THE EFFECT OF SPORTS-FOCUSED NUTRITION EDUCATION AMONG MEN AND WOMEN COLLEGIATE ATHLETES

A THESIS
SUBMITTED TO THE GRADUATE SCHOOL
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE
MASTERS OF SCIENCE IN DIETETICS

BY
KRISTY CLARKE TRUMBO

ADVISOR—DEANNA L. PUCCIARELLI, PhD
BALL STATE UNIVERSITY
MUNCIE, INDIANA

DECEMBER 2010
ABSTRACT

THESIS: The Effect of Sports-Focused Nutrition Education Among Men and Women Collegiate Athletes

STUDENT: Kristy Clarke Trumbo

DEGREE: Master of Science

COLLEGE: Applied Sciences and Technology

DATE: November, 2010

PAGES: 114

The purpose of this experimental pilot study was to examine the relationship of nutrition knowledge, dietary habits, and nutrition behavior of collegiate men and women athletes at a Midwestern University (Ball State University) in Indiana. Other variables examined included demographic information. To evaluate and improve the nutrition knowledge and dietary practices among men and women Division I athletes, a series of four nutrition education classes was designed to increase nutrition knowledge and bring awareness of the specific nutritional concerns facing athletes. Subjects consisted of eighteen collegiate men and women swimmers at Ball State University in Indiana. Results indicated a four point increase (p≤0.001) in knowledge between pre and post nutrition education from 22.5 to 26.8 correct points out of 31 questions in both men and women subjects. A significant behavior change was seen in all eighteen athletes for five out of the six questions when pre and post nutrition education behavior change was measured. Nutrition education positively affected dietary habits among subjects when assessing protein and fat in men; and calcium and vegetable intake for both men and women.
These specific findings suggest the effectiveness of nutrition education among collegiate athletes.
ACKNOWLEDGEMENTS

I would like to extend my heartfelt thanks and appreciation to all who have supported and assisted me throughout this academic endeavor. Without the support and encouragement of my husband Mark, my parents, family, and friends, none of this would have been possible. I would especially like to thank my advisor, Dr. Pucciarelli for her unending patience, advice, guidance, and encouragement; who inspired me to attain goals I never would have thought would be possible. Thank you to my committee members, Dr. Sue Whitaker, Mrs. Kim Pike, and Dr. Jay Kandiah for their unending help. Furthermore, I would like to thank Mr. Kianre Eouanzoui for his assistance in statistical analysis. I would also like to thank Dr. Carol Friesen for her guidance and collection of data of the PFFQ. Lastly, I would like to thank the coaches and athletes for allowing me to use their time during their busy academic and athletic schedules. Without all of you and most importantly God, none of this could have been possible.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>ACKNOWLEDGEMENTS</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>iv</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE OF CONTENTS</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>v</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LIST OF TABLES</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>ix</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHAPTER 1: INTRODUCTION</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem Statement</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Purpose Statement</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Research Hypotheses</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rationale</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Limitations</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assumptions</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Definitions</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summary</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHAPTER 2: REVIEW OF LITERATURE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nutrition Knowledge</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nutrition Education</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dietary Habits</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Carbohydrates and Exercise</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>21</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Protein and Exercise</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dietary Fat and Exercise</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>27</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vitamins and Minerals and Exercise</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>.................................</td>
<td>29</td>
</tr>
</tbody>
</table>
Fluid and Hydration and Exercise ......................................................... 32
Behavior Change .................................................................................. 35
Picture Food Frequency Questionnaire .................................................. 36
Summary ............................................................................................... 37

CHAPTER 3: METHODOLOGY .................................................................. 38
Sample ................................................................................................. 39
Instruments ........................................................................................... 40
Data Collection ...................................................................................... 43
Statistical Analysis ................................................................................ 44
Institutional Review Board .................................................................... 45
Summary ............................................................................................... 45

CHAPTER 4: RESULTS .......................................................................... 46
Subjects ............................................................................................... 46
Demographics ....................................................................................... 47
Nutrition Knowledge ............................................................................ 49
Behavior Change ................................................................................... 51
Dietary Habits ....................................................................................... 53
Summary ............................................................................................... 56

CHAPTER 5: DISCUSSION .................................................................... 57
Demographics ....................................................................................... 57
Nutrition Knowledge ............................................................................ 58
Nutrition Education ............................................................................... 61
Dietary Habits ....................................................................................... 63
Behavior Change........................................................................................................66
Summary......................................................................................................................67

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS ............................................69
Conclusion ..................................................................................................................69
Recommendations for Research .................................................................................71
Recommendations for Practice ..................................................................................72
Summary......................................................................................................................72

REFERENCES .............................................................................................................74

LIST OF APPENDICES.................................................................................................78
Appendix A: Picture Food Frequency Questionnaire (PFFQ).......................................81
Appendix B: PFFQ Questionnaire Instructions ...........................................................82
Appendix C: Stage of Change Questionnaire ..............................................................84
Appendix D: Nutrition Knowledge Test .....................................................................86
Appendix E: Validity of Nutrition Knowledge Test .....................................................87
Appendix F: Participant Profile Information Sheet .....................................................92
Appendix G: Nutrition Education ..............................................................................94
Appendix H: Consent Form- Ball State University (BSU) Associate Athletic Director .................................................................................................................................95
Appendix I: Consent Form- BSU Men’s Swimming Coach .........................................97
Appendix J: Consent Form-BSU Women’s Swimming Coach .....................................99
Appendix K: Consent Form- BSU Men’s Golf Coach ...............................................101
Appendix L: Consent form- BSU Women’s Gymnastics Coach .....................................103
Appendix M: Script for explaining study to athletes ..........................105
Appendix N: Email to experimental athletes regarding PFFQ ..................107
Appendix O: Email to control athletes regarding PFFQ ..........................109
Appendix P: Letter from Ball State Institutional Review Board ...............111
Appendix Q: Collaborative Institutional Training Initiative Certificate ......112
### LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>48</td>
</tr>
<tr>
<td>Table 2</td>
<td>49</td>
</tr>
<tr>
<td>Table 3</td>
<td>50</td>
</tr>
<tr>
<td>Table 4</td>
<td>53</td>
</tr>
<tr>
<td>Table 5</td>
<td>54</td>
</tr>
<tr>
<td>Table 6</td>
<td>55</td>
</tr>
<tr>
<td>Table 7</td>
<td>58</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

Since the ancient Olympians, the importance of nutrition in sport has been recognized for improving both health and sports performance. However, nutritional knowledge, beliefs and practices are extremely diverse. It is important for the sports dietitian to develop and apply individually-tailored and evidence-based strategies with athletes to optimize athletic performance through good hydration and nutrition practices (Gilbert 2009).

Aside from genetics and physical training, it is commonly accepted that the nutritional intake of an athlete is a critical determinant of performance (Economos, Bortz, and Nelson 1993). Athletes require a well balanced diet that contains nutrients to sustain normal daily activities as well as those associated with training and competition (Berning, Troup, VanHankel, J.Daniels, and N. Daniels 1991). Improper nutrition can be detrimental to the athlete’s short and long-term health, and it can decrease performance (Dunford 2006). The American College of Sports Medicine and the American Dietetic Association Joint Position has compiled research which has shown that there is a beneficial effect of nutrition on physical performance (2009).

Swimming is an endurance sport which requires specific nutritional needs. Training places high demands on the respiratory, cardiovascular, and energy-producing
systems of the body. Calories from foods in the diet aid in providing energy while nutrients, such as vitamins and minerals, are used in different capacities to help release the extra energy produced. Therefore, a swimmer’s nutritional status and dietary habits are important factors for success in competition and training (Berning et al. 1991).

Swimmers are not always aware of their nutritional needs, and some may not have the nutrition knowledge to make the necessary food choices to achieve favorable performance in the pool (Berning et al. 1991). Factors that contribute to poor nutrition are due to poor skills in choosing and preparing meals, lack of money and time, frequent travel, poor nutrition knowledge and dietary faddism. Nutrition education for athletes should be practical and should address issues, such as eating strategies, key food choices, and fluid requirements to meet the demands of the sport. Educational tools that concentrate on the nutritional needs of athletes are important resources for athletes, coaches and sports dietitians (Burke 1995).

Collegiate golfers can spend up to eight hours a day on the golf course. Training for golf includes strength training, aerobic conditioning, and flexibility in their training schedule to strengthen muscles involved in the sport of golf, improve endurance, and minimize the risk of injury. The game of golf relies heavily on skill, which is why many golfers come in all shapes and sizes. The dietary habits of golfers should include primarily carbohydrates with moderate amount of protein and less fat. A variety of foods from each food group is highly recommended. During tournaments, many golfers will miss a meal and they may not consume carbohydrates for five or six hours. Sweat loss is another concern for golfers. Tournaments are often played in hot and windy environments, which can lead to dehydration (Fowler and Ray 2004).
Collegiate gymnasts train for about 20 hours per week. Gymnasts require many characteristics for performance such as technical skill precision, muscular strength, explosive power, and flexibility. There are many nutrition concerns facing gymnasts such as calcium deficiency, eating disorders, fluid intake, and calorie needs. Therefore, proper nutrition knowledge of collegiate gymnasts is extremely important for overall health as well as performance (Ray and Fowler 2004).

Studies which have researched the dietary habits of athletes have shown common problems, such as low carbohydrate, micronutrient, and low energy intakes. Additionally, intake of several micronutrients is often inadequate among female athletes, most notably iron, calcium, and zinc (Abood, Black, and Birnbaum 2004). Athletes who are competitive in sports have repeatedly been found to be inadequately educated in proper nutrition and the use of supplements and ergogenic aids. Many athletes believe such supplements enhance performance, and as a result, misuse of supplements often occurs. Studies indicate athletes gain information about nutrition and supplementation from magazines, coaches, peers and parents. Therefore, the athlete may be offered poor advice and/or may be misinformed (Jacobson, Sobonya, and Ransone 2001). Findings from these studies indicate the importance of nutrition education, proper nutrition knowledge and dietary habits of athletes.

**Problem Statement**

The diets of many collegiate athletes are inadequate, due to overly restrictive eating habits and nutrition misinformation. Studies have shown that athletes have a limited knowledge of general nutrition information in addition to inadequate dietary
habits. Athletes may benefit from nutrition knowledge, however sufficient nutrition education resources for athletes are unavailable at most college campuses and universities.

**Purpose Statement**

The purpose of this experimental pilot study was to examine the relationship of nutrition knowledge, dietary habits, and nutrition behavior of collegiate men and women athletes at a Midwestern University (Ball State University) in Indiana. Other variables examined included demographic information. The following questions were asked in this study:

1. Will there be an improvement in nutrition knowledge among the experimental group after completing a nutrition education program compared to nutrition knowledge prior to the nutrition education program?
2. Will there be a change in dietary habits among the experimental group compared to prior intake before the nutrition education program?
3. Will there be a change in behavior among the experimental group, as measured by the Stages of Change Model after the nutrition education program?
4. Will there be a difference in nutrition knowledge between the experimental group (men and women swimmers) and the control group (men’s golf team and women’s gymnastics team).
5. Will there be a difference in dietary habits between the experimental group (men and women swimmers) and the control group (men’s golf team and women’s gymnastics team).

Research Hypotheses

This researcher hypothesizes that:

1. Nutrition education lessons will improve nutrition knowledge among the experimental group.

2. Nutrition education lessons will positively affect dietary habits among the experimental group.


Rationale

The study of nutrition knowledge, behavior, and dietary practices of athletes should further the understanding of the relationship between diet, exercise and health, and should lead to increased effectiveness of nutrition education for collegiate athletes. Athletes require more energy to maintain lean tissue mass, for immune and reproductive function, as well as optimum athletic performance. Many athletes are very concerned about their diets, although this concern is not always reflected by the behavior of basic nutrition principles. Before behavior change can occur, knowledge must be obtained. Thus, there is a need for nutrition education for athletes with the goal of improving dietary habits.
Limitations

The results of this study will be limited by the following factors:

1. The sample study selected was limited to one university.

2. The sample was restricted to men and women swim team members, men golf team members, and women gymnastics team members who were full time students.

3. The scores obtained on the tests could have been influenced by nutrition knowledge prior to the nutrition education program or by uncontrollable variables (friends, TV, Internet, magazines, classes, etc) during the program.

4. Many control group questionnaires were not returned, as such only the experimental data was used for this study.

Assumptions

The researcher makes the following assumptions in the implementation of the study and in the interpretation of the data:

1. The subjects were willing to cooperate and provided honest and accurate answers to the pre-test and post tests and PFFQ.

2. The subjects were literate and able to understand the written instruments.

3. The subjects paid attention during the nutrition education series.

4. The sample was representative of a Division I University.
Definitions

For the purpose of this study, the following definitions were used:

1. Macronutrients: nutrients providing calories (energy). These are proteins, fats and carbohydrates (Wilson 2008).
4. Hemoglobin: the globular protein of the red blood cells that carries oxygen from the lungs to the cells throughout the body. Used as an indicator of Iron status (Whitney and Rolfes 2005).
6. Dietary Reference Intakes (DRI): a set of nutrient intake values for healthy people in the United States and Canada. These values are used for planning and assessing diets and include (Whitney and Rolfes 2005).
   -Estimated Average Requirements (EAR): The accepted standard level of nutrients. The basis for the Recommended Daily Allowance is established by the U.S. government. The EAR is expected to satisfy the needs of 50% of the people in that age group (Whitney and Rolfes 2005).
   -Recommended Dietary Allowances (RDA): the daily recommended intake level of a nutrient considered sufficient to meet the requirements of nearly
all (97–98%) healthy individuals in each life-stage and gender group. It is approximately 20% higher than the EAR (Whitney and Rolfes 2005).

-Adequate Intakes (AI): where no RDA has been established, but the amount established is somewhat less firmly believed to be adequate for everyone in the demographic group (Whitney and Rolfes 2005).

-Tolerable Upper Intake Levels (UL): to caution against excessive intake of nutrients (like vitamin D) that can be harmful in large amounts (Whitney and Rolfes 2005).

7. Supplements: a product taken by mouth that contains a "dietary ingredient" intended to supplement the diet. The "dietary ingredient 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, soft gels, gelcaps, liquids, or powders (US Food and Drug Administration 2009).

8. Glycemic Index: a method of classifying foods according to their potential for raising blood glucose (Whitney and Rolfes 2005).

9. Taper: the practice of reducing exercise in one week or more prior to the days before an important competition (Hawley 1998).

10. Amenorrhea: absence of regular menstruation for a period of six months or more (Whitney and Rolfes 2005).

11. Picture Food Frequency Questionnaire (PFFQ): the most common dietary assessment tool used in large epidemiologic studies of diet and health. The
self-administered PFFQ booklet asks participants to report the frequency of consumption and portion size of approximately 120 line items over a defined period of time (e.g. the last month; the last three months). Each line item is defined by a series of foods or beverages and contains pictures for the foods and beverages. Additional questions on food purchasing and preparation methods enable the analysis software to further refine nutrient calculations (Food Frequency Questionnaire 2009).

12. Dry land: conditioning that a swimmer does out of the pool. This form of cross training includes cardiovascular, flexibility, and strength activities. The goal of dry land training is to condition, stretch, and strengthen muscles that are used in swimming (Henderson 2006).

**Summary**

Inadequate nutrition in collegiate athletes can lead to impaired athletic performance and poor health outcomes. The demands for dietary intake of macronutrients and micronutrients also change through the competitive seasons of training. Knowledge about amenorrhea, general nutrition, sports nutrition, and supplementation is imperative to athletes. Thus, it is important athletes become aware of proper nutrition during intense training to benefit their health and performance. Therefore, this study’s purpose was to examine the relationship of nutritional knowledge, dietary habits, and nutrition behavior of collegiate men and women athletes at a Midwestern University (Ball State University) in Indiana.
CHAPTER 2

REVIEW OF LITERATURE

The purpose of this experimental pilot study was to examine the relationship of nutrition knowledge, dietary habits, and nutrition behavior of collegiate men and women athletes at a Midwestern University (Ball State University) in Indiana. Other variables examined included demographic information. Studies have found that some athletes ignore their diet and others simply acquire unreliable nutrition information. Dietary habits and knowledge, especially among collegiate athletes is not only important for physical well being, but for endurance performance as well. Athletic performance is enhanced through appropriate nutrition practices, and harmed when not appropriately practiced (Wang and McJunkin 2005). This literature review will provide an overview of nutrition knowledge of athletes, assess nutrition education among athletes, review dietary habits of athletes, describe the theory of planned behavior (stages of change) which relates to food and nutrition behaviors of athletes, and discuss the Picture Food Frequency Questionnaire.
Nutrition Knowledge

There have been several studies that evaluated the nutrition knowledge among athletes, focusing mostly on general and sports-related nutrition information. Hamilton et al. investigated general nutrition knowledge, sports nutrition knowledge, sources of nutrition information and dietary habits by a self-administered questionnaire in 53 elite distance runners in New Zealand. These runners aged from 17-43 years old, in which 41 were male and 12 were females. The runner’s nutrition knowledge was compared with non-athletes from New Zealand. The dietary habits of the runners indicated that they had a generally nutritionally sound diet, although vitamin and minerals supplements were misused. This study found that runners with better nutrition knowledge were more likely to report nutritionally sound diets \((r=0.30, p<0.05)\) which supports the benefit of nutrition education. The runner’s nutritional information mostly came from coaches and magazines, \((59\% \text{ of subjects})\), doctors \((51\%)\), and fellow athletes \((49\%)\). The runners who stated they received their information from magazines generally scored higher sports nutrition knowledge than those who did not. Those who stated they received their nutrition information from coaches were associated with lower general nutrition knowledge scores \((p<0.05)\). However, coaches were perceived as one of the most important sources of nutrition information, which suggest a need for appropriate nutrition education programs for coaches and athletes \((1994)\).

Wiita et al. conducted a research study at a Midwestern university to compare the relationship of nutrition knowledge to eating practices and attitudes between female high school and college athletes. The 54 subjects were college cross-country runners and high school runners who were attending an athletic camp. The participants completed a
nutrition knowledge questionnaire consisting of eating practices, attitudes, and sources of dietary information (1995). The athlete’s nutrition knowledge was measured by a modified Werblow Test (Werblow, Fox, and Henneman 1978). The test assessed statements based on basic nutrition and sports nutrition information. The mean score for high school runners was 62 percent correct. The mean score for the college runners was 71 percent correct. The difference between the two scores stated that college runners have more knowledge than high school runners which was significant (p<0.05). Also, more than 50% of the athletes gave incorrect responses to 14 questions showing the prevalence of misinformation or lack of knowledge about nutrition. Advice about nutrition was sought from the runners’ coaches (31%), and others asked their parents, a physician, older runners and nutritional professionals. When looking at nutrition knowledge and dietary habits, the researchers found that runners with greater nutrition knowledge tend to make and eat healthier food choices (Witta, Stombaugh, and Buch 1995).

Abood et al. evaluated the efficacy of nutrition education intervention for college female athletes to improve nutrition knowledge, build self-efficacy with respect to making healthful dietary choices, and improve dietary intake. The participants were 15 female soccer players and 15 female swimmers from a Division I university that were randomly assigned to experimental and control groups. The experimental group took part in eight, one hour nutrition education sessions. The nutrition education sessions were broken down as the following: Session 1: Caloric intake and expenditure, Session 2: Carbohydrate, Session 3: Fat and Protein, Session 4: Fluids, Calcium, Iron, and Zinc, Session 5: Diet record analysis, Session 6: Application of nutrition principles, Session 7:
Eating on the road, Session 8: Putting it all together. A nutrition knowledge questionnaire used was developed by the authors and included 42 true and false nutrition knowledge questions. The questions were related to total calories, and intake of micronutrients and macronutrients. Each question was worth one point. Differences in nutrition knowledge were measured in a change in pretest and post-test scores. The reading level of the test was determined to be 12.0 (12th grade) based on the Flesch-Kincaid Grade Level. Response bias, readability, content validity, and reliability were all evaluated. A Pearson product moment correlation provided a test-retest reliability coefficient of 0.86. Results from this study found that the experimental group involved in nutrition education significantly improved nutrition knowledge, self-efficacy (p <0.05), and the overall number of positive dietary changes, (p <0.03) such as macronutrient percentages that met the dietary guidelines for athletes (2004).

Jacobson et al. designed a study to determine nutrition knowledge and behavior of Division IA college athletes, and to compare knowledge and behavior with a similar study design conducted in 1992. It is important to note that in January, 2001, the Dietary Reference Index (DRI) was revised. The researchers randomly sent surveys with instructions to strength and conditioning coaches at sixteen universities. Results from these surveys reported that women (60.6%) received more nutrition information than men (49.5%). Nutrition information was obtained from questionable sources such as magazines, family members, and coaches. Over 29% of participants accurately identified the correct percentage of recommended carbohydrate intake, whereas only 3% correctly identified protein intake and 17% correctly identified fat intake. Approximately 35% of
men and 40.2% of women correctly identified the appropriate functions of vitamins and a significant amount of men and women thought that vitamins played a role in weight gain. More than 30% of athletes incorrectly thought that vitamins provide immediate energy, and 14.7% thought that vitamins can increase muscle strength. Fifty-two percent of men and 58% of women identified correctly the function of protein, but only 21% thought that protein provides energy. The researchers concluded that sport coaches should be required to have a nutrition background if they plan on issuing nutrition information to their athletes, particularly in programs who cannot afford the advice of trained dietitians (2001).

Jessri et al. studied the nutrition knowledge and the factors determining this knowledge in Iranian college basketball and football athletes. Sixty-six basketball and 141 football players from four medical and eight nonmedical universities in Tehran agreed to participate in this cross-sectional study. A previously validated questionnaire (divided into five main subcategories: nutrient type, recovery, fluid, weight control, and supplements) on sports nutrition knowledge found that nutrition knowledge among the subjects was 33.2% (±12.3%). Men scored 28.2% (±12.7%), and women, 38.7% (±14.2%). When comparing athletes to their peers, a significantly higher score was obtained by women (p<0.001), athletes at medical universities (p<0.001), and those obtaining nutrition information from reputable sources (p=0.03). Athletes stated they utilized their coach for their main source of nutrition information (89.4%). This study revealed that sports nutrition knowledge of these athletes was inadequate. These authors concluded that athletes would benefit from nutrition related training and education
considering their low level of nutrition knowledge may lead to poor dietary choices and behaviors (2010).

A major problem facing America’s college students today is the lack of available healthy fast foods or easily prepared foods. Junk food and unhealthier choices are often easier to make and cheaper than healthy foods. College students also lack time to prepare meals and may have limited space to cook due to living in dorms, apartments or shared housing. Another concern is the knowledge that is needed to choose healthy foods. Research by Dunn et al. discovered a lack of nutritional knowledge among university athletes (2009). As previous researchers have discovered, college athletes are lacking nutritional knowledge (Barr 1987; Jacobson, Sobnyna and Ransone 2001; Jonalagadda 2001).

Athletes are not the only ones who are lacking nutritional knowledge. Coaches also have many common misconceptions about an athlete’s diet. Corley et al. surveyed one hundred and five college coaches at junior and senior colleges in North Carolina about nutritional knowledge. Even though the coaches answered seventy-five percent of the questions correct, they stated that they were not very confident that their responses were correct (1990).

Hornstrom looked at the nutrition knowledge, practice, attitudes, and information sources of Mid-American Conference softball players. She suggested future research studies should include nutrition education sessions for athletes. Moreover, Hornstrom conducted a pre and post- test survey to assess if nutrition education is helpful in increasing athletes’ understanding of sports nutrition. She found that out of 185 softball
players that took a nutrition knowledge test, only 35% of them passed with a 60% or higher (2007).

**Nutrition Education**

The National Collegiate Athletic Association (NCAA), established in 1906, is a voluntary association reporting more than 1,300 member schools and conferences. Cole et al. evaluated the dietary practices of NCAA Division I football players. Cole et al. stated, “Nutrition and performance are topics of concern for the collegiate student athlete. Competition is intense at the collegiate level, and nutritional status can separate winning and losing.” The NCAA has plans for action to guide parents, athletes, trainers, coaches, and administrators in implementing healthy policies on nutrition and for performance for student athletes. The NCAA has recommendations for intervention and treatment of athletes suspected for suffering from eating disorders, guidelines regarding acceptable types of supplements, and referrals to the Food Guide Pyramid and the United States Department of Agriculture. The availability of these references indicates positive progress by the NCAA of expanding nutritional information to student athletes. Cole et al. suggested collegiate athletes would benefit from nutrition education and intervention when major nutritional needs are suspected by coaches (2005).

Cerutti and Quinton researched undergraduate students attitudes towards a healthful diet. They stated that college years are an ideal time to influence a large number of young adults about the impact lifestyle choices such as diet may have on long-term health. However, college nutrition courses are most likely required only for students majoring in nutrition, family and consumer sciences, and other majors related to
According to the Youth Behavior Surveillance National College Health Risk Behavior Survey, less than one-third of college students surveyed indicated having received information on dietary behaviors and nutrition from their college or university (CDC 1997).

For most athletes, sports participation is a positive and healthy experience (Nattiv, Agostini, Drinkwater, and Yeager 1994). However, for some, the desire to succeed and the pressure associated with being the best and winning can cause body image issues, weight reduction behaviors and restrictive eating. These types of behaviors can affect performance and health (Beals 2000). Educational efforts should then be continued for athletes regarding these issues, especially women regarding amenorrhea, disordered eating, and eating disorders (Thompson 2004).

Kunkel et al. researched peer nutrition education program to improve nutrition knowledge of female collegiate athletes. This study stated that athletes may benefit from nutrition education; however many college campuses lack nutrition education resources which could lead an improvement of dietary behaviors. The main challenge in providing nutrition education to collegiate athletes is the development of an effective method for improving nutrition knowledge and attitudes. A peer nutrition education program was found to be an effective method of improving athletes nutrition knowledge in this study (2001).

There have been numerous studies which have found low scores on nutrition knowledge evaluations, low intakes of nutrients, and myths and misinformation about nutrition in athletes, which explain the need for nutrition education. Researchers have
concluded the need for nutrition education as part of athletes overall health and part of
the athletes training (Paschoal and Amancio 2004; Ousley-Pahnke et al. 2001;
Kabasakalis, Kalitsis, Tsalis, and Mougios 2007; Abood, Black, and Birnbaum 2004).

**Dietary Habits**

Several studies have been conducted assessing the dietary habits of athletes. Berning et al. randomly evaluated the diet of 22 adolescent male swimmers and 21
adolescent female swimmers attending a United States Swimming camp in Long, Beach
California. A five day food log was used to record the dietary habits of the swimmers.
Results from this study found that the distribution pattern was basically the same between
the females and the males for protein, and was within the recommended range for protein
intake of 12-15% for both sexes. The men and women were consuming more fat than the
recommended at (25-30% of fat). Both the male and female swimmers in this study were
not meeting carbohydrate needs (45.6% and 47.9% of carbohydrates) which can make
them susceptible to exhaustion, fatigue, and inadequate glycogen stores. This study also
showed that these swimmers were consuming more than the Recommended Daily
Allowance (RDA) of vitamins A, C and thiamin, riboflavin and niacin. When looking at
calcium, this study showed that 52% of the female swimmers were below the RDA for
their age group and 14% of the male swimmers did not meet the RDA. Therefore, the
ability to reach peak bone mass is a concern, since the prevention of osteoporosis begins
early in adolescence. Overall, this study suggests that adolescent swimmers are
consuming enough fuel and nutrients; however the distribution of nutrients is not very
Hinton and colleagues assessed the dietary habits and behaviors of male and female collegiate athletes (n=365) at a NCAA Division I university. The participants represented thirteen different sports and included 180 males and 165 female student athletes. Dietary habits were assessed using the Youth Assessment Questionnaire (YAQ), a food frequency questionnaire that has been validated in adolescent’s age nine to eighteen years old. Results from this study found that only 15% males and 26% of female athletes had adequate intake of carbohydrates and protein based on recommendations for athletes. Male athletes exceeded the Dietary Guidelines for fat, saturated fat, and sodium more than females. These results concluded that athletes would benefit from education on the importance of adequate dietary intake, carbohydrates, and protein to achieve optimal performance. Education should also include helpful ways to help athletes meet their nutrition needs (2004).

Kabasakalis et al. monitored the nutritional status of nine Greek national top level swimmers during a competitive season of eight months. The participants recorded their food and supplement intakes for three days (two weekdays and one weekend day) after receiving special instruction. Results from this study indicated low carbohydrate (36% intake of carbohydrates) and high fat intakes (42% intake of fat), inadequate intake of some micronutrients, and improper use of supplements, indicating suboptimal dietary habits. The authors concluded there is a need for proper nutritional education and guidance of swimmers who participate in top-level training (2007).

Dietary intake and energy expenditure of female collegiate swimmers during decreased training prior to competition was assessed by Ousley-Pahnke et al. Sixteen women at a large Midwestern university swim team participated in this study. A four-
day food log was used to assess dietary habits of the athletes. Results showed that mean macronutrient intakes as percent of energy for carbohydrate (63% intake of carbohydrates) and protein (14% intake of protein) were within the recommended range. When expressed as grams (g)/kilogram (kg)/day (d), recommendations for carbohydrate and protein intakes were slightly lower than the 6 to 10 g/kg recommendations for carbohydrate and 1.5g/kg recommended for protein suggested by the American and Canadian Dietetic Associations. Fat intake was within the recommended for athletes at 23% intake. Vitamin and minerals were assessed as well and vitamin E, pantothenic acid, biotin, iron, zinc, and copper were near the RDA. The authors in the study suggest to avoid under- or over-nutrition, athletes need to be educated that dietary habits must change to meet changing energy and macronutrient requirements (2001).

Paschoal et al. evaluated the diet of eight elite Brazilian male swimmers aged 18-21 through the completion of a four day food log. The dietary assessment showed an adequate ingestion of calories, vitamins, and minerals, with the exception of calcium, in which only half reached the recommendation. Low carbohydrate and high protein diets were also seen in the swimmers diets. The swimmers also consumed amino acids (62.5% intake of amino acids) and antioxidant supplements (25% intake of antioxidant supplements). Biochemical indices showed muscle degradation in the swimmers which is probably due to low carbohydrate intake. In conclusion, the researchers suggest the importance of nutritional education to promote a balanced intake of nutrients, inhibit unnecessary supplement use, maintain ideal performance and improve swimmers health status (2004).
Many studies have found that college students generally underconsume fruits, vegetables, and whole grains while overconsuming foods high in fat, sodium, and added sugar (Cerutti and Quinton 2009). Almost three quarters of college students in the United States consume fewer than five servings of fruits and vegetables a day (Brevard and Rickets 1996; Centers for Disease Control and Prevention-CDC 1997; Huandet et al. 1994; Melby, Femea, and Sciancca 1986).

**Carbohydrates and Exercise:**

The only way to have energy for athletic performance is to consume enough energy. The amount of energy needed depends on each person and their body composition, body weight, and level of fitness. Also, the longer and harder an athlete workouts out, the more energy is required for their muscle’s to work. Carbohydrates however, are the body’s primary energy source and main fuel for muscles (Duyff 2002). An adequate amount of carbohydrates before exercise can help performance by “topping off” liver and glycogen stores in the body. Carbohydrates also aid in maintaining blood glucose levels and carbohydrate oxidation. Also, consuming carbohydrates after glycogen depleting exercise can promote fast refilling of carbohydrate stores, which is particularly important in athletes who are competing in tournaments or daily hard training (Dunford 2006).

Carbohydrates in food are complex sugars (the starches and fibers) and simple sugars. The simple sugars are monosaccharides and disaccharides. The three monosaccharides are glucose, fructose and galactose. The three disaccharides are known as maltose, sucrose, and lactose. Simple sugars are found in many natural foods such as
fruits, vegetables, and milk but are also found in processed foods including soda, candy and baked goods. Complex carbohydrates consist of polysaccharides, which are composed of many monosaccharides linked together. The three important types of polysaccharides are glycogen, starches and fiber. Complex carbohydrates are found in foods such as grains, potatoes, beans, vegetables, fruits, and breads. Both of these supply energy and help to replenish athlete’s muscle glycogen from a hard day’s workout. The main difference is that simple sugars in foods are digested and absorbed into the bloodstream faster. Complex foods must be broken down first and take longer (Whitney and Rolfes 2005).

Carbohydrates are broken down during digestion and are changed to blood sugar or glucose. Some of this glucose is used immediately for glycolysis. Excess glucose is stored as muscle and liver glycogen, or it is converted to fat if excess calories are consumed. The body’s glycogen levels are constantly used and replenished. If more energy is needed, the body fuels muscle with a mixture of both carbohydrates (glycogen) and fat. During practice or competition, when short, intense energy spouts are done (anaerobic), muscle glycogen is the primary energy source that is used. Endurance activities (aerobic) such as long distance swimming, use some glycogen first, and then rely mostly on fat stores for energy (Duyff 2002).

**Recommended Carbohydrate Intake:**

Carbohydrate recommendations for athletes depend on the type of sport, sex, environmental conditions, and total daily energy expenditure. Current carbohydrate recommendations for athletes range from 6 to 10 grams(g)/kilogram(kg) (2.7-4.5g/pound) body weight per day (American Dietetic Association 2009).
Failure to meet daily carbohydrate needs can result in impaired performance due to muscle and glycogen depletion. A deficiency in carbohydrates can lead to negative energy balance that can decrease performance. There is also a decrease in training and performance when adequate amount of carbohydrates and calories are not met between training sessions (Dunford 2006).

It has been shown that eating before exercising has benefits of improving exercise as opposed to being in the fasted state for athletes. Meals and snacks are recommended prior to exercise to prevent hunger and to maintain hydration. The meals/snacks should be low in fiber, easy to digest, high in carbohydrate (to maintain blood glucose levels), moderate in protein and something that the athlete enjoys and is used to eating. For enhanced performance, the athlete should eat three to four hours before exercise or competition, and that food should contain roughly 200-300 grams of carbohydrates based on body weight. It is best for the athlete to plan ahead to make sure the appropriate amount of carbohydrates are being consumed prior to exercise (American Dietetic Association 2009).

Athletes participating in events lasting longer than one hour will benefit from consuming 30-60 grams of carbohydrates per hour which are found in sports drinks. This amount of carbohydrates keeps blood sugar levels stable which can aid in performance. Athletes should avoid carbohydrates that are strictly fructose for they can cause gastrointestinal problems (American Dietetic Association 2009).

The length and intensity of exercise/competition are factors that determine whether glycogen depletion took place, as well as the next exercise/competition that will take place. It is important to replace carbohydrate stores (1.5 to 2.0g/kg) within thirty
minutes after exercise in two hour intervals, up to six hours. The type of carbohydrate after exercise is also important in recovery in the athlete. Consuming foods higher in the glycemic index are also more efficient in increased muscle glycogen levels 24 hours after glycogen depletion in muscles compared to low glycemic foods. It has also been shows that coupling protein with carbohydrates has a benefit of providing amino acids that aid in muscle protein repair (American Dietetic Association 2009).

**Protein and Exercise**

Proteins are called the building blocks of the body. Amino acids, which are different combinations of structures, come from proteins that unite in various ways to make muscle, bone, tendons, skin, hair and other tissues. They also serve as nutrient transportation and enzyme production. Over 10,000 different proteins are in the body. (Quinn 2007). Our bodies require about twenty amino acids for normal functioning. These amino acids in the human body are involved in many physiological processes such as protein turnover (breakdown and synthesis), metabolism, membrane transport, acid-base regulation, and immune function (Dunford 2006). Nine of these amino acids are considered essential which means that the body cannot make them by itself and must get them from the diet (Hark and Deen 2005).

Getting the right amount of protein in the diet for athletes is very important because protein is not stored in the body. There are two different types of proteins that athletes can get through their diet. Complete proteins contain all of the essential amino acids and come mostly from animal products such as meat, fish and eggs. Incomplete proteins lack one or more essential amino acids and come from source such as vegetables, fruits and nuts. Good sources of proteins include: fish, chicken, turkey, beef,
low-fat milk, cheese, yogurt, eggs, nuts and soy (Fueling Swimmers 2006). Vegetarian athletes may have trouble getting adequate protein if they aren’t aware of how to combine foods (Quinn 2007).

**Recommended Protein Intake:**

Athletes need protein for repair and rebuilding of muscle that is broken down during intense exercise and workouts, and also to help to improve carbohydrate storage in the form of glycogen. Protein should be not used as the primary source of fuel for exercise, but it can be used when the diet lacks adequate amounts of carbohydrates. However, this is the last thing you want as an athlete since then it is not used to repair and rebuild body tissues and muscles (Quinn 2007). The current RDA is 0.8g/kg of body weight and the Acceptable Macronutrient Distribution Range (AMDR) for protein intake for adults older than 18 years is 10%-30% of total energy (American Dietetic Association 2009).

Studies have shown that during endurance activities, such as endurance swimming and running, there is an increase in protein oxidation coupled with nitrogen balance. This provides suggestion for increasing protein intakes for recovery from very high training volumes and elevated rates of amino acid oxidation. Studies show that endurance athletes have been at negative nitrogen balance when they just meet the current DRI’s. Therefore, to prevent this negative nitrogen balance, studies suggest endurance athletes to consume 1.2-1.4g/kg/day of protein. Ultra-endurance athletes should consume protein slightly above to 1.5-1.7g/kg/day (American Dietetic Association 2009).
Resistance-trained athletes have an increased need for protein because of increases in muscle protein synthesis of consistent training. It is important for the first three to six months of weight training for athletes to obtain the right amount of protein needed to support muscle growth. Recommended protein intakes for strength trained athletes range from approximately 1.2 to 1.7g/kg/day, which is roughly 0.55 to 0.8 grams of protein per pound of body weight per day (Fueling Swimmers 2006). After the first phase of weight training, the athlete is more efficient in utilizing protein and can lower their protein recommendations and follow the recommendations for endurance athletes (American Dietetic Association 2009). If an athlete is just focusing on resistance training, (ex: body building) it is recommended to consume as much as 1.6 to 1.7g/kg/day (Dunford 2006).

**Protein and Amino Acid Supplements:**

High protein diets have been a major fad throughout history. Recent research has shown that proteins such as whey, casein, and soy are effectively used for repair synthesis and rebuilding of skeletal muscle after training. Proteins and amino acids have also been used to increase and maintain muscle. However, protein and amino acids supplementation has not been shown to positively influence athletic performance, and supplementation should be directed by a dietitian first. A nutrition assessment should be given as well as looking at the athlete’s goals before starting any type of protein and amino acid supplementation (American Dietetic Association 2009).

Creatine supplementation is used by many swimmers. Creatine works by providing quick energy for the initial phase of muscle contraction. It pulls water into muscle cells from surrounding fluid, which creates a larger muscle and over time, a
stronger muscle. Creatine is found naturally in the body, and it is manufactured in the liver. Food sources of Creatine include fish and red meat (Hark and Deen 2005). Taking Creatine is not recommended for swimmers under 18 years of age, since it is unknown if it is safe at this age group. The athlete should also talk over the use of Creatine with a trainer or Registered Dietitian before using it (Fueling Swimmers 2006).

Vegetarian athletes should have diets that are well-planned and that support the recommendations of protein, which assist in influencing athletic performance. Diets that are plant based and high in fiber can reduce energy availability. It is important to monitor body composition and body weight to determine if energy needs are being met. Some athletes (especially females) may eliminate meat to maintain a lean body mass, and this can be a red flag for disordered eating and can increase the risk for the female athlete triad. This is why coaches, trainers, and other health professionals should be aware and alert if an athlete follows a vegetarian diet, and should consistently monitor appropriate weight. It is suggested that athletes who follow a vegetarian diet consume about 10% more protein than a non-vegetarian athlete since plant proteins are not digested as well as animal proteins. The recommendation of protein for vegetarian athletes is 1.3 to 1.8g/kg/d (Dunford 2006).

**Dietary Fat and Exercise**

Fat is an essential component of a normal diet, which provides energy and essential elements of cell membranes and nutrients (American Dietetic Association 2009). When other energy sources are not available during times of starvation or illness, fat provides our bodies with energy. Fat also helps to protect our body organs from trauma, and helps to regulate body temperature. It also assists in the delivery and
absorption of fat-soluble vitamins and carotenoids and also gives foods flavor, palatability, and influences textures. Fatty acids help in cell signaling and can alter the expression of specific genes involved in lipid and carbohydrate metabolism (Dunford 2006).

Unlike glycogen, fat requires oxygen for energy metabolism. That is why endurance sports, which are mostly fueled by fat, are called aerobic activities. Aerobic means “with oxygen” and requires constant intakes of oxygen. The oxygen that the athlete breathes in helps to convert fat to energy (Duyff 2002).

**Recommended Fat Intake:**

Athletes, like most healthy people should eat a diet low in saturated fat, cholesterol and total fat (Duyff 2002). The patterns of dietary fat intake however vary depending on the type of sport, level of intensity of training and the level of performance level of the athlete. The AMDR for fat is 20%-35% of energy intake. The 2005 Dietary Guidelines recommend that the proportion of fatty acids should be 10% saturated, 10% polyunsaturated, and 10% monounsaturated and include sources of essential fatty acids. Athletes should follow these recommendations, since studies have found that adequate daily fat in the diet can have a positive effect of athletic performance (American Dietetic Association 2009). Swimmers should consume about 1g/kg/d of fats. Heart-healthy fats to choose from would be canola oil, olive oil, and nuts (Fueling Swimmers 2006).

**Consequences of a low fat diet:**

The American Dietetic Association (ADA) states that there is no performance benefit of a low fat diet that is less than 15% total calories/day compared to a moderate fat diet, 20-25% total calories. However, fat needs depend on the athlete’s physical
activity level, growth stage, nutritional needs, food preferences, and energy expenditure (Dunford 2006).

Some athletes will reduce their total fat intake because they think it will improve their performance, appearance and increase their competitiveness. There are also athletes who think increasing carbohydrate intake at the expense of dietary fat will help increase glycogen stores. This, however, leads to a decrease in performance and deficiencies of essential fatty acids and fat-soluble vitamins. Females who are consuming a very low fat diet (<25% of energy) can see disruptions in their menstrual cycle. Male athletes with low serum testosterone levels are seen in very low–fat diets, which can also affect their reproductive health function. Very low fat diets can cause a deficiency in fat-soluble vitamins such as vitamins E and D. Therefore, it is important as an athlete to make sure that total fat intake is not less than 15% total energy (Dunford 2006).

**Vitamins and Minerals and Exercise:**

Exercise and physical activity involve many reactions that require vitamins and minerals as cofactors, such as: energy, carbohydrate, fat, protein metabolism, oxygen transfer and delivery and repair. Vitamins and minerals aid in metabolic processes in the human body and help to support growth and development. The type of physical activity, the intensity at which it is performed, and the duration all influence the amount of micronutrients required (Dunford 2006).

Vitamins and minerals which require the most monitoring in an athlete’s diet are calcium, vitamin D, the B complex vitamins (thiamin, riboflavin, niacin, B-6, pantothenic acid, biotin, folate, B-12), iron, zinc, magnesium and some antioxidants (vitamin C, E, beta carotene, and selenium). Athletes who are not taking in the proper amount of
calories a day, or who are restricting a certain food group, have had severe weight loss, or who have a poor diet are at risk for these deficiencies. These types of athletes could gain from taking a daily multivitamin mineral supplement. However, it is important that the athlete knows that mineral supplementation does not enhance athletic performance if adequate nutrition is being met through the diet (American Dietetic Association 2009).

**Recommended Vitamin and Mineral Intake:**

Vitamin and mineral needs of athletes are similar to healthy individuals who are moderately active, and athletes’ following the use of the Dietary Reference Intakes (DRI) is suffice. Physical activity may increase the need for some vitamins and minerals due to its losses, but these needs can be met with a balanced diet from many different foods (Hark, Deen 2005). Some athletes may have an increase need of vitamins and minerals however due to extreme losses of nutrients in their sweat and urine. In this case, supplementation of vitamins and minerals may be required (Dunford 2006).

**Minerals: Calcium, and Iron:**

The minerals that are found to be lower in athlete’s diets, especially women, are calcium, iron, zinc, and magnesium. Usually, the reason these intakes are lower is due to a restriction of calories, or an elimination of animal products from the diet (American Dietetic Association 2009).

Calcium plays many roles in the body. It helps in growth, maintenance, and repair of bone tissue; maintenance and blood calcium levels, regulation of muscle contraction, nerve conduction, and blood clotting. Female athletes who have a low intake of vitamin D and calcium-rich foods, and have menstrual dysfunction are at a high risk for low bone-mineral density and bone fractures. Therefore, it is recommended that athletes who
have disordered eating, amenorrhea, and who show a risk for early osteoporosis to have 1500mg of calcium and 400 to 800IU of vitamin D each day (American Dietetic Association 2009).

Low iron stores are one of the most common nutrient deficiencies seen in female athletes. Iron is needed for forming oxygen-carrying proteins called hemoglobin and myoglobin and it is involved in energy production in enzymes. For endurance athletes, oxygen carrying capacity is important for normal function of the nervous and immune systems. Iron deficiency can cause a decrease in work capacity, and muscle function. Endurance athletes should increase iron requirements by approximately 70% (American Dietetic Association 2009). The RDA for sedentary individuals is 8mg/d for men and 18mg/d for women (Hark and Deen 2005). Vegetarian athletes or regular blood donors should aim for more than 18mg for women and more than 8mg for men of Iron (American Dietetic Association 2009).

Good sources of food that contain iron include: spinach, dried fruit (especially prunes), organ meats, red meat, egg yolks, poultry, sardines, tuna, shrimp and legumes (Hark and Deen 2005). It is important to occasionally screen athletes, especially women, endurance athletes, adolescents, and vegetarians to monitor iron status. It takes about three to six months to turn around iron deficiency, so the earlier the involvement, the better (American Dietetic Association 2009).

Sodium, Chloride, and Potassium:

Sodium is one of the most crucial electrolytes for athletes due to their high sweat losses during exercising and intense workouts. For endurance athletes, it is recommended to consume more than the upper limit of sodium (2.3g/d) and chloride
(3.6g/d). It is also recommended that endurance athletes drink sports drinks containing sodium (0.5 to 0.7g/liter) and potassium (0.8 to 2.0g/liter) as well as carbohydrates (American Dietetic Association 2009).

Potassium is in charge of fluid and electrolyte balance, active transport mechanisms and nerve transmission. Plasma potassium concentrations can decrease (even more than sodium), during intense endurance exercise. It is important as an athlete to maintain normal potassium concentrations by eating a variety of fruits, vegetables, nuts, seeds, dairy foods, lean meats, and whole grains (American Dietetic Association 2009). The DRI for potassium is 4,700mg/d for men and for women (USDA 2010).

**Fluid and Hydration and Exercise:**

To optimize performance and protect health and well-being, it is most important for athletes to maintain proper hydration during physical activity. Athletes have a higher need for daily fluids and electrolytes due to their intense activity and time spent in warm environments (Dunford 2006). Athletes who may be dehydrated have an increased risk for life threatening heat strokes. Decreased athletic performance can be seen with just a 2% loss of body weight as water. Therefore it is imperative for athletes to replenish their bodies with the proper amount of fluids and electrolytes before, after and during exercise (American Dietetic Association 2009).

During exercise, our muscles generate internal heat. To regulate body temperature and to prevent it from rising too high, we sweat, and water and salts are excreted through pores in the skin to cool he body. If an athlete is exercising at an intense level and not replenishing the fluids they have lost, then can are at the risk for
being dehydrated. Symptoms of dehydration include general discomfort, headache, exhaustion and apathy (Hark and Deen 2005).

*Fluid Recommendations:*

It is recommended that males consume 3.7 liters/d (about 16 cups/d) and 2.7 liters/d (about 12 cups/d) for females. These recommendations can be met through foods or beverages such as: fruits, vegetables, milk, soft drinks, fruit juices, sports drinks, water, fruit, coffee, tea, and soup. Foods supply about 20% of our daily water needs and the rest of the 80% is provided from fluids consumed throughout the day. However the total volume of fluid that is lost from an individual’s body varies by many factors such as environmental conditions, the size and surface area of the individual, the individual’s metabolic rate, physical activity, sweat loss, the composition of the diet, and the volume of liquids excreted. There is more daily fluid loss in athletes due to their increase in breathing during exercising (Dunford 2006).

To allow time to for appropriate hydration status and for excretion of any excess fluid as urine, athletes should drink about 5 to 7 ml (milliliter)/kg of body weight (about 2-3 ml/lb) of water or a sports drink four hours prior to exercising. Any increase in fluids that puts the body in hyperhydration has no advantage over being in euhydration (American Dietetic Association 2009). The day before the competition, athletes should drink at least 8 oz (ounces) (240 ml) of fluids during each meal, and two 16 oz drinks between meals. Athletes should try to avoid large amounts of coffee, tea and alcohol since they have a diuretic effect and they increase the amount of urine produced by the body (Hark and Deen 2005).
Athletes disperse heat that is created by physical activity by: conduction, convection, radiation, and vaporization of water. Especially in hot and dry environments, about 80% of metabolic heat is lost through evaporation. There are also many factors that account for the amount of sweat that is lost in an individual, as mentioned before. These sweat rates can vary from 0.3 to 2.4 liters/hr. Sodium is also lost in great amounts in sweat. The average concentration in sweat is about 1 g/liter. The American College of Sports Medicine recommends consuming beverages that contain electrolytes and carbohydrates to help continue fluid balance during exercising for athletes. However, the type, intensity, and duration of exercise and environmental conditions all play a role in how much is needed. Drinks that contain sodium and potassium replace sweat electrolyte losses and the sodium helps to stimulate thirst. The carbohydrates in the drinks supply energy and it is recommended that the sports drink contain about 6-8% of carbohydrates if the event/activity/workout lasts longer than one hour (American Dietetic Association 2009). While exercising, athletes should drink 5-10 oz every 15-20 minutes (Fueling Swimmers 2006).

Many athletes finish a workout or competition dehydrated. This could be prevented and corrected by drinking the appropriate amount of fluids during exercise. It is important to replace the fluids lost from exercise and return the body to euhydration. A good marker of how much sweat was lost during exercise is body weight. The athlete should weigh themselves before and after practice to determine how much weight was lost from sweat. For every pound that is lost, the athlete should drink about 16 to 24 ounces of fluid for replenishment (American Dietetic Association 2009). The athlete should also continue to drink fluids throughout the day to get back to their pre-exercise
weight (Duyff 2002). Eating salty foods during meals and as snacks throughout the day will help to replace electrolytes lost during exercising as well (American Dietetic Association 2009).

**Behavior Change:**

Behavior change theories and models, validated within the field of dietetics, are integral to the nutrition care process, which help to guide nutrition assessment and outcomes. These theories and models suggest explanations for nutrition behavior change. Research supports group versus individual counseling, revealing that dietitians should be encouraged to develop effective group facilitation skills (Spahn et al. 2010).

The transtheoretical model also known as “stages of change model”, developed by James O. Prochaska and colleagues in 1977, is intended to explain or predict a person’s success or failure in achieving a proposed behavior change, such as developing different habits. It focuses on answering why a change “stuck” or why the change was not made. In 1997, the model consisted of five core concepts: “stages of change,” “processes of change,” “decisional balance,” “self-efficacy,” and “temptation” (Transtheoretical Model 2009).

The Stages of Change model shows that for most persons, a change in behavior occurs gradually, with the patient moving from being uninterested or unaware to make a change (precontemplation) to considering a change (contemplation), to deciding and preparing to make a change. A determined action is then taken and through relapses and many attempts, the person works towards the process towards life-long change (Zimmerman, Olsen, and Bosworth 2001).
Helping athletes change unhealthy behavior is an important role for dietitians, and is especially useful in addressing lifestyle modifications for disease prevention. Understanding athletes readiness can improve patient satisfaction and lower dietitian frustration during the change process. Many individuals understand lifestyle modifications, but consistent, life-long behavior changes are difficult (Zimmerman, Olsen, and Bosworth 2001).

There have been numerous studies about the success and failure in helping individuals change, about the barriers of change, and about the role of the physician/dietitian in improving patient outcomes. Repeatedly educating individuals is not always successful and can become frustrating for the physician/dietitian. Also, by promising an improved outcome to an individual does not guarantee their motivation to change (Zimmerman, Olsen, and Bosworth 2001). Hormstrom stated that “Behavior change can be developed and tested if a researcher can identify what motivates individuals to change their behavior in a positive manner. However, “predicting behavior, remains obsolete” (2007).

**Picture Food Frequency Questionnaire**

The Food Frequency Questionnaire (FFQ) is the most common dietary assessment tool used in large epidemiology studies of diet and health. The Picture Food Frequency Questionnaire (PFFQ) is the same questionnaire as the FFQ with added pictures of portions and types of foods and beverages. It is a self-administered test which asks individuals to report the occurrence of consumption and portion sizes of approximately 200 line items over the past week, month or 12 months. Each line item is classified by a
series of foods or beverages. Also, there are additional questions such as food purchasing and food preparation to permit the analysis software to additionally process nutrient calculations (Food Frequency Questionnaire 2009).

The PFFQ attempts to trace usual food consumption over an extended period of time. It is based on the detailed dietary history interview developed by Burke in 1947. The PFFQ is used to proved a more long-term measure of an individual’s diet and is generally less expensive and burdensome for respondents than a 24 hour diet recall (Forshee 2004).

During the past few decades, a wide array of nutritional studies have used the semiquantitative FFQ as a tool for assessing and evaluating dietary habits. However, a main concern in a dietary analysis is the validity of the collected dietary data. A study by Roumeliti and Leotsinids evaluated the relative validity of 400 FFQ’s. Their study revealed that the FFQ provides a reasonably reliable measure of dietary habits (2009).

**Summary**

After reviewing available research that has been conducted on athletes assessing nutrition knowledge, dietary habits, and nutritional behavior, the need for nutrition education among collegiate athletes has become very clear. As such, it is important to identify 1) the nutrition knowledge of collegiate athletes before and after nutrition education; 2) appropriate/adequate dietary habits of collegiate athletes before and after nutrition education; and 3) the behavior/willingness to change of collegiate athletes before and after nutrition education.
CHAPTER THREE

METHODOLOGY

This pilot study was conducted at Ball State University (BSU), Muncie, Indiana with men and women Ball State athletes participating. To evaluate the effectiveness of change in nutrition knowledge among men and women Division I athletes, a series of four nutrition education lessons were administered to men and women swimmers (experimental group). The men’s golf team and women’s gymnastics team did not attend the nutrition education lessons and served as the control group. All athletes were full time students and over the age of 18. A pre and post test nutrition knowledge test was administered to the experimental group to measure change in knowledge. The control group was administered the nutrition knowledge test twice. A picture food frequency questionnaire (PFFQ) was given prior to, and after, the nutrition education lessons to the experimental group to measure change in dietary habits. The control group took the PFFQ twice to measure reliability. Behavior change was assessed using the Stages of Change model. Demographics was assessed using a participant profile information sheet. The purpose of this study was to examine the relationship between nutritional knowledge, dietary habits, and nutrition behavior of collegiate men and women athletes at a Midwestern university in Indiana. Other variables examined were participant profile information.
Sample

The participants in this study consisted of a sample of 78 collegiate varsity athletes (n=34 males, n=44 females) at a Midwestern Division I University. A 47% participation rate was achieved, with 37 out of 78 athletes (n=17 males, n=20 females) completing the study.

Participants in this study consisted of BSU swim members (n=18) and BSU athletes (n=19) from the men’s golf team and women’s gymnastics team. The men and women swimmers participated in the nutrition education sessions (experimental group) and the BSU athletes from the men’s golf team and women’s gymnastics team did not attend the nutrition education sessions and served as the control group.

The requirements for participation in this study were to be ≥18 years old, and part of a Ball State University athletic team with no known medical or physiological diagnosis. Exclusion criteria for the participants included: unable or unwilling to commit to four (forty-five minute) nutrition education lessons and/or completing the Picture Food Frequency Questionnaire (PFFQ), nutrition knowledge test, stages of change questionnaire and participant profile information sheet. All of the volunteers who met the criteria for the study signed a voluntary informed consent form, and a photocopy of the signed consent form was given to each subject who agreed to participate. The study instruments were approved by Ball State University’s IRB committee. To ensure confidentiality of athletes, questionnaires were coded. The code book and questionnaires were kept locked in separate file cabinets the PIs supervisor’s office.
Instruments

Dietary Habits:

Nutrient and dietary habits have been measured using a Picture Food Frequency Questionnaire (PFFQ) [Appendix A]. The PFFQ was used to determine the dietary habits of the control group participants twice for reliability purposes and was taken by the experimental group before and one month after the nutrition education sessions were given to measure change in dietary habits. Each athlete was given a password and login name to take the test online as well as instruction for completing the PFFQ [Appendix B]. The PFFQ questionnaire took approximately fifteen to thirty minutes to complete.

Stages of Change:

Dietary behavior change of athletes was assessed using the stages of change model received with permission from the fundamental survey WiseWomen in Michigan. This survey was adapted from a prior study conducted by Dr. Carol Friesen, a Ball State Family and Consumer Science faculty member. This model was tested for face validity, content validity, and construct validity. The stages of change model survey [Appendix C] was given prior to and after the last nutrition education session in the experimental group and once to the control group. Subjects were asked a series of six questions related to typical food intake choices (e.g., ‘I am able to improve the types of healthy foods I eat’; ‘I eat 2-3 servings of fruit a day.’) The survey had a 5-level Linkert scale with choices: “I don’t do and I don’t think about it (score of 1),” “I think about it but I don’t do (score of 2),” “I feel ready to start (score of 3),” “I do this sometimes (score of 4),” “I usually do this (score of 5),” “I do this all the time (score of 6).” This questionnaire took approximately five to ten minutes to complete. Behavior change was analyzed by the
difference in change of score for each question prior to and after nutrition education.

**Nutrition Knowledge:**

The nutrition knowledge test was developed as a pilot test by the primary investigator. The nutrition knowledge test [Appendix D] included 31 true and false questions from pertinent sports nutrition information from the nutrition education lessons (e.g. ‘Energy expenditure depends on: body size, and the type, intensity, and duration of activity,’ ‘A good marker of how much sweat was lost in exercise is body weight’). The nutrition knowledge test included questions regarding energy/calories, macronutrients, vitamins and minerals, supplements, timing of meals, food choices, fluid and hydration and nutrition concerns.

The content and face validity of the nutrition knowledge test was evaluated and approved by five Family and Consumer Science faculty and four registered dietitians at Ball State University. The amount of time spent on specific topics during the nutrition lessons was based on the amount of questions on the nutrition knowledge test [Appendix E].

The nutrition knowledge test was administered to each subject in the experimental and control group. The experimental group took the test at the beginning of the first session (pre-test), and after completing the fourth nutrition session (post-test). The control group took the test once during the first recruitment meeting and a few months after the study began. The nutrition knowledge test took about five to ten minutes to complete.
Demographic Information:

Demographic information from the participant profile information sheet was developed by the PI and included: athlete’s year in school, major, whether the subject would like to learn more about nutrition, whether the subject eats on or off campus, and whether or not the subject had taken any nutrition classes at BSU [Appendix F]. Height and weight of each athlete was self-recorded by each athlete while completing the PFFQ.

Nutrition Education:

The nutrition education material was developed by the PI [Appendix G]. It contained pertinent sports nutrition information from The American College of Sports Medicine and the American Dietetic Association Joint Position compiled research (ADA 2009). Content validity of the nutrition education sessions was evaluated and approved by four registered dietitians at Ball State University. The education sessions covered all of the information on the nutrition knowledge tests that was given to the athletes. The nutrition education lessons consisted of important sports nutrition topics relevant to the athletes. It included information about macronutrients such as carbohydrates, fats and proteins, micronutrients such as vitamins and minerals, fluids and hydration, and repair/recovery, amenorrhea, osteoporosis, and supplements. The nutrition education lessons were broken into four, forty-five minute sessions: Session 1: Carbohydrates, fats and protein; Session 2: Micronutrients, fluid and hydration; Session 3: Repair/Recovery; Session 4: Amenorrhea, osteoporosis and supplements.

The four nutrition lessons were delivered by the PI at the end of March and the beginning of April, 2010. The experimental group met in the same classroom, twice a week for two weeks after their swimming practice. The PI delivered the information
using a PowerPoint presentation and the participants followed along with their own handouts of the lessons.

**Data Collection**

The athletic director at Ball State University was contacted by the PI through email to ask for permission to work with the men and women’s swimming team, men’s golf team and women’s gymnastics team [Appendix H]. Upon approval, each head coach was contacted by email to invite their team to participate in the study [Appendix I, J, K, and L]. After receiving consent from the coaches, the PI then met with the athletes and informed them about the study and invited them to participate [Appendix M].

**Dietary Habits, Stages of Change, Demographics:**

After the first recruitment meeting with the experimental group, a second meeting was held for the BSU swimmers participating in the study. The PI gave them instructions to help them complete the PFFQ. The PI distributed the participant profile information sheet and stages of change questionnaire for the participants to complete. The researcher emailed the athletes to remind them to take the PFFQ online one month after the fourth nutrition education session to evaluate a change in dietary habits and stages of change [Appendix N]. The results from the PFFQ, and stages of change, pre-test and post-test results was retrieved online and analyzed by the PI.

At the first recruitment meeting with the control group, the PI met with the athletes who agreed to participate in the study. The PI gave them instructions to help them complete the PFFQ. The PI distributed the participant profile information sheet and stages of change questionnaire for the participants to complete. The researcher emailed
the athletes to remind them to fill out the PFFQ online to evaluate their dietary habits [Appendix N]. The results from the PFFQ, and stages of change, was retrieved online and analyzed by the PI.

**Nutrition Education:**

At the second recruitment meeting with the experimental group, the PI explained the dates in which they were to meet for the nutrition education sessions. They met in March and April, 2010. They met four days after their swim practice at the same time every day in the same classroom. An email [Appendix O] was sent prior to each nutrition education session by the PI to remind subjects of the session, time and place. The nutrition education program consisted of four, 45 minute sessions.

**Nutrition Knowledge:**

The nutrition knowledge test was administered to each subject in the experimental and control group. The experimental group took the test at the beginning of the first session (pre-test), and after completing the fourth nutrition session (post-test). The control group took the test once during the first recruitment meeting. The nutrition knowledge test took approximately five to ten minutes.

**Statistical Analysis**

Data was analyzed using SPSS v.18.0 for Windows (SPSS, Inc., 2010). Descriptive statistics were used to determine means and standard deviations. The power for a between-group treatment effect was calculated for 18 subjects per group. The power was set at 80% for detecting a difference between group means for a relative effect size of 0.8 standard deviation. The non-parametric Wilcoxon Test was used when
assessing stages of change, dietary habits, and pre and post nutrition knowledge. Statistical significance was established at $p \leq 0.05$.

**Institutional Review Board**

Prior to start of research, permission was requested from Ball State University Institutional Review Board as exempt [Appendix P]. The researcher conducting this analysis completed the Collaborative Institutional Training Initiative training [Appendix Q].

**Summary**

This study evaluated the effectiveness of change in nutrition knowledge among men and women Division I athletes. A previously administered survey, and instruments developed by the PI was used to collect information related to behavior change, dietary habits, nutrition knowledge, and demographics.
CHAPTER FOUR

RESULTS

The purpose of this study was to examine the relationship of nutritional knowledge, dietary habits, and nutrition behavior of collegiate men and women athletes at a Midwestern University in Indiana. The data presented in this chapter provides information for individuals involved in areas of sports nutrition who may want to use these findings to evaluate athletes’ dietary habits, nutrition knowledge and behavior change prior to and after nutrition education interventions. This chapter contains the findings for each research question and hypotheses as well as a summarization of participant’s demographics.

Subjects

In the spring of 2010, men’s and women’s swimming, men’s golf, and the women’s gymnastics team from Ball State University (BSU) were invited to participate in this study. The participants in this study consisted of a sample of 78 collegiate varsity athletes (n=34 males, n=44 females) at a Midwestern Division I University. A 47% participation rate was achieved, with 37 out of 78 athletes (n=17 males, n=20 females) volunteering for the study. Of these 37 athletes, eighteen were from the men and women’s swim team (n=13 females, n=5 males), eleven were from the men’s golf team,
and nine were from women’s gymnastics team. Due to a lack of returned questionnaires, the control group data was not used as a part of this study.

**Demographics**

Experimental group subjects ranged in academic class standing from freshmen to seniors. Of the eighteen experimental group respondents, seven were freshman (39%), four were sophomores (22%), three were juniors (17%) and four were seniors (22%). Slightly more than one half (56%, n=10) of the eighteen subjects prepared or cooked their meals at home, and 44% (n=8) of the subjects did not prepare or cook their meals at home. There were two subjects enrolled in the dietetics program at Ball State University and ten non-nutrition related majors among the participants. Among the subjects, 78% (n=14) had not taken a nutrition course in college and 22% of the subjects (n=4) had taken a nutrition course in college. Among the subjects, 100% (n=18) were interested in learning more about nutrition (Table 1).

All voluntary subjects from the control group completed the first set of questionnaires (pre-nutrition intervention), but only six of the athletes completed the second set of questionnaires (post-nutrition intervention). The drop-out rate for the control group was 68%, which could largely be due to athletes’ busy schedules with competitions, practices and studying for finals. Moreover, the control group data was not included in this study.

Body Mass Index (BMI) results for each athlete was generated by the PFFQ with a built in BMI formula using height and weight. Six (33%) out of the eighteen athletes
had a BMI between 20.0 and 22.9. Ten athletes (56%) had a BMI between 23.0 and 25.9 and two (11%) athletes had a BMI between 26.0 and 28.9 (Table 1).

Table 1. Experimental Group Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>7</td>
</tr>
<tr>
<td>Sophomore</td>
<td>4</td>
</tr>
<tr>
<td>Junior</td>
<td>3</td>
</tr>
<tr>
<td>Senior</td>
<td>4</td>
</tr>
</tbody>
</table>

**Do you prepare or cook foods at home?**
- Yes: 10
- No: 8

**Major**
- Actuarial Science: 1
- Biology: 1
- Business: 1
- Computer Technology: 1
- Dietetics: 2
- Education: 6
- Exercise Science: 2
- Landscape Architecture: 1
- Medical Technology: 1
- Pre-Medical: 1
- Undecided: 1

**Have you taken a nutrition course in college?**
- Yes: 4
- No: 14

**Are you interested in learning more about nutrition?**
- Yes: 18
- No: 0

**BMI (kg/m^3)**
- 20.0-22.9: 6
- 23.0-25.9: 10
- 26.0-28.9: 2
**Nutrition Knowledge**

The mean Pre-Nutrition Knowledge Test (NKTPre) score for the experimental group prior to the nutrition education was 22.5±1.90; equivalent to a score of 72.6% correct (Table 2). The NKTPre scores ranged from a low of 20 to a high of 25 out of 31 questions correct (65%-81%). The subjects mean Nutrition Knowledge Test (NKTPost) score after the nutrition education was 26.8±2.34, equivalent to 86% correct answers. The NKTPost scores ranged from 23 to 31 out of 31 total questions (74%-100%). Post nutrition knowledge scores showed a four point increase in knowledge between pre and post nutrition education in both men and women experimental subjects (p≤0.001). (Table 2).

<table>
<thead>
<tr>
<th>Report</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>NKTPre</td>
<td>22.5</td>
<td>1.9</td>
<td>20.0</td>
<td>25.0</td>
</tr>
<tr>
<td>NKTPost</td>
<td>26.8</td>
<td>2.3</td>
<td>23.0</td>
<td>31.0</td>
</tr>
</tbody>
</table>

The swimmers’ nutrition knowledge scores on questions regarding hydration, supplements, vitamins and minerals, fats, meal choices and amenorrhea were less than 75% correct. The swimmers scored higher in subject areas such as calcium, energy requirements, recovery drinks, and electrolytes, with all 18 athletes answering these questions correctly (Table 3).
<table>
<thead>
<tr>
<th>Statement</th>
<th>Correct Response Pre</th>
<th>Correct Response Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Energy Expenditure depends on: body size, and the type, intensity, and duration of activity (True)</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>2. Protein is the body’s primary energy source and main fuel for swimmers (False)</td>
<td>94%</td>
<td>83%</td>
</tr>
<tr>
<td>3. An athlete’s plate should consist of ½ protein, ¼ fruits and vegetables and ¼ carbohydrates (False)</td>
<td>83%</td>
<td>61%</td>
</tr>
<tr>
<td>4. Examples of good sources of carbohydrates for athletes are meats, candy and ice cream (False)</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>7. A 5 ounce piece of meat is equal to the size of a deck of cards (False)</td>
<td>33%</td>
<td>83%</td>
</tr>
<tr>
<td>9. Unsaturated fats are solid at room temperature; these fats increase the risk of heart disease (False)</td>
<td>72%</td>
<td>100%</td>
</tr>
<tr>
<td>10. Saturated fats are liquid at room temperature, these fats decrease the risk of heart disease (False)</td>
<td>66%</td>
<td>94%</td>
</tr>
<tr>
<td>12. Athletes should take vitamin and mineral supplements if their diet is balanced and adequate because it can enhance athletic performance (False)</td>
<td>66%</td>
<td>94%</td>
</tr>
<tr>
<td>13. Athletes should drink 20-30 ounces of fluids every half hour of practice (False)</td>
<td>44%</td>
<td>77%</td>
</tr>
<tr>
<td>15. Chocolate milk is not a very good drink for athletes because it has too much sugar (False)</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>16. Chloride and potassium are the most important electrolytes depleted in sweat (False)</td>
<td>44%</td>
<td>61%</td>
</tr>
</tbody>
</table>
17. Electrolytes must be replaced when significant amounts are lost through sports drinks and by eating a variety of fruits, vegetables, nuts, seeds, dairy foods, lean meats, and whole grains (True)  

18. A loss of athletic performance can be seen with just a 0.5% loss of body weight as water (False)  

19. If dehydration reaches 6% of body weight, cramping and heat exhaustion can result (False)  

21. A good marker of how much sweat was lost during exercise is body weight (True)  

25. Amenorrhea: not experiencing a menstrual cycle for at least 4 months (False)  

28. Calcium rich foods are milk, yogurt and cheese (True)  

29. Supplement companies label everything in their ingredients so the possibility of contamination of banned substances is not an issue (False)  

31. A good example of lunch for athletes is 2 slices of cheese pizza and a salad or a piece of fruit (True)  

<table>
<thead>
<tr>
<th>Question</th>
<th>Agree</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>17. Electrolytes must be replaced when significant amounts are lost through sports drinks and by eating a variety of fruits, vegetables, nuts, seeds, dairy foods, lean meats, and whole grains (True)</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>18. A loss of athletic performance can be seen with just a 0.5% loss of body weight as water (False)</td>
<td>22%</td>
<td>38%</td>
</tr>
<tr>
<td>19. If dehydration reaches 6% of body weight, cramping and heat exhaustion can result (False)</td>
<td>11%</td>
<td>11%</td>
</tr>
<tr>
<td>21. A good marker of how much sweat was lost during exercise is body weight (True)</td>
<td>72%</td>
<td>100%</td>
</tr>
<tr>
<td>25. Amenorrhea: not experiencing a menstrual cycle for at least 4 months (False)</td>
<td>27%</td>
<td>66%</td>
</tr>
<tr>
<td>28. Calcium rich foods are milk, yogurt and cheese (True)</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>29. Supplement companies label everything in their ingredients so the possibility of contamination of banned substances is not an issue (False)</td>
<td>66%</td>
<td>83%</td>
</tr>
<tr>
<td>31. A good example of lunch for athletes is 2 slices of cheese pizza and a salad or a piece of fruit (True)</td>
<td>11%</td>
<td>77%</td>
</tr>
</tbody>
</table>

### Behavior Change

When comparing pre and post nutrition education behavior change, all eighteen athletes expressed a significant behavior change for five out of the six questions. The survey had a 5-level Likert scale with choices: “I don’t do and I don’t think about it (score of 1),” “I think about it but I don’t do (score of 2),” “I feel ready to start (score of 3),” “I do this sometimes (score of 4),” “I usually do this (score of 5),” “I do this all the
Behavior change was analyzed by the difference in change of score for each question prior to and after nutrition education. The non-parametric Wilcoxon Test was used when assessing stages of change pre and post nutrition education. The question “I am able to improve the types of healthy food I eat,” revealed a mean positive change (0.78±0.65) of athletes’ behavior of slightly less than one point (p≤0.001). When asked, “I eat 2-3 servings of fruit every day,” the athletes had a positive change in behavior by almost one full point (0.72±0.67, p≤0.001). The athletes exemplified a positive change in behavior by slightly more than one half of a point (0.61±0.79, p≤0.004) when asked “I eat 2-3 servings of vegetables every day.” The question with the greatest change in behavior experienced by the athletes was “I eat nonfat dairy products every day.” The athletes’ showed a positive behavior change by exactly one point (1.00±1.71, p≤0.024). There was a positive behavior change by slightly less than one half of a point (0.44±0.71) when the athletes were asked “I eat whole grain bread and cereal products daily (p≤0.016). The question without significant findings was “I am able to lose weight” with only a mean behavior change of 0.17 ±0.71 (p≤0.331) (Table 4).
Table 4. Stages of Change Pre and Post Nutrition Education

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean</th>
<th>Standard Deviation (±)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am able to improve the types of healthy food I eat</td>
<td>0.78</td>
<td>0.65</td>
<td>p≤0.001</td>
</tr>
<tr>
<td>I am able to lose weight</td>
<td>0.17</td>
<td>0.71</td>
<td>p≤0.331</td>
</tr>
<tr>
<td>I eat 2-3 servings of fruit every day</td>
<td>0.72</td>
<td>0.67</td>
<td>p≤0.001</td>
</tr>
<tr>
<td>I eat 2-3 servings of vegetables every day</td>
<td>0.61</td>
<td>0.79</td>
<td>p≤0.004</td>
</tr>
<tr>
<td>I eat nonfat dairy products every day</td>
<td>1.00</td>
<td>1.71</td>
<td>p≤.024</td>
</tr>
<tr>
<td>I eat whole grain bread and cereal products daily</td>
<td>0.44</td>
<td>0.71</td>
<td>p≤0.016</td>
</tr>
</tbody>
</table>

Dietary Habits

Dietary habits in the experimental group were assessed by the Picture Food Frequency Questionnaire (PFFQ). Two of the experimental athletes did not return their post PFFQ, resulting in sixteen analyzed questionnaires. The third research question examined whether there will be a change in dietary habits and dietary habits among the experimental group compared to prior intake before the nutrition education program. A positive change was seen with an increase of vegetables from 1.5 servings prior to the nutrition education to 1.7 servings of vegetables a day after attending four nutrition education lessons. As hypothesized, nutrition education lessons positively affected calcium intake among female athletes in the experimental group (1867.0mg pre, 1914.3mg post). A decrease in calories (2965.6 kcal pre, 2187.0 kcal post), carbohydrates
(372.7 g pre, 294.4 g post), fat (104.7 g pre, 68.6 g post), protein (114.9 g pre, 87.8 g post), iron (27.0 g pre, 22.8 g post), sodium (5428.1 mg pre, 3896.8 mg post), and water (122.6 g pre, 115.1 g post) was seen in the athletes’ dietary habits post nutrition education lessons. When the athletes completed the dietary habits post nutrition education questionnaire (May 2010), classes were dismissed for the academic year and they were not attending swim practices at BSU. Moreover, the athletes were not expending as much energy at swimming and weight lifting practices which may explain the decrease in these nutrients (Table 5).

**Table 5. Change of Dietary Habits of Experimental Athletes Pre and Post Nutrition Education**

<table>
<thead>
<tr>
<th>Dietary Habits (Mean)</th>
<th>Pre Nutrition Education</th>
<th>Post Nutrition Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium (servings)</td>
<td>9.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Fruit (servings)</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Vegetable (servings)</td>
<td>1.5</td>
<td>1.7</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>1867.0</td>
<td>1914.3</td>
</tr>
<tr>
<td>Calories (kcal)</td>
<td>2965.5</td>
<td>2187.0</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>372.7</td>
<td>294.4</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>104.7</td>
<td>68.6</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>114.9</td>
<td>87.8</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>27.0</td>
<td>22.8</td>
</tr>
<tr>
<td>Potassium (mg)</td>
<td>3923.0</td>
<td>3464.4</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>5428.1</td>
<td>3896.8</td>
</tr>
<tr>
<td>Water (ounces)</td>
<td>122.6</td>
<td>115.1</td>
</tr>
</tbody>
</table>

The female athletes were within recommended protein levels (1.5g/kg pre, 1.2g/kg post) and fat (1.4 g/kg pre) recommendations of gram per kilogram of body weight. The male swimmers did not meet the recommendation for carbohydrates (5.7g/kg pre, 3.9 g/kg post,) but were within the recommendations for calories (49.3g/kg...
pre, 33.6g/kg post). The male swimmers were above protein (2.0g/kg) and fat (1.7g/kg) recommendations post nutrition education, but were within the recommendations post nutrition education, which supports the hypothesis that nutrition education would positively affect dietary habits among experimental group (1.3g/kg protein, 1.1 g/kg fat) (Table 6 and Table 7).

**Table 6. Mean Intake of Calories and Macronutrients of Women**

<table>
<thead>
<tr>
<th></th>
<th>Calories (kcal/kg weight)</th>
<th>Carbohydrate (g/kg weight)</th>
<th>Protein (g/kg weight)</th>
<th>Fat (g/kg weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>37.9</td>
<td>5.0</td>
<td>1.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Post</td>
<td>30.2</td>
<td>4.4</td>
<td>1.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Recommendations</td>
<td>41-58&lt;sup&gt;1&lt;/sup&gt;</td>
<td>6-10&lt;sup&gt;2&lt;/sup&gt;</td>
<td>1.2-1.7&lt;sup&gt;2&lt;/sup&gt;</td>
<td>1.0&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Recommendations based on:
1- Hark and Deen (2006)
2- ADA (2009)

**Table 7. Mean Intake of Calories and Macronutrients of Men**

<table>
<thead>
<tr>
<th></th>
<th>Calories (kcal/kg weight)</th>
<th>Carbohydrate (g/kg weight)</th>
<th>Protein (g/kg weight)</th>
<th>Fat (g/kg weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>49.3</td>
<td>5.7</td>
<td>2</td>
<td>1.7</td>
</tr>
<tr>
<td>Post</td>
<td>33.6</td>
<td>3.9</td>
<td>1.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Recommendations</td>
<td>31-51&lt;sup&gt;1&lt;/sup&gt;</td>
<td>6-10&lt;sup&gt;2&lt;/sup&gt;</td>
<td>1.2-1.7&lt;sup&gt;2&lt;/sup&gt;</td>
<td>1.0&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Recommendations based on:
1- Hark and Deen (2006)
2- ADA (2009)
Summary

The researcher examined the relationship of nutritional knowledge, dietary habits, and nutrition behavior of eighteen collegiate men and women athletes at Ball State University in Indiana. A four point ($p \leq 0.001$) increase in knowledge was seen between pre and post nutrition education from 22.5 to 26.8 correct points out of 31 questions in both men and women experimental subjects. A significant behavior change was seen in the sum of all eighteen athletes for five out of the six questions when pre and post nutrition education behavior change was measured. Nutrition education positively affected dietary habits among experimental group when assessing protein and fat in men; and calcium, and vegetable intake for both men and women. These specific findings suggest the effectiveness of nutrition education among collegiate athletes.
CHAPTER FIVE

DISCUSSION

The purpose of this study was to examine the relationship of nutritional knowledge, dietary habits, and nutrition behavior of collegiate men and women athletes at a Midwestern University in Indiana. Sports nutrition has grown in the past decade, linking how an athlete eats with how they perform during practice or competitive events. Research has demonstrated that athletes who receive nutrition education have significantly higher knowledge and attitude scores. For this reason and given the results of this study, it would be beneficial to hire a dietitian as part of the athletic staff (Clark 1999).

Demographics

A major problem facing America’s college students is the lack of healthy fast foods or easily prepared foods. College students lack time, money and may have limited space to prepare meals. A major concern is the knowledge needed to buy and prepare healthy foods (Dunn et al. 2009). Ten out of the eighteen BSU swimmers stated they prepare their meals at home, and all eighteen subjects stated they want to learn more about nutrition. This implies the importance of nutrition education for college students; more specifically athletes.
The majority of the athletes (n=10) had a BMI value ranging from 23.0 to 25.9 kg/m$^2$. BMI values of 18.5-24.9 kg/m$^2$ are considered normal weight (CDC 2009). Swimmers of a high competitive level tend to have a greater fat percentage than runners and cyclists of the same competitive level and identical training volumes. This has been found to be an advantage to swimmers due to the friction reduction caused by a greater fluctuation, especially in long distance swimmers (Costill et al. 1988).

All voluntary subjects completed the first set of questionnaires (pre-nutrition), but only six of the control group athletes completed the second set of questionnaires (post-nutrition). The drop-out rate for the control group was 68%, which could largely be due to athletes’ busy schedules with competitions, practices and studying for finals. Moreover, due to a lack of returned questionnaires, the control group data was not included in this study.

**Nutrition Knowledge (Research Question #1)**

As hypothesized, the experimental subject’s nutrition knowledge scores showed significant change between pre and post nutrition education in both men and women experimental subjects ($p\leq0.001$). A four point increase ($p\leq0.001$) in knowledge was seen between pre and post nutrition education (22.5 to 26.8 correct points out of 31 questions) in both men and women experimental subjects. As previous research has indicated (Barr 1987; Jacobson, Sobonyina, and Ransone 2001; Witta et al. 1995) college athletes are lacking in nutritional knowledge.

Among the college swimmers participating in this study, knowledge about calcium, calories, and recovery foods/beverages was excellent, with all 18 athletes...
answering these questions correctly. This finding could reflect the increasing interest in nutrition for optimizing athletic performance among athletes. It could also reflect a bias that those interested in nutrition might be more likely to complete this study. These athletes, however, scored less than 75% correct on questions regarding vitamins and minerals, fats, meal choices, amenorrhea, proper hydration and supplements prior to nutrition education. For example, 56% of athletes prior to nutrition knowledge lessons believed chloride and potassium are the most important electrolytes depleted in sweat, and 66% of subjects believed athletes should drink 20-30 ounces of fluids every half hour of practice. Thirty-four percent of subjects thought athletes should take vitamin and mineral supplements if their diet is balanced and adequate because it can enhance athletic performance.

The fitness industry and media, as nutrition information sources for coaches and athletes, may play a role in these invalid beliefs (Jessri al. 2006). Corley et al. found only eighteen percent of one-hundred and five college coaches at junior and senior colleges in North Carolina knew that carbohydrates and protein provided the same amount of energy; less than one half identified eggs as the best source of high quality protein (1990). Furthermore, there is not only a lack of nutrition knowledge of athletes and coaches, but there is also a problem with where to get accurate nutritional information (Hornstrom 2007). A study by Jacobson and Gemmell found that out of 430 varsity Division I college athletes, 40% turned to popular magazine information (1991). Additionally, 55% of Division 1 coaches from Virginia Polytech Institute and State University reported they get their nutrition information mostly from magazines as well (Rockewell et al. 2001). A study by Hamilton and colleagues found coaches were considered one of the most
important sources of nutrition information for runners which is in agreement with studies in the US, which reported coaches normally distribute sports nutrition information to their athletes and see themselves responsible for providing nutritional information to their athletes. Importantly, it is a concern that many US studies found nutrition knowledge of coaches was found to be poor and that their use of a source of information was associated with poorer nutrition knowledge scores for their athletes. Therefore, it would be important to aim nutrition not only to athletes, but also to their coaches (1994).

This study answered research questions one, which found improvement in nutrition knowledge among the experimental group after completing a nutrition education program compared to nutrition knowledge prior to the nutrition education program. The athletes experienced increased nutrition knowledge after attending nutrition education lessons specifically in areas such as macronutrients, hydration, vitamin and minerals, supplementation and amenorrhea. Prior to nutrition education lessons, 66% of athletes answered correctly that supplement companies do not label everything in their ingredients and the possibility of contamination of banned substances is not an issue. After attending four nutrition education lessons regarding sports nutrition, 86% of athletes answered this correction correctly, bridging the gap between misinformation of supplements. Twenty-seven percent of athletes thought amenorrhea was defined as not experiencing a menstrual cycle for three months prior to nutrition education. After the researcher explained amenorrhea and the effects it has on the female body during nutrition education lessons, 66% of the athletes answered the same question correctly for the post nutrition education test. These examples exemplify the positive effect nutrition education had on athletes after attending four nutrition education lessons.
It is important to note an unexplainable decrease in nutrition knowledge for two questions post nutrition education lessons. Prior to nutrition education lessons, 94% of subjects answered correctly that protein is not the body’s primary energy source and main fuel for swimmers. One month after nutrition education lessons, 83% of subjects answered the same questions correctly. Eighty-three percent of participants believed that an athlete’s plate should not consist of ½ protein, ¼ fruits and vegetables and ¼ carbohydrates prior to nutrition education, however 61% of participants answered this question correctly post nutrition education. This decrease in nutrition knowledge could be related to the one month time period between the two tests which could lead to athletes forgetting some of the material from the nutrition education lessons. Additionally, these athletes could have misread these questions. Due to this finding, it is recommended for further research that these questions be re-worded from this questionnaire and the nutrition education should be revisited.

**Nutrition Education (RQ # 1)**

Athletes may benefit from nutrition education; however, insufficient nutrition education resources are common at most college campuses thus barring improvement of dietary knowledge and behaviors. The major challenge in providing nutrition education to collegiate athletes is the development of an effective methodology for improving nutrition knowledge, dietary habits, and behaviors (Cole et al. 2005). Four out of eighteen experimental subjects in this study had taken a nutrition course in college. Four of the subjects were required to take nutrition courses as part of their curriculum at BSU. Most college students are not required to take a nutrition course excluding students majoring in
nutrition, family and consumer sciences, and majors related to health. College years are an ideal time to influence a large number of young adults about the positive impact a healthy diet can have on long term health, which explains the need for nutrition education in the collegiate setting (Cerutti and Quinton 2009). This study found that 100% of participants would like more nutrition information.

Researchers have concluded the need for nutrition education as part of athletes overall health and part of the athletes training (Paschoal and Amancio 2004; Ousley-Pahnke et al. 2001; Kabasakalis, Kalitsis, Tsalis, and Mougios 2007; Abood, Black, and Birnbaum 2004). Moreover, college athletes may be receptive to learning how to improve their dietary habits to correct nutrient inadequacies that can impact their sport performance (Rash et al. 2008).

The National Collegiate Athletic Associate (NCAA) recommends nutritional counseling in the Athletic Trainers Plan of Action when an athlete is suspected for having an eating disorder. Major concerns displayed on the Nutrition Performance NCAA webpage are confidentiality, mandatory weight-ins, and body composition measurements. Nutritional evaluation is not a requirement as part of baseline medical information for collegiate student athletes. Nutritional assessment as well as medical screening would be a solution to solve confidentiality problems of athletes. In addition, an implementation of nutrition education programs and the addition of a nutritional evaluation or assessment would largely benefit athletes (2005).

According to Gilbert, sports nutrition is currently a poorly regulated profession, allowing unethical practitioners and individuals without the necessary skills and qualifications to practice. As previously mentioned, this leads to athletes obtaining
information from less-reliable sources which includes the media and supplement companies. Many collegiate athletes never receive support that would allow them to implement distinctive nutrition strategies that could have a positive effect on their performance. Therefore, it is the role of the registered sports dietitian to assess individual need and work with the athlete to develop and apply an individually-tailored evidenced-based strategy to optimize exercise performances through good nutrition and hydration practices, careful use of ergogenic aids, supplements and routine monitoring. Some athletes experience difficulty adjusting and meeting macronutrient and micronutrient needs according to training demands. Some athletes are resistant to eating certain foods they perceive to be unhealthy and also face challenges with gastrointestinal discomfort with certain foods. Thus, a dietitian would be beneficial in the collegiate setting to work with each athlete on an individual basis to help educate and develop athletes during different periods of training and competition, rest and recovery (2008).

Dietary Habits (Research Question # 2)

As hypothesized, nutrition education positively affected dietary habits among the experimental group when assessing protein and fat in men, and calcium, and vegetable intake for both men and women. Our results suggest an effectiveness of nutrition education among collegiate athletes who participated in top-level training. Swimmers should be encouraged to consume more carbohydrates and less fat, and try to meet the DRI of all micronutrients through the diet.

The experimental group’s average dietary habits prior to and after nutrition education met the DRI (Dietary Reference Intake) for age group of calcium servings
(dietary guidelines: 2-3 servings milk, yogurt, cheese), iron (DRI men 8mg/day, women 18mg/day), fruit servings (dietary guidelines: 2-4 servings) and calcium (DRI 1000mg/day), indicating an overall healthy diet in these areas of nutrition. In contrast, the athletes were below the DRI of vegetable servings (3-5), potassium (DRI 4700mg/day) and water (DRI: 125 ounces/day). These findings correlate with studies which found that college students generally under consume vegetables and whole grains, while over consuming foods high in fat, and sugar (Cerutti and Quinton 2009). Almost three quarters of college students in the United States consume fewer than five servings of fruits and vegetables a day, which is comparable to findings of BSU student athletes who under consume vegetables daily (Brevard and Rickets 1996; Centers for Disease Control and Prevention-CDC 1997; Huandet et al. 1994; Melby, Femea, and Sciancca 1986).

Prior to and after nutrition education, the male swimmers did not meet the recommendations for carbohydrates but were within the recommendations for calories. The male swimmers were above protein and fat intake recommendations prior to the nutrition education lessons, but nutrition education proved to have a positive effect on these dietary habits showing a decrease in protein and fat while meeting appropriate recommendations.

The female swimmers were not meeting caloric and carbohydrate requirements prior to, or after, the nutrition education lessons. The female athletes were within protein and fat requirements prior to the nutrition education lessons, but were just below fat recommendations post nutrition education. These results are comparable to other
research findings. Trends in research have shown athletes to be above the recommended amount of fat, and protein and not meeting carbohydrate needs, which can make them susceptible to exhaustion, fatigue, and inadequate glycogen stores (Hinton et al. 2004; Kabasakalis et al. 2007; Paschoal et al. 2004). Some studies have noted that the general public has a bias toward underreporting by about 20% when recording dietary intake (Burke 2001; Cole et al. 2005).

The swimmers seemed to adjust their nutritional habits to the demands of the training load of swimming and weight lifting. A decrease in calories, carbohydrates, fat, protein, sodium and water was seen in the athletes’ dietary habits post nutrition education lessons. When the athletes took the PFFQ post nutrition education assessment, classes had been dismissed for the academic year and they were not attending swim practices at BSU. Moreover, the athletes had a possible decrease in macronutrients and micronutrients due to the swim season ending and change of training and energy needs. As training volume decreases, Barr and Costill found that energy intake should decrease which is a more reasonable and fitting to a carefully scheduled diet (1992). Results from this study contradict research by Ousley-Pahnke which have shown that swimmers do not always adjust their nutrient needs to the training stress but information about possible modifications of the dietary habits of swimmers during different training phases is limited (2001).

In general, there are many difficulties in assessing the usual dietary habits of individuals including: the ability of respondents to recall what foods they ate and to accurately estimate serving size; limitations of the time period sampled being representative of usual intake; under-reporting of food intake; subject burden; and subject
compliance (Hinton et al. 2004). Given these difficulties, the researcher chose the picture food frequency questionnaire to help athletes identify portion/serving sizes and to maximize the response rate by increasing the likelihood that athletes would complete the dietary assessment. The researcher was interested in habitual dietary habits of subjects, which is why the 24 hour recall or three day food log was not used in this study. These instruments can not accurately represent usual dietary habits.

**Behavior Change (Research Question # 3)**

When comparing pre and post nutrition education behavior change, all eighteen athletes expressed a significant behavior change for five out of the six questions. The question without significant findings ($p \leq 0.331$) was “I am able to lose weight” with only a mean behavior change of 0.167. The researcher did not talk about weight loss or express the need for weight loss during the nutrition education, which may be why this question did not have a positive change in behavior. These results reveal satisfaction with body image for this group of athletes which contradicts research by Hinton et al. which found the majority of female athletes wanted to weigh less than their current weight, regardless of their sport (2004). Many athletes competing in “lean” sports experience greater pressure to maintain a particular body weight, body composition, or physique than those competing in other sports (American College of Sports Medicine 1997). During the nutrition education lessons, the researcher discussed the importance of vegetables, low fat dairy and overall healthy food intakes, which may explain the positive change in behavior for these questions when comparing pre and post nutrition education behavior change.
There have been numerous studies about the success and failure in helping individuals change, about the barriers of change, and about the role of the physician/dietitian in improving patient outcomes. Repeatedly educating individuals is not always successful and can become frustrating for the physician/dietitian. Also, by promising an improved outcome to an individual does not guarantee their motivation to change (Zimmerman, Olsen, and Bosworth 2001). Therefore, it is important for coaches and dietitians to understand the stages of change model for effective change in nutritional habits. Too much change at one time or a nutrition plan that is not matched with the athletes’ correct stage can slow an athlete’s progression through the stages and/or could lead to failure. Positive assurance and guidance from coaches and dietitians about the benefits of proper nutrition can lead athletes in the right direction towards a positive self-image and help increase self-confidence in the will to succeed.

Research evaluating behavior change of adults supports group versus individual counseling, which validates the results of this study which involved nutrition education in a group setting (Spahn et al. 2010). Additionally, Hormstrom stated that “Behavior change can be developed and tested if a researcher can identify what motivates individuals to change their behavior in a positive manner. However, “predicting behavior, remains obsolete” (2007).

Summary

It is well recognized that athletic performance is enhanced by optimal nutrition. However many studies have shown nutrition-related knowledge deficits and dietary
inadequacies among athletes (Rash, Malinauskas, Duffrin, Barber-Heidal and Overton 2007). An understanding of what motivates athletes towards behavior change and what learning environment is best for athletes is important to help athletes move forward in a positive direction towards making healthy choices. It is vital to know the dietary practices and concerns of athletes so that dietary habits can be addressed and changed to meet dietary guidelines. It is also imperative to know the nutrition knowledge of athletes, to bridge the gap between athlete’s actual sports nutrition knowledge and misconceptions about sports nutrition, which may lead to a positive change in dietary habits.
CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

Conclusions

Sports nutrition is a growing field, with research correlating athletes’ food consumption patterns to athletic performance during practice and competitive events. In this study, the swimmers exemplified low nutrition knowledge scores (less than 75% correct) prior to nutrition education sessions on questions regarding hydration, supplements, vitamins and minerals, fats, meal choices and amenorrhea. After attending four nutrition education sessions, the athletes mean nutrition knowledge scores increased, with athletes answering 86% of the questions correct. Results from this study and research shows that athletes who receive nutrition education have significantly higher knowledge scores.

This study suggests that female collegiate swimmers did not meet the recommended amount of intake for carbohydrates and calories, but were just within the recommended range for protein and fat. The male swimmers did not meet the recommendation for carbohydrate intake, but were within the recommendation for daily kilocalories. Moreover, the male athletes were above protein and fat recommended intakes prior to nutrition education, but were within the recommendations post nutrition education. The experimental group’s average dietary habits prior to nutrition education
exceeded the DRI (Dietary Reference Intake) for age group of calcium servings, and iron. The subjects met the DRI of fruit servings as well as calcium prior to nutrition education. The athletes were below the DRI of vegetable servings, potassium and water. One month after the four nutrition education sessions, the experimental group’s daily dietary habits met the DRI for servings of calcium, servings of fruit, calcium servings, iron and sodium. The athlete’s intake of servings of vegetables slightly increased from 1.49 servings/day to 1.72 servings/day but was still below the DRI recommended amount. The athletes did not meet the recommended amount for potassium or water.

Data from this study indicates suboptimal dietary habits of swimmers of potassium, water, vegetable servings, carbohydrates and calories. Research and data from this study provides evidence that nutrition education is needed for swimmers who participate in top-level training. Swimmers should be encouraged to consume more carbohydrates and less fat, and try to meet the DRI of all micronutrients through the diet.

Research demonstrates that it is essential to understand the motivators and barriers necessary for food intake behavior change. Athletes require specialized diets in order to maximize athletic performance. This requires numerous daily decisions about appropriate food intake in order to maintain a healthy body in addition to supporting athletic training. When comparing pre and post nutrition education behavior change, this study revealed that all eighteen athletes expressed a significant behavior change for five out of the six questions. The series of six questions related to typical food intake choices (e.g., ‘I am able to improve the types of healthy foods I eat’; ‘I eat 2-3 servings of fruit a day.’) The survey had a 5-level Linkert scale with choices: “I don’t do and I don’t think about it (score of 1),” “I think about it but I don’t do (score of 2),” “I feel ready to start
(score of 3),” “I do this sometimes (score of 4),” “I usually do this (score of 5),” “I do this all the time (score of 6).” Behavior change was analyzed by the difference in change of score for each question prior to and after nutrition education. These findings about positive behavior change regarding a healthy diet shows that college athletes may be receptive to learning how to improve their dietary habits to correct nutrient insufficiencies that can impact performance for their sport.

Athletes continually seek the advice of professionals to guide them in making the best possible food and fluid choices. Research has found that, sports nutrition is currently a poorly regulated profession, allowing disreputable practitioners and individuals without the required skills and credentials to practice. As previously mentioned athletes may obtain information from less-reliable sources; including the media, magazines and supplement companies. Importantly, many collegiate athletes may not receive support that would permit them to implement individual nutrition strategies that could have a positive effect on their athletic performance. Thus, a dietitian would be beneficial in the collegiate setting to work with each athlete on an individual basis to help educate athletes during different periods of training and competition, rest and recovery.

**Recommendations for future research**

Based on the results of this study, the following recommendations are offered:

*Expand the sample size, geographic location and participation rate*

1. Conduct data on other teams in the Mid American Conference (MAC) with other athletes in different conferences, and other National Collegiate Athletic Association (NCAA) division schools.
2. Design the study with a longer timeline, while athletes are available to allow for higher participation and lower attrition rates.

3. Ensure that the sample is large enough to measure a significant difference on study hypotheses variables.

**Recommendations for practice**

1. Provide nutrition education for athletes, coaches, and athletic trainers by a registered dietitian that stresses the importance of proper nutrition for the sport.

2. Create nutritional handouts for athletes, coaches, and athletic trainers developed by a registered dietitian that is easy to understand and stresses the importance of nutrition for athletic performance and health for sport.

3. A registered dietitian employed by the university should be contacted for intervention and treatment of athletes when major nutritional needs are suspected by coaches.

**Summary**

In conclusion, the findings of this current study suggest that nutrition education may have a significantly positive impact on athletes’ attitudes, and knowledge which may improve their intake of nutrients. Offering a registered dietitian for nutrition advice to athletes, coaches, and trainers may be a simple and cost effective measure to help improve athletes’ diet, overall health and athletic performance. Athletes need guidance in selecting nutrient-dense food (Tilgner and Schiller 1989) necessary to sustain energy
for activities of daily life as well as endurance sports. Moreover, more research is needed regarding the effects of nutrition education on nutrition knowledge, dietary habits and dietary behavior of athletes.
REFERENCES


Cerutti and Quinton. (2009). Taking an Undergraduate Nutrition Course Results in Favorable Attitudes toward a Healthful Diet and Improved Intake of Several Key Nutrients. Family and Consumer Sciences Research Journal, 3-10.


Friesen, C.A. (2002). Operation Wellness Enrollment and Post-Enrollment Form. Ball State University, Muncie, IN.


LIST OF APPENDICES

Appendix A: Picture Food Frequency Questionnaire (PFFQ)
Appendix B: PFFQ Questionnaire Instructions
Appendix C: Stages of Change Questionnaire
Appendix D: Nutrition Knowledge Test
Appendix E: Validity of Nutrition Knowledge Test
Appendix F: Participant Profile Information Sheet
Appendix G: Nutrition Education
Appendix H: Consent form- Ball State University (BSU) Associate Athletic Director
Appendix I: Consent form- BSU Men’s Swimming Coach
Appendix J: Consent form- BSU Women’s Swimming Coach
Appendix K: Consent form- BSU Men’s Golf Coach
Appendix L: Consent form- BSU Women’s Gymnastics Coach
Appendix M: Script for explaining study to athletes
Appendix N: Email to athletes regarding PFFQ
Appendix O: Email to experimental athletes regarding nutrition education
Appendix P: Letter from Ball State Institutional Review Board Approval
Appendix Q: Collaborative Institutional Training Initiative Certificate
APPENDIX A

PICTURE FOOD FREQUENCY QUESTIONNAIRE

Department of Family and Consumer Sciences
Ball State University
Muncie, IN

2010
APPENDIX B

PICTURE FOOD FREQUENCY QUESTIONNAIRE

INSTRUCTIONS

Department of Family and Consumer Sciences
Ball State University
Muncie, IN

2010
VioCare Picture Food Frequency Questionnaire

The VioCare Picture Food Frequency Questionnaire (PFFQ) will provide an estimate of your ‘usual’ nutrient intake over time. You must register to complete the VioCare FFQ. To do this:

1. Open the website

2. Select “Register Now” (in the upper right; blue tab.)

3. Complete the form
   a. Username
   b. Password
   c. Confirm password
   d. Email address
   e. Registration code
   f. First name
   g. Middle name (optional)
   h. Last name
   i. Birth date (mm/dd/yyyy – 04/12/1985)
   j. Height (feet and inches)
   k. Weight
   l. Gender

4. Click on QUESTIONNAIRE. Completing the questionnaire should take about 15-30 minutes.

5. If you have any questions, contact Kristy Trumbo at kbtrumbo@bsu.edu
APPENDIX C

STAGES OF CHANGE QUESTIONNAIRE

Department of Family and Consumer Sciences
Ball State University
Muncie, IN

2010
**Stage of Change**

**Name: __________________**

Read each statement on the left. Check the box that best describes how you feel **TODAY**:

<table>
<thead>
<tr>
<th>Statement of Readiness....</th>
<th>I DON’T do and I DON’T think about it</th>
<th>I THINK about it but do NOT do</th>
<th>I feel READY to start</th>
<th>I do this SOMETIME S</th>
<th>I USUALLY do this</th>
<th>I do this ALL the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am able to <strong>improve</strong> the types of healthy food I eat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am able to <strong>lose</strong> weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I eat 2-3 servings of fruit every day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I eat 2-3 servings of <strong>vegetables</strong> every day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I eat <strong>nonfat dairy</strong> products every day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I eat <strong>whole grain</strong> bread and cereal products daily</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I get 30 minutes of some type of <strong>aerobic activity</strong> 5 times a week</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If a smoker, I will <strong>quit smoking</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D

NUTRITION KNOWLEDGE TEST

Department of Family and Consumer Sciences
Ball State University
Muncie, IN

2010
APPENDIX E

VALIDITY OF NUTRITION KNOWLEDGE TEST

Department of Family and Consumer Sciences
Ball State University
Muncie, IN

2010
<table>
<thead>
<tr>
<th>Questions</th>
<th>ENG/K</th>
<th>CH</th>
<th>PRO</th>
<th>FAT</th>
<th>V and M</th>
<th>SUPP</th>
<th>EX</th>
<th>MEALS</th>
<th>FOO D C.</th>
<th>FL + HY</th>
<th>CONC RNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Energy expenditure depends on: body size, and the type, intensity, and duration of activity.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Protein is the body's primary energy source and main fuel for swimmers.</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. An Athlete's plate should consist of 1/2 protein, 1/2 fruits and vegetables and 1/2 carbohydrates.</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Examples of carbohydrates are meats, candy, and ice cream.</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Carbohydrates benefit performance by helping to maintain blood glucose and glycogen levels.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. To prevent the breakdown of protein, it is necessary to eat the right amount of calories and carbohydrates to use the protein for its function of building and repairing body tissue.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. A 5 ounce piece of meat is equal to the size of a deck of cards.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Fat is an important energy source for maintaining general health.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>9. Saturated fats are veg. oils, lipid fats (good fats), these fats reduce your risk of heart disease.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Questions</td>
<td>ENG /K</td>
<td>CH O</td>
<td>PR O</td>
<td>F A T</td>
<td>V and M</td>
<td>SU PP</td>
<td>EX ER</td>
<td>MEA L S.</td>
<td>FOO D C.</td>
<td>FL + HY</td>
<td>CONC RNS</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>--------</td>
<td>------</td>
<td>------</td>
<td>-------</td>
<td>---------</td>
<td>-------</td>
<td>-------</td>
<td>----------</td>
<td>----------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>10. Unsaturated fats are solid at room temperature such as fats in bacon and hot dogs. These fats increase your risk of heart disease, keep these fats low in your diet.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Heart-healthy fats to choose from would be canola oil, olive oil and nuts.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Athletes should take vitamin and mineral supplements if their diet is balanced and adequate because it can enhance athletic performance.</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Athletes should drink 20-30 ounces of fluids every half hour of practice.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>14. Athletes should try to eat within the first 30 minutes to 2 hours after competition or practice because the body is three times more receptive to replacing muscle glycogen.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Chocolate milk is not a very good drink for athletes because it has too much sugar.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>16. Chloride and Potassium are the most important electrolytes depleted in sweat.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>17. Electrolytes must be replaced when significant amounts are lost, through sports drinks and by eating a variety of fruits, vegetables, nuts, seeds, dairy foods, lean meats, and whole grains.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Questions</td>
<td>ENG /K</td>
<td>CH O</td>
<td>PR O</td>
<td>F A T</td>
<td>V and M</td>
<td>SU PP</td>
<td>EX ER</td>
<td>MEA L S.</td>
<td>FOO D C.</td>
<td>FL + HY</td>
<td>CONC RNS</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>--------</td>
<td>------</td>
<td>------</td>
<td>-------</td>
<td>---------</td>
<td>-------</td>
<td>-------</td>
<td>----------</td>
<td>----------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>18. A loss of athletic performance can be seen with just a 0.5% loss of body weight as water!</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>19. If dehydration reaches 6% of body weight, cramping and heat exhaustion can result.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>20. Athletes should drink every 15-30 minutes during exercise (5-10 oz fluids).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>21. A good marker of how much sweat was lost during exercise is body weight.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>22. For every pound that is lost: you should drink about 2-3 cups of fluid for replenishment.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>23. If your urine is dark in color when the volume and frequency are near normal, you are probably getting enough water.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>24. The Female Athlete Triad is a combination of disordered eating, amenorrhea and low bone density.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>25. Amenorrhea: not experiencing a menstrual cycle for at least 4 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>26. Good food sources of Iron: meat, fish poultry, beans, enriched cereal, green leafy vegetables, eggs, dried fruits.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Questions</td>
<td>ENG/K</td>
<td>CHO</td>
<td>PRO</td>
<td>FAT</td>
<td>V and M</td>
<td>SUPP</td>
<td>EXER</td>
<td>MEAL S.</td>
<td>FOOD C.</td>
<td>FL + HY</td>
<td>CONC RNS</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>-------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>--------</td>
<td>------</td>
<td>------</td>
<td>--------</td>
<td>---------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>27. Peak bone mass is acquired by age 18 in girls and age 20 in boys, which makes youth the best time to &quot;invest&quot; in your bone health.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. Calcium rich foods: milk, yogurt, cheese.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>29. Supplements label everything in their ingredients so the possibility of contamination with banned substances is not an issue.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>30. Dinner should be heavier and breakfast should be lighter for a morning event.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>31. A good example of lunch is 2 slices of cheese pizza and a salad or a piece of fruit.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

Footnote:
ENG/K= Energy/kcal
CHO= Carbohydrates
PRO=Protein
V and M= Vitamins and Minerals
SUPP= Supplements
EXER= Exercise
MEAL S= Meal
Suggestions
FOOD C. = Food Choices
FL + HY= Fluid and Hydration
CONCRNS= Concerns
Participant Profile Information

To respond to this section, please circle the appropriate response.

1. What is your current academic standing?
   - Freshman
   - Sophomore
   - Junior
   - Senior

2. Do you prepare and/or cook your own meals?
   - Yes
   - No

3. What is your major in college?
   ________________________________

4. Have you taken a nutrition course in college?
   - Yes, which course(s)?_____________  No

5. Are you interesting in learning more about nutrition?
   - Yes
   - No
APPENDIX H

CONSENT FORM

BALL STATE UNIVERSITY ASSOCIATE ATHLETIC DIRECTOR

Department of Family and Consumer Sciences
Ball State University
Muncie, IN

2010
Dear Karin Lee,

I am a dietetics graduate student at Ball State University. I am currently working on my thesis and would like your permission to work with the men and women athletic teams at Ball State University.

The purpose of this study is to examine the relationship of nutritional knowledge, dietary habits, and nutrition behavior of collegiate men and women swimmers at a Midwestern University in Indiana. Other variables to be examined will be demographics. This study is completely voluntary. Approval has been given to me by my thesis committee, and has been submitted and approved by the Institutional Review Board. The study will be explained to the participants. Interested participants will be required to sign a consent form.

The athletes will be asked to complete a nutrition knowledge test developed by the researcher, as well as their current dietary habits using the Picture Food Frequency Questionnaire (PFFQ). The on-line PFFQ will take 15-30 minutes to complete. The athletes will be completing the questionnaire two times. Each athlete will be given instructions and a code to assess the questionnaire online. The athletes will also be completing the nutrition knowledge test twice, two weeks apart.

This study will take place in April in each sports team practice location.

If you have any questions, feel free to contact me.

Thank you,

Sincerely,

Kristy Trumbo
Dietetics Graduate Student
APPENDIX I

CONSENT FORM

BALL STATE UNIVERSITY MEN’S SWIMMING COACH

Department of Family and Consumer Sciences
Ball State University
Muncie, IN

2010
Dear Bob Thomas,

I am a dietetics graduate student at Ball State University. I am currently working on my thesis and would like your permission to work with the men’s swimming team at Ball State University.

The purpose of this study is to examine the relationship of nutritional knowledge, dietary habits, and nutrition behavior of collegiate men and women athletes at a Midwestern University in Indiana. Other variables to be examined will be demographics. This study is completely voluntary. Approval has been given to me by my thesis committee, and has been approved by the Institutional Review Board. The study will be explained to the participants. Interested participants will be required to sign a consent form.

The athletes will be asked to complete a nutrition knowledge test developed by the researcher, as well as their current dietary habits using the Picture Food Frequency Questionnaire (PFFQ). The on-line PFFQ will take 15-30 minutes to complete. The athletes will be completing the questionnaire once on their own time. Each athlete will be given instructions and a code to assess the questionnaire online. The athletes will be completing the nutrition knowledge test once as well as a Stages of Change questionnaire which takes 15 minutes total.

The athletes will be asked to participate in this study in April in your practice location.

If you have any questions, feel free to contact me.

Thank you,

Sincerely,

Kristy Trumbo
Dietetics Graduate Student
APPENDIX J

CONSENT FORM

BALL STATE UNIVERSITY WOMEN’S SWIMMING COACH

Department of Family and Consumer Sciences
Ball State University
Muncie, IN

2010
Laura Caudill Seibold  
Head Swimming Coach for Women  
Intercollegiate Athletics  
HP 227  
Muncie, IN 47306  
(765) 285-5173

Dear Coach Laura,

I am a dietetics graduate student at Ball State University. I am currently working on my thesis and would like your permission to work with the women’s swimming team at Ball State University.

The purpose of this study is to examine the relationship of nutritional knowledge, dietary habits, and nutrition behavior of collegiate men and women athletes at a Midwestern University in Indiana. Other variables to be examined will be demographics. This study is completely voluntary. Approval has been given to me by my thesis committee, and has been approved by the Institutional Review Board. The study will be explained to the participants. Interested participants will be required to sign a consent form.

The athletes will be asked to complete a nutrition knowledge test developed by the researcher, as well as their current dietary habits using the Picture Food Frequency Questionnaire (PFFQ). The on-line PFFQ will take 15-30 minutes to complete. The athletes will be completing the questionnaire once on their own time. Each athlete will be given instructions and a code to assess the questionnaire online. The athletes will be completing the nutrition knowledge test once as well as a Stages of Change questionnaire which takes 15 minutes total.

The athletes will be asked to participate in this study in April in your practice location.

If you have any questions, feel free to contact me.

Thank you,

Sincerely,

Kristy Trumbo  
Dietetics Graduate Student
APPENDIX K

CONSENT FORM

BALL STATE UNIVERSITY MEN’S GOLF COACH

Department of Family and Consumer Sciences
Ball State University
Muncie, IN

2010
Dear Mike Fleck,

I am a dietetics graduate student at Ball State University. I am currently working on my thesis and would like your permission to work with the men’s golf team at Ball State University.

The purpose of this study is to examine the relationship of nutritional knowledge, dietary habits, and nutrition behavior of collegiate men and women athletes at a Midwestern University in Indiana. Other variables to be examined will be demographics. This study is completely voluntary. Approval has been given to me by my thesis committee, and has been approved by the Institutional Review Board. The study will be explained to the participants. Interested participants will be required to sign a consent form.

The athletes will be asked to complete a nutrition knowledge test developed by the researcher, as well as their current dietary habits using the Picture Food Frequency Questionnaire (PFFQ). The on-line PFFQ will take 15-30 minutes to complete. The athletes will be completing the questionnaire once on their own time. Each athlete will be given instructions and a code to assess the questionnaire online. The athletes will be completing the nutrition knowledge test once as well as a Stages of Change questionnaire which takes 15 minutes total.

The athletes will be asked to participate in this study in April in your practice location.

If you have any questions, feel free to contact me.

Thank you,

Sincerely,

Kristy Trumbo
Dietetics Graduate Student
APPENDIX L

CONSENT FORM

BALL STATE UNIVERSITY WOMEN’S GYMNASTICS COACH

Department of Family and Consumer Sciences
Ball State University
Muncie, IN

2010
Dear Nadalie Walsh,

I am a dietetics graduate student at Ball State University. I am currently working on my thesis and would like your permission to work with the women’s gymnastics team at Ball State University.

The purpose of this study is to examine the relationship of nutritional knowledge, dietary habits, and nutrition behavior of collegiate men and women athletes at a Midwestern University in Indiana. Other variables to be examined will be demographics. This study is completely voluntary. Approval has been given to me by my thesis committee, and has been approved by the Institutional Review Board. The study will be explained to the participants. Interested participants will be required to sign a consent form.

The athletes will be asked to complete a nutrition knowledge test developed by the researcher, as well as their current dietary habits using the Picture Food Frequency Questionnaire (PFFQ). The on-line PFFQ will take 15-30 minutes to complete. The athletes will be completing the questionnaire once on their own time. Each athlete will be given instructions and a code to assess the questionnaire online. The athletes will be completing the nutrition knowledge test once as well as a Stages of Change questionnaire which takes 15 minutes total.

The athletes will be asked to participate in this study in April in your practice location.

If you have any questions, feel free to contact me.

Thank you,

Sincerely,

Kristy Trumbo
Dietetics Graduate Student
APPENDIX M

SCRIPT FOR EXPLAINING STUDY TO ATHLETES

Department of Family and Consumer Sciences
Ball State University
Muncie, IN

2010
Script for Principal Investigator:

Hello! My name is Kristy Trumbo and I am a dietetics graduate student in the department of Family and Consumer Sciences at Ball State University. I am here today to seek volunteers to participate in a study I am conducting this spring semester. This study will record your nutritional knowledge, dietary habits, and nutrition behavior.

I am interested in looking for individuals who are at least 18 years old and a member of a Ball State athletic team. If you agree to participate in my study, you will be asked to complete four questionnaires. All five questionnaires should take approximately 45 minutes of your time. One of the questionnaires is online in which you can take on your own time. The rest of the questionnaires can be done today after this meeting and will only take about 10-15 minutes. If you are a part of the experimental group, the PI will administer four, forty-five minute nutrition education lessons after practice containing relevant sports nutrition information.

I want to assure you that all data collected in this study will be confidential and will be held under lock and key.

I am hoping that results from this study can offer insight to dietitians trying to develop effective nutrition education programs for collegiate athletes.

If you are interested in participating in my study please see me now or email me at kbtrumbo@bsu.edu. If you have further questions that I may answer please let me know how I can assist you.

Thank you!
APPENDIX N

EMAIL TO EXPERIMENTAL GROUPS

REGARDING PFFQ

Department of Family and Consumer Sciences
Ball State University
Muncie, IN

2010
Email to Participants-Picture Food Frequency Questionnaire

Dear Participants,

This is a friendly reminder to take the Picture Food Frequency Questionnaire (PFFQ) online ____ (when) ___ (Example- prior to the first nutrition lesson) on __________(date). Please follow the log-in instruction sheet that was distributed to you at the meeting. If you have any questions, please let me know!

Thank you,

Sincerely,

Kristy Trumbo
Phone Number: 914-850-1500
Email: kbtrumbo@bsu.edu
APPENDIX O

EMAIL TO EXPERIMENTAL ATHLETES

REGARDING NUTRITION EDUCATION

Department of Family and Consumer Sciences
Ball State University
Muncie, IN

2010
Email to Participants-Nutrition Lessons

Dear Participants,

This is a friendly reminder that the _____(second, third, fourth) nutrition lesson will be held____________(date). We will meet in the pool classroom at _____(time). If you have any questions, please let me know!

Thank you,

Sincerely,
Kristy Trumbo
Phone Number: 914-850-1500
Email: kbtrumbo@bsu.edu
LETTER FROM BALL STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD

Department of Family and Consumer Sciences
Ball State University
Muncie, IN

2010
APPENDIX Q

COLLABORATIVE INSTITUTIONAL
TRAINING INITIATIVE CERTIFICATE

Department of Family and Consumer Sciences
Ball State University
Muncie, IN

2010
CITI Collaborative Institutional Training Initiative

Social & Behavioral Research - Basic/Refresher Curriculum Completion Report
Printed on 2/9/2010

Learner: Kristy Trumbo (username: kbtrumbo)
Institution: Ball State University
Contact Information  Department: Family and Consumer Science
Email: kbtrumbo@bsu.edu

Social & Behavioral Research - Basic/Refresher: Choose this group to satisfy CITI training requirements for Investigators and staff involved primarily in Social/Behavioral Research with human subjects.

Stage 1. Basic Course Passed on 02/09/10 (Ref # 4097628)

<table>
<thead>
<tr>
<th>Required Modules</th>
<th>Date Completed</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belmont Report and CITI Course Introduction</td>
<td>02/09/10</td>
<td>2/3 (67%)</td>
</tr>
<tr>
<td>Students in Research - SBR</td>
<td>02/09/10</td>
<td>9/10 (90%)</td>
</tr>
<tr>
<td>History and Ethical Principles - SBR</td>
<td>02/09/10</td>
<td>3/4 (75%)</td>
</tr>
<tr>
<td>Defining Research with Human Subjects - SBR</td>
<td>02/09/10</td>
<td>3/5 (60%)</td>
</tr>
<tr>
<td>The Regulations and The Social and Behavioral Sciences - SBR</td>
<td>02/09/10</td>
<td>5/5 (100%)</td>
</tr>
<tr>
<td>Assessing Risk in Social and Behavioral Sciences - SBR</td>
<td>02/09/10</td>
<td>4/5 (80%)</td>
</tr>
<tr>
<td>Informed Consent - SBR</td>
<td>02/09/10</td>
<td>3/5 (60%)</td>
</tr>
<tr>
<td>Privacy and Confidentiality - SBR</td>
<td>02/09/10</td>
<td>3/3 (100%)</td>
</tr>
<tr>
<td>Research with Prisoners - SBR</td>
<td>02/09/10</td>
<td>4/4 (100%)</td>
</tr>
<tr>
<td>Research with Children - SBR</td>
<td>02/09/10</td>
<td>4/4 (100%)</td>
</tr>
<tr>
<td>Research in Public Elementary and Secondary Schools - SBR</td>
<td>02/09/10</td>
<td>3/4 (75%)</td>
</tr>
<tr>
<td>International Research - SBR</td>
<td>02/09/10</td>
<td>3/3 (100%)</td>
</tr>
<tr>
<td>Course Title</td>
<td>Date</td>
<td>Score</td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
<td>------------</td>
<td>--------</td>
</tr>
<tr>
<td>Internet Research - SBR</td>
<td>02/09/10</td>
<td>4/5 (80%)</td>
</tr>
<tr>
<td>HIPAA and Human Subjects Research</td>
<td>02/09/10</td>
<td>2/2 (100%)</td>
</tr>
<tr>
<td>Workers as Research Subjects-A Vulnerable Population</td>
<td>02/09/10</td>
<td>4/4 (100%)</td>
</tr>
<tr>
<td>Conflicts of Interest in Research Involving Human Subjects</td>
<td>02/09/10</td>
<td>2/2 (100%)</td>
</tr>
<tr>
<td>Ball State University</td>
<td>02/09/10</td>
<td>no quiz</td>
</tr>
</tbody>
</table>

For this Completion Report to be valid, the learner listed above must be affiliated with a CITI participating institution. Falsified information and unauthorized use of the CITI course site is unethical, and may be considered scientific misconduct by your institution.

Paul Braunschweiger Ph.D.
Professor, University of Miami
Director Office of Research Education
CITI Course Coordinator