THE EFFECTS OF A 5-WEEK NUTRITION EDUCATION INTERVENTION ON COLLEGIATE ATHLETES' KNOWLEDGE AND DIETARY INTAKE

By

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TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

Table Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Collegiate athletes call upon their bodies day in and day out to perform at optimal levels. In order to be successful as an athlete at the collegiate level, genetic endowment, training, coaching, and work ethic all play a vital role in trying to obtain optimal performance. While most athletes focus their efforts on one or more of these factors in order to improve their athletic performance, many of them fail to pay adequate attention to their dietary intakes. Given that optimal energy and nutrient intakes may enhance athletic performance anywhere from 6 to 20% (American Dietetic Association (ADA) 2009), individuals' dietary behaviors may be detrimental to their athletic performance potential, especially when considering elite athletes who compete at the collegiate, Olympic, and professional levels. "Ron Maughan, a world authority on sports nutrition, recently noted that when talented, motivated, and highly trained athletes meet for competition, the margin between victory and defeat is usually small when everything else is equal, nutrition can make the difference between winning and losing" (Williams, 2007). It is important for collegiate athletes to understand basic nutrition information and have basic knowledge of their energy and nutrient needs in order to optimize athletic performance. While only few studies have been conducted on nutrition knowledge among collegiate athletes, majority of them have found a lack of basic nutrition knowledge in this population (Jacobson & Aldana, 1992; Dunn, Turner, & Denny, 2007; Rash et al., 2008; Zawila, Steib, & Hoogenboom, 2003). These finding are concerning because nutrition can be the deciding factor in whether an athlete comes in 1st or 10th, or wins or loses. Furthermore, it is important for athletes to understand and utilize basic nutrition knowledge for general health purposes because it is vital for collegiate athletes to first establish and then continue utilizing healthy dietary practices to maintain their quality of life after their competitive career is over. Several previous studies have indicated that the more nutrition knowledge athletes acquire, the more likely they will apply such knowledge to their actual dietary intake and make better food choices (Kunkel, Bell, & Luccia, 2001; Skinner et al., 2001; Grandjean, 1997). In contrast athletes who lack basic nutrition knowledge are less likely to maximize their athletic performance potential as well as their health status later in life.

Purpose of the Study

This study has two main purposes. The first purpose is to determine if a five-week nutrition education intervention positively impacts National Collegiate Athletic Association (NCAA) Division I intercollegiate athletes' sports nutrition knowledge. The second purpose of this study is to determine whether the nutrition education intervention positively impacts athletes' intakes of total energy, carbohydrates, protein and fat.

Hypotheses

The following null hypotheses were formulated for the study:

1. There will be no significant difference in nutrition knowledge between the intervention group and the control group at pre test.

2. After the completion of a five-week sports nutrition education intervention (at post test), there will be no significant difference in nutrition knowledge between the intervention and control group.
3. There will be no significant increase in nutrition knowledge (after the completion of a five-week sports nutrition education intervention) within the intervention group from pre test to post test.
4. There will be no significant difference in nutrition knowledge within the control group from pre test to post test.
5. At pre test, there will be no significant difference in the intervention group's dietary intakes for energy intake, carbohydrate intake, protein intake and fat intake compared to their dietary recommendations for energy, carbohydrate, protein, and fat.
6. At post test, there will be no significant difference in the intervention group's dietary intakes for energy intake, carbohydrate intake, protein intake and fat intake compared to their dietary recommendations for energy, carbohydrate, protein, and fat.

Limitations

- The size of the study was relatively small.
- The proposed length of the study's intervention of 8 weeks had to be shortened to 5 weeks because of scheduling conflicts, athletes' training regimens and class schedules, and other factors.

- The study was concluded during the final week of the fall semester, which could have impacted participants' normal dietary intake patterns and turn in rate of 3-day food records at the end of the study.
- Due to the time of season when the study was conducted, some athletes were unable to participate in the study because of their rigorous traveling and competition schedules.
- Males represented a small proportion of the study sample.
- Due to limited available space in athletic department, there was no technology equipment available to present nutrition education material to participants.
- Participants may have under or over reported food or fluid intake on dietary records.
- Study was only conducted in one Division I university and the results cannot be generalized to collegiate athletes in other Division I, II, or III universities and junior colleges.

Assumptions

The following assumptions were made for the study:

- All of the study's participants could read, follow direction appropriately, and be equipped with appropriate writing skills to complete the survey and food records
- Intervention participants did not disclose any nutrition education material or knowledge learned during the study to the control participants.
- Participants answered the survey questions truthfully.
- Participants completed their dietary recall as accurately and truthfully as possible.

- Participants assigned to the intervention group would attend all scheduled nutrition education sessions.

Definitions of Terms

ATP-PCr System – The energy system that uses ATP as an immediate energy source to produce fast, powerful muscle contractions; ATP is regenerated by the breakdown of the Phosphocreatine (PCr).

Dehydration – Is a state where the body's water level is below the normal level of hydration and cannot be replaced because fluid output exceeds fluid input.

Dietary Supplement – A product that can include: vitamins, minerals, herbs, amino acids, enzymes, organ tissues, glandulars, metabolites, and botanicals that is taken in addition to one's dietary intake and can be found in forms such as tablets, liquids, powders, capsules, softgels, gelcaps, nutrition bars and drinks.

Heat Exhaustion – May develop after several days of exposure to high temperatures and inadequate replacement of fluids that can cause dizziness, tiredness, muscle cramps, nausea and vomiting, heavy sweating, and/or weakness.

Heat Stroke – Is a life threatening condition where the body produces or absorbs more heat than it can dissipate.

Heat Syncope – Occurs when body temperature reaches above 40 degrees Celsius with the event of fainting.

Hydration – It is the act of consuming fluids to maintain the body's normal level of hydration.

Macronutrient – Included: carbohydrates, protein, and fat, which are needed in daily amounts of greater than a few grams to support the body's needs.

Micronutrient – Daily dietary nutrients, such as vitamin and minerals, which are only needed in amounts of a few grams or less.

Nitrogen Balance – A state where the body does not gain or loses protein tissue as a result of nitrogen input is equivalent to the nitrogen output.

Significance of the Study

This study contributes significantly to the existing literature because it provides updated insight on the current state of nutrition knowledge and dietary intakes among collegiate athletes. Furthermore, the study evaluates the impact of a 5-week intervention study on nutrition knowledge and dietary intakes of collegiate athletes and thus it helps identify effective educational methods that may improve nutrition knowledge and dietary intakes among this unique population. The results of the study demonstrate that nutrition education interventions may serve as effective tools for increasing nutrition knowledge among collegiate athletes. While development of additional strategies and teaching approaches is warranted in order to positively influence actual dietary behaviors of athletes, the results of this study suggest that athletic programs should invest more time and finances into nutrition education programs and nutrition professionals in order to improve basic sports nutrition knowledge of collegiate athletes.

CHAPTER II

REVIEW OF LITERATURE

Importance of Nutrition and Current Nutrition Knowledge among Collegiate Athletes

Nutrition plays a crucial role in a collegiate athlete's daily routine. Enhanced athletic performance is not just attributed to an athlete's genetic endowment, rigorous training regimen, work ethic, and mental toughness, but also optimal nutrition intake. "Over 20 years, research has clearly documented the beneficial effects of nutrition on exercise performance. There is no doubt that what an athlete eats and drinks can affect health, body weight and composition, substrate availability during exercise, recovery time after exercise, and ultimately, exercise performance" (ADA, 2000). However, if athletes do not possess basic nutrition knowledge, it is possible they may never reach their peak athletic performance. Several previous studies investigating the level of nutrition knowledge among athletes has come to one similar conclusion; athletes appear to lack basic nutrition knowledge (Dunn et al., 2007; Rash et al., 2008; Rosenbloom, Jonnalagadda, & Skinner, 2004; Zawila et al., 2003). If athletes are not equipped with the proper nutrition knowledge or receive misleading information from unqualified sources, such as the media, coaches, teammates, personal trainers, parents, the Internet, and supplement manufactures, they are more likely to have poor nutrient intake and use unhealthy dietary practices (Benari & Quatromini, 2008). Some of the previous studies examining nutrition knowledge among athletes and athletic staff have found that it would be beneficial to hire a registered dietitian/qualified nutrition professional as part of the athletic staff due poor nutrition knowledge results (Dunn et al., 2007; Rockwell, Nikols-Richardson, & Thye, 2001; Shifflett, Timm, & Kahanov, 2002). Fortunately, more athletic departments in recent years have recognized the need for qualified nutrition professionals in order to foremost provide nutritional guidance to athletes and athletic staff and to gain a competitive edge over their competition (Burns et al., 2004; Shattuck, 2001).

It is vital for athletes entering college to have basic understanding of nutrition so that they can optimize performance, decrease risk of injury, avoid negative dietary behaviors, and maintain overall health status. While several studies have shown collegiate athletes often lack basic nutrition knowledge (Abood, Black, & Bimbaum, 2004; Barr, 1987; Dunn et al., 2007; Shifflett et al., 2002; Zawila et al., 2003), Shifflett and colleagues (2002) found that athletes tend to overestimate their understanding of nutrition knowledge. The same study found athletes to have scored the lowest on the nutrition knowledge survey when compared to coaches and athletic trainers. This potentially can be a concern because these results indicate athletes perceive they have good dietary habits when in fact they do not, and do not possess the knowledge to tell otherwise.

Most commonly, athletes appear to lack knowledge about macronutrient needs and the primary functions carried out by macronutrients, vitamins, and minerals in the body, proper supplement usage and how supplements affect performance (Jacobson & Aldana, 1992; Rash et al., 2008; Rosenbloom et al., 2004). Moreover, studies show that even if athletes possess some nutrition knowledge, they have a difficult time translating their knowledge into food choices (Dunn et al., 2007; Murphy & Jeanes, 2006). A study conducted by Benari and Quatromoni (2008) found “athletes want practical information that will teach them how nutrition can maximize and enhance their performance,” cooking demonstrations that can help translate their knowledge into food choices and cooking skills, and advice on how to shop on a budget (Benari & Quatromoni, 2008). Some studies have found athletes who have fair nutrition knowledge demonstrate a weak correlation between their nutrition knowledge and dietary intake (Rash et al., 2008; Murphy & Jeanes, 2006). It is obvious nutrition knowledge is not only about knowing and understanding, but also knowing how to apply the knowledge to actual dietary intakes and utilizing nutrition information in practical and economical ways.

To date, only a small number of published studies have investigated the effects of nutrition interventions on collegiate athletes’ nutrition knowledge, dietary behaviors and other nutrition-related factors. Most of the studies were also conducted with female athletes only, which illustrates a gap in scientific knowledge on the impact of a nutrition intervention on both female and male athletes. In addition, the existing studies have utilized a variety of different sub-populations of athletes, study designs, methodologies, research instruments, and intervention strategies. Thus, the results of these studies must be interpreted in the light of the individual study’s design and methodologies used and a direct comparison of the results between these studies is difficult.

Despite the differences in design and methodologies, several studies evaluated pre and post nutrition knowledge and reported a significant increase in athletes’ knowledge after the completion of the intervention (Abood et al., 2004; Collison, Kucsmarski, &

Vickery, 1996; Kunkel et al., 2001). Along with evaluating nutrition knowledge change, some studies have also examined the impact of nutrition education interventions on body image perceptions, dietary intakes, and self-efficacy (Abood et al., 2004; Collison et al., 1996; Kunkel et al., 2001). The studies in which dietary intake changes were evaluated after the implementation of the nutrition education intervention have mixed conclusions. For example, Collison and colleagues (1996) evaluated the effectiveness of a nutrition education program, which consisted of two nutrition workshops, had on 28 female collegiate athletes' dietary intake and found no significant differences in dietary intake after the conclusion of the nutrition intervention. In contrast, Abood et al. (2004) reported a significant number of positive dietary changes in 13 women collegiate soccer players after the completion of 8 1-hour education sessions which were constructed based on the Social Cognitive Theory (SCT). These inconsistent results could be a result of the different intervention designs, who conducted the intervention, and lengths of the interventions. Thus, further studies need to be conducted to find specific intervention approaches that positively impact athletes' dietary habits.

Common Nutrition-Related Issues among Collegiate Athletes

Although proper nutrition is crucial for optimizing athletic performance, many athletes do not meet their dietary recommendations or use inappropriate practices to achieve their athletic goals (Rash et al., 2008; Rosenbloom et al., 2004; Zawila et al., 2003; Ziegler et al., 2001). Several research studies have been conducted to identify areas of nutrition in which athletes are lacking most knowledge and fail to meet the current sports nutrition recommendations. Some of the most common nutrition-related issues that athletes experience are discussed in the following sections, including energy needs, protein, carbohydrate, fat, and fluid intake, dietary supplement use, and weight management (Jacobson & Aldana, 1992; Jacobson et al., 2001; Rash et al., 2008; Rosenbloom et al., 2004).

Total Energy Intake

The first priority for any athlete, nutritionally, should be to obtain recommended energy needs. In order for an athlete to reach and maintain optimal athletic performance, increase and/or maintain lean body mass, and maintain proper immune and reproductive function, it is vital for him/her to achieve energy balance (ADA, 2009). Athletes who fail to reach energy balance may ultimately compromise their athletic performance, ability to train at a high level, and they may also increase their risk of injury. There are a variety of methods used to estimate an athlete's energy needs. One method is by using prediction equations, such as the Cunningham (Cunningham, 1980) and the Harris-Benedict (Harris & Benedict, 1919). These two predication equations are commonly used among nutrition professionals because of their close estimations of energy needs for athletes. Other methods include using the Dietary Guidelines for Americans 2005 estimated calorie requirements developed for physically active adults or the Dietary Reference Intakes (DRIs) for estimated energy requirements and macronutrients recommendations for adults (ADA, 2009).

A study conducted with professional soccer players in the UK found that macronutrient consumption was significantly less than the control group that was made up of non-athletes (Murphy & Jeanes, 2006). In addition, the athletes' total caloric intakes were lower than the dietary guidelines for macronutrients specifically established for soccer players (Murphy & Jeanes, 2006). Another study conducted by Ziegler and colleagues (2001) found that female and male elite figure skaters demonstrated similar finding in that the participants' energy intakes were significantly lower than the mean energy intakes established by the Second National Health and Examination Survey (NHANES II) for men and women between the ages of 16-19 years of age. It was also found the elite figure skaters consumed fewer kilocalories per kilogram than what is currently recommended for aerobic athletes who train greater than 90 minutes per day (Ziegler et al., 2001). However, a study reported that participants met current dietary guidelines for fat, protein, and carbohydrate intake after the completion of the intervention (Collison et al., 1996).

Based on previous research, athletes at all athletic levels, ages, and gender often fail to meet energy requirements. Athletes involved in aesthetic sports such gymnastics and dancing, weight class sports such as wrestling and bodybuilding, and sports that put much emphasis on having a extremely lean body, such as long distance running, are most at risk for poor nutrient intake (Williams, 2007). Furthermore, female athletes are more likely to have an inadequate dietary intake when compared to male athletes (Williams, 2007). These groups of athletes are at an increased risk for injury and developing stress fractures due to the combination of the high impact sport and chronic low calorie diet, which is often low in certain micronutrients such calcium (Anderson & Anderson, 1993). Based on scientific studies, health professionals recommend athletes who are not meeting their macronutrient energy requirements through dietary intake to take a nutrient supplement/s in order to meet their micronutrient needs and maintain a healthy status (Anderson & Anderson, 1993). A study conducted on female runners who had regular and irregular menstrual functions found the energy intake of the irregular menstrual functioning group was significantly lower than in the regular menstrual function group (Tomten & Hostmark, 2006). This led the authors to believe a chronic inadequate energy intake along with other dietary intake factors could play a role in the disturbance of the endocrine system in female athletes (Tomten & Hostmark, 2006).

Only a few studies have analyzed collegiate athletes' knowledge pertaining to energy intake recommendations. A study lead by Jacobson et al. (1992) found only 1.1% of collegiate athletes surveyed chose the correct percentage of protein from total calories, 2.9% chose the correct percentage of fat, and 5.1% chose the correct percentage of carbohydrates. Six years later, the follow-up study by Jacobson et al., (2001) found that 3% of collegiate athletes surveyed chose the correct percentage of protein from total calories, 11.7% chose the correct fat percentage, and 29.5% chose the correct carbohydrate percentage. It is evident there was a slight knowledge improvement among collegiate athletes within a six year period, but it still demonstrates that the majority of athletes lack basic nutrition knowledge pertaining to energy intake.

Carbohydrate Intake

The 2009, American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine position paper on nutrition and athletic performance recommends for athletes to consume 6 to 10 grams of carbohydrates per kilogram of body weight each day, whereas some sources set the minimum recommended value at approximately 5 grams of carbohydrates per kilogram of body weight per day (Kundrat, 2005). In order to determine the specific amount of carbohydrates required to support an athlete's energy requirements, several factors such as gender, type of sport, and environmental conditions have to be taken into consideration (ADA, 2009).

Several studies have examined collegiate athletes' knowledge and carbohydrate intake to determine whether a knowledge deficit exists and whether this is reflective of athletes' dietary intakes of carbohydrates. A study conducted by Rosenbloom and colleagues (2002) found that over half of the athletes surveyed knew that carbohydrates, along with fats, are the main sources of energy for activity. A surprising 85% of athletes surveyed in another study correctly identified that carbohydrates provided immediate energy during activity, but in the same study researchers found that only 5.1% of participants identified the recommended percentage of carbohydrates from total calories (Jacobson & Aldana, 1992). A positive trend was reported six years later in the follow-up study conducted by Jacobson et al. (2001) with 29.5% of the athlete correctly identifying the recommended percentage of carbohydrates from total calories. Although some positive trends in carbohydrate knowledge have been reported among athletes, researchers have documented numerous negative trends and thus recommend that athletes need to improve their carbohydrate knowledge (Dunns et al., 2007).

Studies that have examined athletes' actual carbohydrate intake support the notion that athletes need to increase their knowledge of carbohydrates as well as their intake (Hinton et al., 2004; Murphy & Jeanes, 2006). Hinton et al. (2004) reported that only 15% of collegiate athletes surveyed met their carbohydrate recommendation of 6 to 10 grams of carbohydrates per kilogram of body weight, which was based on carbohydrate recommendations made by the ADA position paper on nutrition and athletic performance (ADA, 2009). Murphy and Jeanes (2006) found professional soccer players in the UK to consume 51% of their energy from carbohydrates or 4.3 grams of carbohydrates per kilogram of body weight, which is below the recommendations established for soccer players, more than 55% of total energy from carbohydrates or at least 6 grams of carbohydrates per kilogram of body weight. Finally, another study conducted with 161 male and female elite figure skaters found their mean carbohydrate intake to be 5.1 grams per kilogram of body weight, which fell below the current sports nutrition recommendation of 6 to 10 gram of carbohydrates per kilogram of body weight (Ziegler et al., 2001).

Protein Intake

Protein recommendations for athletes differ depending on the level at which the athlete trains and what type of sport the athlete is involved in, such as endurance vs. strength sport (Lamont, 2003). According to the most recent DRIs, the general protein recommendation for all adults (excluding pregnant and lactating women), active or sedentary, is 0.8 grams per kilogram of body weight per day (ADA, 2009). The DRIs state there is a lack of consistent evidence demonstrating that healthy adults who participate in endurance or resistance exercise need additional protein (ADA, 2009), Studies examining nitrogen balance in endurance athletes have concluded endurance athletes need anywhere from 1.2 to 1.4 grams of protein per kg of body weight per day (Phillips, Moore, & Tang, 2007; Tipton & Witard, 2007). With respect to strength athletes, research has found a range between 1.2 grams per kg of body weight per day to 1.7 gram per kg of body weight per day to be most effective in maintaining and supporting muscle growth (Phillips et al., 2007). The International Society of Sports Nutrition (ISSN) position stand on protein and exercise came to similar protein recommendations, ranging from 1.4 to 2.0 gram per kg of body weight per day for active adults (Campbell et al., 2007). ISSN also recommends individuals who take part in endurance activity to consume levels of protein at the lower end of the range, individuals who take part in a combination of endurance and strength should consume levels in the middle of the range, and for individuals who take part in power/strength activity to consume level at the upper end of recommendation range (Campbell et al., 2007). Research has not supported a protein intake of > 2.0 grams per kg of body weight per day to be beneficial for any type of athlete (Williams, 2007).

Several studies have examined collegiate athletes' protein knowledge and intake. Jacobson and Aldana (1992) found that 51% of the respondents (division-1 collegiate athletes) believed protein was the main source of immediate energy during activity; however, over half of the respondents correctly identified the main function of protein in the body. Nearly 80% of respondents thought protein intake should account for 40% or more of total calorie intake, whereas only 1.1% chose the correct percentage of protein from total calories, and almost 75% of the respondents thought athletes could not possibly obtain protein recommendations through diet alone and needed protein supplements to meet their protein needs (Jacobson & Aldana, 1992). The follow-up study lead by Jacobson (2001) conducted six years later found athletes' knowledge concerning protein function was slightly lower, however the study found a slight increase in the number of respondents who selected the correct percentage of protein from total calories (3%).

Studies evaluating athletes' protein intake have reported mixed results. Murphy and Jeanes (2006) reported professional soccer players in the UK to consume adequate amounts of protein at 17% of total intake; however Hinton et al. (2004) found only 26% of collegiate athletes to consume adequate amounts of protein between 1.2 to 1.7 grams per kilogram of body weight. Ziegler et al. (2001) concluded that male and female elite figure skaters between the ages of 16 to 19 had a lower mean intake of protein compared to the mean protein intake of the NHANES II for 16 to 19 year olds.

Fat Intake

Fat is a very important and necessary part of an athlete's daily dietary intake. Out of the macronutrients, it provides the greatest amount of energy per gram, and provides essential nutrients such as fat-soluble vitamins, D, A, K, and E and essential fatty acids. The 2005 Dietary Guidelines for Americans recommend fat intake to make up between 20-35% of total calories with the majority of fat coming from polyunsaturated and monounsaturated sources, less than 10% coming from saturated sources, and minimal amount coming from *trans* fatty acids. The American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine current position on recommended intake of dietary fats for athletes coincide with the 2005 Dietary Guidelines for Americans and the organizations further recommend athletes to avoid diets where fat makes up ≤ 20% of energy because they have been shown to hinder athletic performance (ADA, 2009). In addition, the recommendation includes avoiding high-fat diets as well.

Researchers have been long interested in looking at the effects of dietary fat intake on athlete's overall performance, endurance, injury risks, reproductive function, immune function, and other physiological responses (Anonymous, 1996; Gerlach et al., 2008; Raloff, 1996; Tomten & Hostmark, 2004). A study by Tomten and Hostmark (2004) compared dietary intakes of female runners with and without menstrual disorders and found that carbohydrate and protein intake in both groups was sufficient; however, dietary fat intake was significantly lower in the irregular menstrual function group compared to the regular menstrual function group (Tomten & Hostmark, 2004). Another study analyzing injury occurrence with fat intake among runners found that injured runners had a significantly lower consumption of total fat and percentage of total energy from fat than non-injured runners (Gerlach et al., 2008). Thus, it is apparent that a low fat intake is correlated with a variety of negative physiological side effects that athletes should avoid in order to protect their health as well as to maximize their athletic performance. Despite the popularity of low fat diets among athletes, research has found that marathon runners and other highly trained endurance athletes perform better when consuming a diet that is made up of 30-45 % of total calories from fat for 4 weeks than a diet made up of only 16% of total calories from fat for 4 weeks (Raloff, 1996). The athletes on a higher-fat diet were shown to increase their endurance, decrease exercise-induced muscle fatigue, and increase their running time at peak capacity (Raloff, 1996). Another research study found that athletes who switched from a low-fat diet to a moderate-fat or high-fat diet increased the secretion of a protein called interleukin 2 (IL2), which is linked to enhancing immune function (Anonymous, 1996).

Studies examining athletes' knowledge about fat are mixed, with some stating that athletes lack adequate knowledge of fat and some indicating that athletes have sufficient dietary fat knowledge. For instance, Dunn and colleagues (2007) found athletes demonstrated a great deal of knowledge regarding fat content of specific foods, but lacked knowledge about different types of fat. Jacobson et al. (1992) found that 59% of athletes said total fat intake should make up 10% or less of total dietary intake, and the follow up study by Jacobson et al. (2001) found 49.5% of the athletes to believe total fat intake should make up 12% or less of total dietary intake. In both studies, only 2.9% and

11.7% of athletes were able to identify the correct recommended fat range of 25-30% of total calories (Jacobson and Aldana, 1992; Jacobson et al., 2001). Based on the results of these studies, it appears athletes need more education on the importance of fat in the diet, the types of dietary fats in foods, and the current sports nutrition recommendation for dietary fat intake.

Fluid Intake

Proper hydration and athletic performance goes hand in hand. It is vital for athletes to consume adequate amounts of fluids before, during, and after exercise to optimize athletic performance, maintain health, and avoid dehydration and heat related injuries (ADA, 2009). If an athlete loses >2% of body weight through fluid loss, dehydration occurs which can impair athletic performance, cognitive performance, and place an athlete at greater risk of experiencing heat syncope, heat exhaustion, and even heat stroke (Nichols et al., 2005, Sawka et al., 2007). To help prevent dehydration and protect athletes from heat illness the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine position paper on nutrition and athletic performance (ADA, 2009) established fluid intake recommendations for athletes before, during and after exercise. It is recommended that individuals drink 5 to 7 mL per kilogram of body weight of water or sports drink prior to engaging in physical activity (at least 4 hours before) (ADA, 2009). Also, they need to consume16 ounces of water or a sports drink 1 hour before physical activity (Howe & Boden, 2007). During exercise, several factors influence the hydration status of an athlete, including the following: the type of exercise, duration, intensity level, environmental conditions, and individual's sweat rate (ADA, 2009); thus, the amount and rate of fluid to be consumed should be estimated based on individual athletes' needs and specific environmental conditions in which the exercise takes place (ADA, 2009). In general, it is recommended for an individual to consume 4 to 8 ounces of fluid every 15 to 20 minutes of activity (Howe & Boden, 2007) and if activity lasts longer than 1 hour, athletes are encouraged to consume a beverage that contains 6% to 8% carbohydrate, sodium, and potassium in order to provide energy and replace electrolytes loss through sweat (ADA, 2009). After exercise, it is recommended for individuals to consume 16 to 24 ounces of fluid for every pound lost of total body weight (prior to exercise) from sweat loss (ADA, 2009).

Researchers have found athletes to have a difficult time realizing they are becoming dehydrated and suggest that this may be due to a lack of nutrition knowledge (Howe & Boden, 2007). A study by Nichols and colleagues (2005) suggested that collegiate athletes lack proper hydration and fluid replacement knowledge and need to be educated in these areas, along with being monitored regularly to reinforce positive attitudes and behaviors regarding hydration. In support of this suggestion, a study conducted by Shifflett et al. (2002) found that collegiate athletes have difficult time understanding hydration. In contrast, several other studies have found athletes to have a high degree of knowledge pertaining to fluids and hydration (Rosenbloom et al., 2002; Zawila et al., 2003). The mixed results of previous research on hydration knowledge may have been influenced by the fact that different types of athletes were utilized for the studies, with some types of athletes having a greater knowledge of hydration compared to others. Certain groups of athletes, such as endurance athletes, are more inclined to learn about nutrition and how it affects their performance compared to athletes who participate in skilled sports (Nicholas et al., 2005). However, it is vital to continue investigating this population's knowledge of proper hydration to identify positive or negative trends in knowledge and techniques to help translate knowledge into a healthier behavior.

Dietary Supplement Misuse

"Congress defined the term "dietary supplement" in the Dietary Supplement Health and Education Act (DSHEA) of 1994. A dietary supplement is a product taken by mouth that contains a "dietary ingredient" intended to supplement the diet. The "dietary ingredients" in these products may include: vitamins, minerals, herbs or other botanicals, amino acids, and substances such as enzymes, organ tissues, glandulars, and metabolites. Dietary supplements can also be extracts or concentrates, and may be found in many forms such as tablets, capsules, softgels, gelcaps, liquids, or powders. They can also be in other forms, such as a bar, but if they are, information on their label must not represent the product as a conventional food or a sole item of a meal or diet" (U.S. Department of Health & Human Services, 2009). Up until October of 1994, the Food Drug and Cosmetic Act, under the Food and Drug Administration (FDA), applied the same regulatory requirements subject to foods to dietary supplements (U.S. Department of Health & Human Services, 2009). However, in October of 1994 the Dietary Supplement Health and Education Act (DSHEA) was implemented, which created new, less rigorous guidelines for dietary supplements and amended the Food, Drug and Cosmetic Act (U.S. Department of Health & Human Services, 2009). After the DSHEA was implemented, it is no longer required for dietary supplement manufactures to received approval from the FDA before marketing a dietary supplement, except in the cases where a new dietary ingredient is used (U.S. Department of Health & Human Services, 2009). It should also be known, manufacturers do not have to provide evidence to support the safety or effectiveness of the dietary product to the FDA before or after they market the product, and manufactures are left to develop and implement their own safety guidelines to ensure the dietary supplements produced are safe and the ingredients within the supplement are true to their label (U.S. Department of Health & Human Services, 2009).

Since the FDA does not test dietary supplements for safety or purity, the National Collegiate Athletic Association (NCAA) has taken steps to regulate the use of dietary supplements among collegiate athletes. In 2000, the NCAA defined guidelines for Division I institutions to determine if a supplement is permissible (legal by NCAA's bylaws for institutions to provide a supplement to athletes), or non-permissible (not legal for institutions to provide a supplement to athletes) (National Collegiate Athletic Association (NCAA), 2003). In order for a supplement to be permissible, it has to fall under one of these categories: energy bars, carbohydrate/electrolyte drinks, carbohydrate boosters, and vitamins and minerals, as well as qualify as a non-muscle building supplement (contains $\leq$ 30% of calories from protein) (NCAA, 2003). If a supplement does not fall within one of the above four categories and is a muscle building supplement, it will be classified as a non-permissible supplement (NCAA, 2003).

Even though Division I institutions cannot give athletes non-permissible supplements, this does not mean athletes cannot purchase and take supplements such as creatine, protein powders, sports bars with >30% calories from protein, and herbal supplements themselves (Rockwell & Kundrat, 2008). As long as a non-permissible supplement is not on the NCAA banned substance list, athletes can take supplements at their own risk (Rockwell & Kundrat, 2008). To warn athletes about the safety and purity of dietary supplements, the NCAA posts this warning: "Many nutritional/dietary supplements contain NCAA-banned substances. In addition, the U.S. Food and Drug Administration does not strictly regulate the supplement industry; therefore, purity and safety of nutritional/dietary supplements cannot be guaranteed. Impure supplements may lead to a positive NCAA drug test. The use of supplements is at the student-athlete's own risk" (NCAA, 2008).

Dietary Reference Intakes (DRIs) for vitamins and minerals recommended for adults are also used as guidelines to base intake recommendations for college age athletes (Anderson & Anderson, 1993). However, in general vitamin and mineral supplements are not needed by athletes if they are eating a well balanced diet that matches their energy needs (Nieman, 2007). Research has only shown individuals with preexisting vitamin deficiencies to improve physical performance after vitamin supplementation and that a vitamin deficiency may result in decreased physical performance (Armstrong & Maresh, 1996) but no solid or consistent scientific evidence supports general use of vitamins and minerals to enhance athletic performance (Singh, Moses, & Deuster, 1992).

Vitamins and minerals play many important roles in the body such as: maintaining bone health, supporting immune function, synthesizing hemoglobin, and protecting the body against oxidative damage (ADA, 2009). It is evident there is an increase of use of vitamins and minerals and other dietary supplements among athletes over recent years; a study reported in 1992 that 37% of collegiate athletes surveyed took some type of dietary supplement (Jacobson & Aldana, 1992), in 1994, a study reported 45% (Sobal & Marquart, 1994), in 1998, a study reported 72% (Jacobson et al., 2001) and in 2004 83% (Burns et al., 2004). With the increase in consumption of dietary supplements, researchers have examined athletes’ believes pertaining to dietary supplements to determine if a knowledge deficit exists. Several studies have reported a high percentage of athletes to believe vitamins, minerals provide energy (Burns et al., 2004; Jacobson & Aldana, 1992; Rash et al., 2008; Rosenbloom et al., 2002) as well as other misconception such as, vitamins and minerals increase muscle strength, aid in weight gain, athletes must take a multivitamin every day, and athletes require more vitamins and minerals than normal adults (Jacobson & Aldana, 1992; Jacobson et al., 2001; Rash et al., 2008).

Some of the most popular dietary supplements taken among collegiate athletes today are creatine, energy supplements, weight gainers and meal replacement shakes, and protein supplements (Kundrat & Rockwell, 2008). Creatine has been labeled as one of the most popular sports supplement of all times (Williams, 2007) and in a study conducted by Jacobson et al. (2001) was found to be the most widely used supplement among collegiate men and women athletes, along with vitamin/mineral supplements. Creatine is a nitrogen containing compound that may be formed in the kidney and liver from glycine and arginine and stored in skeletal muscle to be called upon to form phosphocreatine to fuel the ATP-PCr energy system during high-intensity exercise (Williams, 2007). The position stand of the International Society of Sports Nutrition (ISSN) on creatine supplementation and exercise established the use of creatine supplementation to be safe, effective, and ethical if used within established guidelines (Buford et al., 2007). However, researchers have failed to look at athletes' knowledge on proper use of creatine supplementation such as dosage and fluid intake.

Weight gainers and meal replacement shakes are other dietary supplements on the rise among collegiate athletes. One study conducted in 2004, found that nearly half (47%)

of the collegiate athletes surveyed currently used calorie-replacement drinks (Burns et al., 2004) compared to a study conducted in 1998, which found only 16% to consume carbohydrate drinks and 2.7% to consume a weight gaining supplement (Jacobson et al., 2001). The use of protein supplementation appears to be on the rise as well. Burns et al. (2004) also reported 40% of collegiate athletes surveyed used protein supplements, compared to Jacobson et al. (2001) which found only 7.7% of collegiate athletes surveyed to consume a protein supplement and 2.3% to consume an amino acid supplement. One study reported 45% of collegiate athletes surveyed believed protein is the main source of energy for the working muscles, as well as over one third of the athletes believed that protein supplements are needed for athletes to achieve daily protein recommendations (Rosenbloom et al., 2002). An earlier study also found a large percentage of collegiate athletes (51%) to believe protein provides immediate energy to the muscles (Jacobson & Aldana, 1992), but saw an improvement in the follow-up study when only 21% of athletes surveyed believed in this statement (Jacobson et al., 2001). Also to coincide with Rosenbloom et al. (2002), the study conducted by Jacobson and Aldana (1992) found almost three fourth of the athletes to believe that athletes need additional protein in a supplement form in order to reach daily protein recommendations. It is evident from these studies that collegiate athletes lack knowledge about protein function and supplementation.

Energy supplements such as caffeine "is the most widely consumed drug in the world" (Schwenk & Costley, 2002) and is alleged to increase time to exhaustion during prolonged exercise, increase mental awareness, and increase metabolic rate (Schwenk and Costley, 2002). The NCAA's 2008-09 list of banned-drugs has caffeine listed as a banned stimulant only if the concentration in urine exceeds 15 micrograms/ml (NCAA, 2008). Other energy supplements and stimulants readily found over-the-counter such as guarana, ephedra (natural and synthetic forms), and psenylpropanolamine are considered banned substances by the NCAA (Jenkins, 1997; NCAA, 2008). These types of energy supplements come with a list of adverse side effects which may hinder athletic performance and even cause death. Common side effects include, but are not limited to, elevated heart rate and blood pressure, onset of diarrhea, heart palpitations, hypertension, insomnia, nausea, anxiety, shakiness, and gastric distress (Jenkins, 1997). Currently, there are a lack of studies conducted with athletes on their knowledge pertaining to energy supplements.

Weight Management Practices among Athletes

Many athletes at some point or another attempt to lose weight, gain muscle, or gain body fat to improve athletic performance, meet weight requirements, or for appearance purposes (Armstrong, 2006). It is vital for athletes to understand appropriate weight loss and gain practices before engaging to avoid negatively impacting athletic performance and overall health. Unfortunately, it is already estimated that a large percentage of collegiate athletes engage in negative weight altering behaviors (Bonci et al., 2008; Martin, Schlabach, &Shibinski, 1998).

It is widely accepted among health professionals that the most safe and effective way to lose weight is slow and steady (Rockwell & Kundrat, 2008). Weight loss recommendations state it is safe for adults to lose 1 to 2 pounds per week, which is a very realistic goal that can be sustained by an individual until goal weight is reached (Rockwell & Kundrat, 2008). In order to lose weight, the body must be in negative energy balance, meaning taking in fewer calories than burned (Rockwell & Kundrat, 2008). It is recommended for individuals to subtract 500 to 1000 calories per day to achieve a 1 to 2 pound weight loss per week and to eat 4 to 5 time throughout the day and avoid skipping meals, especially breakfast (Rockwell & Kundrat, 2008).

It has been known for athletes to engage in risky weight loss practices such as: extreme food restriction, fluid restriction, use of diet pills, laxatives, diuretics and saunas, purging, and over exercising (Armstrong, 2006). At the beginning of the 1997 collegiate wrestling season, three wrestlers turned to risky weight loss practices that promoted dehydration to make competition weight and as a result died from hyperthermia (Ransone & Hughes, 2004). This tragedy lead the NCAA to develop and enforce a wrestling weight-certification program in 1998, to attempt to detour collegiate wrestlers from participating in unsafe weight loss practices (Ransone & Hughes, 2004). The program established permanent weight classes for an entire season and several other safety guidelines to ensure wrestlers engage in proper weight loss practices (Ransone & Hughes, 2004). NCAA also enforces penalties if the established guidelines are not properly followed. (Rasone & Hughes, 2004) Female athletes are another group of athletes who are known to want to lose weight, and like wrestlers engage in negative weight loss practices. Hinton et al., (2004) found that 62% of collegiate female athletes surveyed wanted to lose at least 5 pounds and the National Athletic Trainers' Association (NATA) estimates the prevalence of disorder eating (DE) among female athletes to be as high as 62% (Bonci et al., 2008). Such results make it even more important for athletes to be educated on proper weight loss practices to ensure their health and well-being.

However, studies examining nutrition knowledge among collegiate athletes have failed to study athletes' knowledge on proper weight loss practices.

The American Academy of Pediatrics (AAP) reports athletes who participate in strength sports such as football, power lifting, basketball, rugby, and bodybuilding are encouraged to gain weight. However, if approached improperly can result in athletes gaining excess body fat impacting athletic performance and long term health negatively by decreasing agility, endurance, and speed, and increasing risks of cardiovascular disease, hypertension, and type 2 diabetes later in life (Armstrong, 2006). In order to build muscle, an athlete needs to combine a resistance training program with consuming at least 3,000 to 4,000 more calories per week than normal (Kundrat, 2005). Athletes who have an extra high metabolism may need to add more calories to see results and results may take longer to appear (Kundrat, 2005). It is recommended for athletes to maximize eating opportunities, consume a high quality diet, take advantage of liquid calories, and avoid skipping meals in order to gain weight primarily through muscle mass (Kundrat, 2005). Unfortunately, research examining collegiate athletes' knowledge pertaining to proper weight gain recommendations is lacking.

Relationship between Nutrition Knowledge and Nutrition Behaviors

Previous studies conducted with athletes indicate that the nature of the relationship between athletes' nutrition knowledge and their actual dietary behaviors is inconsistent and it is not clear whether nutrition knowledge is a good predictor of an individual's behaviors (Neil, Wise, & McLeish, 2000). Some research studies have shown a positive correlation between the nutrition knowledge of athletes and the quality of their dietary intakes (Dunn et al., 2007; Nichols et al., 2005; Wilta, Stombaugh, &

Buch, 1995). For instance, Wilta et al. (1995) found that runners with greater nutrition knowledge made better food choices compared to their peers with lower nutrition knowledge. Similarly, Nichols et al. (2005) observed a positive and significant correlation between the knowledge and nutrition behavior scores in a sample of collegiate athletes, indicating that an increase in athletes' knowledge leads to better dietary behaviors in this population. However, other studies have found nutrition knowledge to be a weak predictor of nutrition behaviors (Nichols et al., 2005). A study conducted by Rash et al. (2007) analyzed college track athletes' nutrition knowledge, attitudes, and dietary intakes and found that nutrition knowledge and attitude were not primary factors impacting dietary intake. Murphy and Jeanes (2006) came to a similar conclusion after analyzing nutrition knowledge and dietary intakes of professional soccer players. The study found a major gap between the athletes' nutrition knowledge and their actual dietary practices (Murphy & Jeanes, 2006). Another study found collegiate athletes to have issues translating their nutrition knowledge into their daily food choices (Dunn et al., 2007). Based on the mixed results of these studies, it is apparent that further research examining the relationship between nutrition knowledge and dietary behaviors is warranted, especially because athletes represent a special population with unique characteristics.

Researchers have moved a step forward from analyzing current nutrition knowledge and behavior in athletes to designing and implementing nutrition intervention programs. Researchers have designed these intervention programs in order to study the impact they may have on athletes' nutrition knowledge, attitude, and behaviors, and to identify techniques that may be beneficial in improving these areas of concern (Abood et al., 2004; Kunkel et al., 2001). However, there is a paucity of published studies in this area and the findings from these studies are not consistent, partly because of different methodologies and approaches that have been used in these research projects.

Collison et al. (1996) implemented a nutrition education program to evaluate the effectiveness it may have on female athletes' nutrition knowledge, attitudes, and intakes. The study consisted of a nutrition education program made up of two workshops, and a pre, post, and retention nutrition knowledge test, 3-day food record, and nutrition attitude test (Collison et al., 1996). The topics that where discussed in the workshops where chosen from the knowledge pretest results; if 50% or more of participants answered an item incorrectly it was chosen as a nutrition topic for the two workshops (Collison et al., 1996). The workshops included these topics: "energy needs and sources, fat and cholesterol content in foods, synthetic vs. natural foods, fluids for athletes, vitamins and minerals, diet and weight control, osteoporosis and bone health" (Collison et al., 1996) as well as a session using popular food items on the market and label reading (Collison et al., 1996). After the study was concluded, researchers found a significant increase in knowledge scores and attitude scores among the female athletes between their mean nutrition knowledge and nutrition attitude pretest and posttest scores, as well as their pretest and retention scores (Collison et al., 1996). However, the athletes' dietary intakes showed no significant difference between pre, post, or retention periods (Collison et al., 1996). Similar results were seen in the study conducted by Chapman et al. (1997) using female athletes. In this study, the nutrition education program consisted of two 45-minutes lectures once a week, which included discussions on ergogenics, precompetition fueling, dehydration, weight control, energy sources, and vitamin and mineral supplements (Chapman et al., 1997). The program also incorporated nutrition demonstrations and provided educational handouts to the participants in hope of increasing the impact of the program (Chapman et al., 1997). In order to analyze the impact of the program on the participants' nutrition knowledge and behaviors, the researchers administered a pre nutrition knowledge test and a 24-hour dietary recall prior to the start of the nutrition education program and a post nutrition knowledge test and a 24-hour dietary recall after the conclusion of the nutrition education program (Chapman et al., 1997). Similar to the Collison et al. (1996) study, the results revealed a significant increase in participants' nutrition knowledge after the completion of the nutrition education program, but showed no significant change in dietary intakes after the completion of the nutrition education program (Chapman et al., 1997). These interventions were shown to be successful in increasing nutrition knowledge, but failed to impact dietary intakes of athletes.

Other researchers have taken a different approach when designing their nutrition education intervention by using behavioral model theories as frameworks for their interventions. Behavioral theories have been used in research to promote positive changes in health behaviors and help predict behavioral changes among a variety of populations (Abood et al., 2004; Lippke & Ziegelmann, 2008, Clifford et al., 2009). There are a variety of behavioral theories which include: Social Cognitive Theory (SCT), Transtheoretical Model (TTM), Health Belief Model (HBM), Theory of Reasoned Action, Theory of Planned Behavior, and Health Action Process Approach (HAPA) (Lippke and Ziegelmann, 2008).

Recent studies with college student population have used the SCT in order to promote not only positive changes in individuals' knowledge, but also in their self-efficacy and ultimately in their dietary intakes. The concepts that make up the SCT include: environment, behavioral capability, expectations, self control, observational learning, reinforcements, self-efficacy, and reciprocal determinism (Glanz, Lewis, & Rimer, 2002). One of the main concepts of the SCT is self-efficacy. Self-efficacy is the ability to believe that one is capable of performing a certain behavior (Abood et al., 2004). According to a renowned psychologist and researcher in the area of SCT, Albert Bandura, being knowledgeable of health risks and benefits helps initiate change; however for most people additional self influences, such as believing in ones' ability to change are needed to adopt new lifestyle habits (Bandura, 2004).

A study conducted by Abood et al. (2004) utilized the SCT in designing a nutrition intervention for a sample of female collegiate athletes. One of the main focuses of the intervention was to increase self-efficacy for making dietary choices by incorporating in-class activities, such as calculating energy requirements and observing positive dietary behaviors from other athletes (Abood et al., 2004). The intervention also incorporated education sessions that focused on specific nutrients athletes usually lack knowledge about, including: inadequate energy intake, low carbohydrate intake, high protein intake, and inadequate intake of certain micronutrients (calcium, zinc, and iron) (Abood et al., 2004). The intervention lasted eight weeks with one, one hour session conducted per week (Abood et al., 2004). Prior to the start and end of the intervention, participants completed a nutrition knowledge and self-efficacy test and a 3-day food record. These instruments were used to evaluate the impact the nutrition intervention had on the athletes' knowledge, self-efficacy toward making healthful choices, and dietary intake (Abood et al., 2004). The finding showed participants who took part in the intervention program to have significantly increased their nutrition knowledge and self-efficacy, along with demonstrating a significant degree of positive dietary changes (Abood et al., 2004).

A similar intervention study utilizing SCT was conducted with college students, but yielded less positive results than the Abood et al., (2004) study (Clifford et al. 2008). Clifford et al. (2008) designed a study to evaluate the impact of a T.V. cooking show on college students' cooking self-efficacy, knowledge, attitudes, and behaviors regarding fruit and vegetable intake. The study consisted of an intervention that included four 15-minute cooking series shown each week for four consecutive weeks. The study included a pre, post, and follow-up food frequency questionnaire and personal factor survey, which consisted of questions on demographics, knowledge, attitudes, and behaviors related to fruit, vegetables, and cooking. Similar to other previous studies, nutrition knowledge significantly increased in the intervention group, however the intervention group showed no significant change in self-efficacy or dietary intake.

Another behavioral intervention study conducted with children utilized the Theory of Planned Behavior (TPB) as the framework for the intervention (Angelopoulos et al., 2009). This study examined the impact the intervention had on the children's body mass index (BMI), blood pressure, and dietary intakes (Angelopoulos et al., 2009). A 12-month intervention program was implemented, which consisted of 1-2 hour sessions per week that incorporated several motivational methods and strategies to increase knowledge, increase skills and self-efficacy, improve self monitoring, change attitudes and beliefs, and change social influences (Angelopoulos et al., 2009). TPB questionnaires were administered pre and post intervention to the children to identify determinants of their dietary and physical activity behaviors, and fruit, vegetable, dairy and sweet consumption; 3-day food recalls were also collected pre and post intervention to retrieve dietary intakes (Angelopoulos et al., 2009). In conclusion of the intervention, the children showed favorable changes in BMI, blood pressure, and dietary intakes.

The intervention studies reviewed above used different behavioral theories and had very different designs, therefore making it difficult to evaluate techniques used and compare and contrast results. Lippke and Ziegelmann (2008) stated "theories are needed to explain and predict health behavior, as well as for the design and evaluation of interventions." Only three of the reviewed intervention studies based their intervention on a behavioral theory, but had different behavioral outcomes. Tobias (2009) has found that behavior-change campaigns often fail even though the target behavior is easy to perform, the person has a positive attitude toward the behavior, and the person's social surroundings are in support of performing the behavior. A popular explanation for this failure states that habits hinder behavior change (Tobias, 2009). Habits are not the only inhibitor of forming a new behavior, memory has also been found to be an inhibitor as well (Tobias, 2009). Tobias (2009) stated that, "only behaviors that can be remembered without any effort will be performed." And in order for people to change habitual behaviors in a real-world setting, they must be reminded about the new behavior enough times to perform it habitually (Tobias, 2009). Given the limited studies on nutrition knowledge, dietary intakes and other nutrition-related factors among athletes, it is apparent that further research in this area is warranted. There is a strong need for more studies using similar study designs and methodologies, and intervention techniques in order to identify effective ways to increase athletes' nutrition knowledge, improve their dietary intakes and thus optimize their athletic performance.

Sources Athletes Seek to Obtain Nutrition Information

Not every athletic department hires the same professional staff, but the most basic positions are head coaches, athletic trainers, and strength and conditioning coaches. Positions for registered dietitians/nutrition professionals are infrequently seen within athletic departments (Rockwell et al., 2001) and most college campuses do not provide sufficient nutrition education resources to students (Kunkel et al., 2001). This can contribute to the reason why athletes primarily seek nutrition advice from coaches, parents, athletic trainers, teammates, magazines, TV, and the Internet (Benari & Quatromoni, 2008; Douglas & Douglas, 1984; Graves et al., 1991; Short & Short, 1982; Rockwell et al., 2001; Zawila et al., 2003), which may be unreliable or less qualified sources than registered dietitians/nutrition professionals. Unlike dietitians who have received bachelor's degree with course work approved by the Commission for Accreditation of Dietetics Education of the American Dietetic Association (CADE) completed a 1100 hour CADE-accredited supervised dietetic internship program, and passed a national exam administered by the Commission on Dietetic Registration (CDR) to become registered, hold a license through a state medical board in order to practice, and obtain 75 hours of continuing education credit every 5 years to maintain registration (ADA: information sheet, 2009); certified athletic trainers are only required to complete one formal nutrition course (National Athletic Trainers' Association (NATA), 2009), and sport coaches have no minimum requirements which have to be met (Rockwell et al., 2001). Registered dietitians who specialize in sports nutrition can even take their credentials and expertise a step further by taking an exam to become Board Certified as a Specialist in Sports Dietetics (CSSD), and may be the best resource for competitive athletes to seek out (Clark, 2007).

In past studies, athletes have identified parents as their primary source for nutrition information (Douglas & Douglas, 1984; Graves et al., 1991; Parr, Porter, & Hodgson, 1984) and media used as a secondary source to retrieve nutrition information (Parr et al., 1984; Short & Short, 1984). The findings of a more recent study conducted by Shifflett et al.; (2002) supports the earlier findings that parents are the primary source of nutrition information and also shows coaches as the second most sought out source for nutrition information. However, Burns et al. (2004) found athletic trainers to be the primary source of nutrition information for Division I college athletes at 39.8%, followed by strength and conditioning coaches at 23.7%, and then dietitians at 14%. Another study reported the top four nutrition information resources for female college runners were magazines, parents, coaches, and teammates (Zawila et al., 2003).

Several studies have examined the nutrition knowledge among athletic trainers, team coaches, strength and conditioning coaches, and athletes. Findings by Shifflett et al. (2002) showed certified athletic trainers to be more familiar with sport nutrition issues by averaging a 74% on the study’s nutrition knowledge survey, compared to coaches who on average, answered 64% of the questions correctly, and athletes, with 55% correct responses; however an analysis of missed questions concluded, basic nutrition principles were not well understood amongst any one of the three groups. Graves et al. (1991) also analyzed nutrition knowledge scores among both coaches and athletic trainers and concluded a lack of nutrition knowledge existed in both groups due to low test scores. Nutrition knowledge scores compiled by Rockwell et al. (2001) were similar to the ones reported by Graves et al. (1991) and Shifflett et al. (2002); however strength and conditioning coaches in the study gave significantly more correct responses than team coaches and athletic trainers. It was also found in the study that coaches and trainers with knowledge of and/or access to dietitian services did not take full advantage of such expertise (Rockwell et al., 2001).

Based on the studies covered, it is obvious athletes seek out more unreliable sources than reliable for nutrition information, but this should be of no surprise when majority of athletes do not have or do not know they have access to registered dietitians/qualified nutrition professionals or there is a lack of nutrition educational resources to improve their dietary knowledge (Rockwell et al., 2001). Understandably, this has raised some concern among researchers because athletes may be receiving misleading and potentially harmful nutrition information (Corely, Demarest-Litchford, & Bazzarre, 1990; Grandjean et al., 1981; Parr et al., 1984; Benari & Quatromoni, 2008).

Summary

The majority of the current research on nutrition knowledge among collegiate athletes has come to one similar conclusion; athletes lack certain degrees of basic nutrition knowledge (Dunn et al., 2007; Rash et al., 2008; Rosenbloom et al., 2004; Zawila et al., 2003). Most commonly, athletes appear to lack knowledge about macronutrient needs, primary functions carried out by macronutrients, vitamins and minerals, and proper supplement use (Jacobson & Aldana, 1992; Rash et al., 2008; Rosenbloom et al., 2004). Researchers have recognized the knowledge deficit among this population and have designed studies to address these issues in hopes of improving nutrition knowledge and behaviors. However, the correlation between nutrition knowledge and nutrition behaviors is controversial. It is not clear if knowledge is a good predictor of a person's behaviors (Neill et al., 2000). Past studies conducted on athletes have shown both a positive correlation between knowledge and quality of dietary intake and no correlation between knowledge and quality of dietary intake (Nichols et al., 2005; Rach et al., 2007). This is why the main purpose of this study is to analyze the impact a nutrition education intervention has on collegiate athletes' nutrition knowledge and dietary intakes. By conducting this study it will help add to the limited research literature and provide more consistency to whether nutrition knowledge correlates with dietary behaviors.

CHAPTER III

METHODOLOGY

Study Design and Participant Recruitment

The study's design is reflective of a "classic design for exploring cause-and-effect relationships", the pretest-posttest randomized control group design (Patten, 2009). Approval was obtained from both the Oklahoma State University Institutional Review Board (IRB) and Oklahoma State University (OSU) Athletics Department, before the study was launched. The recruiting process entailed announcements made before or after team practices by recruiters, which included the primary investigator, athletic trainers, and strength and conditioning coaches. The recruiters informed student-athletes about the study, along with posting informational flyers (Appendix A) in the OSU athletic training and weight lifting facilities. In order for student-athletes to qualify for the study, they had to be a member of an OSU collegiate athletic team, be 18 years or older, and provide a written consent to participate (Appendix B). The recruiters administered informed consent forms to student-athletes who showed interest in participating in the study. Student-athletes were given time to read through the consent form, ask questions, sign, date, and return it before the deadline date. It was conveyed to the student-athletes that their potential participation in the study would be on a voluntary basis only and no punishments or repercussions would be enforced for the athletes who chose not to or could not finish the study due to competition/training requirements, class schedules, personal reasons, and/or other time conflicts. The consent form also informed student-athletes about the study's confidentiality policy that any information obtained from participants would be kept confidential and could only be viewed by the study's primary investigator and the primary investigator's advisor. On the back of each consent form was a time availability sheet for participants to mark times and days in which they were available for one hour blocks during the week in order to help the primary investigator schedule meetings with the participants.

Pre Test Data Collection

After the recruitment process was completed, a total of 38 participants signed up for the study. The first meeting was scheduled for all 38 participants to complete a pre test nutrition knowledge survey. Participants were given up to 30 minutes to complete the survey and were asked to turn the completed survey directly to the primary investigator. The primary investigator stayed in the area where participants were taking the survey to be available to clarify any questions and to monitor participants. Each survey contained an ID number which participants where directed to record before turning in their survey. The primary investigator informed participants that for confidentiality purposes they would be referred to as their ID number instead of name. In addition to the nutrition knowledge survey completion, all participants were also asked to record their dietary intake for 3 days. The 3-day food records were distributed to all participants at the meeting and instructions provided to participants were explained thoroughly by the primary investigator. Pictures of portion sizes were attached to the food records to better ensure accuracy of recorded intake by participants and the analysis of their intake by the primary investigator. The participants were asked to directly return their completed food records in the provided envelope sealed (identified by their ID number) to the primary investigator within the next 7 days or to one of the recruiters in the athletic department. In order to analyze participants' pre-intervention 3-day food records, self reported height, weight, birth date, and race were obtained from each participant.

After the first meeting, the participants were randomly assigned to either the control or intervention group. The participants' ID numbers were randomly chosen from a hat and each athlete was assigned to either the intervention (I) group or control (C) group. The participants were notified about their group assignment through email on the following day and were given further instruction about their participation in the study. The intervention group was asked to attend one intervention session per week, approximately 1 hour in length, for 5 consecutive weeks. The control group was contacted after the 5-week nutrition education intervention was completed and the participants were asked to attend an hour-long meeting where post test data were collected. The control group participants were also given the opportunity to participate in the nutrition education intervention during the following semester.

The Nutrition Education Intervention

The first session of the nutrition education intervention took place one week following the first meeting and each week thereafter for a total of five consecutive weeks. The intervention participants were given the option of attending each session on one of two days during each week in order to accommodate their hectic schedules. The primary investigator conducted all intervention sessions and instructed the intervention group to keep all knowledge and intervention materials confidential from the control group participants. The nutrition education intervention focused on the most common nutrition issues athletes deal with on a daily basis. The intervention utilized fourteen of the twenty nutrition topics from the RK TeamNutrition collegiate and adult nutrition manual “Keys for Performance: Sports Nutrition Series 1” (2008). The manual was developed by the two certified sports dietitians (Rockwell and Kundrat, 2008) and it specifically targets competitive athletes and nutrition professionals working with this unique population. Due to time constraints, a limited number of nutrition-related issues were covered during the intervention. The topics (See Table 1) were selected based on the results of existing studies with athletic populations that have determined which nutrition issues athletes struggle with most frequently. Examples of such issues are inadequate energy intake and carbohydrate intakes, protein and fat misconceptions, misuse of dietary supplements, dehydration, and lack of knowledge about healthy weight management (Abood et al., 2004; Collison et al., 1996; Jacobson et al., 2001; Nichols et al., 2005; Rash et al., 2007; Rosenbloom et al., 2002).

The intervention consisted of different teaching techniques that were used successfully in previous intervention studies such as lecture, group activities (i.e. reading food labels, calculating calorie and macronutrient needs), food demonstration (i.e. using food provided to create a recovery snack using the 1-2-3 approach), reward activities (i.e. calculating energy needs review game and Nutrition Jeopardy: individuals who answered the most questions correctly were rewarded) , and case studies (Abood et al., 2004; Chapman et al., 1997; Clifford et al., 2009; Collison et al., 1996). In addition, hands-on activities were included in the intervention in order to increase the participants’ self-efficacy for improving their dietary intake (i.e. calculating your own calorie and macronutrient needs) (Abood et al., 2004; Clifford et al., 2009). At the end of each session the intervention participants received the manual handouts covered to help increase memory retention. Below is a summary of the nutrition topics that were covered each week during the intervention (See Table 1) and a more detailed summary is located in appendices (Appendix E).

Table 1. Sports nutrition education intervention topics

Sports Nutrition Education Intervention Topics	
Week 1	Sport Fuel -1.02, Determining Calorie Needs-1.03, Protein-1.04, Carbohydrates-1.05, and Fat-1.06
Week 2	Fluids and Hydration-1.07 and Sports Drinks, Bars, and Gels-1.08
Week 3	Pre-Competition Nutrition -1.09 and Recovery Nutrition-1.10
Week 4	Vitamin and Mineral for Athletes-1.11, Dietary Supplement Overview-1.18, Popular Sports Supplements-1.19
Week 5	Weight Loss-1.14 and Weight Gain-1.15

Post Test Data Collection

After the completion of the last intervention session, all participants were contacted to attend the final meeting of the study. During the meeting, all participants completed the post nutrition knowledge survey. After the completion of the survey, the participants were handed the 2^{nd} and final 3-day food record to complete. They were given the same instructions as at pre test and they were asked to complete and return the food records in a sealed envelope to the primary investigator or the recruiters within one week. In order to analyze participants' post-intervention 3-day food records, self reported height, weight, and birth date were obtained at the last meeting. Participants who belonged to the control group were reminded again they would have the opportunity to participate in the nutrition education intervention in the spring semester of 2009 if they wanted to receive the nutrition education material the intervention group received.

Research Instruments and Study Variables

Sports Nutrition Knowledge Survey

The nutrition knowledge survey (Appendix C) consisted of two questions pertaining to prior exposure of the participants to nutrition education either in the form of nutrition courses or nutrition workshops. The survey also included thirty quantitative questions pertaining to knowledge on various nutrition-related and sports nutrition-related topics. The nutrition knowledge content of the survey instrument was created by the primary investigator reflecting the topics to be covered in the nutrition education intervention. Individual questions were derived from the nutrition education materials of the RK TeamNutrition collegiate and adult nutrition manual "Keys for Performance: Sports Nutrition Series 1", developed by Rockwell and Kundrat (2008). The primary investigator received verbal permission from both authors of the manual to use the materials as the primary teaching tool in the study, as well as permission to utilize information from the manual to develop the nutrition knowledge survey instrument. In addition to the two authors of the RK sports nutrition manual, one nutrition faculty member reviewed the knowledge instrument for face and content validity prior to the study. Face validity is determined by a superficial inspection of an instrument to see if the instrument appears to measure what it proposes to measure (Patten, 2009). Content validity is determined by the appropriateness of the instrument's contents to what it proposes to measure (Patten, 2009).

3-Day Food Record

Dietary intakes of athletes were estimated using a 3-day food record instrument (Appendix D). From the 3-day food records, the primary investigator estimated participants' total energy, protein, carbohydrate, and fat intakes using the Diet Analysis Plus 8.0.1 software system (Webb et al., 2007). This nutrition software system contains a food database with more than 20,000 foods and beverages, including sports bars and other products specifically designed for athletes. The software determines individual's energy and nutrient needs based on the following variables: height, weight, age, sex, and activity level (Webb et al., 2007). All participants' activity level was estimated as "very active", which consisted of intense athletic training 5-7 days per week (Webb et al., 2007). All participants were categorized as "meeting their dietary recommendations" or "not meeting their dietary recommendations."

The recommendations for each athlete were established using the current Dietary Reference Intakes (DRIs) estimated energy requirements (EER) and specific sports nutrition recommendations for carbohydrates, protein and fat intakes (DRI, 2002; ADA, 2009). EER is "the average dietary energy intake that is predicted to maintain energy balance in a healthy adult of a defined age, gender, weight, height, and level of physical activity consistent with good health" (Mahan & Escott-Stump, 2004). Participants' total energy intakes were compared to their EER for total energy intake. Protein recommendation for each participant was established at 1.2 gram per kilogram of body weight per day which is the lowest recommendation for protein intake for athletes (ADA, 2009). Carbohydrate recommendation for each athlete was established at 5 grams per kilogram of body weight which is the lowest recommendation for carbohydrate intake for athletes (Williams, 2007). Fat recommendation was established at 30% of actual intake, which falls within the 20%-35% of total energy needs from fat recommendation established by the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine 2009 position paper on nutrition and athletic performance (ADA, 2009).

Data Analysis

To analyze the data, SPSS 16.0 statistical software for Windows (SPSS, Inc; Chicago, IL) was used. In order to compare sports nutrition knowledge scores between the intervention group and control group at pre test and post test, independent-t tests were conducted. The pre test and post test sports nutrition knowledge scores within the intervention and control group were compared using paired t-tests. The participants' reported total energy, carbohydrate, protein and fat intake were estimated using the 3-day food records and compared to the participants' dietary recommendations for energy, carbohydrates, protein and fat. Paired t-tests were conducted to compare the participants' pre and post dietary intakes to their pre and post dietary recommendations within the intervention and control group. The level of significance for all statistical tests was set at $p < 0.05$.

CHAPTER IV

FINDINGS

Demographic and Anthropometric Characteristics of the Sample

The study started with 38 participants, including 18 intervention and 18 control participants. The final analysis was conducted with 32 participants. Six participants were excluded from the final analyses because they did not participate in at least 75% of the study's activities. Of the 32 participants, 26 were females (81%) and 6 males (19%), 75% were White, 3% African American, 3% Native American, and 3% Asian, 6% Hispanic, and 9% other (Table 2). Other demographics such as age (yrs) ($p=0.583$), weight (kg) ($p=0.969$), and height (cm) ($p=0.975$) were similar between the intervention group and control group (Table 2). Over half of the participants in both the intervention group (56%) and in the control group (64%) received some type of nutrition information either by participating in a nutrition workshop and/or by taking a college nutrition-related course while attending college (Table 3). The study participants were athletes from several collegiate sport teams, including baseball, cross country (cc), equestrian (equest), soccer, softball, tennis, track and field (track), and wrestling (wrest) (Figure 1).

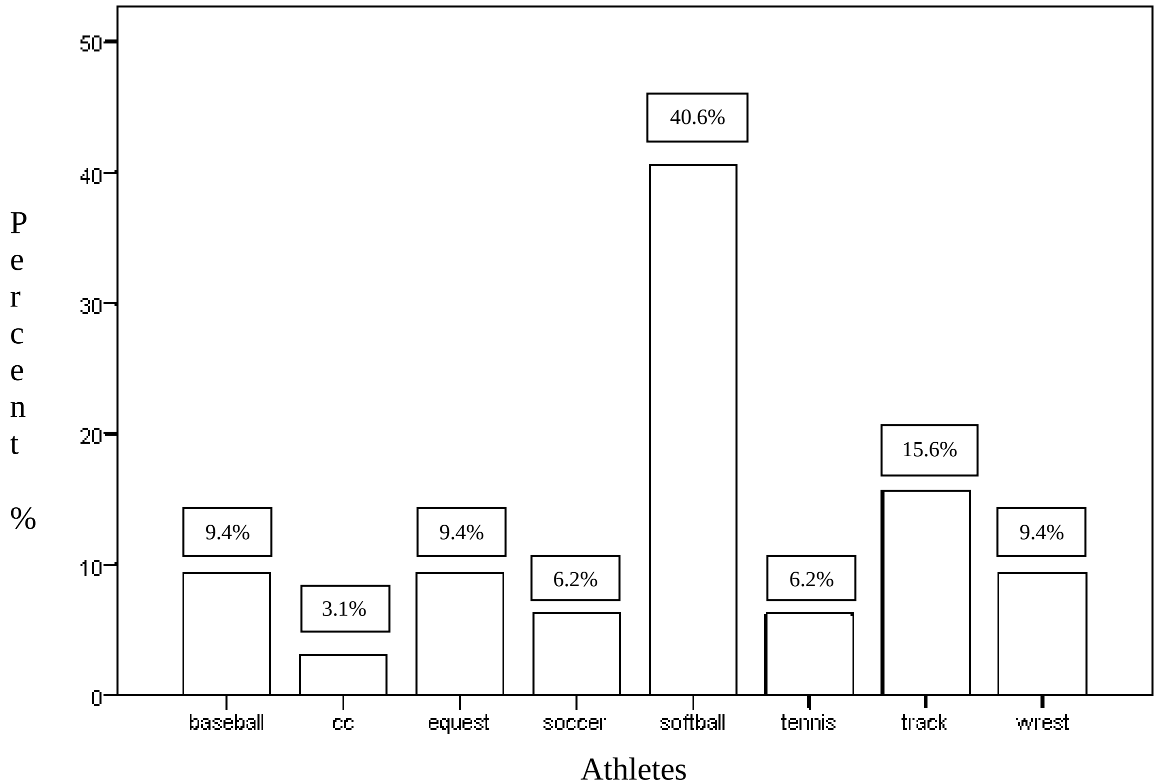
Table 2. Demographics and anthropometric characteristics of the study's participants

Variable	Intervention (n=18)	Control (n=14)	Total (n=32)
Demographic	%	%	%
Gender			
Male	22	14	19
Female	77	86	81
Ethnicity			
White	77	71	75
African American	5	0	3
Hispanic	11	0	6
Native American	0	7	3
Asian	0	7	3
Other	5	14	9
	Mean ± SD	Mean ± SD	Mean ± SD
Age (yrs)	19.61±1.38	19.35±1.15	19.50±1.27
Pre-Weight (kg)	69.57±11.13	69.42±10.02	69.50±10.49
Post-Weight (kg)	69.42±11.09	69.64±10.17	69.52±10.53
Height (in)	67.61±2.83	67.64±2.93	67.63±2.83

Table 3. Proportion of the participants who received some type of nutrition information while in college

Variable	Intervention (n=18)	Control (n=14)
Prior Nutrition Education	%	%
Nutrition-Related Course	22	28
Nutrition Workshop	33	36
Total	**55**	**64**

Figure 1. Proportion of different types of athletes represented in the study sample



Pre and Post Nutrition Knowledge Survey

At pre test, athletes in the intervention group (n=18) answered 55% of the 30 questions correctly on the sports nutrition knowledge survey, while the control group (n=14) answered 53% of the 30 questions correctly. Together, the participants answered 54% of the survey questions correctly. Individual raw scores of the participants for the pre and post sports nutrition knowledge survey are listed in Table 4. An independent t-test was conducted to compare nutrition knowledge between the intervention group and control group at pre test. The result indicated no significant difference (p=0.758) in sports nutrition knowledge scores between the control group and the intervention group (Table 5) at pre test. This result fails to reject the first null hypothesis of the study: "There will be no significant difference in nutrition knowledge between the intervention group and the control group at pre test."

An independent t-test was conducted to compare nutrition knowledge between the control and intervention groups at post test. The results indicated that the intervention group's post intervention nutrition knowledge was significantly higher ($p=0.000$) compared to the control group's post intervention nutrition knowledge (Table 5). This finding rejected the second null hypothesis of the study which states: "After the completion of a five-week sports nutrition education intervention (at post test), there will be no significant difference in nutrition knowledge between the intervention and control group."

Paired t-tests were used to compare nutrition knowledge change within the intervention group and control group from pre test to post test. After the conclusion of the 5-week sports nutrition education intervention, the intervention group improved their sports nutrition knowledge score by answering 86% of the 30 questions of the sports nutrition knowledge survey correctly, which was significantly higher ($p=0.008$) compared to 55% that the participants answered correctly at pre test (Table 5). This finding rejected the third null hypothesis of the study which states: "There will be no significant increase in nutrition knowledge (after the completion of a five-week sports nutrition education intervention) within the intervention group from pre test to post test."

In contrast, the sports nutrition knowledge scores remained similar ($p=0.651$) in the control group from pre test to post test (Table 5), with the participants answering only 52% of the questions correctly at post test compared to 53% at pre test. Because there was no significant difference in the pre and post test nutrition knowledge within the control group, we failed to reject the fourth null hypothesis which states: “There will be no significant difference in nutrition knowledge within the control group from pre test to post test.”

Table 4. Raw sports nutrition knowledge pre and post survey scores for each participant of the study

Participant's ID Number	Group*	Pretest Score (%)	Posttest Score (%)
1	I	56.67	86.67
2	I	43.00	73.33
3	I	80.00	100.00
4	C	66.67	80.00
5	C	53.57	40.00
6	C	36.67	33.33
7	I	56.67	90.00
8	I	53.33	80.00
9	C	46.67	46.67
10	I	40.00	76.67
12	C	70.00	70.00
14	I	50.00	83.33
15	C	40.00	30.00
16	I	62.07	80.00
17	I	63.33	93.33
18	I	70.00	93.33
19	C	66.67	63.33
20	I	46.67	86.67
21	I	40.00	80.00
22	I	50.00	90.00
23	C	46.67	26.67
24	I	66.67	96.67
25	C	50.00	43.33
26	C	56.67	63.33
27	C	53.33	66.67
29	C	53.33	50.00
30	I	40.00	96.67
31	C	50.00	50.00
32	I	60.00	96.67
33	C	56.67	66.67
35	I	60.00	93.33
36	I	43.33	56.67

*I = Intervention Group; C = Control Group; Scores are based on the percent questions answered correctly out of a total of 30 questions.

Table 5. Nutrition knowledge scores

Time of Measurement	Intervention (n=18) Mean ± SD	Control (n=14) Mean ± SD	P-value [b]
Pretest (%)	54.54±11.46	53.35±9.70	0.758
Posttest (%)	86.30±10.72	52.14±16.47	0.000
P-Value [a]	0.008	0.651	

[a] Comparison of the pre and post nutrition knowledge scores within the intervention and control group utilizing paired t-test
[b] Comparison of the pre and post nutrition knowledge scores between the intervention and control group utilizing independent t-test

Dietary Intakes of the Participants

At pre test, all participants were asked to complete a 3-day food record. 100% of both the intervention (n=18) and control (n=14) participants completed and turned in the food records. After the completion of the nutrition education intervention, 11 out of the 18 (61%) intervention participants and 12 out of 14 (86%) control participants completed and turned in a post intervention 3-day food record. Paired t-tests were used to compare the intervention group's pre and post dietary intakes (total energy, carbohydrate, protein, and fat) to their pre and post dietary recommendations. The paired t-tests were also used to compare the control group's pre and post dietary intakes to their pre and post test dietary recommendations. The intervention group and control group significantly under consumed total energy intake compared to their total energy intake recommendation both at pre test ($p=0.000$, $p=0.000$) and post test ($p=0.000$, $p=0.011$). However, there were no other statistically significant differences between carbohydrate, protein, or fat intakes and the recommendations within the intervention group and control group at pre and post test. The fifth null hypothesis formulated was thus partly rejected: "At pre test, there will be no significant difference in the intervention group's dietary intakes for energy intake, carbohydrate intake, protein intake and fat intake compared to their dietary recommendation for energy, carbohydrate, protein, and fat." The results also partly rejected the sixth null hypothesis formulated: "At post test, there will be no significant difference in the intervention group's dietary intakes for energy intake, carbohydrate intake, protein intake and fat intake compared to their dietary recommendation for energy, carbohydrate, protein, and fat." These hypotheses were partly rejected because intervention participants both at pre and post test significantly under consumed total energy intake compared to their recommended total energy intake, however had no other significant differences between pre and post test carbohydrate, protein, and fat intakes compared to their carbohydrate, protein, and fat recommendations.

CHAPTER V

CONCLUSION

This study's main purpose was to determine if a five-week sports nutrition education intervention based on the materials from the sports nutrition manual "Keys for Performance" (Rockwell & Kundrat, 2008) may positively impact sports nutrition knowledge in a sample of collegiate athletes. The second purpose of this study was to determine whether the sports nutrition education intervention may positively impact athletes' intakes of total energy, carbohydrates, protein and fat. Given the lack of research on nutrition knowledge, dietary intakes, and potential impacts of nutrition education interventions on knowledge and dietary behaviors among collegiate athletes and athletes in general, the study contributes significantly to the existing literature.

Nutrition Knowledge Summary

The average nutrition knowledge score the athletes in the study answered correctly in both groups combined was 54% at pre test. This result suggests student-athletes at this division I university had poor sports nutrition knowledge at the beginning of the study. However, after the conclusion of the 5-week sports nutrition education intervention, the athletes in the intervention group had significantly ($p=0.036$) greater nutrition knowledge compared to the athletes in the control group and they significantly ($p= 0.008$) increased their own nutrition knowledge from pre test to post test. Based on these results, it appears that the 5-week sports nutrition education intervention had a positive impact on the nutrition knowledge of the collegiate athletes that participated in the study.

The results of this study are consistent with the findings of several previous studies that implemented a nutrition education intervention with athletes. Collison and colleagues (1996), Chapman and colleagues (1997), Abood and colleagues (2004), and Clifford and colleagues (2009) all reported significant increase in nutrition knowledge among the participants who participated in the nutrition education intervention. Thus, the results of our study provide further evidence that nutrition education interventions may be effective tools for increasing athletes' nutrition knowledge.

Several factors may have contributed to the success of the sports nutrition education intervention in increasing nutrition knowledge among the participating athletes. First, there was a 100 % attendance rate among the intervention group for the entire five week intervention. The unusually high attendance rate could be contributed to careful scheduling of the intervention sessions (e.g., schedule each weekly meeting at two different times each week so participants can choose; use the least busy days such as Sunday and Monday evenings; sending reminders through email and text message about the meetings). Second, a variety of teaching techniques was incorporated into the intervention sessions (e.g. lectures, group activities, hands-on activities, demonstrations, and games) in order to capture the participants' attention, stimulate their motivation and engage them actively in the learning process. Finally, the utilization of the RK TeamNutrition educational materials proved to be effective in increasing the participants' knowledge of sports nutrition due to their clear, concise and organized content.

The Relationship between Nutrition Knowledge and Dietary Intakes

Participants' dietary intakes (total energy, carbohydrate, protein, and fat) were examined pre and post test and compared to the dietary intake standards that where established based on the needs of this unique population. While all the participants (n=32) turned in their pre test dietary records, only 61% (n=11) of the intervention group and 85% (n=12) of the control group turned in their post test dietary records. The results of the study showed that neither the intervention or control group significantly improved their dietary intakes toward their dietary recommendations for total energy, carbohydrates, protein or fat after the conclusion of the 5-week nutrition education intervention. Thus, the participants in the intervention group failed to improve their dietary intakes even though they attended the 5-week nutrition education intervention. Although no statistically significant differences between intakes and recommendations, except in energy intakes, were found between pre and post test, interesting trends were identified in our study. For example, at pre test 11 intervention participants did not meet their carbohydrate recommendation and 12 intervention participants did not meet their protein recommendations. In contrast, more than half of the intervention participants met their fat intake at pre test. At post test, only one intervention participant met his/her carbohydrate recommendation and only 3 met their protein needs. Similarly to pre test, the majority of athletes met their recommended fat intake. Even though the results were not significant, it is evident these athletes had a difficult time meeting their carbohydrate and protein needs.

The results from this study coincide with several previous intervention studies with athletes and college students. Studies conducted by Chapman and colleagues (1997), Collison and colleagues (1996), and Clifford and colleagues (2009) all found a significant increase in nutrition knowledge post intervention, but found no significant positive changes toward dietary intake among the participants post intervention. These interventions are very different from one another and from the current study, making it difficult to directly evaluate the results of these studies. Comparing the current study to the studies conducted by Chapman et al. (1997), Collison et al. (1996), and Clifford et al. (2009) the length of the studies' interventions were all different ranging from 2 days to 5 weeks, as well as differences in the education material presented in the interventions differed, teaching techniques differed, delivery methods, instruments used to measure knowledge and dietary intakes, as well as the population that each study targeted. Because there are so many differences between the studies it is extremely difficult to compare the results and analyze the methods used to determine which ones were effective and which ones were not.

While several of the nutrition knowledge intervention studies with athletes resulted in similar findings, there is some evidence that an intervention may lead to a positive change not only in nutrition knowledge but also in dietary behavior. Abood and colleagues (2004) implemented a sports nutrition education intervention that was designed using the Social Cognitive Theory (SCT) to help increase participants' self-efficacy which in turns helps achieve changes in behavior. The intervention was made up of 8 1-hour educational sessions that were conducted on a weekly basis. After the sports nutrition education intervention was concluded, intervention participants' showed a significant number of positive dietary changes, such as increasing total energy, carbohydrate, protein, calcium, iron, and zinc intake (Abood et al., 2004). Even though the current study did not specifically use the SCT to design its intervention, it did incorporate aspects of the SCT into its intervention, such as hands-on activities (e.g. calculating one's energy, carbohydrate, protein, and fat needs and choosing appropriate recovery snacks based on the 1-2-3 approach) to increase participants' self-efficacy. Also, the lengths of the interventions where different, Abood et al., (2004) intervention was a total of 8 weeks, whereas this study's intervention was a total of 5 weeks.

Another intervention study that incorporated a behavioral theory showed positive behavioral changes in children after a 1-year school-based intervention program (Angelopoulos et al., 2009). The intervention program was based on the Theory of Planned Behavior (TPB), and showed favorable changes in the children's blood pressure and body mass index (Angelopoulos et al., 2009). These favorable changes were explained through the improvements in the children's dietary intakes by increasing fruit consumption and lowering fats/oils and sweets/beverages consumption (Angelopoulos et al., 2009). Comparing Angelopoulos et al., (2009) study with the current study, intervention lengths are much different and the current study's intervention was not based on a behavioral theory.

For future research, designing a nutrition education intervention based on a behavioral theory may be more successful in changing dietary behavior along with increasing nutrition knowledge than the current study's intervention design. It is important to note before designing an intervention based on a behavioral theory that it is feasible to carry out. It is important to make sure enough time is available to conduct all aspects of the behavioral theory, a variety of resources are available, and the environment is supportive of the intervention. For this study, we could have incorporated more behavioral theory based concepts if more time and resources were available.

Given the limited number of studies on nutrition knowledge and dietary behaviors with athletes and the fact that these studies utilized different samples and methodologies (e.g. females or males only, intervention length ranging from 2 days to 1 year), it is difficult to compare and evaluate the results of the current study to previous studies. The current study's methodologies could have contributed to the failure of improving dietary intakes among the athletes. First, the study's intervention was relatively short and may have been a reason why dietary intakes among the athletes were not impacted. The original intervention was designed to be eight weeks in length, but due to time constraints three weeks were eliminated from the intervention, making it only 5 weeks in length. Second, the time between the intervention meetings was fairly long. Only one, approximately 1 hour meeting was scheduled each week for five weeks during the intervention, which could have been too much time between meetings to reinforce what was previously learned to develop it into a behavior. Third, the intervention might not have been as effective on supporting behavioral changes because it was not specifically designed based on a behavioral theory, such as the SCT. Finally, the intervention may have not been effective in impacting participants' memory because the short length of the intervention and fairly long length between each meeting. Tobias (2009) mentioned that in order to change or discard a habitual behavior, memory retention and reminders of a new behavior are essential.

Limitations

There were several limitations in the present study. First, the study's sample only came from one NCAA Division I public university; therefore, the study's results cannot be generalized to other populations or different groups within the athlete population without further research. Second, the small sample utilized in the study did not represent the entire athletic entity at the university where the study was conducted. The sample size did not contain participants from each collegiate sport at the targeted university and did not contain an even number of female and male participants. Third, only a limited number of the participants completed the final 3-day food record which may have skewed the final results on dietary intakes. Finally, the intervention sessions were delivered to the participants without any type of technology and the participants were asked to follow the presenter using hard copies of the educational handouts. The absence of technology limited the creativity and visual entertainment that would have otherwise been used during the intervention sessions and that could have positively influence the participants' attention, motivation and participation in the study.

Recommendations for Practice and Future Research

Collegiate athletes are highly trained individuals who have to follow a rigorous training and competition schedule in order to improve athletic performance. However, being highly trained is just one component of reaching one's full athletic potential. It is vital for athletes to combine their rigorous training and competition schedules with a sound diet to reach a peak performance level. Collegiate athletic departments are usually not short on coaches and trainers, but it is uncommon to see a nutrition expert such as a registered dietitian on staff, which is concerning because athletes are known to have poor nutrition knowledge, practice poor nutrition behaviors, and seek out sources that are not credible. If athletic institutions would invest in hiring or consulting a nutrition expert for their athletes, these areas of concerns could properly be handled by a professional through implementing nutrition education programs/workshops, individual nutrition consulting, providing nutrition education material, and being a credible resource available to athletes. Below are several recommendations for research professionals, nutrition experts, and athletic administrators who are interested in developing a sports nutrition education intervention based on the results of this study:

- Each athlete has different nutritional demands. In order for these demands to be met it is important to provide services that can create nutrition plans catered to each athlete’s nutritional needs. It is vital for collegiate athletic departments to invest in creating positions that provide such services by employing a registered dietitian.
- Athletes in general have poor nutrition knowledge, practice poor nutrition behaviors, and seek out unreliable nutrition sources. Collegiate athletic departments also need to look at addressing these common concerns among athletes through employing a registered dietitian to increase nutrition knowledge, improve dietary practices, and be available as a credible nutrition resource.
- Designing the sports nutrition education intervention based on one of the existing behavioral theory models may result not only in increased nutrition knowledge but also in improved dietary behaviors among athletes.

- Since memory has been known to impact behavioral changes, creating an intervention that reinforces information learned on a daily basis through some type of contact with participants through technology (i.e. email, text message) or face-to-face may be more successful at changing dietary behaviors.
- Even though this study did have male participants, conducting a sports nutrition education intervention study with a large sample of male and female athletes would allow for gender comparisons and thus would result in further knowledge on how to improve nutrition knowledge and dietary intakes among both male and female collegiate athletes.
- For this study there was no access to technology during the intervention, limiting the way the educational material and activities were presented. Having access to technology for the intervention may help present education material and nutrition concepts more effectively through visual aids and entertainment.
- Future studies need to investigate lengths of interventions or total time spent in which are effective in changing both nutrition knowledge and dietary intakes of athletes.

There are many different factors that can impact an athlete's knowledge and dietary behaviors. These factors need to be investigated extensively to identify which positively impact both collegiate athletes' nutrition knowledge and dietary practices. It is known that athletes often lack basic nutrition knowledge and practice poor dietary behaviors prior to entering into college (Chapman et al., 1997; Dunn et al., 2007) and continue to lack nutrition knowledge and practice poor dietary behaviors throughout their collegiate athletic careers (Dunn et al., 2007; Jacobson et al., 2001; Rosenbloom et al., 2002). This provides evidence that athletes are not learning about or utilizing proper sports nutrition information prior to and during college. As discussed earlier, very few collegiate athletic departments employ a nutrition professional such as a registered dietitian, which may be a reason why nutrition deficits and poor nutrition practices are commonly seen among this population. It is important to continue to promote and support the need for nutrition professionals within collegiate athletic departments to address these concerns and provide athletes with knowledge and resources to become the best athlete possible.

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APPENDICES

APPENDIX A

Recruitment Flyer

Nutrition Workshop

Do you want to learn more about sports nutrition??

Here's your chance to:

- **Receive free sports nutrition material from the RK Team Nutrition manual "Keys for Performance"!**
- **Optimize your performance during training and competition!**
- **Stay healthy and injury free!**
- **Learn how to utilize nutrition skills and knowledge to make you a better athlete!**

The Department of Nutritional Sciences (OSU) is conducting a study on the effects of sports nutrition education on collegiate athletes. If you are interested in participating in the study, please talk with your athletic trainer or strength and conditioning coach and they will provide you with a consent form to complete for the study.

For additional information or questions please contact Lindsay Brown RD/PLD: 405-612-0051, lindsay.brown@okstate.edu

Sign-up Today!!

APPENDIX B
Informed Consent for Participants

Project Title: The Effects of Nutrition Education on Collegiate Athletes
Project Leaders: Lindsay Brown, RD; Lenka Shriver, PhD

Lindsay Brown RD/PLD, graduate student in nutritional sciences, and primary investigator of this study and Dr. Lenka Shriver, primary investigator's advisor, are asking you to participate in a study measuring the effects of nutrition education on collegiate athletes. We are asking you to volunteer to participate because you are an OSU student athlete who is 18 years of age or older. The study will assess nutrition knowledge and dietary intake changes among the athletes throughout study. The purpose of this research project is to determine whether OSU male and female athletes benefit in terms of nutrition knowledge and dietary intake from nutrition education sessions, determine if the materials presented are affective in increasing nutrition knowledge, and help contribute research literature to an area of nutrition that currently has very little existing research literature.

You will be invited to make one visit per week for 7 consecutive weeks to an available room in Gallagher Iba. Each visit will take approximately 1 hour. The first meeting you will complete a nutrition related survey based on the nutrition material that will be covered during the study and the last meeting you will complete a nutrition related survey after the nutrition sessions have concluded. Each survey will take approximately 30 minutes to complete. After the first meeting there will be five nutrition education sessions that will consist of the presentation of nutrition material from the RK Team

Nutrition Manual “Keys for Performance”. PowerPoint slides, sports nutrition handouts, and group activities involving food and drinks will all be utilized during the study.

The primary investigator will assign participants to the intervention group or control group by randomly drawing assigned ID numbers participants will receive on the first meeting from a hat, half will be placed in the intervention group and half will be placed in the control group. Participants in the intervention group will complete a nutrition related survey during the first meeting, followed by attending one nutrition education session each week for 5 consecutive weeks, and followed up with completing another nutrition related survey after the education sessions have concluded at the last meeting. During the first and last scheduled meetings, the intervention group will be asked to complete a 3-day food record. Instructions on how to complete the 3-day food record will be provided at the first session and be available to the participants to read on the front page of the food record activity. Participants will have one week to complete each record and turn into athletic trainers in a sealed envelope.

Participants in the control group will complete a nutrition related survey at the beginning of the study in 2008 and will be asked to complete another nutrition related survey after the nutrition sessions have concluded. Controlled participants will also be asked to complete a 3-day food record at the beginning of the study and the end of the study and will have one week to turn into athletic trainers in a sealed envelope. Participants in the control group will have to opportunity to participate in the nutrition education sessions offered in the fall to the intervention group in the spring of 2009. More information will be available upon request.

We will protect your confidentiality during the project by assigning you an ID number. The list of all names and corresponding ID numbers will be kept in a locked drawer and only the project leaders will have access to the list and 3-day food records will be given to trainers in a sealed envelope. The completed nutrition surveys and 3-day food records will be kept in a locked draw as well, and only the project leaders will have access to this information. The hard copies of the nutrition surveys and 3-day food records will be stored up to twelve months before being destroyed. Statistical data will be stored on a portable media device (zip drive or CD), to avoid data being accessed on the internet. Project leaders will only have access to this media device. Any reports we prepare from the study will be for grouped data and no individual will be identified. None of the scores will be shared with your coaches and the only people to have access to this information will be the project leaders, but it is possible that the consent process and data collection will be observed by research oversight staff responsible for safeguarding the rights and wellbeing of people who participate in research.

The OSU Institutional Review Board has the authority to inspect consent records and data files to assure compliance with approved procedures. The participation in the study is voluntary. If you feel uncomfortable while reporting any information, you can choose not to answer any question, or to withdraw completely from the study at any time. A decision to withdraw from the study will not result in any loss of benefits to which you are otherwise entitled.

If you have any questions about the study, please contact Lindsay Brown at (405) 612-0051 or lindsay.brown@okstate.edu or Lenka Shriver at (405) 744-8285 or lenka.humenikova@okstate.edu. If you have any questions about your rights as a research participant, you may contact Dr. Shelia Kennison, Institutional Review Board Chair, 218 Cordell Hall, Oklahoma State University, Stillwater, OK 74078 at (405) 744-1676.

DOCUMENTATION OF INFORMED CONSENT

You are voluntarily making a decision whether or not to participate in the research study. Your signature certifies that you have decided to participate having read and understood the information presented. You will be given a copy of this consent form to keep.

I have read and fully understand the consent form. I, ______________________________(print name), agree to participate in the described research.

____ ____________________

Signature Date

____

I certify that I have personally explained this document before requesting that the participant sign it.

____ ____________________

Signature of PI Date

APPENDIX C

Sports Nutrition Knowledge Survey

ID#_____________

Name: _________________________________ **Date:** ____________

Directions: You will have 30 minutes to complete the test. Please circle your answers and turn in when completed.

1. **Athletes should eat ______ per day, regardless of whether their goal is weight loss, weight gain, or weight maintenance.**
   A. 2-3 times
   B. 3-4 times
   C. 5-6 times
   D. 7-8 times

2. **What is the main energy source for working muscles?**
   A. Protein
   B. Carbohydrate
   C. Fat
   D. Electrolytes

3. **What is essential for maintaining and building muscle mass?**
   A. Fat
   B. Electrolytes
   C. Protein
   D. Carbohydrate

4. **What is important for immunity, providing essential fatty acids, and absorbing certain vitamins?**
   A. Fat
   B. Carbohydrate
   C. Protein
   D. Electrolytes

5. **How many calories are in 1 gram of carbohydrate?**
   A. 1
   B. 6
   C. 4
   D. 8

6. **How many calories are in 1 gram of protein?**
   A. 5
   B. 10
   C. 8
   D. 4

7. **How many calories are in 1 gram of fat?**
   A. 9
   B. 12
   C. 6
   D. 4

8. **How many gram/s of protein per pound of body weight is/are recommended to be consumed in order to gain muscle mass?**
   A. 1gram/pound
   B. 2 grams/pound
   C. 0.5 grams/pound
   D. 3 grams/pound

9. **Does an athlete's protein needs increase or decrease when workouts become more vigorous and longer?**
   A. Increase
   B. Decrease

10. **Protein should make up ______ of total daily calories.**
   A. 30-40%
   B. 40-50%
   C. 10-20%
   D. 35-45%

11. **What serves as a good source of fiber and contains many vitamins and minerals?**
   A. Proteins
   B. Carbohydrates
   C. Fats
   D. Water

12. **Carbohydrates should make up ______ of total daily calories.**
   A. 70-80%
   B. 30-40%
   C. 35-45%
   D. 50-65%

13. **The longer the workout, the more the body turns to _____ to recharge and go.**
   A. Carbohydrates
   B. Protein

C. Vitamins
D. Fats

14. Which type of fats raise blood cholesterol levels and can increase risk of cardiovascular disease?

A. Sunflower and Corn Oil
B. Regular Margarines and Shortenings
C. Olive and Peanut Oil
D. Sesame and Safflower Oil

15. Fats should make up _____ of total daily calories.

A. 10-15%
B. 35-40%
C. 40-50%
D. 20-30%

16. How many ounces of fluid does an athlete need to consume every 15-20 minutes of training?

A. 4 ounces
B. 8 ounces
C. 6 ounces
D. 10 ounces

17. How many ounces of fluid needs to be consumed for every pound lost from training?

A. 16 ounces
B. 10 ounces
C. 32 ounces
D. 24 ounces

18. How can an athlete tell if they are properly hydrated?

A. Increase in thirst
B. Urine is clear or light in color
C. Urinate every 4-5 hours
D. Urine is a dark color

19. When should an athlete's main fluid consumption come from a sports drink instead of water?

A. Train or compete for 20 minutes
B. Train or compete for 60 minutes or longer
C. Train or compete for 45 minutes
D. Train or compete for 30 minutes

20. Consume sports drinks that contain ______ grams of carbohydrates per 8 ounces.

A. 10-18 grams
B. 30-35 grams
C. 5-7 grams
D. 2-3 grams

21. Which electrolyte is significantly lost through athletes' sweat?

A. Potassium
B. Calcium
C. Sodium
D. Magnesium

22. How many hours before training or competition should a large meal be consumed?

A. 2-3 hours
B. 1-2 hours
C. 3-4 hours
D. 30 min.-1hour

23. An athlete needs to consume at least 50 grams of carbohydrates and 15 grams of protein within _____ of finishing a workout or competition.

A. 1 hour
B. 30 minutes
C. 2 hours
D. 1.5 hours

24. What sources of iron are best absorbed?

A. Red meat, pork, fish, eggs
B. Leafy green veggies
C. Dried fruits
D. Whole grains, cereals

25. When is it a prime time for an athlete to make changes in their weight and body composition?

A. In-Season
B. Off-Season

26. How many pound/s per week is considered safe to lose for the majority of athletes with weight loss goals?

A. 4-5 pounds/week

B. 1-3 pounds/week
C. 6-7 pounds/week
D. 5-6 pounds/week

27. How many calories burned or consumed are equal to 1 pound?

A. 4500 calories
B. 5000 calories
C. 2500 calories
D. 3500 calories

28. What are excellent food sources of creatine?

A. Salmon and Pork
B. Chicken and Turkey
C. Cheese and Milk
D. Whole Grains and Cereals

29. Does the U.S. government test supplements for safety?

A. Yes
B. No

30. Choose the best recovery snack.

A. 2 bananas and 16 oz of water
B. 1 cup of trail mix and 16 oz of water
C. 24 ounces of flavored sports drink
D. 1 large bagel and 16 oz of sports drink

Comments:____

____

____

____

____

Thank You!

APPENDIX D

3-Day Food Record

ID# ________

3-Day Food Record

This is a great tool to help evaluate your overall diet, but it is extremely important to keep a detailed record that reflects your true intake. Here are some helpful tips for making your record as accurate as possible:

1. Record your dietary intake for 3 days. Be sure to record one weekend day.

2. You will have one week to complete the food record from the time you receive it and turn into your athletic trainer in a sealed envelope.

3. Record **EVERYTHING** you **EAT** and **DRINK**, including water. Be aware of condiments, salad dressings, sauces, and snacks!

4. Record any activity you engage in and the duration.

5. Try to be specific when describing the foods you list such as providing brand names, restaurant names, or submitting a food label if the food is unusual.
   Ex: Instead of recording "bread", record "1 slice of Sara Lee 100% Whole Wheat Bread"

6. Use common objects such as your fist, palm, a tennis ball, Eskimo Joe's cup, handful, etc… or measurements such as tablespoons, teaspoons, cups, ounces, etc…when you are recording the amount of a specific food consumed. You can also refer to the attached food and beverage portion pictures to help in recording your portion amounts.
   Ex: "1 Eskimo Joe's cup full of 2% milk"

7. Try not to alter your normal eating habits.

8. **Do not** record your intake on days that are out of the norm (illness, holiday/special occasion, etc). Instead, record your intake on **typical days!!!** If this is not possible to complete in one week due to the above reasons, inform your trainer and an extension will be granted to complete the record.

3-Day Food Record

Name: ____________________________________ **Date:** __________________

1st Day:

TIME	FOOD	AMOUNT

Record any physical activity engaged in today: ________________Minutes
________________Miles (if applicable)
Type of event/s: __________________________

3-Day Food Record

Name: ______________________________________ Date: ___________________

2nd Day:

TIME	FOOD	AMOUNT

Record any physical activity engaged in today: _______________Minutes
_______________Miles (if applicable)

Type of event/s: ________________________

3-Day Food Record

Name: ____________________________________ **Date:** __________________

3rd Day:

TIME	FOOD	AMOUNT

Record any physical activity engaged in today: ________________Minutes
________________Miles (if applicable)

Type of event/s: _________________________

APPENDIX E

Sports Nutrition Education Intervention Detailed Schedule

I. Week 1
   A. Sports Fuel-1.02
      a. Energy Nutrient Keys
      b. Carbohydrate Overview
      c. Protein Overview
      d. Fat Overview
      e. Warning: Calorie Content in Alcohol
      f. Reading Labels: Group Activity
      g. Bonus Point: Snack Options
   B. Determining Calorie Needs-1.03
      a. Calorie Keys
      b. Warning: Low Calorie Diet
      c. What You Need to Know about Calories
      d. Determining Calorie Needs: Individual Activity
      e. Determining Calorie Needs Examples: Group Activity
      f. Calorie Questions and Answers
   C. Protein-1.04
      a. Protein Keys
      b. What You Need to Know about Protein
      c. Warning: High protein diets
      d. Is Protein Used for Energy?
      e. Calculating Protein Needs: Individual Activity
      f. Protein in Food
      g. Bonus Point: On the Go and In Budget Protein Sources
   D. Carbohydrates-1.05
      a. Carbohydrate Keys
      b. Warning: Low carbohydrate diets
      c. What You Need to Know about Carbohydrates
      d. Carbohydrate Guidelines for Exercise
      e. Calculating Carbohydrate Needs: Individual Activity
      f. Carbohydrate Content in Food
      g. Bonus Point: Carb Loading
   E. Fat-1.06
      a. Fat Keys
      b. Warning: Low fat diet

c. What You Need to Know about Fat
d. Types of Fat
e. Calculating Fat Needs: Individual Activity
f. The Effects of Too Much or Too Little Fat in Diet
g. Bonus Point: Lowfat Fast Food Options

F. Review
a. Calculating Calorie, Carbohydrate, Protein, and Fat Needs Game: Reward Activity

II. Week 2

A. Fluids & Hydration-1.07
a. Fluid & Hydration Keys
b. What You Need to Know about Fluids & Hydration
c. Warning: Dehydration
d. Pre-Hydrate Before Workouts
e. Know Your Sweat Losses
f. Calculating Sweat Loss Example: Group Activity
g. When Should a Sports Drink be Used
h. Shake the Salt
i. Signs of Proper Hydration
j. Bonus Point: Sample Daily Hydration Plan

B. Sports Drinks, Bars, and Gels-1.08
a. Sports Drink Keys
b. Warning: Experiment with sports drinks, recovery drinks, gels, and bars in practices before using in competition
c. Sports Drink Basics
d. Sports Drink and Athletic Performance
e. Sports Bars and Gels
f. Recovery Drinks
g. Bonus Point: Sports Drinks, Bars, and Gels Questions and Answers

C. Review
a. Calculating sweat losses, how to replace sweat losses, and when to use a sports drink

III. Week 3

A. Pre-Competition Nutrition-1.09
a. Pre-Competition Nutrition Keys
b. What You Need to Know about Pre-Competition Nutrition
c. Timing of Pre-Competition Fuel
d. Sample Pre-Competition Ideas
e. Pre-Competition Food Choice When on the Road

f. Pre-Competition Meal Ideas
g. Warning: Poor Pre-Exercise Fuel Options

B. Recovery Nutrition-1.10
  a. Recovery Nutrition Keys
  b. Warning: Waiting too long to eat after workouts/competitions
  c. What You Need to Know about Recovery Nutrition
  d. The 1-2-3 Approach to Recovery: Fluids, Carbohydrates, and Proteins: Food Demonstration
  e. Developing Your Recovery Plan
  f. Recovery Food/Drink Options

C. Review
  a. Timing and Size of Pre-Competition Fuel, 1-2-3 Approach to Recovery Nutrition

IV. Week 4

B. Vitamins and Mineral for Athletes-1.11
  a. Vitamin and Mineral Keys
  b. Warning: Vitamin and Minerals Supplements Can't Replace the Real Deal – Food.
  c. What You Need to Know about Vitamins and Minerals
    i. Calcium
    ii. Iron
    iii. Antioxidants
  d. Bonus Point: Getting the Right Amount
  e. Vitamin & Mineral Math: Case Study

C. Dietary Supplements Overview-1.18
  a. Dietary Supplement Keys
  b. What You Need to Know about Dietary Supplements
    i. Legality
    ii. Safety
    iii. Purity
    iv. Effectiveness
  c. Bonus Point: Supplement Assessment Form

D. Popular Sports Supplements-1.19
  a. Popular Supplement Keys
  b. Warning: Negative Side Effects of Dietary Supplements
  c. What You Need to Know about Dietary Supplements
    i. Energy Supplements
    ii. Weight Gainers & Meal Replacement Shakes
    iii. Creatine

iv. Protein Supplements

E. Review

a. Important Keys Steps to Take Before Taking a Vitamin, Mineral, or Dietary Supplement

V. Week 5

A. Weight Loss-1.14

a. Weight Loss Keys
b. Warning: Don't Skip MEALS!
c. What You Need to Know about Proper Weight Loss
d. Appropriate Time to Reach Goal Weight/Body Composition
e. Weight Loss Guidelines
f. Bonus Point: Is Food a "Go-To" Behavior for You?

B. Weight Gian-1.15

a. Weight Gain Keys
b. Warning: See Food Eat Food Diet
c. What You Need to Know about Proper Weight Gain
d. Bonus Point: High Calorie Meal Plan

C. Review

a. Proper Weight Loss and Weight Gain Tactics

D. Sports Nutrition Review Game: Sports Nutrition Jeopardy (only included information from nutrition education material covered in intervention): Reward Activity

VITA

Lindsay Nicole Brown

Candidate for the Degree of

Master of Science

Thesis: THE EFFECTS OF A 5-WEEK NUTRITION EDUCATION INTERVENTION ON COLLEGIATE ATHLETES' KNOWLEDGE AND DIETARY INTAKE

Major Field: Nutritional Sciences

Biographical:

Education:
Graduated from Hennessey High School, Hennessey OK. Received Bachelors of Science in Nutritional Sciences from Oklahoma State University, Stillwater, Oklahoma in May, 2007. Completed the requirements for the Master of Science in Nutritional Sciences at Oklahoma State University, Stillwater, Oklahoma in July 2009.

Experience:
Became a registered dietitian and licensed dietitian in the state of Oklahoma in August and October of 2008. Work experience includes private dietary consulting for collegiate athletes and the general college student population and certified personal trainer.

Professional Memberships:
American Dietetic Association (ADA) Member
Sports, Cardiovascular, and Wellness Nutritionists (SCAN) Member

Name: Lindsay Nicole Brown
Date of Degree: July, 2009

Institution: Oklahoma State University
Location: Stillwater, Oklahoma

Title of Study: THE EFFECTS OF A 5-WEEK NUTRITION EDUCATION INTERVENTION ON COLLEGIATE ATHLETES' KNOWLEDGE AND DIETARY INTAKE

Pages in Study: 96
Candidate for the Degree of Master of Science

Major Field: Nutritional Sciences

Scope and Method of Study: Previous research identified that collegiate athletes lack nutrition knowledge and practice poor nutrition behaviors. However, there is limited understanding on how to effectively address these areas of concern. The purpose of our study was to determine if a five-week nutrition education intervention positively impacted National Collegiate Athletic Association (NCAA) Division I intercollegiate athletes' sports nutrition knowledge and dietary intakes. Data for this pre test-post test randomized control group design study came from 32 male and female collegiate athletes. Athletes' nutrition knowledge was evaluated using a pre and post sports nutrition knowledge survey and their dietary intakes were evaluated through retrieving pre and post test 3-day food records.

Findings and Conclusions: Subjects who participated in the 5-week sports nutrition education intervention showed a significant increase in nutrition knowledge at the conclusion of the intervention compared to their pre test nutrition knowledge and to the control group's post nutrition knowledge. However, the participants who participated in the 5-week nutrition education intervention did not significantly improve their dietary intakes toward their dietary recommendations for total energy, carbohydrate, protein, or fat.

ADVISER'S APPROVAL: Dr. Lenka H. Shriver