athletes. The mean caloric intake among the players was 2,685 calories the day before competition, 2,657 calories the day of competition, and 2,177 calories the day after competition. Macedonio (2000) recommended the total energy requirements for male soccer players to be between 47-60 calories per kilogram of body weight. A male who weights 165 pounds should consume approximately 3375-4500 calories a day to maximize muscle glycogen and glucose levels. Clark (1994) reported similar findings. She reported that professional male athletes who play at high intensities for long periods of time can consume 3,150 to 4,300 calories per day. The primary goal of post-competition meals was to replenish muscle and liver glycogen stores. The literature recommended either a liquid or solid; or simple or complex forms of carbohydrates after exercise to replenish muscle glycogen stores. Their calorie and carbohydrate consumption was lowest on the day after competition when intake is of utmost importance to replenish glycogen stores. Current research recommended that athletes consume 8-10 grams of carbohydrate per kilogram of body weight or 60-70% of total calories a day to maintain muscle glycogen stores (American Dietetic Association, 2000).

Rico-Sanz (1998) concluded that the carbohydrate intake for elite male soccer players was generally below the recommended requirements for competition and training. He found that the average carbohydrate intake consisted of 50-53% of the players' caloric intake. The total carbohydrate intake among the players in the study was consistent with Rico-Sanz (1998) findings,

being below the recommended guidelines for competition and training. The percent of calories consumed as carbohydrate among the players the day before competition was 57 percent, the day of competition was 52 percent, and the day after competition 51 percent of their total calories.

The Recommended Daily Allowance (RDA) for protein is 0.8 grams per kilogram of body weight for an average individual or 15-20% of an individual's total caloric intake. According to Lemon (1994) soccer players needed more protein than sedentary individuals and suggested a protein intake of 1.4 to 1.7 g/kg per day. Macedonio (2000) indicated that if an athlete was consuming appropriate calories to maintain a desirable weight and was eating from a variety of foods, the increased recommendations of 1.4 to 1.7 g/kg of protein per day is achievable. The protein intake among the players was not significantly different on the three days but the percent of calories from protein was lower than recommended for soccer athletes. Their protein intake on the day before competition was 18 percent, the day of competition was 17 percent, and the day after was 15% of their total caloric intake

The general recommendation for fat intake was 25-30% of a person's total caloric intake. The American Dietetic Association recommends that athletes follow the Dietary Guidelines for American of 30% of total calories as fat (10% saturated, 10% polyunsaturated, and 10% monounsaturated) each day. It was also suggested that athletes decrease their fat intake to accommodate for the large quantities of carbohydrates. However, the American Dietetic Association (2000) suggested there was no performance benefit to consuming a diet with



less than 15% fat compared to a diet with 20 to 25% fat. The percent of calories from fat among the players was consistent with the recommendations for soccer players. The percentage of fat the day before competition and the day of competition was 31 percent and the day after competition was 24 percent of their total calories.

Past studies indicated that food choices among college athletes were below recommendations because they did not have the nutritional knowledge about making appropriate food choices for training and competition or have access to registered dietitian services (Rosenbloom, Jonnalagadda, & Skinner, 2001). It was suggested that they may rely on coaches or athletic trainers who typically do not have adequate nutrition knowledge or education to help athletes to enhance performance (Rockwell, Nickols-Richardson, & Thye, 2001). Although there were no differences among the players, on the three days, the finding from this study may be related to their limited nutrition knowledge about sports nutrition. Athletes may benefit by working with a registered dietitian who could advise them about eating for competition and training based on current recommendations.

The athletes' food selections for breads, fruits, and vegetables were below the current recommendations based on the USDA Food Guide Pyramid. These food groups, especially the bread and grain group, supply the majority of carbohydrates in our diets. According to the USDA Food Guide Pyramid, the maximum number of recommended servings from the grain group is 11 servings a day. The results of the study indicated that the male collegiate, Division I male

soccer players were not consuming adequate servings of carbohydrates from the bread group for optimal performance and good health. Only fifty percent of the soccer players ate more than the recommended 11 servings from the bread group, and 16.7% ate less than six servings (the minimum). The American Dietetic Association (2000) recommended that athletes consume the maximum number of servings from these carbohydrate-based food groups. These carbohydrate-rich food groups include the grain group, which includes foods such as bread, rice, cereals, and pasta, the fruit group, and vegetable group. Five servings were recommended per day from the vegetable group and 4 servings were recommended per day from the fruit group. Fifty-three percent of the soccer players ate less than 2 servings of fruit each day and eighty percent ate less than 3 servings of vegetables each day. The American Dietetic Association (2000) recognized that the energy requirements for athletes would far exceed the maximum number of servings. Athletes were advised to consume additional servings from these food groups as needed.

### *Recommendations*

*Recommendations for Practice.* The results of this study could be used to more effectively target nutrition information to male collegiate, Division I soccer players. Athletes could be made aware of the importance of adequate nutritional intakes for carbohydrates, protein and fats, and of selecting healthy foods from the grain, fruit and vegetable group the day before, the day of, and the day after competition. With proper nutritional education and support from registered

dietitians, the athlete could have maximized athletic performance and recovery from exercise. The current study also contributes to the literature the need to better prepare collegiate athletes for competition by making better food selections.

*Recommendations for Improving this Research.* The current study could be improved by completing more three-day food intake studies the day before, the day of, and the day after competition to compare the results. This may provide additional data to support the findings of this study or may provide more accurate records. The timing of meals could be documented, especially the hours after competition so recommendations could be made based on research. Larger samples could have been collected from multiple sites and performance outcomes measured. A longitudinal study could take place starting with freshman soccer players and track their eating habits through the four years to determine if there is improvement in their food intake. Nutritional educational sessions could occur to see if there are improvements based on these sessions. Incentives could be offered to recruit more athletes to participate in the study. An assessment could be conducted to see what is important to the soccer players and then offer such incentives to them for participation. These incentives might include having days off practice, leading the team in practice, offering t-shirts for practice, coupons for free lunch or dinners, or providing gifts for each day that they complete a food log.

*Recommendations for Future Research.* Future research could involve comparing the intakes of calories, carbohydrates, proteins, and fats with the

recommended daily allowances for these macronutrients. It would be ideal to obtain the players' weight before each study so that the carbohydrate, protein, and fat recommendations for training and competition could be compared with the current recommendations and calculated more accurately. Various micronutrients could be compared with actual intake and the recommended daily allowances such as iron, calcium, zinc, thiamine, niacin, and riboflavin. These micronutrients are important and are related to athletic performance.

In addition to collecting more three-day intake records, data could be collected during a specific season of the year which could enable the researchers to compare dietary intakes during different times of the year, such as during practice, scrimmage, and regular season play.

Players' weights could be checked at the beginning of the season and followed them through the year to determine if they are maintaining their weights in comparison to their food intakes. This could be done before and after competition to measure fluid consumption and the need for replacement.

In order to generalize the study, researchers could involve other collegiate, Division I soccer players from other local universities to measure their dietary intake the day before, the day of, and the day after competition. This study could be conducted the same way in which the current study was conducted. Data could be compared and possible generalizations made based on the findings. This could allow researchers to analyze the data of soccer players at comparable competition levels.

## References

- American College of Sports Medicine. (1996). Position stand: exercise and fluid replacement. *Medicine and Science in Sports and Exercise*, 28:i-vii.
- American Dietetic Association, Dietitians of Canada, & American College of Sports Medicine. (2000). Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. *Journal of the American Dietetic Association*, 100, 1543-1557.
- Balsom, P.D., Wood, K., Olsson, P., & Ekblom, B. (1999). Carbohydrate intake and multiple sprint sports: with special reference to football (soccer). *International Journal of Sports Medicine*, 20 (1), 48-52.
- Bangsbo, J. (1994). The physiology of soccer-with special reference to intense intermittent exercise. *Acta Physiologica Scandinavica*, 619 suppl.,1-155.
- Basiotis, P.P., Carlson, A., Gerrior, S.A., Juan, W.Y., & Lino, M. (2002). The Healthy Eating Index: 1999-2000. *U.S. Department of Agriculture, Center for Nutrition Policy and Promotion*, CNPP-12.
- Basiotis, P.P., Welsh, S.O., Cronin, F.J., Kelsay, J.L., & Mertz, W. (1987). Number of days of food intake records required to estimate individual and group nutrient intakes with defined confidence. *The Journal of Nutrition*, 117 (9), 1638-1641.
- Bergstrom, J., Hermansen, L., & Saltin, B. (1967). Diet, muscle glycogen, and physical performance. *Acta Physiologica Scandinavica*, 71, 140-150.
- Burke, L.M., Collier, G.R., & Hargreaves, M (1998). The glycemic index-a new tool in sport nutrition? *International Journal of Sports Nutrition*, 8, 401-415.
- Burke, L.M., Collier, G.R., & Hargreaves, M. (1998). Muscle glycogen storage after prolonged exercise: effect of glycemic index. *Journal of Applied Physiology*, 75, 1019-1023.
- Carroll, C. Protein and Exercise (2000). In: C. Rosenbloom (ed) *Sports Nutrition: A Guide for the Professional Working with Active People*. Chicago, IL: The American Dietetic Association, pp. 33-50.
- Casey, A., Short, A.H., Curtis, S. & Greenhaff (1996). The effects of glycogen availability on power output and the metabolic response to repeated bouts of maximal, isokinetic exercise in man. *European Journal of Applied Physiology*, 72, 249-255.

- Clark, N., Tobin, J. & Ellis, C. (1992). Feeding the ultra endurance athlete: Practical tips and a case study. *Journal of the American Dietetic Association*, 92, 1258-1262.
- Clark, K. (1994). Nutritional guidance to soccer players for training and competition. *Journal of Sports Sciences*, 12 suppl., 43-50.
- Coleman, E. (1994). Update on carbohydrate: solid versus liquid. *International Journal of Sports Nutrition*, 4, 80-88.
- Coleman, E. Carbohydrate and Exercise (2000). In: C. Rosenbloom (ed.) Sports Nutrition: A guide for the Professional Working with Active People. Chicago, IL: The American Dietetic Association, pp. 13-30.
- Committee on Dietary Reference Intakes. (1997). Dietary reference intakes for calcium, phosphorus, magnesium, vitamin d, and fluoride. Washington, D.C.: National Academy Press. Retrieved May 3, 2003, from [http:// www.nal.usda.gov/fnic/dga/rda/pdf](http://www.nal.usda.gov/fnic/dga/rda/pdf)
- Costill, D.L., Bowers, R., Branam, G., & Sparks, K. (1971). Muscle glycogen utilization during prolonged exercise on successive days. *Journal of Applied Physiology*, 31, 834-838.
- Coyle, E. (1991). Timing and method of increased carbohydrate intake to cope with heavy training, competition, and recovery. *Journal of Sports Sciences*, 9, 29-51.
- Fallowfield, J.C., & Williams, C. (1993). Carbohydrate intake and recovery from prolonged exercise. *International Journal of Sports Nutrition*. 3150-164.
- First Databank Inc. (2000). Nutritionist pro. Retrieved June 12, 2003, from [http://www.firstdatabank.com/nutrition/nutritionist\\_pro/nutritionist\\_pro.htm](http://www.firstdatabank.com/nutrition/nutritionist_pro/nutritionist_pro.htm)
- Foster-Powell, K., Holt, S.H.A., Brand-Miller, J.C. (2002). International table of glycemic index and glycemic load values. *American Journal of Clinical Nutrition*, 76 (1), 5-56.
- Hargreaves, M. (1994). Carbohydrate and lipid requirements of soccer. *Journal of Sports Sciences*, 12 suppl, 13-16.
- Ivy, J.L., Lee, M.C., Broznick, J.T., & Reed, M.T. (1988). Muscle glycogen storage after different amount of carbohydrate ingestion. *Journal of Applied Physiology*, 65, 2018-2023.

- Jacobson, B.H., Sobonya, C., & Ransone, J. (2001). Nutrition practices and knowledge of college varsity athletes: a follow-up. *Journal of Strength and Conditioning Research*, 15, 63-68.
- Jacobson, B.H., & Aldana, S.G. (1992). Current nutrition practice and knowledge of varsity athletes. *Journal of Applied Sport Science Research*, 6, 232-238.
- Jenkins, D.G., Palmer, J., & Spillman, D (1993). The influence of dietary carbohydrate on performance of supramaximal intermittent exercise. *European Journal of Applied Physiology*, 67, 309-314.
- Jonnalagadda, S. S. Dietary Fat and Exercise (2000). In: C. Rosenbloom (ed.) *Sports Nutrition: A guide for the Professional Working with Active People*. Chicago, IL: The American Dietetic Association, pp. 51-62.
- Kirkendall, D.T. (1993). Effects of nutrition on performances in soccer. *Medicine and Science in Sports and Exercise*, 25, 1370-1374.
- Learmouth, J. (1979). *Soccer fundamentals*. New York: St. Martin's Press.
- Lemon, P. (1994). Protein requirements of soccer. *Journal of Sports Sciences*, 12, suppl.17-22.
- Luxbacher, J. A. (1997). *Conditioning for soccer*. Chicago: Masters Press.
- Macedonio, M. Soccer (2000). In: C. Rosenbloom (ed.) *Sports Nutrition: A guide for the Professional Working with Active People*. Chicago, IL: The American Dietetic Association, pp. 637-652.
- Maughn, R., Greenhaff, P., Leiper, J., Ball, D., Lambert, C., & Gleeson, M. (1997). Diet composition on the performance of high intensity exercise. *Journal of Sports Sciences*. 15, 265-275.
- Maughn, R., & Leiper, J. (1994). Fluid replacement requirements in soccer. *Journal of Sports Sciences*, 12 suppl. 29-34.
- National Academy of Science. (1989). *Recommended dietary allowances (10<sup>th</sup> ed.)*. Washington, D.C.: National Academy Press. Retrieved May 3, 2003, from <http://nal.usda.gov/fnic/dga/rda.pdf>
- National Collegiate Athletic Association (n.d.). What's the difference between Division I, II and III? Retrieved June 12, 2003, from [http://www.ncaa.org/about/div\\_criteria](http://www.ncaa.org/about/div_criteria)

- Nike Research Review. (1997) In J.A. Luxbacher (Ed.), *Conditioning for soccer* (pp.2-3). Chicago: Masters Press.
- Neufer, P.D., Costill, D.L., Flynn, M.G., Kirwan, J.P., Mitchell, J.B., Houmard, J. (1987). Improvements in exercise performance: effects of carbohydrate feedings and diet. *Journal of Applied Physiology*, 62, 983-988.
- Parr, R.B., Porter, M.A., & Hodgson, S.C. (1984). Nutrition knowledge and practice of coaches, trainers, and athletes. *Physiology of Sportsmedicine*, 12, 127-138.
- Pearson, D.R. (1998) Eating to win. *Strength and Conditioning*, 20, 69.
- Rico-Sanz, J. (1998). Body composition and nutritional assessments in soccer. *International Journal of Sports Nutrition*, 8 (2), 230-240.
- Rockwell, M.S., Nickols-Richardson, S.M., and Thye, F.W. (2001). Nutrition knowledge, opinions, and practices of coaches, and athletic trainers at a division 1 university. *International Journal of Sports Nutrition and Exercise Metabolism*. 11:174-185.
- Rosenbloom, C. A., Jonnalagadda, S.S., & Skinner, R., (2002) Nutrition Knowledge of collegiate athletes in a division I national collegiate athletic association institution. *Journal of the American Dietetic Association*. 102 (3), 418-420.
- Sherman, W.M., Peden, M.C., & Wright, D.A. (1991). Carbohydrate feedings 1 hour before exercise improves cycling performance. *American Journal of Clinical Nutrition*, 54,866-870.
- Saltin, B. (1973). Metabolic fundamentals in exercise. *Medicine and Science in Sports*, 5:137-146.
- Smith, M.R., Walberg Rankin, J., Stevens, H. & Williams, J. (2000). Effects of muscle glycogen status on sarcoplasmic reticulum function and performance of intermittent high intensity exercise. *Medicine and Science in Sports and Exercise*. suppl.363.
- Swinburn, B., & Ravussin, E. (1993). Energy balance or fat balance? *American Journal of Clinical Nutrition*, 57suppl. 766-771.
- Thomas, D.E., Brotherhood, J.R., & Brand, J. C. (1991). Carbohydrate feeding before exercise: effect of glycemic index. *International Journal of Sports Medicine*, 12, 180-186.



- U.S. Department of Health and Human Services (2000). *Healthy People 2010* (2<sup>nd</sup> ed.) Vol. 1. Washington DC: U.S. Government Printing Office.
- U.S. Department of Agriculture and U.S Department of Health and Human Services. (2000). *Nutrition and Your Health: Dietary Guidelines for Americans*. (5<sup>th</sup> ed.). *USDA Home and Garden Bulletin No. 232*.
- U.S. Department of Agriculture. (1992). *The Food Guide Pyramid*. *USDA Home and Garden Bulletin No. 252*.

## Appendix A

### Food Log

Date: October 27, 2001

Name: \_\_\_\_\_

Time	Food/Beverage with details	Amount	Method of Preparation

### Food Log

Date: October 28, 2001 Name: \_\_\_\_\_

Time	Food/Beverage with details	Amount	Method of Preparation

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## Food Log

Date: October 29 ,2001






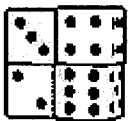







Name: \_\_\_\_\_

Time	Food/Beverage with details	Amount	Method of Preparation

## Appendix B






### Seven Ways to Size Up Your Serving

Measure food portions so you know exactly how much food you're eating. When a food scale or measuring cups aren't handy, you can still estimate your portion. Remember:

1	3 ounces of meat is about the size and thickness of a deck of playing cards or an audiotape cassette.	 = 
2	A medium apple or peach is about the size of a tennis ball.	 = 
3	1 ounce of cheese is about the size of 4 stacked dice.	 = 
4	1/2 cup of ice cream is about the size of a racquetball or tennis ball.	 = 
5	1 cup of mashed potatoes or broccoli is about the size of your fist.	 = 
6	1 teaspoon of butter or peanut butter is about the size of the tip of your thumb.	 = 
7	1 ounce of nuts or small candies equals one handful.	 = <b>1 oz.</b>

**MOST IMPORTANT**

Especially if you're cutting calories, remember to keep your diet nutritious.

- |  |   |
|--|---|
| <p> 2-4 servings from the Milk Group for calcium</p> <p> 2-3 servings from the Meat Group for iron</p> | <p> 3-5 servings from the Vegetable Group for vitamin A</p> <p> 2-4 servings from the Fruit Group for vitamin C</p> <p> 6-11 servings from the Grain Group for fiber</p> |
|--|---|

## Appendix C

Informed Consent  
Nutritional Analysis of Collegiate Soccer Players  
Health Promotion & Education Program  
University of Cincinnati  
Brad Wilson, Ph.D.  
513-556 3862

Before agreeing to participate in this study, it is important that the following explanation of the proposed procedures be read and understood. It describes the purpose, procedures, risks, and benefits of the study. It also describes the right to withdrawal from the study at any time. It is important to understand that no guarantee can be made as to the results of the study.

The purpose of this study is to determine the nutritional intakes of male and female soccer players. Comparisons will be made between male and females, and among in-season, off-season, and spring training time periods. Approximately 20 to 25 male and female soccer players (maximum 50 total) will be asked to take part. This study may last up to one year and include up to three diet record sessions.

Participants in the study will be asked to record all food intakes for a three-day period. When possible this will include a consecutive Sunday, Monday, and Tuesday. The data will be analyzed by computer and an intake report will be provided to each participant. Additionally, the researcher is requesting use of previous data collected in April and August, 2001. This data was collected at the request of coaches. You have received individual reports from this data. The researcher is requesting this data to be included in the study in order to compare team intakes during in-season, off-season, and spring season. There will be no financial cost to the participant and no remuneration.

Individual data will be coded by number and no reference will be made to any one individual. Participants will receive a report with their data. No coaches or others will have access to individual data. At the conclusion of the study all references to individual data will be destroyed.

Participation in the study is voluntary. Refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled. Participants have the right to withdrawal from the study at any time without penalty or loss.

Due to the nature of the study no foreseeable risks or discomforts are anticipated. Participants only need to record data. No modification of daily activity is required. There are no potential risks anticipated. The benefits of participation include a diet report which can be used in conjunction with a

nutritionist provided by the athletic department to make voluntary diet modifications which will improve health and/or performance.

All information provided by participants will be strictly confidential. No individual data will be shared. All data will be recorded by a subject number with no individual identification. Only group data will be provided to coaches and used in the publication of data.

If you have any questions about the study I will contact Dr. Bradley Wilson at 556-3862 or the West campus Human Subjects Committee Chair, Dr. Margaret Miller at 558-5251.

I have read the information provided above. I voluntarily agree to participate in the "Nutritional Analysis of Collegiate Soccer Players." After it is signed, I will receive a copy of this consent form.

---

Signature of Participant

---

Date

---

Signature of Investigator

---

Date

## Appendix D

October 26, 2001

TO: UC Soccer Team Members

FM: Dr. Brad Wilson

RE: Diet Analysis for Improved Performance

It is time for the third (and most important) nutritional analysis. We are asking all players to complete the enclosed food record forms on October 27, 28, and 29. It is important that we get a weekend day and two weekdays. Also, we are intentionally getting a game day and the day before. This will give us valuable information about game-day preparation. The directions for recording are below and a serving size sheet is enclosed. Please complete these forms on the days requested and be as accurate as possible. This information will be combined with the spring and summer information and used to help you develop a better eating plan to improve your performance on the field. After you are finished on October 30, please put the food record forms in the envelope and give it to your coach.

Also, enclosed is a consent form. We would like to use this data for research. In doing this NO individual data will be shared. Only team data will be used. Please see the consent form if you have questions call me. After reading it over please sign and return to your coach with the food record forms.

Remember that the coaches will not receive specific information about you. Only team data will be given to the coaches and specific information will be given only to you. So please be honest and as accurate as reasonably possible.

### Food Log Directions

Please record **all** food and beverages (including water) consumed on the forms provided. The more accurately you record the information, the better the information we can provide you and help you improve your soccer performance. Writing the information on the form as soon after eating or drinking as possible will increase the accuracy. Please record the following information:

Time: write the time the food/beverage was consumed.

Food/Beverage with details: write the type of food/beverage consumed and be as specific as possible. If you know the brand name of the food or the restaurant where it was prepared, include that information, for example: "McDonald's Caesar Salad: or Lean Cuisine Cheese Lasagna." Also, indicate if butter, margarine, dressing or other condiments were used.



Amount: Please be as accurate as possible. The attached sheet should help you determine amounts. Estimate the best you can using cups, ounces, etc. It is not necessary to weigh or measure the food but estimate as close as possible.

Method of Preparation: when appropriate indicate if the food item was baked, fried, broiled, boiled, steamed, etc.

If you have any questions please contact Dr. Brad Wilson at 556-3862, [Bradley.Wilson@uc.edu](mailto:Bradley.Wilson@uc.edu) or your coach.