A Nutritional Profile of Female NCAA Division II Swimmers

A THESIS

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Master of Science

By
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THESIS APPROVAL

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First and most important, thanks to my parents. Your constant love, guidance, and support has enabled me to become the person that I am today. Also, thanks the rest of my family, cousins, uncles, aunts, and my Grandma. You all mean the world to me and I thank you for everything you do.

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To all the people I have met at McGuffey High School, the coaches and especially the students, I had a great experience and I will miss you all. To my Athletic Director, Mike Malesic, thanks for understanding my car troubles and hardly ever making me work late or weekends.

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INTRODUCTION

Proper implementation of sport nutrition principles is essential to achieving optimal athletic performance.\textsuperscript{1-8} It is no secret that physical activity, athletic performance, and recovery from exercise are enhanced by nutrition.\textsuperscript{1-6,9} Today, the dietary habits of many female collegiate athletes are insufficient, due in part to overly restricted eating habits, nutrition misinformation, and lack of general nutritional knowledge.\textsuperscript{2,8-13} Athletes are regularly faced with difficult decisions such as weight management strategies during competition, appropriate food choices on the road, and fluid requirements in various exercise environments.\textsuperscript{3,6,9} When compared to their sedentary counterparts, athletes must pay particular attention to meeting caloric requirements because of the high-energy demands of their sports.\textsuperscript{1,2,4-6} Many athletes are not familiar with how to adequately fuel and replenish their bodies using sound nutrition principles. Because of this, many are hindering peak performance.\textsuperscript{9-12} Research indicates that female athletes do not engage in favorable nutrition habits despite their knowledge of improved performance associated with nutrition.\textsuperscript{9,10}
During training, energy and macronutrient needs must be met in order to maintain body weight, replenish glycogen stores, and provide adequate protein for the building and repair of tissue. Athletes' nutritional needs are determined by their training load (intensity, frequency, duration of workouts) and body weight. Research suggests that many female athletes are not ingesting enough carbohydrate (CHO) based on the requirements for their age, gender, and sport. CHO requirements can be as high as 70 - 75% of total caloric intake, in athletes, in order to meet energy demands and maintain glycogen stores. Loosli et al reported that collegiate distance runners were not following dietary recommendations for optimal muscle glycogen restoration. These athletes did not regularly meet the 7 - 12g · kg⁻¹ · day⁻¹ of CHO that is necessary to maintain muscle glycogen stores and blood glucose during intense periods of training. If muscle glycogen stores and blood glucose levels are depleted, athletes will experience a number of debilitating side effects including weakness and loss of mental focus resulting in ineffective training. Swimmers and runners are good examples of athletes that can be especially susceptible to nutrient deficits due to the extreme energy demands of their sport.
Zawila et al\textsuperscript{10} assessed the nutritional knowledge and attitudes of 60 female collegiate cross-country runners and found that many athletes appeared to have a positive attitude towards nutrition. Additionally, they were receptive to nutrition education if specific areas of knowledge deficits or reasons behind nutritional choices could be identified. One way to identify knowledge deficits or specific eating habits is to test subjects using a nutritional knowledge and eating habits questionnaire. Exposing specific problem areas in diets will allow Certified Athletic Trainers (ATCs) the opportunity to provide sport and athlete-specific nutrition education.

Individuals striving for peak athletic performance must include nutrition as part of their game plan.\textsuperscript{1-8} The same athlete who spends long hours in the gym or practice facility, must devote a similar amount of time to constructing a diet that will compliment performance. Athletes and coaches alike are becoming more aware of the link between nutrition and athletic performance.\textsuperscript{9,10} However, research indicates that nutritional education is still needed for athletes and those who may influence this population. This includes parents, coaches, teachers, and health-care professionals such as ATCs.\textsuperscript{10,17-20}
Once proper nutrition is recognized as a valuable performance enhancement tool, a measuring device must be implemented so that problem areas in diets can be identified, and steps can be taken to facilitate improvement. A nutritional profile is a good way to identify strengths and weaknesses of dietary practices among athletes.\textsuperscript{21,22} For the purposes of this research, a nutritional profile was a collection of data that included information on subjects' anthropometric data, nutritional knowledge, nutritional habits, and nutritional intake (APPENDIX C1). Documenting nutritional intake can help identify existing eating habits and encourage steps towards constructive life-long dietary habits.\textsuperscript{21,22} Simply compiling a nutritional profile can promote awareness among athletic teams and increase nutrition related conversation between athletes, coaches, and ATCs.\textsuperscript{18} If athletes are made aware of their current nutritional habits, and the recommendations of experts, they will have the tools to effectively prevent problems associated with disordered eating. The purpose of this study was to establish a nutritional profile of female NCAA Division II swimmers.
METHODS

The purpose of this study was to establish a nutritional profile of female NCAA Division II swimmers. The following sections are discussed: (1) Research Design, (2) Subjects, (3) Pilot Research, (4) Instruments, (5) Procedures, and (6) Data Analysis.

Research Design

A descriptive research design was used for this study. Variables of interest included subjects': (1) anthropometric measurements (BMI), (2) nutritional knowledge score, (3) eating habits score, and (4) nutritional intake. Demographic information was collected using a Demographic sheet (APPENDIX C2). BMI was calculated using height and weight measurements taken by the researcher (APPENDIX C3). Nutritional knowledge and eating habits scores were determined using a revised, 32-item, questionnaire (APPENDIX C4), originally developed by Marino. Nutritional intake (APPENDIX C1) was reported by food records completed by each subject over the course of four days (three weekdays and one weekend day) and recorded on Nutritional Intake Collection Sheets (NICSs) provided by
the researcher (APPENDIX C5). NICS data was compiled using Nutritionist Pro® (First Databank, Inc., San Bruno, CA.) dietary analysis software. This study was designed to potentially expose nutrient deficits resulting from disordered eating habits among female collegiate athletes. Results were limited to NCAA Division II female swimmers from one university.

Subjects

Subjects (N = 12) were healthy, female, National Collegiate Athletic Association (NCAA) Division II swimmers from California University of Pennsylvania. The population for this study was determined by selecting only those athletes who were planning on being members of the swim team throughout the off-season and into next season. A sample was obtained by announcing the concept of the study orally to potential volunteers and by written document with no involvement from the coach. Only volunteers were considered for the study. All subjects read and signed informed consent forms prior to the study (APPENDIX C6). Subject confidentiality was maintained by the researcher at all times. All subjects were provided an “Athlete #” by which they were identified. Fourteen swimmers were
recruited. Athlete #8 was disqualified because of history of an eating disorder and Athlete #14 was excluded because of a scheduling conflict. This study was reviewed and approved by the Institutional Review Board (IRB) for the protection of human subjects at California University of Pennsylvania (APPENDIX C7).

Pilot Research

The pilot research was designed to establish reliability \( (r) \) coefficients for the Nutritional Knowledge and Eating Habits Questionnaire. The two-part, Old Nutritional Knowledge and Eating Habits Questionnaire (APPENDIX C8) was distributed to members of the female volleyball and softball teams at California University of Pennsylvania \((N = 33)\). That 47-item questionnaire consisted of 29 nutritional knowledge questions and 18 eating habit questions. The questionnaire was scored with the Scoring Key for the old Nutritional Knowledge and Eating Habits Questionnaire (APPENDIX C9) using a Likert-type scale ranging from 1 - 4.

An Item-total analysis was completed using data collected from the old Nutritional Knowledge and Eating Habits Questionnaire. Any question with a \( r < .30 \), in the
correlation matrix, was considered weak and rejected; 15 questions were discarded under this condition. A Cronbach’s alpha test was then used to establish reliability coefficients for the 32-item, Revised Nutritional Knowledge and Eating Habits Questionnaire. A reliability of $\geq 0.70$ was accepted.

Reliability coefficients were increased from previous research to 0.88 for the Nutritional Knowledge section and 0.81 for the Eating Habits section. Upon completion of the pilot research, the revised questionnaire consisted of 32 questions; 22 questions designed to test nutritional knowledge and 10 questions designed to test eating habits.

Instruments

The following instruments were used in this study: Demographic sheet (APPENDIX C2), balance-beam scale (Detecto Scales Inc., Brooklyn, NY.), revised Nutritional Knowledge and Eating Habits Questionnaire (APPENDIX C4), and Nutritionist Pro® computer software (First Databank, Inc., San Bruno, CA.). Nutritional intakes were documented on Nutritional Intake Collection Sheets (NICS) (APPENDIX C5).
A demographic sheet (APPENDIX C2) was completed by each subject, which included information on subjects’ age, academic year in college, prior nutrition courses, nutrition resources, eating disorders, and injury status. Any subject who answered “yes” to question seven* or eight, indicating that they received treatment for an eating disorder, or an injury/illness, was excluded from the study. This was to ensure that data would represent a truthful depiction of nutrition related experiences and dietary habits among female NCAA Division II swimmers.

Subjects’ height and weight was taken by the researcher, using a balance-beam scale (Detecto Scales Inc., Brooklyn, NY.), and included with demographic information. This allowed the researcher to report BMI as weight(kg)/height(m²) (APPENDIX C3).

Nutritional knowledge and eating habits were measured using a revised version of a two-part questionnaire (APPENDIX C4) developed by Marino²³ for her study on female collegiate gymnasts. Following pilot research, reliability coefficients were established for the revised Nutritional Knowledge and Eating Habits Questionnaire at 0.88 and 0.81 respectively. The questionnaire has been updated from its original version to reflect current nutrition recommendations set by the United States Department of
Agriculture (USDA) at www.mypyramid.gov. Requirements are based on female athletes, age 18 - 25, who get at least 60 minutes of exercise each day.

The first section of the questionnaire contained 22 questions intended to test the level of nutritional knowledge of each subject. Subjects were asked to indicate to what degree they agreed with each statement using a four-point Likert-type scale; answers ranged from: Strongly Agree (4) to Strongly Disagree (1). Subjects were asked questions about pre-event meals, breakfast habits, individual nutrient effect on performance, vitamin consumption, and food group choices according to www.mypyramid.gov. All questions were scored according to their value. This means if the subject answered with a 4, they were awarded 4 points. Scores on this section range from 22 - 88 points. A percentage was established by dividing each subject’s score by 88. Nutritional knowledge was scored as: excellent (85 - 100%), good (70 - 84%), fair (55 - 69%), or poor (54% or below). Higher scores for this section indicate increased nutrition knowledge among individual subjects.23

The second section of the questionnaire contained 10 questions intended to test the quality of eating habits of each subject. Subjects were asked to indicate how often
they consume particular foods or engage in certain eating habits using a four-point Likert-type scale; Answers included: Always (4), Often (3), Sometimes (2), and Never (1). Always (4) indicates that a habit occurs 5 - 7 days per week, Often (3) indicates a habit that occurs 3 - 4 days per week, Sometimes (2) indicates a habit that occurs 1 - 2 days per week, and Never (1) indicates a habit that does not occur at all. Questions numbering 2, 3, and 6 were reverse scored. Reverse scoring occurs when a subject answers a question with a 4, but is awarded 1 point. All other questions were scored according to their value; if the subject answered with a 4, they were awarded 4 points. Scores on this section range from 10 - 40 points. Each subject’s total was divided by 40 and reported as: excellent (85 - 100%), good (70 - 84%), fair (55 - 69%), or poor (54% or below). Higher scores on this section indicated that a subject exhibited increased positive eating habits.

Computer software programs capable of analyzing nutrient content are a helpful tool when investigating the dietary habits of athletes. Beshgetoor et al\textsuperscript{25} used Nutritionist V\textsuperscript{®} software in 2003 to measure the dietary intake and supplement use in female master cyclists and runners. This same software was utilized again in 2006 by
Petersen et al\textsuperscript{12} to determine the dietary intake of female collegiate swimmers and divers. The dietary intakes collected in this study were analyzed for nutrient content using Nutritionist Pro\textsuperscript{®} software (First Databank, Inc., San Bruno, CA.), an updated version of the aforementioned Nutritionist V\textsuperscript{®} software. Nutritionist Pro\textsuperscript{®} utilized the following nutrient databases to complete analysis: USDA Standard Reference Base, Canadian Nutrient File, Food and Nutrient Database for Dietary Studies, Mexfoods Database, Nutrient Composition of Malaysian Food, and Nutrient Composition of Alaskan Foods.

Nutritional intake (APPENDIX C1) was measured by self-reported four-day food records in which subjects documented everything they consumed during that period of time. Numerous studies utilize three to four day food records to estimate the nutritional intakes of various athletic populations.\textsuperscript{11,13,21,25-27} Food records lasting longer than four days show reduced accuracy and are thus deemed impractical and associated with memory interference, incomplete records, and a high drop out rate.\textsuperscript{22} All data regarding nutritional intake was recorded on NICSs (APPENDIX C5) provided to each subject by the researcher.
Procedures

The researcher applied for and received approval from the IRB of California University of Pennsylvania to perform this study (APPENDIX C7). Pilot research was conducted to establish reliability of the old Nutritional Knowledge and Eating Habits Questionnaire (APPENDIX C8). That questionnaire was then modified and reliability coefficients were re-established for the revised Nutritional Knowledge and Eating Habits Questionnaire (APPENDIX C4).

Potential volunteers from the Women’s Swim team were then recruited for participation by announcing the concept of the study orally and by written document with no involvement from the coach. At this time, the researcher offered the informed consent form (APPENDIX C6) in order for potential volunteers to understand the need and risks of involvement in the study, and to determine that they are willing participants. Then each subject was assigned a number for identification in order to maintain confidentiality. This number was included on documents as “Athlete #”.

Two appointments were then arranged for each athlete. The first was to conduct anthropometric measurement and
took place the following day. The second appointment was to collect the Nutritional Intake Collection Sheets (NICSs) and complete the revised Nutritional Knowledge and Eating Habits Questionnaire; this took place the day following completion of NICSs. Subjects were then given a demographic sheet (APPENDIX C2) and four NICSs (APPENDIX C5). Subjects were given time to complete the demographic sheet and it was collected immediately by the researcher. Any subject who answered yes to question seven* or eight, confirming treatment for an eating disorder, or injury/illness was disqualified from the study. Athlete #8 was disqualified under this condition.

Subjects were instructed, in small groups, by the researcher to record the type and amount of all food and beverage consumed for four consecutive days (three weekdays and one weekend day), using English measures such as cups, teaspoons, and tablespoons when available. Subjects were asked to provide as much detail as possible about the foods and fluids they consumed, including brand names, restaurant names, and recipes for home cooked meals. Two-dimensional food visual aids were obtained from www.mypyramid.gov and distributed to subjects as examples of portion sizes. Each item was recorded on NICSs in one of the following time slots: (5:00 - 8:59am), (9:00am - 12:59pm), (1:00 -
4:59pm), (5:00 - 8:59pm), and (after 9:00pm). Subjects were provided with my contact information and encouraged to contact me with any questions or concerns.

During the first scheduled appointment, the researcher took anthropometric measurements in the morning prior to breakfast or any physical activity. Height and weight was measured with no shoes in light, indoor clothing using a balance-beam scale (Detecto Scales Inc., Brooklyn, NY.). Standing height was measured to the nearest 0.25 in. and converted to the nearest 0.1 cm. Body weight was measured to the nearest 0.5 lb. and converted to the nearest 0.1 kg. These measurements enabled the researcher to report body mass index (BMI) for each athlete (APPENDIX C3).

Subjects then completed the food record over the subsequent four days on the provided NICSs. At the second scheduled appointment, subjects met with the researcher to turn in NICSs and complete the revised Nutritional Knowledge and Eating Habits Questionnaire. Food record information from each NICS was then be put into the Nutritionist Pro® computer software program and analyzed to determine nutritional intake (APPENDIX C1). Food record information acquired from dining services on campus required logical estimations on the part of the researcher. Ingredients for those meals were taken from the official
website of campus food service, www.avifoodsystems.com. Ingredient amounts were estimated based on serving size. All statistics were analyzed using SPSS v. 13.0 for Windows.²⁴

Data Analysis

A full workup of descriptive statistics present the results of this study. Data are arranged in tables and figures as percentages (%), means, and standard deviations (APPENDIX C1). Pilot research was conducted a priori to establish reliability (r) of the Nutritional Knowledge and Eating Habits Questionnaire. An Item-total analysis was completed using the old, 47-item Nutritional Knowledge and Eating Habits Questionnaire. Any question with a r < .30, in the correlation matrix, was considered weak and rejected; 15 questions were discarded under this condition.²⁴ A Cronbach’s alpha test was then used to establish reliability coefficients for the revised, 32-item Nutritional Knowledge and Eating Habits Questionnaire. A reliability of > .70 was accepted. Coefficients were established for the Nutritional Knowledge section and the Eating Habits section as 0.88 and 0.81 respectively. All
data were analyzed with SPSS v. 13.0 statistical software package for Windows®.²⁴
RESULTS

The purpose of this study was to establish a nutritional profile of female NCAA Division II swimmers. This section will explain: Demographic Data, Descriptive Analysis, and Additional Findings. Subjects were required to complete a Demographic sheet, a revised Nutritional Knowledge and Eating Habits Questionnaire, and four-day food records that served as a typical representation of nutritional intake.

Demographic Data

Data includes 12 female NCAA Division II swimmers from California University of Pennsylvania. Fourteen swimmers were recruited. Athlete #8 was disqualified because of history of an eating disorder and Athlete #14 was excluded because of a scheduling conflict. The information collected from the demographic sheet (APPENDIX C2) included height and weight (taken by the researcher), age, academic year in college, nutrition courses taken, consultation about nutrition, sources of nutrition information, previous history with eating disorders, and current injuries/illnesses.
The mean age was 20.0 ± 1.04 years with the majority of the subjects (75.0%) being sophomores and juniors in college. The other 25.0% (n = 3) of the subjects were in the freshman class. No seniors were on the swim team during data collection. Seven out of twelve (58.3%) subjects indicated that they had not taken a nutrition course. Out of those who had taken a nutrition course (n = 5), one had taken two courses, three of them had taken one course, and one failed to indicate how many courses were taken.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (cm)</td>
<td>160.0</td>
<td>177.2</td>
<td>168.17</td>
<td>5.692</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>54.9</td>
<td>88.0</td>
<td>67.62</td>
<td>9.493</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>18</td>
<td>22</td>
<td>20.0</td>
<td>1.04</td>
</tr>
<tr>
<td>BMI*</td>
<td>20.1</td>
<td>29.9</td>
<td>23.88</td>
<td>2.883</td>
</tr>
<tr>
<td>Year in College**</td>
<td>1</td>
<td>3</td>
<td>2.2</td>
<td>0.84</td>
</tr>
<tr>
<td>Nutrition Courses***</td>
<td>1</td>
<td>2</td>
<td>1.6</td>
<td>0.52</td>
</tr>
</tbody>
</table>

*Calculated as kg/m² (APPENDIX C3)
**1=freshman, 2=sophomore, 3=junior, 4=senior
***Indicates number of nutrition courses taken

The majority of subjects (75.0%) indicated that a medical professional had never spoken to them about nutrition. Out of those who did (n = 3), two had a Certified Athletic Trainer (ATC) speak to them and one reported that a ATC, a Medical Doctor, and a Registered Dietician had spoke to them.
Subjects were asked if they had ever consulted a medical professional about nutrition. Two of twelve (16.7%) subjects indicated that they had previously consulted a medical professional about nutrition. Out of those two, one consulted a Medical doctor and one consulted a Sports Nutritionist; weight loss and supplementation were stated as reasons for consultation. No subject indicated that they had a current injury/illness that would influence their eating habits (Table 2).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of Yes responses</th>
<th>% of Yes responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Med Prof Talk</td>
<td>3</td>
<td>25.0</td>
</tr>
<tr>
<td>Consulted Med Prof</td>
<td>2</td>
<td>16.7</td>
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</table>

*Table 2 refers to questions #5 and 6 on the demographic sheet

<table>
<thead>
<tr>
<th>Sources of Nutrition Information</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Doctor</td>
<td>3</td>
<td>25.0</td>
</tr>
<tr>
<td>Certified Athletic Trainer</td>
<td>2</td>
<td>16.7</td>
</tr>
<tr>
<td>Registered Dietician</td>
<td>2</td>
<td>16.7</td>
</tr>
<tr>
<td>Coach</td>
<td>2</td>
<td>16.7</td>
</tr>
<tr>
<td>Parents</td>
<td>1</td>
<td>8.3</td>
</tr>
<tr>
<td>Friends</td>
<td>1</td>
<td>8.3</td>
</tr>
<tr>
<td>Other: Professor</td>
<td>1</td>
<td>8.3</td>
</tr>
<tr>
<td>Teammate</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Counselor</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Table 3 refers to question #7 on the demographic sheet
Descriptive Analysis

Subjects were instructed, by the researcher, to document everything they consumed over the course of four consecutive days. Subject's used English measures such as cups and tablespoons when available. The following table consists of macronutrient and selected micronutrient intakes among female NCAA Division II swimmers at one university. (Table 4).

Table 4. Nutritional intake of macronutrients and selected micronutrients of female NCAA Division II swimmers (N = 12)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>kcal/day</td>
<td>2371.9</td>
<td>731.18</td>
<td>2198.6</td>
</tr>
<tr>
<td>kcal/kg</td>
<td>35.8</td>
<td>13.06</td>
<td>45.6</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g/day</td>
<td>317.0</td>
<td>103.56</td>
<td>349.1</td>
</tr>
<tr>
<td>g/kg</td>
<td>4.8</td>
<td>1.90</td>
<td>7.1</td>
</tr>
<tr>
<td>% of energy</td>
<td>52.7</td>
<td>4.82</td>
<td>17.2</td>
</tr>
<tr>
<td>Protein (g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g/day</td>
<td>81.4</td>
<td>23.67</td>
<td>70.6</td>
</tr>
<tr>
<td>g/kg</td>
<td>1.2</td>
<td>0.46</td>
<td>1.4</td>
</tr>
<tr>
<td>% of energy</td>
<td>13.9</td>
<td>2.77</td>
<td>9.9</td>
</tr>
<tr>
<td>Total Fat (g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g/day</td>
<td>90.2</td>
<td>33.45</td>
<td>102.8</td>
</tr>
<tr>
<td>g/kg</td>
<td>1.4</td>
<td>0.51</td>
<td>1.5</td>
</tr>
<tr>
<td>% of energy</td>
<td>33.4</td>
<td>5.03</td>
<td>17.5</td>
</tr>
<tr>
<td>Saturated Fat (g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g/day</td>
<td>32.6</td>
<td>12.09</td>
<td>37.9</td>
</tr>
<tr>
<td>% of total fat</td>
<td>36.8</td>
<td>3.75</td>
<td>11.9</td>
</tr>
<tr>
<td>Monounsaturated Fat (g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g/day</td>
<td>23.7</td>
<td>7.07</td>
<td>23.2</td>
</tr>
<tr>
<td>% of total fat</td>
<td>26.2</td>
<td>2.23</td>
<td>7.6</td>
</tr>
<tr>
<td>Polyunsaturated Fat (g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g/day</td>
<td>15.1</td>
<td>9.28</td>
<td>30.9</td>
</tr>
<tr>
<td>% of total fat</td>
<td>15.8</td>
<td>6.10</td>
<td>16.5</td>
</tr>
</tbody>
</table>
Linoleic acid (g) 9.5 5.46 21.4  
Linolenic acid (g) 1.3 0.85 2.6  
Total Dietary Fiber (g) 16.7 5.22 18.5  
Calcium (mg) 812.4 253.18 802.3  
**Iron (mg)** 15.9 4.40 13.2  
Potassium (mg) 2123.6 946.12 3442.6  
Sodium (mg) 4024.6 1382.64 4346.0  
Zinc (mg) 8.8 3.17 10.6  
Beta-carotene (µg) 2305.7 1937.46 6374.1  
Vitamin C (mg) 102.8 65.19 194.1  
Vitamin D (µg) 2.2 1.28 4.4  
Vitamin E (mg) 2.2 1.20 5.0  
Vitamin K (µg) 74.9 51.67 161.5  
Biotin (µg) 7.3 4.28 13.8  
Folate (µg) 366.5 144.09 400.6  
Niacin (mg) 21.7 7.26 22.9  
Pantothenic Acid (µg) 3.3 1.79 6.1  
Riboflavin (mg) 1.6 0.49 1.5  
Thiamin (mg) 1.5 0.53 1.9  
Vitamin B6 (mg) 1.6 0.63 1.9  
Vitamin B12 (µg) 3.2 1.50 4.9

Following completion of the four-day food records, the revised Nutritional Knowledge and Eating Habits Questionnaire was presented to all 12 subjects as one document with two parts; 22 nutritional knowledge questions scored from 22 – 88 and 10 eating habit questions scored from 10 – 40 (APPENDIX C4). Nutritional knowledge was measured by dividing each subject’s score by 88. Likewise, eating habits were measured by dividing each subject’s score by 40. The following classifications were then used: (4) excellent (85 – 100%), (3) good (70 – 84%), (2) fair (55 – 69%), (1) poor (54 or below). All 12 subjects classified as excellent/good on the nutritional knowledge
section, but scored in the fair/poor range for eating habits (Table 5).

Table 5. Distribution of classifications of scores on the Nutritional Knowledge and Eating Habits Questionnaire (N = 12)

<table>
<thead>
<tr>
<th>Classifications</th>
<th>Excellent (4)</th>
<th>Good (3)</th>
<th>Fair (2)</th>
<th>Poor (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutritional Knowledge*</td>
<td>8</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>% of subjects</td>
<td>66.7</td>
<td>33.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Eating Habits**</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>% of subjects</td>
<td>0</td>
<td>0</td>
<td>66.7</td>
<td>33.3</td>
</tr>
</tbody>
</table>

Classifications: excellent = 85-100%, good = 70-84%, fair = 55-69%, poor = 54% or below

*Nutritional Knowledge scores range from 22-88
**Eating Habits scores range from 10-40

Subjects mean nutritional knowledge score was 77.8 ± 5.84 (88.4%), indicating an “excellent” knowledge of nutrition (Table 6). Conversely, mean eating habits score was 22.4 ± 2.67 (56.0%), indicating “fair” eating habits on a scale that includes: excellent, good, fair, and poor (Table 7).
Table 6. Nutritional Knowledge scores from the Nutritional Knowledge and Eating Habits Questionnaire (N = 12)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Nutritional Knowledge Score*</td>
<td>77.8</td>
<td>5.84</td>
</tr>
<tr>
<td>% on Nutritional Knowledge section**</td>
<td>88.4</td>
<td>6.65</td>
</tr>
<tr>
<td>Nutritional Knowledge Classification***</td>
<td>3.7</td>
<td>0.49</td>
</tr>
</tbody>
</table>

*Nutritional Knowledge scores range from 22-88
**Percentages are based on 0-100% scale
***Classifications: 4=excellent, 3=good, 2=fair, 1=poor

Nutritional Knowledge scores of female NCAA Division II swimmers reported from the Nutritional Knowledge and Eating Habits Questionnaire

![Nutritional Knowledge Scores](image)

Figure 1. *Note: Possible Nutritional Knowledge scores range from 22-88*
Table 7. Eating Habits scores from the Nutritional Knowledge and Eating Habits Questionnaire (N = 12)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Eating Habits Score*</td>
<td>22.4</td>
<td>2.67</td>
</tr>
<tr>
<td>% on Eating Habits section**</td>
<td>56.0</td>
<td>6.69</td>
</tr>
<tr>
<td>Eating Habits Classification***</td>
<td>1.7</td>
<td>0.49</td>
</tr>
</tbody>
</table>

*Eating Habits scores range from 10-40
**Percentages are based on 0-100% scale
***Classifications: 4=excellent, 3=good, 2=fair, 1=poor

Eating Habits scores of female NCAA Division II swimmers reported from the Nutritional Knowledge and Eating Habits Questionnaire

![Bar chart showing eating habits scores by athlete number]

Figure 2. *Note: Possible Eating Habits scores range from 10-40
Additional Findings

Subjects were categorized according to their year in college to determine if experience may have played any role in nutritional knowledge, eating habits, and/or nutritional intake. All three groups classified as good or excellent on Nutritional Knowledge and fair or poor on Eating Habits (Table 8).

Table 8. Nutritional knowledge and eating habits classification distribution according to year in college (N = 12)

<table>
<thead>
<tr>
<th>Classifications</th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshmen (n = 3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutritional Knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of subjects</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Eating Habits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of subjects</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Sophomores (n = 4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutritional Knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of subjects</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Eating Habits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of subjects</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Juniors (n = 5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutritional Knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of subjects</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Eating Habits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of subjects</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Classifications: excellent = 85-100%, good = 70-84%, fair = 55-69%, poor = 54% or below

Mean nutritional knowledge and eating habit scores did not increase with experience. The sophomore class had the lowest mean score for both nutrition knowledge and eating
habits at 77.0 ± 6.48 and 20.8 ± 3.40. Freshmen scored the highest on both the nutritional knowledge and eating habits sections with scores of 78.7 ± 6.81 and 23.7 ± 2.31 (Table 9).

| Table 9. Nutritional Knowledge and eating habits scores distribution according to year in college (N = 12) |
|---------------------------------------------------------------|------------------|------------------|
| Variable                                                      | Mean             | SD               |
| Freshmen (n = 3)                                              |                  |                  |
| Nutritional Knowledge Score*                                  | 78.7             | 6.81             |
| Eating Habits Score**                                         | 23.7             | 2.31             |
| Sophomores (n = 4)                                            |                  |                  |
| Nutritional Knowledge Score*                                  | 77.0             | 6.48             |
| Total Eating Habits Score**                                   | 20.8             | 3.40             |
| Juniors (n = 5)                                               |                  |                  |
| Nutritional Knowledge Score*                                  | 77.8             | 6.18             |
| Eating Habits Score**                                         | 23.0             | 2.00             |

*Nutrition knowledge scores range from 22-88.

**Eating Habits scores range from 10-40.

Intakes of CHO and Iron did not improve as year in college increased (Table 10). Nutritional knowledge and eating habits scores were higher among those athletes who had taken nutrition courses when compared to those who had not taken any courses (Table 11). However, actual CHO and Iron intakes were higher among those athletes who had not taken any nutrition courses (Table 11).
Table 10. Nutritional intake of carbohydrate and iron according to year in college

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carbohydrate</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All (N = 12)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g/day</td>
<td>317.0</td>
<td>103.56</td>
</tr>
<tr>
<td>g/kg/day</td>
<td>4.8</td>
<td>1.90</td>
</tr>
<tr>
<td>% energy</td>
<td>52.7</td>
<td>4.82</td>
</tr>
<tr>
<td>Freshmen (n = 3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g/day</td>
<td>298.2</td>
<td>119.06</td>
</tr>
<tr>
<td>g/kg/day</td>
<td>3.7</td>
<td>1.15</td>
</tr>
<tr>
<td>% energy</td>
<td>52.2</td>
<td>4.76</td>
</tr>
<tr>
<td>Sophomores (n = 4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g/day</td>
<td>357.7</td>
<td>33.96</td>
</tr>
<tr>
<td>g/kg/day</td>
<td>5.6</td>
<td>0.64</td>
</tr>
<tr>
<td>% energy</td>
<td>51.6</td>
<td>7.27</td>
</tr>
<tr>
<td>Juniors (n = 5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g/day</td>
<td>295.6</td>
<td>138.05</td>
</tr>
<tr>
<td>g/kg/day</td>
<td>4.9</td>
<td>2.73</td>
</tr>
<tr>
<td>% energy</td>
<td>53.9</td>
<td>3.15</td>
</tr>
<tr>
<td><strong>Iron (mg)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>15.9</td>
<td>4.40</td>
</tr>
<tr>
<td>Freshmen</td>
<td>17.4</td>
<td>5.62</td>
</tr>
<tr>
<td>Sophomores</td>
<td>16.0</td>
<td>3.84</td>
</tr>
<tr>
<td>Juniors</td>
<td>14.9</td>
<td>4.83</td>
</tr>
</tbody>
</table>

Table 11. Nutritional knowledge, eating habits, CHO intake, and iron intake among subjects who have taken nutrition courses and those who have not (N = 12)

<table>
<thead>
<tr>
<th>Nutrition Background</th>
<th>Courses (n = 5)</th>
<th>No Courses (n = 7)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Mean ± SD)</td>
<td>(Mean ± SD)</td>
</tr>
<tr>
<td>NK Score (%)</td>
<td>90.0 ± 5.76</td>
<td>87.2 ± 7.42</td>
</tr>
<tr>
<td>EH Score (%)</td>
<td>60.0 ± 3.06</td>
<td>53.2 ± 7.14</td>
</tr>
<tr>
<td>CHO Intake (g/day)</td>
<td>259.4 ± 102.98</td>
<td>370.6 ± 72.78</td>
</tr>
<tr>
<td></td>
<td>3.4 ± 0.88</td>
<td>5.8 ± 1.77</td>
</tr>
<tr>
<td></td>
<td>53.3 ± 1.99</td>
<td>52.3 ± 6.29</td>
</tr>
<tr>
<td>Iron Intake (mg/day)</td>
<td>13.8 ± 4.82</td>
<td>17.7 ± 3.71</td>
</tr>
</tbody>
</table>

*Note: NK = Nutritional Knowledge, EH = Eating Habits, CHO = Carbohydrate
DISCUSSION

The following discussion is divided into three sections: Discussion of Results, Conclusions, and Recommendations.

Discussion of Results

This study was designed to establish nutrition information on female NCAA Division II swimmers. Variables of interest included: anthropometric measurements, nutritional knowledge, eating habits, and nutritional intake. Findings suggest that subjects are not meeting energy requirements to adequately fuel for sport. In particular, low intakes of CHO and Iron may be impeding athletic performance.

Requirements for CHO in athletes depend largely on their body weight, total daily energy expenditure, sport, gender, and environmental training conditions. Previous studies indicate that female athletes regularly fail to meet the CHO and Iron requirements associated with their activity level. Current research suggests that $7 - 12g \cdot kg^{-1} \cdot day^{-1}$ of CHO is necessary to optimize muscle glycogen storage and to recover from heavy training
sessions or competition.\textsuperscript{1-4,6,13} The swimmers who participated in this study reported \(4.8 \pm 1.90\text{g} \cdot \text{kg}^{-1} \cdot \text{day}^{-1}\) of CHO. Athletes such as these, who fail to meet daily CHO requirements, can experience loss of muscle mass, menstrual dysfunction, and loss or failure to maintain bone density. These symptoms will decrease athletic performance and increase the onset of fatigue as well as the opportunity for injury and illness.\textsuperscript{1-6,8,9,13,14}

As training intensity increases, so does the body’s reliance on CHO as a primary fuel source.\textsuperscript{3,6} Lack of adequate dietary CHO will force athletes to use amino acids to cover a portion of their energy demands. Subjects averaged \(1.2 \pm 0.46\text{g} \cdot \text{kg}^{-1} \cdot \text{day}^{-1}\) of protein, which is in accordance with research suggesting that \(1.2 - 1.4\text{g} \cdot \text{kg}^{-1} \cdot \text{day}^{-1}\) is necessary for athletes engaged in endurance training.\textsuperscript{1,2,4,6} However, this assumes that CHO levels are sufficient. Compromised CHO intakes will force the body to require a larger portion of the energy pool to come from protein. Subjects’ protein intakes may not be adequate to cover the energy deficit that comes from lack of CHO and the requirements associated with the repair and building of muscle tissue. If adequate amino acids are not available in the diet, the athlete will experience the effects of a negative nitrogen balance causing the body to metabolize
lean tissue for energy.\textsuperscript{4-6} This imbalance will negatively affect athletic performance through muscle degradation and subsequently result in the inability to repair tissue due to nutrient deficiency.\textsuperscript{4-6} Consequently, subjects did not consume adequate macronutrients to maintain energy stores and support the repair and maintenance of tissue following exercise. As a result, they are impairing their ability to perform at their best.

Subjects reported intakes of 15.9 ± 4.40mg · day of Iron, which is below the recommended dosage for female athletes. Female athletes (age 19 - 50) are recommended to intake at least 18mg of Iron each day; however, as much as 23mg · day may be necessary if the athlete is menstruating.\textsuperscript{2,14} Iron losses in female athletes can come from menstrual bleeding, heavy sweating, and lack of red meat and iron-fortified breakfast cereals.\textsuperscript{12,14} Protein-iron compounds, hemoglobin and myoglobin, are responsible for assisting the delivery of oxygen to working tissues. Because swimming is often a highly aerobic sport, restricting Iron intake could inhibit athletic performance.

Many explanations exist as to why these athletes have reported less than favorable eating habits. One reason may be that they have under-reported their food record information. Some athletes will purposefully document less
than they actually eat for fear of revealing inappropriate dietary behavior to a coach or researcher. Others may be out to impress or fear being seen as an over-eater. This scenario would produce seemingly poor nutrition habits with little or no ability to gauge an accurate caloric intake. However, because the subjects in this study were provided detailed instructions and two-dimensional examples of portion sizes to enhance their ability to report food data, the researcher suspects that nutrient intake was reported to the best of their ability. If that is the case, these athletes are inhibiting their ability to perform at a high level. Consider the fact that these are competitive swimmers who compete nationally at the NCAA Division II level. If these food records are a truthful depiction of nutritional intake, these athletes have made it to this level of competition with sub-optimal eating habits. Imagine their ability to improve upon performance if proper sport nutrition principles were introduced and practiced religiously.

Height and weight measurements were taken to report subjects' BMI (APPENDIX C3). Subjects' mean BMI was 23.88 ± 2.882 indicating a “normal” level of body mass among the group. However, it was interesting to note that fat comprised 33.4% of subjects’ diet, while current research
specifies that 25 – 30% of athletes’ diet should come from fat.¹

Previous research by Zawila et al¹⁰ suggests that many female athletes lack nutritional knowledge critical to preventing nutrition-related health problems. This research disputes that concept. Mean nutritional knowledge score on the questionnaire was 88.4%, indicating an excellent level of nutritional knowledge among these swimmers. Previous research also states that nutritional education is needed for, not only athletes, but parents, coaches, and Certified Athletic Trainers (ATCs).¹⁰,¹⁷-²⁰ This study reported 41.7% of its subjects seeking a parent, coach, or ATC regarding nutrition information. If this is representative of the athletic population, Allied-health care professionals, have our work cut out for us. Sport related nutrition education programs should be offered at high schools, colleges, universities, and even in local communities. This gives the ATC an opportunity to act as the first line of defense against nutrition deficiency among athletes in schools and local communities. ATCs are active in both the prevention and healing of injuries; therefore, the role of the ATC should include educating athletes on the importance of nutrition to performance and healing.¹⁰ Additionally, if ATCs can educate the coaches and
parents who are responsible for today’s youth, perhaps we can make nutrition a priority and encourage positive dietary habits in younger populations.

Excellent knowledge of nutrition does not always equate to excellent eating habits. Research indicates that female athletes do not engage in favorable nutrition habits despite their knowledge of improved performance associated with proper nutrition.\textsuperscript{9,10} Subjects’ mean eating habits score was 56.0\% suggesting that they exhibit fair, almost poor, eating habits on a scale that includes: excellent, good, fair, and poor. As discussed earlier, subjects averaged 88.4\% (excellent) on the nutritional knowledge section of the questionnaire. It is difficult to say why a seemingly educated group of female athletes would report such low eating habits scores despite their apparent excellent knowledge of nutrition. The relationship between level of nutrition knowledge and actual eating habits is poorly understood and must be researched further.

A previous study\textsuperscript{29} found that collegiate athletes who completed a nutrition course in college demonstrated greater nutritional knowledge than those who did not. This study supports that research. Subjects who had previously taken nutrition courses scored higher on both the nutritional knowledge and the eating habits section of the
questionnaire. Mean nutritional knowledge scores were 90.0% among those who had taken nutrition courses compared to 87.2% among those who had not. Eating habit scores averaged 60.0% among students who had studied nutrition compared to 53.2% among those who had not. Despite the apparent increase in knowledge exhibited by athletes who have taken nutrition courses, they reported lower total daily CHO intake, as well as g·kg⁻¹·day⁻¹ of CHO and mg·day of Iron. This suggests that nutrition courses are successful in passing on knowledge, but not necessarily effective in changing the eating habits of female collegiate athletes. This researcher believes that more drastic, individualized intervention programs are necessary to promote and enforce the strong nutritional knowledge base that many of these athletes already posses. Annual, team-oriented nutrition education programs, hosted by ATCs, could provide athletes with current, sport-specific nutrition information. Additional literature, videos, and posters could be made available to coaches and athletes in order to keep the ideas fresh in their mind. Forty-two percent of subjects who participated in this study indicated that they would consult a Medical Doctor or ATC for nutritional advice. ATCs can work along side Medical Doctors using dietary analysis software such as
Nutritionist Pro®. This will help the ATC to identify problem areas in diets and develop quality sport and athlete-specific nutrition programs in conjunction with nutrition professionals. Three out of 12 subjects in this study had a medical professional speak to them about nutrition and two of 12 consulted a medical professional on their own. Not enough is being done to get pertinent nutrition information to all NCAA athletes.

This group of swimmers reported nutritional knowledge scores that suggest enough knowledge of nutrition to implement a healthy lifestyle; one that would compliment athletic performance. They seemingly understood the difference between positive and negative nutrition behaviors, but still chose the latter. Perhaps they have an understanding of nutrition concepts but do not make the all important connection between constructive nutrition habits and superior athletic performance. Even though subjects exhibit excellent nutrition knowledge, they may be unaware of how to apply that knowledge in regard to the increased demands of training and competition. For instance, they may not know that ingesting 1 - 1.5g of CHO · g of BW within 30 minutes of exercise will substantially increase glycogen storage.\textsuperscript{1,3} Or that the ingestion of 6 - 20g of protein included in a post-game meal could aid the
Athletes could benefit from bringing a CHO and protein-rich snack to practice in order to re-fuel their muscles immediately after depleting their resources. The best preparation for competition starts with a good recovery meal following the previous workout.

Additional findings of this research indicate that subjects’ nutritional knowledge and eating habits scores did not improve as their year in college increased. This suggests that subjects are not receiving enough nutrition intervention throughout their collegiate career to positively affect their knowledge and habits. Or if they are receiving information, they do not seem to be making the link between knowledge and habit. Dietary analysis completed multiple times throughout the year may indicate performance changes that can be linked to nutrition. Perhaps if athletes are shown evidence that when they eat poorly, their performance suffers, they will begin to understand that proper nutrition is considered a significant determinant of athletic performance. Other than limits from heredity and training, no single factor plays a greater role in optimizing performance than diet.

This research was designed to assess nutritional knowledge, eating habits, and nutritional intake among female collegiate athletes. However, it may also be used
as a resource for current principles in sports nutrition. Through the use of this nutritional profile, researchers can recognize current trends among the eating behavior in athletes and better understand the importance of using nutrition as a performance enhancement tool. Unfortunately, the correlation between level of nutritional knowledge and actual eating habits is debatable and must be researched further with a larger and more diverse population of athletes. Considering that these athletes reported inadequate macronutrient intake to cover energy costs, the impact of the resulting negative effects they feel is hard to judge. At the very least, they are impeding athletic performance. At best, they have maintained enough nourishment throughout their athletic career to compete at the Division II level. However, they may never realize their full athletic potential unless dietary changes are made.

Conclusions

Findings suggest that female NCAA Division II swimmers are not meeting energy requirements to adequately fuel for sport. Although subjects scored high on the nutritional knowledge portion of the questionnaire, they reported low
eating habits scores and poor nutritional intake. Consequently, it does not seem as though level of nutritional knowledge and eating habits are dependant on one another. Future research is necessary to determine the relationship between nutritional knowledge and eating habits. For level of nutrition knowledge to have a positive effect, this knowledge must affect eating behaviors. Analysis of the relationship between increased nutrition knowledge and eating behaviors may identify the benefits of improved knowledge.

Nutritional knowledge scores, eating habits scores, and nutritional intake did not improve as athletes’ year in college increased. Additionally, athletes who had taken nutrition courses scored higher on both the nutritional knowledge and eating habits sections of the questionnaire, but did not report improved nutritional intake. ATCs should administer sport and athlete-specific nutrition education to attempt to bridge the gap between knowledge of nutrition and actual eating habits. The ATC should be aware of areas of decreased nutrition knowledge in collegiate athletes and be qualified to formulate a plan of intervention through pre-season seminars, handouts, posters, individual counseling, and dietary analysis.
Recommendations

This study established a nutritional profile of NCAA Division II swimmers at one university. Similar studies should expand populations including more athletes at multiple universities, a variety of sports, both genders, and various NCAA Divisions. Future studies should complete nutritional profile’s multiple times throughout the year using the same sample. This will give the researcher the opportunity to monitor nutrient intakes throughout a competitive season and implement effective correction strategies as necessary. The ATC should focus on changing dietary behavior by scheduling individual meetings with athletes following completion of the nutritional profile to discuss results and possible methods of dietary change. Additionally, future research should include an estimation of body fatness such as skinfold thickness measurement.

Similar studies using female subjects should collect data on menstruation cycles and individual training habits to assess possible connections to decreased Iron levels. Additionally, researchers can use this revised 32-item Questionnaire with similar populations to assess nutritional knowledge and eating habits. Future research may benefit from expanding the questionnaire to include
even more sport-related nutrition topics, if reliability coefficients can be maintained. Studies may also want to look at the influence course load, sleeping habits, and training habits have on individual nutritional intake at different points throughout a competitive season.
REFERENCES


APPENDICES
APPENDIX A

Review of the Literature
Nutrition is an integral part of successful athletics. It is no secret that physical activity, athletic performance, and recovery from exercise are enhanced by optimal nutrition.\textsuperscript{1-7} Athletes are often faced with difficult decisions regarding food choices such as what, when, and how much to eat in order to meet the specific demands of their sport. When compared to their sedentary counterparts, athletes must pay particular attention to meeting caloric requirements because of the high-energy demands of their sport.\textsuperscript{1,2,4-6} Many athletes are not familiar with how to adequately fuel and replenish their bodies through the use of sound nutritional principles. Female athletes often choose not to engage in favorable nutritional habits for various reasons.\textsuperscript{7,8} Pressure from coaches or peers, fear of weight gain and their idea of what they should look like based on public biases all play into this cycle of poor habits.\textsuperscript{9,10} Those athletes who do subscribe to positive nutritional habits have shown greater opportunity for improvement in athletic performance.\textsuperscript{1-8} A nutritional profile (APPENDIX C1) is a good way to identify strengths and weaknesses of the dietary practices of athletes.\textsuperscript{12} A profile can serve to identify existing eating habits and caloric intake thereby encouraging steps toward developing constructive life-long dietary habits. The
purpose of this review is to analyze the following topics: (1) current sports nutrition recommendations, (2) eating behavior in female college athletes, and (3) suggested methods for assessing dietary intake.

Current Sports Nutrition

Athletes’ Knowledge

As the American public becomes more concerned with health and health issues, the interest in nutrition, physical activity, and the correlation between the two has increased.6 Athletes and coaches are becoming increasingly more aware of the important link between nutrition and performance.7,8 Research indicates that nutritional education is needed for athletes, parents, coaches, teachers, and health care professionals such as Certified Athletic Trainers (ATCs).8,9,13-15 In a 1999 study, Turk et al15 assessed the knowledge of eating disorders possessed by collegiate coaches and the services they provided for their athletes regarding those disorders. Using a two-part questionnaire, 138 NCAA Division 1-A coaches from 18 sports at 5 universities were sampled. Only 38.3% of coaches reported that their teams had attended a program about eating disorders and only 23.9% indicated mandatory
attendance of those programs. A mere 8.7% of coaches indicated that educational video tapes were made available and only 37.7% acknowledged that literature regarding eating disorders was made available to their athletes. Considering the influence that collegiate coaches have over their athletes, they must play a more active role in preventing disorders. ATCs have the opportunity to provide athletes and coaches with quality sports nutrition information and act as the first line of defense against disordered eating.

Despite the importance of implementing good nutrition habits, some female athletes still lack nutritional knowledge or fail to comply with nutritional recommendations for unknown reasons. An increased nutritional knowledge base could enhance an athlete’s athletic performance as well as their day to day well being. In 2003, Zawila et al. assessed nutritional knowledge and attitudes among female collegiate cross-country runners (N = 60). Findings suggest that subjects lack nutritional knowledge critical to preventing nutrition-related health problems. Because most of the runners in their study exhibited positive attitudes towards nutrition, researchers concluded that they were receptive to nutritional education if provided. When asked, “Does
your knowledge of nutrition affect how you eat?” 83.3% responded yes. Additionally, 91.7% strongly agreed with the statement, “Learning facts about nutrition is the best way to achieve favorable changes in food habits.” Increasing nutritional knowledge may give these athletes the necessary tools to meet the energy demands of their sport. Inability to meet nutrient demands puts an athlete at a performance disadvantage resulting in a number of detrimental consequences that will be discussed later in the literature review.1-7 Providing athletes with the knowledge to recognize disordered eating habits before they become a problem is a necessary step toward creating healthy, energy efficient athletes who regularly meet the caloric requirements of their sport.

Energy Requirements for Female Athletes

During periods of training and competition, athletes must consume adequate amounts of energy in order to maintain body weight, maximize training effects, and maintain overall health.1-7,10,12,16-18 Athletes who fail to meet daily energy requirements may experience loss of muscle mass, menstrual dysfunction, and loss or failure to gain bone density. These symptoms will increase the onset of fatigue, as well as increase the incidence of injury and
The American Dietetic Association (ADA), the American College of Sports Medicine (ACSM), and the Dieticians of Canada released a joint position statement on Nutrition and Athletic Performance in 2000. They agree that CHO should comprise approximately 60% of daily caloric intake, fats 25% - 30%, and proteins 15%. With that said, it may be more suitable for the purposes of this paper to refer to intake requirements as grams per kilogram of body weight per day (g · kg\(^{-1}\) · day\(^{-1}\)). This will allow athletes to set and achieve their energy goals more accurately according to their individual body size and type. Athletes such as swimmers and runners, who expend massive amounts of energy each day, need to increase their caloric intake to maintain muscle tissue throughout intense training and ensure proper refueling, rehydration and overall recovery between training sessions.

CHOs act as the body’s primary energy source during exercise and are used more efficiently than protein or fat. CHOs are a critical fuel source for muscle as well as the Central Nervous System (CNS). CHO can be divided into two main categories: simple (sugars) and complex (starches). Simple CHOs include monosaccharides and disaccharides. These are referred to as simple because of their respective one or two molecule arrangement. Complex
CHOs consist of oligosaccharides, polysaccharides, and dietary fibers (soluble and insoluble) that are considered complex because of their multiple molecule orientation (>3). However, athletes may want to speak of CHOs in terms of their effect on blood glucose, or their glycemic response. The glycemic response is measured by the ability of food to contribute glucose to the bloodstream. Many factors may influence the glycemic response of a food including the amount eaten, the fiber content, and the amount of fat. By ranking foods according to their ability to elevate blood sugar, a glycemic index (GI) was developed. To determine GI, blood sugar levels are measured two hours post food ingestion and assigned a value ranging from 1 (lowest) to 100 (highest) based on their effect compared to pure glucose. This system was originally designed to help diabetics closely control their blood sugar and has since been utilized by athletes to assist them regarding pre- and post-competition meals to enhance performance.

Foods with a low-to-moderate GI (< 70) are often seen as a wise pre-event meal choice for athletes because they slowly empty glucose into the bloodstream and provide sustained energy over a long period of time. Conversely, high GI (> 70) foods cause a rapid, short-lived rise in
blood glucose and are more suited for glycogen replenishment during or immediately following exercise.\textsuperscript{2-4} Athletes who choose low-to-moderate GI pre-event meals may experience enhancement of stamina and endurance. However, if that athlete will be consuming CHO during exercise (e.g., sports drinks, gels, fruit), the energizing power of those high GI snacks will outweigh the effect of the low GI meal. Consequently, athletes should concentrate most on fueling their bodies during and immediately following exercise rather than worrying about the glycemic effect of a pre-event meal.

Worthwhile high GI foods include: baked potatoes, whole wheat bread, Gatorade\textregistered, rice cakes, watermelon, and cereals such as Cream of Wheat\textregistered and Grape-nuts\textregistered.\textsuperscript{2} Examples of quality foods that can be grouped into the low-to-moderate GI category include: rice, pasta, bananas, milk, and yogurt. However, keep in mind that some of these options may not be suitable pre-exercise choices because they may cause stomach discomfort (e.g., dairy).\textsuperscript{3} Athletes should employ a trial and error type system to identify pre- and post-exercise diet habits that work best for them.

The most important form of CHO to athletes is glycogen. Glycogen is the storage form of glucose, found
only in animals, and is considered complex because of its similar chemical structure to starch and fiber.\textsuperscript{2} Humans are capable of storing anywhere between 400 - 600g (1,600 - 2,400kcal) of glycogen in their muscles and liver at any given time. However, only about 125g (500kcal) will be stored in the liver and therefore readily available for increasing blood glucose during activity.\textsuperscript{2} Blood glucose acts as the primary fuel source for the CNS. Without it athletes may be lethargic and unable to make quick decisions.\textsuperscript{1-3,6} Maintenance of blood glucose is also essential for athletes to maintain energy levels and nerve cell function during competition. If adequate levels cannot be maintained, muscular contraction and subsequent athletic performance are significantly inhibited.\textsuperscript{1-3,6} As the duration and intensity of exercise increases, muscle glycogen becomes depleted, causing the body to seek circulating blood glucose and liver stores as a source of energy. Consuming adequate dietary CHO is the key to maintaining blood glucose levels during training and replacing muscle glycogen stores following exercise.\textsuperscript{1-4,6,16,17}

Requirements for CHO in athletes depend largely on their body weight, total daily energy expenditure, sport, gender, and environmental training conditions.\textsuperscript{1-4,6,16,17} As training intensity increases, so does the body’s reliance
on CHO as a primary fuel source. Tarnopolsky et al. found that a minimum CHO intake of 8 - 10g · kg\(^{-1}\) · day\(^{-1}\) is required to CHO load among endurance-trained cyclists. This is in accordance with other research suggesting that that 7 - 12g · kg\(^{-1}\) · day\(^{-1}\) is necessary to optimize muscle glycogen storage and to recover from heavy training sessions or competition.

The amount of CHO ingested each day is extremely important to athletes to ensure that adequate preparation and recovery from training sessions is maintained. However, equally important is the timing of that CHO ingestion. The liver will deplete and restore its glucose levels quickly. It can completely empty after a prolonged workout, but will also rapidly re-fuel within 2 - 4 hours of a high CHO meal. Following exercise, the body gives priority to the recovery of muscle glycogen stores over liver stores making it absolutely imperative for athletes to consume adequate CHO at this time. Exercise leaves the muscle more sensitive and with a greater capacity to take up glucose. If athletes do not eat CHO immediately following exercise, the liver will work hard to convert compounds such as lactate and amino acids into glucose, and promote a low rate of muscle glycogen recovery. After a couple of hours, the benefits of immediate post-exercise
CHO consumption dissipate and glycogen stores slow to more typical rates.\(^2,3\) Glycogen replacement occurs more rapidly if 1 - 1.5g of CHO \(\cdot\) kg of body weight (BW) is consumed within 30 minutes following exercise and another 1 - 1.5g of CHO \(\cdot\) kg of BW every 2 hours after that, eventually totaling 7 - 12g \(\cdot\) kg\(^{-1}\) \(\cdot\) day\(^{-1}\).\(^1,3\) Tanaka et al\(^17\) assessed the CHO intake of 14 male and 10 female collegiate distance runners. Findings indicate that CHO was ingested immediately following exercise only 50% of the time or less, and was far less than suggested quantities (< 1g \(\cdot\) kg). This would make it very difficult for an athlete to adequately recover from a training session, especially when the period until the next session was short (< 12 hours).\(^3\) Clearly, these athletes were not ingesting enough CHO to fuel their active bodies, and most likely were impeding performance.

The best preparation for training or competition starts with a quality recovery meal. However, athletes must also pay attention to pre-exercise nutrition in order to maximize training effects. Pre-event CHO ingestion should be low in fat and moderate in fiber to aid in digestion and reduce the risk of gastrointestinal discomfort.\(^1,6\) Timing of meals is often a personal choice and one the athlete may need to decipher on their own.
through trial and error.\textsuperscript{4} Still, athletes should attempt to ingest CHO-rich foods and drinks providing at least 1g $\cdot$ kg of BW 1 - 4 hours prior to a workout.\textsuperscript{1-4} Some athletes may find themselves in a prolonged workout ($>60 - 90$ min) or situation where they are unable to adequately fuel prior to a workout (e.g., morning sessions). In these situations, approximately 1g per min, or 60g of CHO per hour, is necessary to maintain blood glucose levels.\textsuperscript{1,3,4} Often, the best way for athletes to maintain is through the use of sports drinks, gels, and bars. For instance 700ml of most sports drinks will provide about 50g of CHO. If adequate CHO levels are not upheld, symptoms of overtraining, fatigue, and muscle degradation will set in.\textsuperscript{1-4,6,16} Because sports such as swimming and distance running require large amounts of fuel for long bouts of energy, restricting CHO intake in these athletes would be suicidal to performance.\textsuperscript{3,4}

In addition to CHO, protein is a macronutrient considered essential for optimal athletic performance.\textsuperscript{1,2,4,6} Proteins consist of individual amino acid molecules composed of carbon (C), hydrogen (H), oxygen (O), and nitrogen (N) that are held together by peptide bonds.\textsuperscript{2} Twenty different amino acids are available for use in the human body. Nine of these are considered essential because
they cannot be produced within the body and must be ingested. Conversely, the additional eleven are referred to as non-essential because they are produced in the body and therefore need not be consumed. Proteins form the structural basis for connective tissue, regulate cell functions, serve as the major component of most enzymes in muscle, and act as a source of energy during exercise. Seeking proteins from both plant and animal sources is important to athletes. Animal proteins are considered complete proteins because they contain ample amounts of all essential amino acids. Conversely, plant proteins are incomplete because they are missing one or more of these essential amino acids. Examples of plant proteins include: grains, legumes, nuts, seeds, and beans, while animal proteins exist largely in meats, fish, poultry, milk, cheese, and eggs. Soy is the only complete plant protein, making it a common choice among athletes, especially in vegetarian populations.

Athletes require higher protein intakes than their sedentary counterparts because of the energy demands of sports. Extra protein is necessary to cover a small portion of the energy costs of training and to assist the repair and recovery process. Adequate protein intake ranges from 1.1 - 1.4g · kg⁻¹ · day⁻¹ in recreational athletes to as
much as 1.8 – 2.0g · kg\(^{-1}\) · day\(^{-1}\) in elite athletes\(^1,2,4,6\). Protein recommendations for endurance athletes are 1.2 – 1.4g · kg\(^{-1}\) · day\(^{-1}\) compared to athletes that engage in resistance and strength training who require 1.6 – 1.8g · kg\(^{-1}\) · day\(^{-1}\).\(^1,2,4,6\) Protein metabolism is a constant balance between protein breakdown and protein synthesis. During exercise the balance shifts toward protein breakdown, while during recovery the balance tips in the opposite direction, encouraging amino acid uptake.\(^4-6\)

Nitrogen (N) content is often noted as a marker of protein status in the body. The more N that is present, the more available protein exists in the body. A state of N balance occurs when an athlete’s nutritional intake of N (protein gain) is equal to the output of N (protein loss).\(^2,6\) In other words, the athlete is not lacking protein, nor are they consuming excess. Athletes are constantly losing proteins, primarily to cellular metabolism but also because of broken fingernails and hair follicles.\(^2\) When amino acids are broken down in the body, the N group is severed from the molecule. This leads to N loss during urea formation in the liver, or to a lesser extent, as ammonia.\(^2\) In order to maintain N balance, or positive N status, athletes must consume adequate daily calories from protein.\(^1,2,4,6,7\) A positive N balance indicates
that an athlete is in a protein building state, which is beneficial during recovery from training for the growth and repair of connective tissue.\(^2,^6\) A negative N balance occurs when an athlete’s protein intake is insufficient. This forces an athlete into a state of protein breakdown causing the body to metabolize lean tissue for energy.\(^4-^6\) This imbalance will negatively affect athletic performance through muscle degradation and subsequently result in an inability to repair tissue due to nutrient deficiency.\(^4-^6\)

Consuming protein immediately following exercise (within 30 min) may enhance the uptake and retention of amino acids.\(^4,^6\) The ingestion of 6 – 20g of protein included in a post-game meal can aid the recovery process.\(^4,^6\) Similar to CHO, protein synthesis is dramatically increased, as much as 10 – 80% within 4 – 24 hours following exercise, making adequate daily protein intake essential to the recovery process.\(^4,^6\)

Over-consumption of protein (\(> 2g \cdot kg^{-1} \cdot day^{-1}\)) is common among athletic populations and can have negative consequences on performance.\(^1,^2,^4,^6\) Increasing protein intakes beyond recommended levels is unlikely to result in additional increases in lean tissue because there is a limit to the rate at which tissue can be accrued.\(^1,^4,^6\)

Symptoms of over-ingestion include: inhibited uptake of
other nutrients (e.g., calcium depletion), water loss through dehydration, advanced hunger and a slower metabolism.\textsuperscript{2,6} One example to illustrate this point is the effect a high-protein intake can have on calcium levels in the body. A diet high in protein will increase the amount of calcium excreted from the body in the form of urine.\textsuperscript{6} Athletes are then more susceptible to weakened bones and subsequent injury and illness.\textsuperscript{4,6} This can lead to much bigger problems (e.g., female athlete triad) when dealing with female athletes with low-energy intakes. Additionally, high-protein intakes are usually a result of consumption of large amounts of animal products (e.g., meats and dairy) which often contain mass quantities of fat. The main concern with athletes who intake large quantities of protein are that they displace other valuable foods (fruits and vegetables) and other important nutrients such as CHO and fiber.\textsuperscript{6}

Conversely, low protein consumption (< 1g · kg\textsuperscript{-1} · day\textsuperscript{-1}) is a problem among undernourished athletes because their active bodies require larger amounts of energy.\textsuperscript{1,4-6} Those individuals at greatest risk for low-protein intakes are active individuals who restrict energy intake for weight loss or follow vegetarian diets, especially active women.\textsuperscript{6} Inadequate protein consumption forces an athletes' body
into a state of negative N balance accompanied by the aforementioned symptoms such as muscle degradation and the inability to repair tissue damaged from prior workouts.\textsuperscript{1,2,4,6} Athletes who seek top performance must maintain adequate protein levels to fuel for and recover from sport.

The importance of fats (lipids) should be stressed to athletes in all sports because of its importance as an energy source.\textsuperscript{1,4-7} For some athletes, the topic of fat raises negative feelings.\textsuperscript{5,6} These feelings can arise from social biases that often suggest what they are supposed to look like or because they are aware of the detrimental affect extreme body fat levels can have on performance.\textsuperscript{6} This leads some athletes to believe that fats offer no athletic benefit.\textsuperscript{1,5,6} Fats can be used as a source of energy during rest, recovery between intense bouts of exercise, and also during a wide variety of exercise intensities.\textsuperscript{2,5,6} However, the proportion of energy contributed from fat is inversely related to exercise intensity (when exercise intensity increases, fat contribution decreases).\textsuperscript{1,6}

Fats exist as fatty acids in three forms: saturated, monounsaturated, and polyunsaturated. Fatty acids are chains of C, O, and H atoms that vary in length and degree of saturation of C with H. Saturated fats contain a full quota of hydrogenated ions so that all of its C bonds are
full.\textsuperscript{5,6} Whereas, C molecules in unsaturated fatty acids may take on more H because they have some unfulfilled bonds or double bonds. Monounsaturated fatty acids have a single double bond capable of incorporating two H ions, while polyunsaturated fatty acids have two or more double bonds capable of incorporating four or more H ions.\textsuperscript{2} Three of these fatty acids combine with glycerol to form a triglyceride, (also known as true or neutral fat) the principle form in which fats are eaten and stored in the body. Fats are crucial in helping to transport lipid-soluble vitamins (A, D, E, and K), regulate cholesterol metabolism, and provide essential fatty acids that the body cannot produce naturally. Fats also serve as a protection and insulation device for the body’s organs and are necessary for estrogen production in females.\textsuperscript{1,2,4-6,23}

Some sports have a history of athletes with particularly low levels of body fat; cross-country and gymnastics are prime examples.\textsuperscript{10,17,22,24-27} Some of these athletes are a result of external pressures such as their coaches, peers, or society’s distorted view of what they should look like. While, others may suffer from internal pressures that do not comply well with their sport, such as their own perception of what they want to look like. Nevertheless, no performance benefits have been shown with
consuming a diet comprised of less than 15% of its calories from fats.\textsuperscript{1,2,4-6} In fact, some of the disadvantages associated with low body fat levels, such as hormonal imbalances and decreased immune function, arise directly from the methods that athletes use to try to lose body fat. These include energy or nutrient restriction, excessive training loads, and/or disordered eating behavior.\textsuperscript{6} Consider that an athlete who must consume 4,000 – 5,000 kcal per day in order to meet increased energy needs, requires no less than 600 – 750 kcal (66 – 84 g) from fat per day to stay at that 15% threshold. Realistically, an athlete with increased nutrient requirements such as these should consume between 1,000 – 1,500 kcal (111 – 167 g) from fat, putting them closer to 25 – 30% fat intake.\textsuperscript{1,5,6} Training improves the body’s ability to use fat as energy by enhancing the working muscle’s capacity to oxidize fats during exercise.\textsuperscript{2,6} This gives superiorly trained athletes an opportunity to use this high-yield energy source more efficiently during long bouts of exercise. Considering that fat is the most dense fuel source (9 kcal · g), adequate fat intake can greatly improve energy levels during training.

Just as with CHO and protein, incorporating fat into a diet will vary from athlete to athlete.\textsuperscript{1-6} Each athlete’s ideal level of body fat and weight are specific to them,
and can really only be judged by trial and error over a period of time. Hawley et al suggests that ideal body fat levels must encompass a range of health, nutrition, and sporting issues. Specifically, they must achieve the following goals: (1) be associated with consistently good performances over the long term, (2) keep the athlete healthy, or without an added risk of injury and illness that can occur both from being overfat or underfat, and (3) allow the athlete to eat a well-rounded diet with sufficient energy to meet all their nutritional goals, and to be free of unreasonable food-related stress. After all, the concept of “ideal” body fat levels may change over an athlete’s career or even from competition to competition.

Athletes may want to focus more on the type of fats in their diet, rather than the exact amount, consumed daily. Successful diets are often low in saturated and trans fats while providing adequate amounts of monounsaturated and polyunsaturated fatty acids. Diets comprised of large amounts of their energy intake from saturated and trans fats have shown detrimental effects on cardiovascular fitness and long-term overall health. On the contrary, polyunsaturated fatty acids, such as omega-3 and omega-6, are required to make a number of potent biological compounds within the body that assist with the
regulation of blood clotting, blood pressure, heart rate, and immune response. Most fatty acids are synthesized within the body (non-essential) making their consumption unnecessary, however linoleic acid (omega-6) and linolenic acid (omega-3) are examples of fatty acids that are considered essential and must be consumed. Linoleic acid is found in vegetable and nut oils (e.g., sunflower, safflower, corn, soy, peanut oil) and it is recommended that adult women consume 11 - 12g · day. Most Americans may get adequate amounts of linoleic acid, due to the high amount of salad dressings, salad oils, margarine, and mayonnaise-based foods they consume on a regular basis. The second essential fatty acid, linolenic acid, is found primarily in leafy green vegetables, walnuts, soy products, canola oil, and fish products. Even though recommended intakes for adult women are a mere 1.1g · day, Americans are more likely to under-consume this fatty acid because of the nature of their diet.

Monounsaturated and polyunsaturated fats can be considered the most beneficial, leading to more favorable cholesterol levels and possibly aiding in the prevention of cancer and arthritis. Focusing primarily on plant sources can help athletes to consume healthier forms of fats. Good plant sources of fat exist largely in soy products and
nuts. It is important to preserve a balance between fat, CHO, and protein needs relative to total caloric intake to ensure athletes are properly fueled while striving to meet their training goals.¹⁻⁶

Micronutrients (MN), such as vitamins and minerals, are required for normal body function, making them essential to optimal performance.¹⁻⁴,⁶,²⁷,²⁸ Vitamins and minerals play vital roles in energy production, metabolic processes, hemoglobin synthesis, building and repair of muscle tissue, immune function, and the protection of tissues from oxidative damage.¹⁻⁴,⁶ Increasing MN intakes is necessary for athletes to cover increased needs for growth and repair of tissue.¹⁻²,⁴,⁶ Exercise stresses many of the metabolic pathways in which these MN are required, in addition to causing muscle biochemical adaptations that increase MN needs.¹,⁶ Exercise also increases the turnover and loss of MN from the body, and the need for these MN to repair and maintain the increased lean tissue mass of active individuals, especially athletes.⁶ Individuals at the greatest risk of poor MN status are those who restrict energy intake, use severe weight loss practices, or eliminate/restrict one or more food group from their diet (e.g., little or no CHO or fat).¹⁻²,⁶ MN needs can be met by
consuming a diet comprised of a variety of nutrient dense foods including fruits and vegetables.

Even though adequate intake of all MN is necessary for proper body function, some vitamins and minerals play a particularly important role during exercise. These include, but are not limited to: iron, calcium, sodium, potassium, B vitamins, and vitamins C and E.\textsuperscript{1,2}

Iron is particularly important to athletes because of its role in the formation of hemoglobin and myoglobin.\textsuperscript{2,21} Hemoglobin is a protein-iron compound found in red blood cells, which carry O from the lungs out to body tissues. Similarly, myoglobin is found in muscle tissue and assists the transport of O to the muscle.\textsuperscript{2} Clearly, without adequate function of these protein-iron compounds, O delivery to working tissues and subsequent athletic performance will suffer. Iron is also involved in the electron transport system (controls the release of energy from cells) and is required for healthy immune function.\textsuperscript{2} Inadequate iron consumption can impair aerobic metabolism by decreasing the delivery of O to tissues and reducing the capacity of muscles to use O for the production of energy.\textsuperscript{2,6} Iron deficiencies affect as many as 60\% of female athlete’s today, prompting the Center for Disease Control and Prevention to emphasize screenings for any women of
childbearing age. The distinction between iron deficiency and iron deficiency anemia is that the former relates to depleted iron stores, whereas the latter not only includes depleted stores, but also progression to low hemoglobin concentration. Female athletes (age 19 - 50) are recommended to intake at least 18mg of iron each day. However, as much as 23mg · day may be necessary if the athlete is menstruating. Iron losses in athletes come primarily from menstrual bleeding, but also through heavy sweating, lack of red meat or breakfast cereals, and damaged red blood cells from the pounding of their feet on the ground.

Both heme and non-heme exist as separate forms of iron. Heme iron is found mostly in animal products and is readily absorbed into the body. Non-heme iron is found primarily in plant products, such as cereals, vegetables, legumes, and nuts, and is not used as efficiently. However, uptake of non-heme iron can be enhanced by consuming foods that are rich in vitamin C. In other words, an athlete reporting low iron levels can substantially benefit from consuming a glass of orange juice along with an iron-fortified cereal in the morning. Substances that have been shown to impede iron uptake include: tea, coffee, fiber, and soy, as well as high intakes of minerals zinc and
calcium. These substances may need to be modified or restricted when iron status is poor.

Calcium plays a fundamental role in muscular contraction and is therefore extremely important to all athletes. Calcium also plays vital roles in the building and maintenance of teeth and bones and the prevention of osteopenia, a condition marked by consistent weakening of bone tissue. Women diagnosed with osteoporosis are reportedly four times more likely to fracture a bone. Likewise, sodium and potassium are critical to athletes for their roles in transmission of nerve impulses and muscle contraction as well as the absorption of glucose. Both sodium and potassium are lost during sweat, making it difficult for some athletes to maintain adequate levels. Consuming sports drinks during exercise is an effective way to accomplish this. On the other hand, too much sodium in an athlete’s diet will inhibit the uptake of calcium, making sodium intake another important marker to monitor in athletes.

B-complex vitamins such as riboflavin, thiamin, and niacin are required for protein synthesis and production of red blood cells, as well as tissue repair and maintenance. Adequate intakes of B vitamins is also
critical for athletes because of their assistance with energy producing body systems.

Vitamins A, C, and E play vital roles in preventing oxidative damage to cells caused by strenuous exercise; because of this they are termed anti-oxidants.\(^1,2\) A diet rich in a variety of fruits, vegetables, and fats will assist athletes in maintaining anti-oxidant levels. Supplement use for some, and possibly all, of these vitamins and minerals may be necessary for athletes who restrict energy intake, engage in severe weight loss practices, or eliminate food groups from their diet.\(^1-6,27,28\) However, any athlete considering vitamin/mineral supplementation should consult a physician prior to making any decisions.

When analyzing nutrient requirements for the athletic population, water and electrolyte balance must not be overlooked.\(^1-4,6,18\) An athlete utilizing effective hydration strategies can avoid abnormal increases in heart rate and core temperature, both of which are devastating to performance.\(^2,18\) Water also plays vital roles in liver and endocrine function as well as nutrient distribution throughout the body.\(^2,18\) Without effective hydration, athletes may consume enough MN and still not reap the
benefits because of the inability of the body to transport those MN to the necessary tissues.

It is important for athletes to be well hydrated prior to exercise. In addition to drinking generous amounts of fluid in the 24 hours preceding exercise, athletes should consume approximately 400 - 600mL (13 - 20oz) of water or sports drink in the 2 - 3 hours prior to exercise and 200 - 300mL (7 - 10oz) of water or sports drink 10 - 20 minutes before exercise. If optimal hydration status cannot be maintained during exercise, the maximal amount of fluid tolerated should be consumed by the athlete. However, approximately 150 - 350mL (6 - 12oz) of fluid in 15 - 20 minute intervals during bouts of exercise will usually achieve this. If the exercise is long (> 60 min) or takes place in a hot environment, sports drinks containing sodium and a 4 - 8% CHO concentration should be employed in order to maintain and replace muscle glycogen stores. Sports drinks are also suitable for events lasting less than 60 minutes, however water is also appropriate under these conditions. Athletes’ post-exercise goals should focus on replacing fluid losses due to sweat and urine and allowing no more than 2% loss in body weight. In most cases, athletes do not consume enough fluids to balance losses from competition. Once body fluid
losses from sweat approach the > 3% range, the body’s ability to regulate temperature is dramatically compromised. Consequently, recommendations for fluid replacement following exercise are to consume 150% of BW losses within two hours following exercise. This fluid should be part of the post-exercise meal, which should also contain sodium, either in food or beverage form. Sodium helps the rehydration process by maintaining plasma osmolality and the desire to drink. Weighing athletes before and after exercise is an effective strategy for determining fluid losses, especially in extreme temperatures.

Eating Behavior in Female College Athletes

Poor nutrition habits by athletes can lead to many problems during competition including fatigue, dehydration, and lack of concentration. These symptoms are associated with decreased performance and increased incidence of injury. Research indicates that the eating habits of female collegiate athletes are insufficient, due in part to overly restricted eating habits, nutrition misinformation, and lack of general nutritional knowledge. Tanaka et al reported that collegiate cross-country runners were
not practicing dietary recommendations for optimal glycogen restoration. Their study demonstrated that female runners derived 65 - 67% of their total caloric intake from CHO. However, the daily amount of CHO ingested was insufficient for their activity level (< 10g · kg\(^{-1}\) · day\(^{-1}\)). Athletes were not consuming enough energy each day to meet the caloric needs of their sport. Because of this, subsequent training sessions and competition most likely suffered. This is one illustration of the benefits of measuring macronutrient consumption using g · kg\(^{-1}\) · day\(^{-1}\) instead of percentages (%).

Further research indicates that female collegiate athletes fail to consume daily requirements of iron. Cowell et al\(^{29}\) states that iron deficiency is the most prevalent nutritional deficiency in the United States and has been reported of effect 60% of female athletes. In a similar study, Malczewska et al\(^{22}\) studied iron status in 126 female endurance athletes and 52 control subjects ages 16 - 20. They concluded that an increased intake of iron prevented possible exercised-induced losses of iron. This suggests that many female athletes may benefit from increasing their iron intake and are simply not aware.

Additionally, Hawley et al\(^{25}\) found that female track and field and marathon runners were not meeting energy requirements based on training load. As a result, intakes
of CHO and iron were reported below the recommended levels. Athletes averaged chronically low CHO intakes (≈5g·kg⁻¹·day⁻¹) and as a result were probably inhibiting optimal athletic performance. Clearly, a link between CHO, iron intake, and exercise exists and athletes can benefit from meeting current recommendations.

In the past, the correlation between energy demand and energy intake of female swimmers has shown that they are in a state of negative energy balance. Decreased energy availability can cause disturbances to hormonal, metabolic and immune functions which in turn will affect performance. CHO and iron are not the only nutrients to prove deficient in female athletes. Petersen et al reported that female collegiate swimmers took in 13 - 14% of their diet in protein when tested pre- and post-season respectively. This does not meet the recommendation of 15 - 20% that may be necessary for swimmers depending on their current training load. These athletes should probably have been eating closer to 20% of their diet in protein based on the vast energy demands of their sport. An athlete who fails to reach daily recommendations of protein will find their body in the aforementioned negative N balance.
Disordered Eating

Eating disorder is a term used to refer to any of several psychological disorders (such as anorexia nervosa and bulimia nervosa) characterized by serious disturbances in eating behavior. However, disordered eating differs from defined clinical eating disorders such as anorexia nervosa and bulimia nervosa. It encompasses those individuals who exhibit less severe forms of eating disorders that meet some but not all formal diagnostic criteria of eating disorders.\textsuperscript{10,13,26} Disordered eating can be considered a circumstance by which an individual engages in undesirable eating patterns and dietary behaviors.\textsuperscript{2,10,13} A disordered eater may routinely engage in chronic dieting, fasting, laxative use, and/or self-induced vomiting.\textsuperscript{10,26} These behaviors can negatively affect an athlete’s health and obviously inhibit performance. Baer et al\textsuperscript{13} identified the prevalence of disordered eating among female athletes as high as 62\% in the United States. If left unattended, poor nutritional practices can evolve into to full blown eating disorders.\textsuperscript{9,13,14}

Beals and Monroe\textsuperscript{10} studied female collegiate athletes (n=425) from 7 universities across the United States who participated in endurance and team/anaerobic sports. They found that athletes who participated in endurance sports
were often more “at risk” for disordered eating. Additionally, those athletes “at risk” for eating disorders more frequently reported menstrual irregularity ($p = .004$) and sustained more bone injuries ($p = .003$) during their collegiate career. Prevention of disordered eating is based on sound nutritional practice. If athletes are not aware of their current nutritional habits, and the recommendations of experts, they will not be able to effectively prevent problems associated with disordered eating.

The female athlete triad is a topic of concern for active women, especially those competing in collegiate athletics. Research shows that sports emphasizing low body weight or physique pressure female athletes into maintaining unrealistically low body weights and body fat percentages. Dietary practices such as these put female athletes at risk for a syndrome known as the female athlete triad. This is a collective term used to describe the interrelationship between disordered eating, amenorrhea, and osteopenia in female athletes. Zawila et al reports that the prevention of the female athlete triad requires education of athletes, peers, parents, coaches, and health care workers about warning signs, contributory psychological factors, and
outcomes associated with the disorder. Baer et al.\textsuperscript{13} agreed and added that the ACSM has put out a call to action regarding education and intervention for female athletes who may be at risk for eating disorders. Assessment of dietary intake can be the first step toward realizing and changing poor nutrition habits.

Assessing Dietary Intake

Eating behavior among female college athletes can be analyzed in order to make athletes aware of their eating habits and increase nutrition related communication between coaches, athletes, and ATCs.\textsuperscript{1,7,11,12,31} Increasing emphasis on research identifying the relationship between diet, health, and performance justifies the need to accurately report dietary intake data.\textsuperscript{6,7} Dietary analysis is crucial in determining the nutritional status of athlete’s in hopes of correcting disordered eating behavior and providing opportunity for increased performance.\textsuperscript{7,11,12} Many methods of measuring diet are available. Choice of method largely depends on the accessibility of subjects, time constraints, and budget.\textsuperscript{11} A few of the most common methods include food records (FR), food frequency questionnaires (FFQs), and 24-hour dietary recalls.\textsuperscript{11,12} Often times a nutritional profile
will include one or more of these strategies for assessing an athletes’ nutritional well being. However, these methods are limited in that they rely on the information being reported by subjects who must be literate, motivated, and accurate, or else the analysis suffers.\textsuperscript{11,12,31}

FRs require the athlete to write down everything that they consume for a given period of time.\textsuperscript{11,12} Many studies find that three to seven days of reported diet is an adequate representation of normal dietary habits.\textsuperscript{11,16,20,27,28,30} If the FR is too short, representation of the athletes’ diet will be inaccurate. On the other hand, if the athlete is asked to record dietary intake for a long period of time, the tedious nature of this task may negatively affect results.\textsuperscript{12} Using FRs that last longer than three or four days have shown reduced accuracy due to memory interference, incomplete records, and a high subject mortality rate.\textsuperscript{11} A middle ground must be met based on the demographics of the subject pool and other constraints of the study.

FFQs list specific foods and ask subjects if they eat them and if so how much and how often.\textsuperscript{11,12} This method is employed as a qualitative measurement of frequency of food consumption and is commonly used in large groups. FFQs may be modified according to ethnicity or specific needs of the
study. For example, FFQs may differ depending on nationality, just as they may be customized to assess fiber or fat intake respectively. FFQs are not necessarily the best tool for measuring current nutrient intake and may be better suited to evaluate past dietary patterns.\textsuperscript{11}

A twenty-four-hour dietary recall involves an interview about what the athlete consumed the day before.\textsuperscript{11,12} This method is not well suited for judging intakes of athletes for nutritional content because it only reports food consumption of one day.\textsuperscript{11} This may not accurately represent the diet of an athlete. Food consumption, meal times, and hydration status may change from day to day. Also, subjects may encounter difficulty recalling everything they consume in a 24 hour period.

As with any method of collecting data, error is involved. This error may involve actions of the subjects or those of the researcher.\textsuperscript{11,31} Athletes often give biased responses while recording food intake data. This may be because some foods are viewed as socially desirable and are over-reported, or that the process itself of having to record the data alters eating habits. The fear of fat may also affect the reporting of food records as well as dietary habits in general.\textsuperscript{12}
Error can also be introduced by the researcher through poor instruction. In order to accurately report their diet, athletes must be properly educated on portion sizes and caloric value of food. Serving sizes can be difficult to standardize and substitute foods may sometimes need to be included. Although reliability of these methods is in question, they are still considered standard practice.

Summary

Athletes and coaches are becoming more aware of the link between nutrition and performance. Research indicates that nutritional education is needed for athletes and those who influence the athletic population. Some female athletes lack nutritional knowledge or fail to comply with nutritional recommendations for unknown reasons. The ATC can serve as the first line of defense in the prevention and identification of nutrition-related health problems.

The ACSM and ADA agree that CHO should comprise approximately 60% of daily caloric intake, fats 25% - 30%, and proteins 15%. An athlete’s diet should incorporate strategic intake of CHO, protein, and fat before and after training sessions to optimize metabolic adaptations and
enhance recovery. Both macronutrients and micronutrients have their roles in the body regarding exercise and energy production.\textsuperscript{1-7,21} CHO acts as the body’s primary energy source during exercise, replaces muscle glycogen stores for future bouts of exercise and maintains blood glucose levels during training.\textsuperscript{1-4,6} Protein is essential to athletes because it forms the structural basis for muscle tissue, serves as the major component of most enzymes in the muscle and acts as a source of energy during exercise.\textsuperscript{1,2,4-6} Fats are necessary to help transport lipid-soluble vitamins, regulate cholesterol metabolism, and provide essential fatty acids that the body does not produce.\textsuperscript{1,2,5,6} Micronutrients such as vitamins and minerals play important roles in energy production, hemoglobin synthesis, maintenance of bone health, immune function, and the protection of tissues from oxidative damage.\textsuperscript{1,2,22,27-29}

Eating behavior among female college athletes must be analyzed in order to make athletes aware of their eating habits and increase nutrition related communication between coaches, athletes, and ATCs.\textsuperscript{1,7,11,12,31} Many athletes fall into a vicious cycle of disordered eating and intense training putting negative stresses on their body that often end with injury and/or illness.\textsuperscript{3} Prevention of disordered
eating is based on sound nutritional practice and must be emphasized to athletes of all ages and ability levels.\textsuperscript{10,13-15}

Dietary analysis is a tool used to determine the nutritional status of athlete’s in hopes of correcting disordered eating behavior and providing opportunity for increased performance.\textsuperscript{11,12,31} Many avenues exist for analyzing diet intake, however, food records are widely used and accepted methods of analyzing nutrient intake.\textsuperscript{11,16,27,28,30} Food records can be tedious and may vary as far as representation of diet, but until more effective methods are explored, they will continue to be used regularly.\textsuperscript{11} FFQs and 24-hour recalls rely of subjects’ memory about food, serving size, frequency, meal time, and hydration status. Because of this, there is a large error associated with these methods.\textsuperscript{11,12,31}

In order to accurately report their diet, athletes must be properly educated on portion sizes and caloric value of food as well as techniques for recording intake.\textsuperscript{12} In the end, the value of a study may rely on the researchers ability to convey pertinent information to subjects prior to data collection to insure accuracy. Overall, athletes must be provided with the necessary resources to analyze their own nutritional habits and use
nutrition as a tool to enhance their athletic performance and personal well being.
APPENDIX B

The Problem
Statement of the Problem

Today, the dietary habits of many female athletes are insufficient.2,8-11 Athletes must pay particular attention to meeting the caloric demands of their respective sports because of the high-energy requirements.1,2,4-7,17,21 Some athletes may not receive the necessary guidance from educated professionals required to positively affect nutritional habits. Despite this lack of guidance, collegiate athletes are entrusted to make sound dietary decisions.7,8 If athletes appear unable to make constructive nutrition decisions, avenues must be explored to provide them with the necessary tools to do so. A nutritional profile is a widely accepted method of documenting dietary habits in order to promote dietary change among athletes.11,16,27,28,30 The purpose of this study is to establish a nutritional profile of female NCAA division II swimmers.

Definition of Terms

The following terms will be incorporated throughout the study and therefore are defined as they pertain to this specific research:

1. Nutritional profile – collection of data that includes information on subjects’ anthropometric measurements,
nutritional knowledge, nutritional habits, and nutritional intake (APPENDIX C1).

2. **Body Mass Index (BMI)** – a number calculated from a subject’s weight and height (kg/m²) that serves as an estimate of body mass (APPENDIX C3).

3. **Nutritional knowledge** – reported as a score (%), set out to measure the quality and background of knowledge each athlete has received in the field of sport related nutrition (APPENDIX C4).

4. **Nutritional habits** – reported as a score (%), used to determine the perceived quality of current eating habits each athlete possesses (APPENDIX C4).

5. **Kilocalorie (kcal)** – a unit by which heat is measured and used to characterize the energy-producing potential in food. One kilocalorie is the amount of heat necessary to raise the temperature of 1 kilogram (kg) of water 1°C.²

6. **Glycogen** – large polysaccharide composed of hundreds of glucose molecules manufactured in the liver and stored in the liver and muscles. This storage form of glucose can later be converted back into glucose and released into the bloodstream to be used as energy.²

7. **Hemoglobin** – the globular protein of red blood cells that carries oxygen from the lungs to cells throughout the body.²
8. **Myoglobin** – protein compound found in muscle tissue that assists the transport of oxygen to the muscle.\(^2\)

9. **Free radicals** – unstable and highly reactive molecules, capable of damaging body tissues, that have one or more unpaired electrons in their outer orbital.\(^2\)

10. **Antioxidants** – compounds in foods that significantly decrease the adverse effect of free radicals on normal physiologic function. They donate electrons to unstable and highly reactive free radicals to neutralize them and protect other tissues from oxidative damage.\(^2\)

11. **Disordered eating** – a term used to describe less severe forms of eating disorders that meet some, but not all formal diagnostic criteria of eating disorders.\(^{13}\)

12. **Eating disorder** – refers to any of several psychological disorders (such as anorexia nervosa and bulimia nervosa) characterized by serious disturbances in eating behavior.\(^2\)

13. **Anorexia nervosa** – an eating disorder characterized by a refusal to maintain minimally normal body weight and a distortion in perception of body shape and weight.\(^2\)

14. **Bulimia nervosa** – an eating disorder characterized by repeated episodes of binge eating usually followed by self-induced vomiting, misuse of laxatives or diuretics, fasting, or excessive exercise.\(^2\)
15. **Female athlete triad** - a term used to describe the interrelationship between disordered eating, amenorrhea, and osteopenia in female athletes.⁵

16. **Food record (FR)** - recording everything that is consumed for a given period of time, frequently 3 to 7 days.¹¹

17. **24-hour dietary recall** - asks subject to remember and document all foods, beverages, and quantities of food consumed in the previous 24 hours and may include information on timing of meals and snacks, eating environment, and food preparation.¹¹

18. **Food frequency questionnaire (FFQ)** - lists specific foods and asks the subject if they eat them and if so how often and how much.¹¹

**Basic Assumptions**

The following assumptions can be made about this study:

1. Subjects’ food records accurately reflected nutritional intake for that period.

2. All participants received a physical within the last year.

3. Subjects were instructed on how to properly measure food and accurately report nutritional intake.

4. All scales, measurements, and software used in this study were considered valid and reliable.
Limitation

The following was a possible limitation of this study:

1. Results were limited to a convenient sample of 12 NCAA Division II female swimmers at one university.

Significance of the Study

The dietary habits of many female collegiate athletes are insufficient, due in part to overly restricted eating habits, nutrition misinformation, and lack of general nutritional knowledge.\textsuperscript{2,8-11} Documentation of the nutritional habits of athletes is helpful when attempting to increase athletes’ awareness and subsequent benefits of nutrition.\textsuperscript{11,12} Athletes can benefit from increasing this knowledge, especially when applied on a personal level. As athletes adhere to nutrition advice there appears to be a greater opportunity for improvement in performance and injury prevention.\textsuperscript{7,8} Today’s athletes are faced with tough decisions such as weight management strategies during competition, making appropriate food selections while traveling and fluid needs in various exercise environments.\textsuperscript{3,6,7,8} Information provided to athletes can include advice on body composition and weight management, timing of eating for training and competition, management
of disordered eating behavior, dehydration, and supplementation.\textsuperscript{1,7} A nutritional profile is a good way to realize the strengths and weaknesses of individual and group diets.\textsuperscript{11} A profile can serve to identify possible eating disorders or the precursors to those eating disorders effectively preventing them before they fully develop into life-long habits.\textsuperscript{11,12} In turn, this can encourage dialogue between coaches and ATCs regarding nutrition and its benefits. Coaches, players, and ATCs must be able to communicate openly and confidently about sports nutrition and its advantages. If this can be accomplished, nutrition may be able to play a larger role in performance enhancement and recovery at the Division II level. Properly meeting nutrient needs will supply the body with the required fuel to meet and hopefully exceed performance expectations.\textsuperscript{1,2} Most importantly, through the completion of a nutritional profile, athletes should be able to recognize their eating habits and use nutrition as a tool to enhance their athletic performance and personal well being.
APPENDIX C

Additional Methods
APPENDIX C1

Nutritional Profile
Nutritional Profile

The following demographic and nutrient information will comprise the nutritional profile. Data will be displayed in tables and graphs as percentages (%) and means ± standard deviations.

Variable:

- n
- Age (yrs)
- Height (cm)
- Weight (kg)
- BMI (kg/m²)
- Nutritional Knowledge (%)
- Eating Habits (%)
- Energy (kcal)
  - kcal/day
  - kcal/kg
- Carbohydrate (CHO)
  - g/day
  - g/kg
  - % of energy
- Protein
  - g/day
  - g/kg
  - % of energy
- Total Fat
  - g/day
  - % of energy
- Saturated Fat
  - g/day
  - % of total fat
- Monounsaturated Fat
  - g/day
  - % of total fat
- Polyunsaturated Fat
  - g/day
  - % of total fat
- Cholesterol (mg)
- Total Dietary Fiber (g)

- Calcium (mg)
- Iron (mg)
- Sodium (mg)
- Potassium (mg)
- Zinc (mg)
- Beta-carotene (µg)
- Vitamin C (mg)
- Vitamin D (µg)
- Vitamin E (mg)
- Vitamin K (µg)
- Riboflavin (mg)
- Thiamin (mg)
- Niacin (mg)
- Vitamin B₆ (mg)
- Folate (µg)
- Vitamin B₁₂ (µg)
- Biotin (µg)
- Pantothenic Acid (µg)
- Zinc (µg)
- Linoleic acid (g)
- Linolenic acid (g)
APPENDIX C2

Demographic Sheet
Demographic Sheet

Please DO NOT write your name anywhere on this questionnaire. Please answer the following questions honestly and to the best of your knowledge. All of your responses and the results of this study will be kept strictly confidential. Thank you for your time.

1. **Height________     **Weight_________     **to be filled out by researcher

2. Age_______           Sport____________________           Athlete #______

3. Academic year in college (Please check one)
   ___Freshman ___Sophomore ___Junior ___Senior

4. Have you ever taken a nutrition course?  ____yes*  ____no
   *If yes, how many nutrition courses have you taken?____

5. Has a medical professional ever talked to you about nutritional habits?
   ____yes*  ____no  *If yes, who? (Please check all that apply):
   ___Certified Athletic Trainer   ___Registered Dietician
   ___Medical Doctor   ___Other(Please specify):___________________

6. Have you ever consulted a medical professional about nutrition/diet?
   ____yes*  ____no
   *If yes, who? (Please check all that apply):
   ___Certified Athletic Trainer   ___Registered Dietician
   ___Medical Doctor   ___Other(Please specify):___________________
   *If yes, for what purpose? (Please check one):
   ___To lose weight       ___Supplementation
   ___To gain weight       ___Other(Please specify):___________________

7. If you had a question about nutrition, whom would you most likely consult?  (Please check only one):
   ___Certified Athletic Trainer   ___Medical Doctor   ___Counselor
   ___Teammate   ___Coach   ___Registered Dietician
   ___Parents   ___Friend   ___Other (Please Specify):_____________

8. Have you ever been diagnosed with an eating disorder?  ____yes*  ____no
   *If yes, are you currently being treated for it?  ____yes  ____no

9. Do you currently have an injury/illness that may influence your eating, training, or sleeping habits?
   ____ yes  ____ no
APPENDIX C3

Body Mass Index
### Body Mass Index

Body mass index (BMI) reported as weight(kg)/height(m^2).

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI (kg/m^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.5</td>
</tr>
<tr>
<td><strong>Normal</strong></td>
<td><strong>18.5-24.9</strong></td>
</tr>
<tr>
<td>Overweight</td>
<td>25.0-29.9</td>
</tr>
<tr>
<td>Obesity (Class I)</td>
<td>30.0-34.9</td>
</tr>
<tr>
<td>Obesity (Class II)</td>
<td>35.0-39.9</td>
</tr>
<tr>
<td>Extreme Obesity (Class III)</td>
<td>&gt;40</td>
</tr>
</tbody>
</table>

APPENDIX C4

Revised Nutritional Knowledge and Eating Habits Questionnaire
SECTION 1: Please circle the number for each statement indicating to what extent you agree or disagree with each of the following statements.

4 - Strongly Agree
3 - Agree Somewhat
2 - Disagree Somewhat
1 - Strongly Disagree

1. Skipping breakfast can negatively affect athletic performance.
   4  3  2  1

   4  3  2  1

3. Calcium excretion from the body increases with alcohol consumption.
   4  3  2  1

4. According to mypyramid.gov, it is recommended that females, age 18-25, who engage in more than 60 min. of exercise per day, should consume 8 daily ounce equivalents from the grains group.
   4  3  2  1

5. According to mypyramid.gov, females age 18-25, who engage in more than 60 min. of exercise per day, should consume 2 cups of fruit daily.
   4  3  2  1

6. According to mypyramid.gov, females age 18-25, who engage in more than 60 min. of exercise per day, should consume 3 servings from the dairy group each day.
   4  3  2  1

7. According to mypyramid.gov, females age 18-25, who engage in more than 60 min. of exercise per day, should consume 6.5 ounce equivalents from the meat/bean group every day.
   4  3  2  1

8. Eating breakfast can improve concentration.
   4  3  2  1

9. Excess vitamin consumption can be toxic.
   4  3  2  1

10. Anemia is a deficiency of iron.
    4  3  2  1

11. Average percentage of body fat in females is 20-25%.
    4  3  2  1

12. Cereal, bread, bagels, and pasta are good sources of carbohydrates.
    4  3  2  1

13. Tofu, nuts, and beans are good sources of protein.
    4  3  2  1

14. Athletes tend to consume twice as much protein as recommended.
    4  3  2  1

15. The best sources of iron come from animal products and fish.
    4  3  2  1
16. Eating cereals or breads enriched with iron should be eaten with a source of vitamin C to enhance absorption of iron.
   4 3 2 1

17. Proteins act to repair and build muscle tissue and make hormones to boost the immune system.
   4 3 2 1

18. Fats are essential in all diets.
   4 3 2 1

19. If a diet is lacking in carbohydrates, proteins are then used for energy.
   4 3 2 1

20. Oatmeal, legumes, and fruits are sources of soluble fiber.
   4 3 2 1

21. The recommended amount of iron for females is 18-23 milligrams per day.
   4 3 2 1

22. Vitamin C is also known as ascorbic acid.
   4 3 2 1

SECTION 2: Please circle the number that applies to each of the following questions. Refer to the scale below to determine the number of days per week defined in each rating. All of the results will be strictly confidential.

Thank you for your cooperation.

4 - Always: Occurs 5-7 days per week
3 - Often: Occurs 3-4 days per week
2 - Sometimes: Occurs 1-2 days per week
1 - Never: Does not occur at all

1. How often do you eat breakfast in the morning?
   4 3 2 1

2. How often do you take vitamin supplements?
   4 3 2 1

3. How often do you take mineral supplements?
   4 3 2 1

4. How often do you eat three base meals per day?
   4 3 2 1

5. How often do you record what you eat?
   4 3 2 1

6. How often are you on a “diet”?
   4 3 2 1

7. How often do you eat fruits, such as apples, bananas, or oranges?
   4 3 2 1

8. How often do you eat vegetables, such as broccoli, tomatoes, carrots, or salad?
   4 3 2 1

9. How often do you eat dairy products such as milk, yogurt, or cheese?
   4 3 2 1

10. How often do you seek out nutrition information?
    4 3 2 1
APPENDIX C5

Nutritional Intake Collection Sheet
(NICS)
Nutritional Intake Collection Sheet

Day____  Athlete #____

**Make sure to include a name, description, and portion size for every food/drink consumed.

wakeup-8:59am

9:00am-12:59pm

1:00-4:59pm

5:00-8:59pm

9:00-sleep
APPENDIX C6

Informed Consent Form
Informed Consent

1. Matt Shepard, a Certified Athletic Trainer and Graduate Assistant Athletic Training Student, has requested my participation in a research study at California University of Pennsylvania. The title of the study is: A Nutritional Profile of Female NCAA Division II Swimmers.

2. I have been informed that the purpose of this study is to establish a nutrition profile of collegiate-level female athletes. This study will examine: anthropometric measurements, nutritional knowledge, eating habits, and nutritional intake.

3. My participation will involve demographic information, completing a nutritional knowledge and eating habits questionnaire, and recording nutritional intake over the course of four days. Height and weight measurements will also be taken in order to report the body mass index of all participants.

4. There are no foreseeable risks associated with this study. Inconveniences are limited to height and weight measurements and the tedious nature of recording food consumption for a four day period.

5. There are no feasible alternative procedures available for this study.

6. I understand that possible benefits of my participation in this study are that athletes, coaches, and athletic trainers may be able to communicate more effectively about nutrition and its importance in athletic performance enhancement and every day well-being regardless of sport.

7. I understand that the results of the research study may be published but that my name or identity will not be revealed. In order to maintain confidentiality of my records, the researcher will maintain all documents in a secure location in which only he and his research adviser can access. The surveys and dietary record data will be completely anonymous and only codes will be used during data analysis.

8. I have been informed that I will not be compensated for my participation.

9. I have been informed that any questions I have concerning the research study or my participation in it, before or after my consent, will be answered by:
10. I understand that written responses may be used in quotations for publication but my identity will remain anonymous at all times.

11. I have read the above information. The nature, demands, risks, and benefits of the project have been explained to me. I knowingly assume the risks involved, and understand that I may withdraw my consent and discontinue participation at any time without penalty or loss of benefit to myself. In signing this consent form, I am not waiving any legal claims, rights, or remedies. A copy of this consent form will be given to me upon my request.

Subject’s signature____________________________Date___________

I certify that I have explained to the above individual the nature and purpose, the potential benefits, and possible risks associated with participation in this research study, have answered any questions that have been raised, and have witnessed the above signature.

I have provided the subject/participant a copy of this signed consent document upon their request.

Researcher’s signature___________________________Date___________

Approved by the California University of Pennsylvania IRB
APPENDIX C7

Institutional Review Board
California University of Pennsylvania

PROTOCOL for Research Involving Human Subjects

Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects

(Reference IRB Policies and Procedures for clarification)

<table>
<thead>
<tr>
<th>Project Title</th>
<th>A Nutritional Profile of Female NCAA Division II Athletes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Researcher/Project Director</td>
<td>Matthew Wayne Shepard</td>
</tr>
<tr>
<td>Phone #</td>
<td>(301) 440-3636</td>
</tr>
<tr>
<td>E-mail Address</td>
<td><a href="mailto:she3940@cup.edu">she3940@cup.edu</a></td>
</tr>
<tr>
<td>Faculty Sponsor (if required)</td>
<td>Dr. Benjamin Reuter</td>
</tr>
<tr>
<td>Department</td>
<td>Health Science and Sport Studies</td>
</tr>
<tr>
<td>Project Dates</td>
<td>Jan 2007 to Apr 2007</td>
</tr>
<tr>
<td>Sponsoring Agent (if applicable)</td>
<td></td>
</tr>
<tr>
<td>Project to be Conducted at</td>
<td>Hamer Hall, California University of Pennsylvania</td>
</tr>
<tr>
<td>Project Purpose:</td>
<td>☑ Thesis  □ Research  □ Class Project  □ Other</td>
</tr>
</tbody>
</table>

Keep a copy of this form for your records.

Required IRB Training

The training requirement can be satisfied by completing the online training session at http://cme.nci.nih.gov/. A copy of your certification of training must be attached to this IRB Protocol. If you have completed the training at an earlier date and have already provided documentation to the California University of Pennsylvania Grants Office, please provide the following:

| Previous Project Title | |
| Date of Previous IRB Protocol | |
Please attach a typed, detailed summary of your project AND complete items 2 through 6.

1. Provide an overview of your project-proposal describing what you plan to do and how you will go about doing it. Include any hypothesis(s) or research questions that might be involved and explain how the information you gather will be analyzed. For a complete list of what should be included in your summary, please refer to Appendix B of the IRB Policies and Procedures Manual.

2. Section 46.11 of the Federal Regulations state that research proposals involving human subjects must satisfy certain requirements before the IRB can grant approval. You should describe in detail how the following requirements will be satisfied. Be sure to address each area separately.

   a. How will you ensure that any risks to subjects are minimized? If there are potential risks, describe what will be done to minimize these risks. If there are risks, describe why the risks to participants are reasonable in relation to the anticipated benefits.

      No risks will be associated with this study.

   b. How will you ensure that the selection of subjects is equitable? Take into account your purpose(s). Be sure you address research problems involving vulnerable populations such as children, prisoners, pregnant women, mentally disabled persons, and economically or educationally disadvantaged persons. If this is an in-class project describe how you will minimize the possibility that students will feel coerced.

      No subject shall be coerced into this study by anyone at anytime. Coaches will not be present during volunteer recruitment of potential test subjects. Subjects will be informed that they may withdraw from the study at any time without any possibility of penalty or personal loss to self.

   c. How will you obtain informed consent from each participant or the subject’s legally authorized representative and ensure that all consent forms are appropriately documented? Be sure to attach a copy of your consent form to the project summary.

      Informed consent forms will be read and completed by each potential volunteer prior to this study.

   d. Show that the research plan makes provisions to monitor the data collected to insure the safety of all subjects. This includes the privacy of subjects’ responses and provisions for maintaining the security and confidentiality of the data.

      The researcher will administer all forms and questionnaires for the safety of all subjects and privacy of response. All forms containing subject identity will be kept in a secure location in which only the researcher, Matt Shepard, and research advisor, Benjamin Reuter, can access information. The results of this study may be published, but subjects’ identity will not be revealed.

3. Check the appropriate box(es) that describe the subjects you plan to use.
4. Is remuneration involved in your project?  □ Yes or □ No. If yes, Explain here.

5. Is this project part of a grant?  □ Yes or □ No  If yes, provide the following information:
   Title of the Grant Proposal ________________________________
   Name of the Funding Agency ________________________________
   Dates of the Project Period ________________________________

6. Does your project involve the debriefing of those who participated?  □ Yes or □ No
   If Yes, explain the debriefing process here.

   Subjects will be instructed by the researcher to record the type and amount of food and beverage consumed for four consecutive days (3 weekdays and 1 weekend), using standard English measures such as cups and teaspoons. Subjects will be instructed to provide as much detail as possible about the foods and fluids they consume, including brand names and recipes for home-cooked meals. Subjects will also be told to document the timing of each meal by recording it in a designated time slot on the provided Nutrition Intake Collection Sheets (NICS). Two-dimensional visual aids will be utilized to provide examples of serving size for subjects to record. Results of study will be presented to subjects following its completion.

7. If your project involves a questionnaire interview, ensure that it meets the requirements of Appendix ___ in the Policies and Procedures Manual.
Project Director’s Certification
Program Involving HUMAN SUBJECTS

The proposed investigation involves the use of human subjects and I am submitting the complete application form and project description to the Institutional Review Board for Research Involving Human Subjects.

I understand that Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects. If the Board grants approval of this application, I agree to:

1. Abide by any conditions or changes in the project required by the Board.
2. Report to the Board any change in the research plan that affects the method of using human subjects before such change is instituted.
3. Report to the Board any problems that arise in connection with the use of human subjects.
4. Seek advice of the Board whenever I believe such advice is necessary or would be helpful.
5. Secure the informed, written consent of all human subjects participating in the project.
6. Cooperate with the Board in its effort to provide a continuing review after investigations have been initiated.

I have reviewed the Federal and State regulations concerning the use of human subjects in research and training programs and the guidelines. I agree to abide by the regulations and guidelines aforementioned and will adhere to policies and procedures described in my application. I understand that changes to the research must be approved by the IRB before they are implemented.

Professional Research

<table>
<thead>
<tr>
<th>Project Director’s Signature</th>
<th>Department Chairperson’s Signature</th>
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Student or Class Research

<table>
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<tr>
<th>Student Researcher’s Signature</th>
<th>Supervising Faculty Member’s Signature if required</th>
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<td>Department Chairperson’s Signature</td>
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ACTION OF REVIEW BOARD (IRB use only)

The Institutional Review Board for Research Involving Human Subjects has reviewed this application to ascertain whether or not the proposed project:

1. provides adequate safeguards of the rights and welfare of human subjects involved in the investigations;
2. uses appropriate methods to obtain informed, written consent;
3. indicates that the potential benefits of the investigation substantially outweigh the risk involved.
4. provides adequate debriefing of human participants.
5. provides adequate follow-up services to participants who may have incurred physical, mental, or emotional harm.

☑ Approved  ☐ Disapproved

Chairperson, Institutional Review Board  03-21-02

Date
APPENDIX C8

Old Nutritional Knowledge and Eating Habits Questionnaire
Old Nutritional Knowledge and Eating Habits Questionnaire

**SECTION 1:** Please circle the number for each statement indicating to what extent you agree or disagree with each of the following statements.

4 - Strongly Agree  
3 - Agree Somewhat  
2 - Disagree Somewhat  
1 - Strongly Disagree

**Athlete #______**

1. Skipping breakfast can negatively affect athletic performance.
   4 3 2 1

2. Proteins are the best and most efficient source of energy.
   4 3 2 1

   4 3 2 1

4. The pre-event meal should be eaten 3-4 hours prior to competition.
   4 3 2 1

5. Calcium excretion from the body increases with alcohol consumption.
   4 3 2 1

6. According to mypyramid.gov, it is recommended that females, age 18-25, who engage in more than 60 min. of exercise per day, should consume 8 daily ounce equivalents from the grains group.
   4 3 2 1

7. According to mypyramid.gov, females age 18-25, who engage in more than 60 min. of exercise per day, should consume 2 cups of fruit daily.
   4 3 2 1

8. According to mypyramid.gov, females age 18-25, who engage in more than 60 min. of exercise per day, should consume 3 servings from the dairy group each day.
   4 3 2 1

9. According to mypyramid.gov, females age 18-25, who engage in more than 60 min. of exercise per day, should consume 6.5 ounce equivalents from the meat/bean group every day.
   4 3 2 1

10. Eating breakfast can improve concentration.
    4 3 2 1

11. Carbohydrates are less fattening than fatty foods.
    4 3 2 1

12. At least 60% of total calories should come from carbohydrates.
    4 3 2 1

13. Carbohydrates are easier to digest than fats or proteins.
    4 3 2 1

14. Excess vitamin consumption can be toxic.
    4 3 2 1

15. Anemia is a deficiency of iron.
    4 3 2 1

16. Average percentage of body fat in females is 20-25%.
    4 3 2 1
17. Cereal, bread, bagels, and pasta are good sources of carbohydrates.
   4  3  2  1

18. Tofu, nuts, and beans are good sources of protein.
   4  3  2  1

19. Athletes tend to consume twice as much protein as recommended.
   4  3  2  1

20. Over-consumption of protein is beneficial for athletes.
   4  3  2  1

21. The best sources of iron come from animal products and fish.
   4  3  2  1

22. Eating cereals or breads enriched with iron should be eaten with a source of vitamin C to enhance absorption of iron.
   4  3  2  1

23. Proteins act to repair and build muscle tissue and make hormones to boost the immune system.
   4  3  2  1

24. Fats are essential in all diets.
   4  3  2  1

25. If a diet is lacking in carbohydrates, proteins are then used for energy.
   4  3  2  1

26. Oatmeal, legumes, and fruits are sources of soluble fiber.
   4  3  2  1

27. The recommended amount of iron for females is 18-23 milligrams per day.
   4  3  2  1

28. Vitamin C is also known as ascorbic acid.
   4  3  2  1

29. If you are not thirsty, then you must not be dehydrated.
   4  3  2  1

SECTION 2: Please circle the number that applies to each of the following questions. Refer to the scale below to determine the number of days per week defined in each rating. All of the results will be strictly confidential. Thank you for your cooperation.

   4 - Always: Occurs 5-7 days per week
   3 - Often: Occurs 3-4 days per week
   2 - Sometimes: Occurs 1-2 days per week
   1 - Never: Does not occur at all

1. How often do you eat breakfast in the morning?
   4  3  2  1

2. Based on three meals per day, how often do you skip at least one meal per day?
   4  3  2  1

3. How often do you take vitamin supplements?
   4  3  2  1
4. How often do you take mineral supplements?
   4 3 2 1

5. How often do you eat three base meals per day?
   4 3 2 1

6. How often do you record what you eat?
   4 3 2 1

7. How often do you drink water?
   4 3 2 1

8. How often do you drink carbonated beverages?
   4 3 2 1

9. How often are you on a “diet”?  
   4 3 2 1

10. How often do you eat breads, cereals, pasta, potatoes, or rice?
    4 3 2 1

11. How often do you eat fruits, such as apples, bananas, or oranges?
    4 3 2 1

12. How often do you eat vegetables, such as broccoli, tomatoes, carrots, or salad?
    4 3 2 1

13. How often do you eat dairy products such as milk, yogurt, or cheese?
    4 3 2 1

14. How often do you eat berry jams, cookies, candies, or other sweets?
    4 3 2 1

15. How often do you snack on foods like potato chips, cakes, candies, donuts, or soda?
    4 3 2 1

16. How often do you snack on foods like bagels, yogurt, popcorn, pretzels, or fruits?
    4 3 2 1

17. How often do you eat fast foods?
    4 3 2 1

18. How often do you seek out nutrition information?
    4 3 2 1
APPENDIX C9

Scoring key: Old Nutritional Knowledge and Eating Habits Questionnaire
Scoring Key: Old Nutritional Knowledge and Eating Habits Questionnaire

SECTION I:

1. Skipping breakfast can negatively affect athletic performance. 4
2. Proteins are the best and most efficient source of energy. 1
3. Nutrition affects mental performance. 4
4. The pre-event meal should be eaten 3-4 hours prior to competition. 4
5. Calcium excretion from the body increases with alcohol consumption. 4
6. According to mypyramid.gov, it is recommended that females, age 18-25, who engage in more than 60 min. of exercise per day, should consume 8 daily ounce equivalents from the grains group. 4
7. According to mypyramid.gov, females age 18-25, who engage in more than 60 min. of exercise per day, should consume 2 cups of fruit daily. 4
8. According to mypyramid.gov, females age 18-25, who engage in more than 60 min. of exercise per day, should consume 3 servings from the dairy group each day. 4
9. According to mypyramid.gov, females age 18-25, who engage in more than 60 min. of exercise per day, should consume 6.5 ounce equivalents from the meat/bean group every day. 4
10. Eating breakfast can improve concentration. 4
11. Carbohydrates are less fattening than fatty foods. 4
12. At least 60% of total calories should come from carbohydrates. 4
13. Carbohydrates are easier to digest than fats or proteins. 4
14. Excess vitamin consumption can be toxic. 4
15. Anemia is a deficiency of iron. 4
16. Average percentage of body fat in females is 20-25%. 4
17. Cereal, bread, bagels, and pasta are good sources of carbohydrates. 4
18. Tofu, nuts, and beans are good sources of protein. 4
19. Athletes tend to consume twice as much protein as recommended. 4
20. Over-consumption of protein is beneficial for athletes. 1
21. The best sources of iron come form animal products and fish. 4
22. Eating cereals or breads enriched with iron should be eaten with a source of vitamin C to enhance absorption of iron. 4
23. Proteins act to repair and build muscle tissue and make hormones to boost the immune system. 4
24. Fats are essential in all diets. 4
25. If a diet is lacking in carbohydrates, proteins are then used for energy. 4
26. Oatmeal, legumes, and fruits are sources of soluble fiber. 4
27. The recommended amount of iron for females is 18-23 milligrams per day. 4
28. Vitamin C is also known as ascorbic acid. 4
29. If you are not thirsty, then you must not be dehydrated. 1

RANGE OF SCORES: 29-116

SECTION II:
1. How often do you eat breakfast in the morning? 4
2. Based on three meals per day, how often do you skip at least one meal per day? 1
3. How often do you take vitamin supplements? 1
4. How often do you take mineral supplements? 1
5. How often do you eat three base meals per day? 4
6. How often do you seek out nutrition information? 4
7. How often do you record what you eat? 4
8. How often do you eat fast foods? 1
9. How often do you drink water? 4
10. How often do you drink carbonated beverages? 1
11. How often are you on a “diet”? 1
12. How often do you eat breads, cereals, pasta, potatoes, or rice? 4
13. How often do you eat fruits, such as apples, bananas, or oranges? 4
14. How often do you eat vegetables, such as broccoli, tomatoes, carrots, or salad? 4
15. How often do you eat dairy products such as milk, yogurt, or cheese? 4
16. How often do you eat berry jams, cookies, candies, or other sweets? 1
17. How often do you snack on foods like potato chips, cakes, candies, donuts, or soda? 1
18. How often do you snack on foods like bagels, yogurt, popcorn, pretzels, or fruits? 4

RANGE OF SCORES: 18-72

CLASSIFICATIONS:
*Excellent = 85-100%
*Good = 70-84%
*Fair = 55-69%
*Poor = 54% or below
APPENDIX C10

Scoring Key: Revised Nutritional Knowledge and Eating Habits Questionnaire
SECTION 1:

1. Skipping breakfast can negatively affect athletic performance. 4
2. Nutrition affects mental performance. 4
3. Calcium excretion from the body increases with alcohol consumption. 4
4. According to mypyramid.gov, it is recommended that females, age 18-25, who engage in more than 60 min. of exercise per day, should consume 8 daily ounce equivalents from the grains group. 4
5. According to mypyramid.gov, females age 18-25, who engage in more than 60 min. of exercise per day, should consume 2 cups of fruit daily. 4
6. According to mypyramid.gov, females age 18-25, who engage in more than 60 min. of exercise per day, should consume 3 servings from the dairy group each day. 4
7. According to mypyramid.gov, females age 18-25, who engage in more than 60 min. of exercise per day, should consume 6.5 ounce equivalents from the meat/bean group every day. 4
8. Eating breakfast can improve concentration. 4
9. Excess vitamin consumption can be toxic. 4
10. Anemia is a deficiency of iron. 4
11. Average percentage of body fat in females is 20-25%. 4
12. Cereal, bread, bagels, and pasta are good sources of carbohydrates. 4
13. Tofu, nuts, and beans are good sources of protein. 4
14. Athletes tend to consume twice as much protein as recommended. 4
15. The best sources of iron come from animal products and fish. 4
16. Eating cereals or breads enriched with iron should be eaten with a source of vitamin C to enhance absorption of iron. 4
17. Proteins act to repair and build muscle tissue and make hormones to boost the immune system. 4
18. Fats are essential in all diets. 4
19. If a diet is lacking in carbohydrates, proteins are then used for energy. 4
20. Oatmeal, legumes, and fruits are sources of soluble fiber. 4
21. The recommended amount of iron for females is 18-23 milligrams per day. 4
22. Vitamin C is also known as ascorbic acid. 4

RANGE OF SCORES: 22-88
SECTION 2:

1. How often do you eat breakfast in the morning? 4
2. How often do you take vitamin supplements? 1
3. How often do you take mineral supplements? 1
4. How often do you eat three base meals per day? 4
5. How often do you record what you eat? 4
6. How often are you on a “diet”? 1
7. How often do you eat fruits, such as apples, bananas, or oranges? 4
8. How often do you eat vegetables, such as broccoli, tomatoes, carrots, or salad? 4
9. How often do you eat dairy products such as milk, yogurt, or cheese? 4
10. How often do you seek out nutrition information? 4

RANGE OF SCORES: 10-40

CLASSIFICATIONS:

*Excellent = 85-100%
*Good = 70-84%
*Fair = 55-69%
*Poor = 54% or below
REFERENCES


ABSTRACT

TITLE: A Nutritional Profile of Female NCAA Division II Swimmers

RESEARCHER: Matthew W. Shepard

ADVISER: Dr. Ben Reuter

DATE: May 2007

RESEARCH PROBLEM: Master Thesis

PURPOSE: The purpose of this research was to establish a nutritional profile of female NCAA Division II swimmers.

PROBLEM: Female collegiate athletes consistently report sub-optimal energy intakes and may be impeding athletic performance.

METHODS: Using a descriptive research design, 12 NCAA Division II collegiate swimmers completed Demographic information, a Nutritional Knowledge and Eating Habits Questionnaire, and four-day food records.

FINDINGS: Subjects reported low intakes of Carbohydrate and Iron. Increased nutrition knowledge did not positively affect eating habits.

CONCLUSIONS: Female Division II swimmers were in accordance with research suggesting chronically low nutrient intakes. Athletic Trainers should be aware of decreased nutrition knowledge in collegiate athletes and be qualified to formulate a plan of intervention through pre-season seminars, handouts, posters, individual counseling, and dietary analysis.