I, Angela S Bruzina, hereby submit this original work as part of the requirements for the degree of Master of Science in Nutrition.

It is entitled:
Bearcats in the Kitchen: A Food Lab-Based Cooking Intervention for Female Athletes

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Bearcats in the Kitchen: A Food Lab-Based Cooking Intervention for Female Collegiate Athletes

A thesis submitted to the Graduate School of the University of Cincinnati in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE
Department of Nutritional Sciences
College of Allied Health Sciences

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ABSTRACT

**Purpose:** The purpose of this study was to assess the acceptability and impact of a ten-week foods lab-based cooking intervention program on the energy and nutrient intake, body composition, and iron status indices in female collegiate athletes.

**Methods:** Female Collegiate athletes were recruited for this study. Participants were excluded if they had severe food allergies, current or planned pregnancy, eating disorder diagnosis, or any metabolic disorder. Participants completed eight food lab-based intervention classes during their summer training period. The classes consisted of nutrition education focusing on healthy eating for optimizing sports performance, skill-based learning that incorporated basic kitchen skills with recipe preparation, and behavioral strategies including food monitoring and goal setting. Dietary intake, anthropometrics, and blood samples were analyzed pre- and post-intervention for changes as well as adequacy in meeting general sports nutrition recommendations for athletes. Dependent variables were anthropometric measures (weight, body fat percentage, fat mass, and fat free mass), iron status indicators (ferritin, hemoglobin (Hb), and hematocrit (Hct)), and dietary measures (energy, macronutrients, and iron). Shapiro-Wilk test of normalcy was run on all data and paired T-tests were used to examine the differences pre- to post-intervention for all outcome measures.

**Results:** Eleven NCAA Division I Female Collegiate athletes, age (20.4 ± 1.2 years) participated in the intervention. At the end of the 10 weeks, lean mass increased significantly, 56.1 ± 4.6kg to 56.8 ± 4.6kg, respectively ($p = 0.017$). In terms of iron status, there were significant increases in Hct and Hb from pre- to post-intervention ($p\leq0.01$), while there was a downward trend in ferritin ($p = 0.067$). Thirty six percent of the participants did not meet the minimum 30g/kg energy recommendation for weight maintenance post-intervention. Further, not one athlete met the minimum carbohydrate recommendation of 5g/kg either pre- or post-intervention. In addition, three participants ($n=3, 27\%$) did not meet the minimum 1.2g/kg protein recommendation post-intervention. The direction of change for all dietary measures was favorable, however, no significant differences were observed in energy, carbohydrate, protein, fat, or iron intake from pre- to post-intervention.
**Conclusion:** A foods lab-based cooking intervention that incorporates nutrition education, cooking skills, and dietary goal setting may have benefits relative to nutritional intake, body composition, and iron status in female collegiate athletes. Larger, controlled studies are necessary to determine if Bearcats in the Kitchen could be a useful approach to improve diet quality and body composition in collegiate athletes across different sports.
Acknowledgements

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Introduction

Athletes are placed under high physiological demands due to their intense training schedule and their energy and nutrient needs vary with training periodization. Due to this, it is imperative for athletes to consume adequate nutrients (including energy, carbohydrates, protein, fat, and micronutrients) for optimal health and performance. As female athletes are at risk for iron deficiency, it is important to assess both dietary iron intake and iron status in this population. The aforementioned dietary components have been observed to be inadequate in female athletes, but few interventions exist to improve these measures. Body composition can also be affected by changes in training periodization and dietary intake and is therefore a target of many dietary interventions. In the literature review below, the function, recommendation, and current trends in energy, carbohydrate, protein, fat, and iron intake are examined. In addition, the current research on iron status and assessment of body composition of female athletes are discussed. Finally, the existing data from dietary interventions in athletes are sparse and reveals the need for a theory-based nutrition intervention for female collegiate athletes, incorporating both nutrition education and practical application such as cooking skills.
Literature Review

Energy Intake Function

Energy intake has proven to be essential for athletes for sufficient health and performance.1-5 Collegiate athletes face increased energy needs due to their intense training schedule and higher physiological demands result in higher energy needs.2 Failing to meet energy needs can generate a negative energy balance, which is associated with the catabolism of protein, from sources such as skeletal muscle.1 Inadequate caloric intake results in the body using lean tissue as fuel, potentially compromising strength, endurance, and immune function.6

Energy Intake Recommendations

As direct measurement of each person’s energy requirements is often not feasible, estimates are used to determine recommendations for energy intake. One commonly used method to determine estimated energy requirements (EER) for healthy adults is the Food and Nutrition Board of the Institute of Medicine Dietary Reference Intake (DRI) for energy requirements. These values are determined by incorporating age, weight, and height into an equation that accounts for the level of physical activity (PAL). This PAL is based on the frequency of the individual’s physical activity and varies based on BMI, height, and weight.2,7,8 These estimations have been validated in different population groups,2,9-11 but few studies have been conducted on the efficacy of this method in female athletes.2 In general, these estimates have been found to underestimate requirements in athletes, as they do not cover the wide range in body size or activity levels of competition.8 Using the DRI as a method for estimating energy needs in this population has been found to accurately predict only 37.5% of individual athletes’ EER when using the calculated EER from the doubly labeled water method as a comparison.2 The DRI’s are not only inaccurate when determining energy needs in this population, but it also does not account for training cycles where an athlete’s needs will vary depending on activity level.

Other equations, such as the Harris-Benedict and Cunningham, are recommended to better estimate the energy needs of athletes, but were actually not initially developed for the athletic
population.\textsuperscript{8,12} The Cunningham equation, which includes fat free mass (FFM), may seem advantageous as FFM accounts for 50% to 80% of individual variability in energy expenditure, but the large variability in elite athletes across sports may affect the applicability of this and many other commonly used equations.\textsuperscript{4,8,12} Athletes’ energy requirements will fluctuate depending on the periodized training regimen, competition cycle, and could vary daily due to changes in training intensity and volume, making it challenging to use predictive formulas and a specific PAL for this population.\textsuperscript{1,8}

Over the past decade, a gram per kilogram of bodyweight approach has been used for determining carbohydrate and protein intake recommendations in the athletic population in order to ensure adequacy, as it is more prescriptive than simply a percentage of intake (which can still be insufficient if the total energy intake is insufficient). Along these lines, there has recently been a shift to utilizing this method for determining energy requirements for athletes in lieu of predictive equations and instead, expressing in terms of kilocalories per kilograms of bodyweight (kcal/kg/BW).\textsuperscript{3,4,6,8,13-15} The g/kg method can also be used for estimating energy requirements, however, unlike PAL predictions, it can be easily adjusted to account for changes in training intensity.\textsuperscript{4} It provides a recommendation range rather than a strict PAL, but most importantly, it provides a simplified method that can be used in practice, thus making it more feasible for practitioners whom work with this population. This method is additionally used in practice as a way to make recommendations for both carbohydrate and protein intake in athletes.\textsuperscript{3,6,14-16} This method is believed to minimize energy need miscalculations for athletes with very high-energy intakes and to account for training.\textsuperscript{4} 37-45kcal/kg is the recommended range in this population and can be adjusted to account for changes in the athlete’s periodized training regimen, competition cycle, and training intensity and volume.\textsuperscript{3,4,13,14} Though a wide range of recommendation exists with this method, it seems the most efficient and practical way to account for variations in training intensity and body size.

\textit{Energy Intake Current Trends}

Numerous studies have been conducted on the adequacy of energy intake in female athletes and found that many failed to meet their energy requirements.\textsuperscript{3,4,6,13,14,16,18,19} Some studies utilized predictive
equations, such as the Cunningham, and found that between 89% and 91% of female athletes studies did not meet their energy needs. In a study by Shriver et al, 3-day food record analyses revealed that 91% of female athletes were failing to meet their energy needs when estimating using the Cunningham equation. In a similar study by Wenzel et al, 89% of the female athletes were failing to meet their energy needs, however, these needs were estimated using the Nelson equation (RMR = 25.80*fat free mass + 4.04*fat mass). When using the kilocalories per kilogram method, studies showed that female athletes are still not meeting their needs, reporting as low as 24.0kcal/kg in this population which is well below the lower limit of recommendation for all athletes of 37 kcal/kg.

In addition, when energy intake is low, the athlete is at greater risk for not meeting recommendations for other essential nutrients, particularly those most important to performance for the athlete, carbohydrate and protein. At least 74% of the female athletes who do not meet their energy needs also do not meet a minimum carbohydrate recommendation of 5g/kg of bodyweight. This calls attention to examine macronutrient intake and level of adequacy in this population in addition to energy intake.

**Carbohydrate Intake Function:**

Ingestion of carbohydrates on a regular basis is the primary way for athletes to replenish and maintain their body’s glycogen (carbohydrate) stores and fuel prolonged training sessions. In fact, the most important factor that affects muscle glycogen storage is the consumption of carbohydrates. Carbohydrates are not only utilized by skeletal muscle for fuel, but they also provide key fuel for the brain and central nervous system. In addition, due to their versatile substrate capabilities, carbohydrates can be used by both the anaerobic and oxidative metabolic pathways, thus proving essential for all athletes regardless of the primary energy system used in their sport. The differences in recommendations for carbohydrate intake seen in practice are primarily to account for the variability in length and intensity of physical activity that athletes may engage in, but minimum levels are still established.
Carbohydrate Intake Recommendations

One may determine adequacy of carbohydrate intake by examining standards set by the FNB of the Institute of Medicine including: Dietary Reference Intakes (DRIs) and the Acceptable Macronutrient Distribution Ranges (AMDRs) for carbohydrates. These recommendations were created for a general healthy population, however, current literature calls to question if these recommendations are appropriate for use as a standard of comparison in the athletic population.

The recommended dietary allowance (RDA) for carbohydrates, 130 grams, is described by the Institute of Medicine as the average dietary intake level that would be “sufficient to meet the nutrient requirements of 97% to 98% of healthy individuals” (22). In addition, the AMDR for carbohydrates, 45% to 65%, describes the acceptable percentage of calories coming from carbohydrate, but sports nutrition recommendations advise athletes to provide a minimum of 55% of their calories from carbohydrate.

The most individualized method of determining carbohydrate needs in the athletic population, which also accounts for training and body size, is using grams per kilogram bodyweight to make a recommendation. Like energy intake, this weight-based approach can be applied to a range and used to make recommendations based on intensity and length of exercise, which is commonly used in practice.

It has been determined that a minimum of 5g/kg of carbohydrate is needed to maintain adequate glycogen stores and support general training sessions of athletes, however, a wider variety of recommendations can be used to account for variability in training. The Academy of Nutrition and Dietetics gives the following carbohydrate recommendations based on current applicable research:

<table>
<thead>
<tr>
<th>Table 1: Academy of Nutrition and Dietetics: Nutrition and Athletic Performance</th>
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<tbody>
<tr>
<td>Light</td>
</tr>
<tr>
<td>Moderate</td>
</tr>
<tr>
<td>High</td>
</tr>
<tr>
<td>Very High</td>
</tr>
</tbody>
</table>
Carbohydrate Intake Current Trends

There are numerous observational studies on the intake of carbohydrate in the female athlete population, but few have examined intake and determined its adequacy based on sports nutrition recommendations. When energy intake is low, the athlete is at greater risk for not meeting recommendations for other essential nutrients, like carbohydrates. Studies that have examined whether a team’s average carbohydrate intake meets a recommendation of 7g/kg report that not only do female athletes fail to meet the 7g/kg recommendation, but only 19%-25% of those athletes meet the minimum recommendation of 5g/kg, which is considered necessary for glycogen repletion.

Many studies have also examined the percentage of total calories from carbohydrate and compared it to the AMDR. Athletes are reported to consume between 52%-57% of their total caloric intake from carbohydrates, which includes the 55% minimum recommendation made by sports nutrition experts, however, these studies also demonstrate a low percentage of athletes meeting the g/kg recommendation. This supports the importance of making recommendations for athletes based on the total quantity of carbohydrate in their diet utilizing the g/kg method, and not solely relying on the macronutrient distribution (percentage of carbohydrate), as adequacy in both categories is essential.

Functional Role of Protein in Athletes

Protein intake is an essential component of an athlete’s nutrition, as it promotes repair and creation of muscle tissue, aids in maintenance of lean mass during an injury, and can maximize the effects of training. It plays a key role in muscle protein synthesis and breakdown, which ultimately dictates the net gain or loss of skeletal muscle. Muscle protein synthesis occurs as a response to nutrient timing and intake, along with physical demand. For at least 24 hours post resistance training, there is an increased sensitivity to the uptake of amino acids and an upregulation of muscle protein synthesis. This response to meals and exercise long-term is the primary determinant for changes in lean body mass. Adequate caloric and protein intake is needed to avoid muscle protein breakdown, which in turn will spare lean mass from being used as fuel and contribute to its accrual. Evaluating protein intake
adequacy is a commonly used nutrition strategy that can ensure proper adaptation and recovery from training, which ultimately may improve an athlete’s performance.\textsuperscript{4,8,23,24}

\textit{Protein Intake Recommendations}

The AMDR for protein intake is between 10\% - 35\% of total energy intake, however, due to the large AMDR range for protein and no current upper limit, it is not commonly used as a reference for determining adequacy in intake in the athletic population.\textsuperscript{22,24,26} There is good rationale for recommending a protein intake that is well above the RDA of 0.8g/kg for the athletic population.\textsuperscript{8,22} The RDA was originally established for general populations, but sports nutrition professionals have agreed that needs in this population are higher.\textsuperscript{8,24}

At minimum, all athletes are recommended to consume 1.2g/kg/day of protein to ensure adequate recovery, tissue repair, and promote muscle protein synthesis.\textsuperscript{3,4,8,24} However, recommendations range from 1.2g/kg/day in endurance athletes to potentially 2.0g/kg/day in strength athletes or those focusing on weight loss.\textsuperscript{4,8} This range is meant to encompass variations in training intensity and load while accounting for the body size of the athlete.\textsuperscript{24} Protein recommendations should not be static, but should be made based on an individual athlete’s need and, similar to carbohydrate recommendations, centered around training load, volume, and specific adaptation goals.\textsuperscript{8,24}

\textit{Protein Intake Current Trends}

Protein needs should be as individualized as possible and modified to cater to training adaptations, so it is difficult to determine a cut-point other than the minimum 1.2g/kg recommendation. In Table 1, protein intake is reported in studies of female athletes from various sports. Studies report female athletes are not consuming the minimum recommendation of 1.2g/kg of protein,\textsuperscript{3,6,27} however, others report adequate or even excessive intake.\textsuperscript{4,20,23,25} All studies reported percentage of calories from protein falling within the AMDR.\textsuperscript{3,4,6,20,23,25,27} Due to the variability in research and recommendations, ensuring protein intake adequacy should be based on meeting the minimum of 1.2g/kg of protein.
### Table 2: Review of Protein Intake in Female Collegiate Athletes

<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>Protein Intake (g/kg)</th>
<th>Percentage of Calories from Protein (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mielgo-Ayuso et al, 2015</td>
<td>Elite female volleyball athletes (n=22)</td>
<td>2.1 ± 0.4</td>
<td>19.7 ± 2.1</td>
</tr>
<tr>
<td>Reed et al, 2014</td>
<td>Division I female soccer athletes (n=19)</td>
<td>2.0 ± 1.0</td>
<td>15.0 ± 1.0</td>
</tr>
<tr>
<td>Shriver et al, 2013</td>
<td>Division I female athletes (n=52)</td>
<td>1.2 ± 0.4</td>
<td>16.0 ± 3.0</td>
</tr>
<tr>
<td>Wenzel et al, 2012</td>
<td>Division I female volleyball athletes (n=11)</td>
<td>1.0 ± 0.3</td>
<td>N/A</td>
</tr>
<tr>
<td>Valliant et al, 2012</td>
<td>Division I female volleyball athletes (n=11)</td>
<td>0.9 ± 0.3</td>
<td>15.5 ± 3.4</td>
</tr>
<tr>
<td>Anderson et al, 2010</td>
<td>Division II female volleyball athletes (n=8)</td>
<td>1.1 ± 0.1</td>
<td>12.7 ± 1.1</td>
</tr>
<tr>
<td>Clark et al, 2003</td>
<td>Division I female soccer athletes (n=14)</td>
<td>1.4 ± 0.3</td>
<td>15.0 ± 3.1</td>
</tr>
</tbody>
</table>

**Fat Intake Function**

Dietary fat is a necessary component of an athlete’s healthy diet as it provides essential elements of cell membranes, aids in the absorption of fat-soluble vitamins, and provides more energy per gram than any other macronutrient.\(^8,28\) The two types of fatty acids, saturated and unsaturated, should be considered, as excessive saturated fat intake could generate adverse health outcomes, while some unsaturated fats, specifically omega-3 fatty acids, have shown to reduce inflammation and are associated with the risk of diabetes and cardiovascular disease.\(^8,28,30\) Polyunsaturated fatty acids (PUFA), specifically omega-3 fatty acids, have been found to play a role in enhancing immune function and reducing oxidative stress and inflammation, however, there is not enough evidence to support a beneficial effect on exercise performance.\(^28,31\) On the contrary, some PUFAs, such as arachidonic acid-derived omega-6 fatty acids, have been found to produce pro-inflammatory effects, thus stressing the importance of differentiating between omega-3 and omega-6 fatty acids.\(^31,66\) Though failing to meet the minimum recommended intake for protein and/or carbohydrate often affect exercise performance, failing to meet fat recommendations is
often associated with inadequate intake of fat-soluble vitamins and essential fatty acids, thus affecting necessary cell functions, but not necessarily exercise performance.\textsuperscript{8,25,28}

\textit{Fat Intake Recommendations}

The current AMDR for dietary fat intake is 20-35\% of an individual’s dietary intake, which also includes the goal of limiting energy intake from saturated fats to less than 10\% of calories.\textsuperscript{4,8,22,25,29} This recommendation, made in the Dietary Guidelines for Americans, aims to encourage individuals to replace saturated fat with unsaturated fat sources in the diet. Replacing saturated fat with unsaturated fat has been shown to reduce the risk of developing diabetes and cardiovascular disease with age.\textsuperscript{29,30} An athlete’s fat intake should be in line with these public health guidelines, but should also be individualized based on training level and body composition goals.\textsuperscript{3,4,8} Unlike energy, carbohydrates, and protein, there are currently no weight-based guidelines on the dietary fat intake for athletes.\textsuperscript{3,4,6,8} Instead, sports nutrition professionals make recommendations for dietary fat intake after carbohydrate and protein needs have been met while keeping in mind recommendations to reduce risk of chronic disease.

\textit{Fat Intake Current Trends}

The AMDR range of 20-35\% of total calories from fat is used in research and practice to determine whether dietary fat intake is appropriate.\textsuperscript{4,6,8,20,25,27} It is common in athletes, specifically females, to limit their consumption of fat, as many believe excess intake may compromise their performance and increase body fat mass.\textsuperscript{8,28} However, current studies in the athletic population that have examined dietary fat intake report that female athletes are consuming between 28\%-35\% of their total calories from fat, which is well within the AMDR.\textsuperscript{4,6,13,14,22,25,27}

\textbf{Iron Status and Dietary Intake}

\textit{Iron Function and Effect on Performance}

Iron deficiency (ID) is the most common nutritional disorder in the world, with iron deficiency anemia (IDA) affecting about a third of the population worldwide.\textsuperscript{32,33} The prevalence of IDA is not found to be different between female athletes and their non-athletic controls, however, ID without anemia is 5 –
7 times more prevalent in female athletes than in sedentary females.\textsuperscript{32,34,35} Females, in general, are more susceptible to ID due to a combination of inadequate dietary intake and iron loss by menses, but participation in intense training sessions, as seen in female athletes, can contribute additionally to ID.\textsuperscript{32,34,36-39} Extensive physical activity initiates an increase in red blood cells and blood vessels, thus increasing the physiological demand for iron.\textsuperscript{41-43} A corresponding growth in muscle mass and blood volume from training can also cause an increase in an athlete’s iron requirements.\textsuperscript{37,42-44}

Iron plays a crucial role in immune function, temperature regulation, cognitive abilities, and energy metabolism, and deficiency can greatly impair an athlete’s sport performance.\textsuperscript{36-38,40} Iron deficiency anemia is associated with reductions in oxygen carrying capacity, which can impact an athlete’s aerobic performance such on fitness tests as a VO\textsubscript{2}\text{max} assessment.\textsuperscript{36,37,40} and thus likely during competition as well. However, findings have been mixed on whether ID without anemia also decreases performance in this population.\textsuperscript{36}

\textit{Assessing Iron Status}

To differentiate between ID with and without anemia, there are many analyses that can be performed. To determine the extent of the deficiency, one can examine both an early indicator of low iron status (such as ferritin which represents the body’s iron stores) and a later indicator of functional iron deficiency (such as hemoglobin (Hb) levels) in the blood.\textsuperscript{59} Hematocrit, which is used to measure the percentage of red blood cells compared to the total blood volume, is also used in iron status assessments.\textsuperscript{59} Iron deficiency anemia is considered when there is both a depleted ferritin level and a depleted Hb level. On the contrary, ID without anemia includes a depleted ferritin level, but a normal Hb level is still present.\textsuperscript{34,36-39} Clinical cutpoints of these biomarkers vary in practice and the literature,\textsuperscript{32,34,36-39} but according to the World Health Organization, depleted ferritin and Hb levels are classified as <15μg/L and <12g/dL, respectively.\textsuperscript{33}
Iron Intake Current Trends

As mentioned, ID is primarily caused in females by the loss of iron through menses and inadequate iron intake.\textsuperscript{32,35-37,43} In fact, it has been reported that the majority of female collegiate athletes fail to meet the RDA of 18mg/day for iron, which is similar to non-athletic females of the same age.\textsuperscript{22,36,43,57} In a study by Kokubo et al, 90\% of their female collegiate gymnasts did not meet the RDA for iron intake and reported an average of 7.6 ± 2.8mg/day of iron intake (compared to the recommended 18mg/d).\textsuperscript{45} Currently, there are limited studies examining the impact of a dietary intervention to improve iron status,\textsuperscript{19,45} as many interventions utilize supplementation to correct deficiency.\textsuperscript{37,40} However, current recommendations to address mild ID (without anemia) are mixed as supplementation is only recommended with an iron deficiency anemia diagnosis.\textsuperscript{32} This stresses the need to investigate the impact of a dietary intervention, without the use of supplementation, on the iron status of female athletes.

Body Composition in Collegiate Athletes

Body Composition and Performance

Body composition has been a focal point for athletes and coaches for decades, due to the common belief that it plays a role in exercise performance. This has influenced athletes to view modifying their body composition as a way to improve their performance.\textsuperscript{8} Various sports and positions may require different physiological demands, which places emphasis on obtaining an optimal body composition.\textsuperscript{8,46,47} Body fat percentage has been found to affect energy expenditure, power-to-weight ratio, and acceleration capacity, which are all essential components of an athlete’s performance.\textsuperscript{8,47,48} In sports like volleyball, basketball, and hurdles, athletes have to repeatedly lift themselves against gravity, therefore, excess adipose tissue could hinder them during those activities.\textsuperscript{46,47} Team sports athletes may specifically benefit from lower body fat levels as it can increase their speed and agility.\textsuperscript{8} On the other hand, increases in fat free mass, particularly skeletal muscle, can be beneficial for athletic performance, as it contributes to the production of power.\textsuperscript{46} It can also provide greater absolute strength for resistance to high dynamic and static loads.\textsuperscript{46,49} Though changes in body composition can be deemed beneficial or detrimental to an
athlete, sport performance is multifaceted and body composition alone has not been shown to be an adequate predictor of their performance.\textsuperscript{8,47,49,50}

Assessing Body Composition

Body composition can be measured in a variety of ways, all with differing levels of accuracy, which makes it difficult to compare the various methods\textsuperscript{8,46,47,49} The commonly used methods include: dual energy x-ray absorptiometry (DXA), hydrodensitometry, air displacement plethysmography, skin fold measurements, and single multi frequency bioelectrical impedance analysis.\textsuperscript{8} Issues around cost, accessibility, and low dosages of radiation inhibit DXA from being used, even though it does produce the lowest standard error of estimate. Skinfold measurements are thought to have the highest standard error of estimate, but due to low equipment costs and ease of conducting in the field, they are still commonly used to assess body composition in research and practice.\textsuperscript{8,47,50} Air displacement plethysmography (BOD POD) has been found to underestimate body fat by 2\% - 3\%, but it is a quick and reliable alternative method to DXA that, when available, is a preferred method of analysis.\textsuperscript{8}

Link Between Body Composition and Dietary Intake

Studies have identified body composition as one aspect, out of many, that affects athletic performance, but few have examined the effects of a dietary intervention on dietary intake and body composition.\textsuperscript{3,6,8,20,47,50} Accruals in lean mass have been accepted as a result of a simultaneous increase in energy, carbohydrate, and protein intake, which is said to allow for lean mass growth.\textsuperscript{3,6,8} Changes in body composition and dietary intake throughout an athlete’s competitive season have been reported in many observational studies, but few dietary intervention studies have been conducted to purposefully influence body composition.\textsuperscript{3,6,20,41,46,47,50} In a study by Wenzel et al, individual dietary education significantly improved caloric intake and lean mass accrual in collegiate athletes, but the relationship between changes in dietary intake of macronutrients and body composition was not examined.\textsuperscript{3}
**Nutrition Education and Dietary Intake**

Nutrition education programs primarily aim to improve nutritional knowledge, however, it is not well established that higher nutrition knowledge equates to improved dietary intake. Studies that have detected a positive effect have reported only weak associations between higher nutrition knowledge and dietary intake.\(^3,6,52\) This weak association is mostly due to the challenges and heterogeneity of assessing knowledge and intake, in addition to finding a sample large enough to discover associations between variables.\(^52\)

“Food Literacy” is a term to describe the everyday practicalities associated with navigating food selection, planning, management, and preparation; part of which, an individual must build a well-rounded understanding, including knowledge and skill, of food.\(^53\) Although intervention to enhance food literacy have been shown to be effective in improving the quality of dietary intake in general populations, few studies have implemented educational interventions in effort to improve the dietary intake in the athletic population.\(^3,6,19,27\) Of methods that have been used, individualized feedback has been found to improve energy and macronutrient intake, nutrition knowledge, and body composition in this population, with improvements maintaining even at a follow-up appointment.\(^3,6,27\) Though feedback and improved dietary knowledge has shown to produce positive dietary changes, obtaining ‘food literacy’ can be described as a myriad of components as mentioned above, not just knowledge.\(^53\) Often, outcome measures tend to focus on one piece of the puzzle, such as cooking, food skills, eating competence, or nutrition knowledge, but ultimately a combination of both knowledge and skills are necessary.\(^53\)

Though the majority of college students report feeling *confident* or very *confident* in their cooking skills, only 30% of college students report making a meal for themselves daily.\(^61\) Additionally, higher cooking skills have been attributed to increased food preparation frequency in college students, with increased cooking skills also being associated with meeting the minimum recommendations for fruit and vegetables.\(^61\) Also, students with higher healthy eating attitudes possessed higher overall quality of diet.\(^61\) Students who live off-campus tend to have a poorer diet quality than those living on-campus, who primarily utilize campus dining halls for meals.\(^62\) Frequency of eating out at restaurants and purchasing
‘convenience meals’ contributes to lower overall quality of diet and failure to meet the recommended food group servings in the Dietary Guidelines for Americans.63

Since this idea of a multifaceted ‘food literacy’ model is novel and not yet expanded, to our knowledge, there are currently no intervention studies that incorporate knowledge and skills in an effort to improve dietary intake of athletes. Though there are numerous observational studies that have examined the current dietary intake of female collegiate athletes, few studies have implemented an intervention in an effort to improve energy, carbohydrate, protein, fat, and iron intake, body composition, or nutrient status. Based on the current literature, it is evident that collegiate athletes fail to meet many of the minimum sports nutrition recommendations, thus demonstrating the need for a unique intervention, which incorporates both knowledge and skill, to improve these outcomes.

Purpose

The purpose of this study was to determine the effects of a ten-week food-lab based cooking intervention program on the overall energy, carbohydrate, protein, fat and iron intake, nutrient (iron) status, and body composition of collegiate female athletes. Additionally, dietary intake of energy, carbohydrate, protein, fat, and iron was compared to current sports nutrition recommendations and their adequacy determined. The findings of this study can provide information essential to developing an effective and sustainable foods lab-based cooking intervention for collegiate female athletes that focuses on dietary intake.

Research Questions

1. What is the effect of a ten-week foods lab-based cooking intervention on the energy, carbohydrate, protein, and fat intake in female collegiate athletes?
   a. Are athletes meeting current sports nutrition recommendations for energy, carbohydrate, protein, and fat?

2. What is the effect of a ten-week foods lab-based cooking intervention on the body composition of female collegiate athletes?
3. What is the effect of a ten-week foods lab-based cooking intervention on the iron status of female collegiate athletes?

**Hypotheses**

*Dietary Intake Null Hypotheses:*
There will be no effect of a ten-week foods lab-based cooking intervention on the dietary intake of energy, carbohydrate, protein, fat, and iron intake in female collegiate athletes.

*Iron Status Null Hypotheses:*
There will be no effect of a ten-week foods lab-based cooking intervention on the iron status of female collegiate athletes, as measured by serum ferritin, hemoglobin, and hematocrit.

*Body Composition Null Hypotheses:*
There will be no effect of a ten-week foods lab-based cooking intervention on the body composition of female collegiate athletes, specifically on body weight, body fat percentage, fat mass, and fat free mass.

**Methods**

This intervention was a pilot study with curriculum designed by graduate students and faculty at the University of Cincinnati (UC) Nutritional Sciences Department in Cincinnati, Ohio, under the direction of Dr. Abigail Peairs and Dr. Sarah Couch. This study was in collaboration with University of Cincinnati Athletics Sports Medicine Department under direction of Robert Mangine. The Institutional Review Board of the University of Cincinnati approved this study and all participants signed an informed consent prior to study procedures.

*Subjects and Recruitment*

A convenience sampling method was used for this study. Recruitment for this study occurred during a regularly scheduled sports nutrition education session. Participants were recruited at a regularly scheduled sports nutrition team talk with the approved recruitment script (*Appendix A*). Those who were interested provided contact information to the research staff and were screened for the study (*Appendix B*). Athlete participation in the study was voluntary and participation had no effect on their status as NCAA collegiate athletes. (*Appendix C*).
Inclusion/Exclusion Criteria

To participate in the study, subjects needed to meet the following criteria: (1) 18 years of age or older, (2) NCAA collegiate female athlete (3) available to attend the two data collection periods, and (4) able to read, write, and speak English. These criteria were selected due to the desire to examine the collegiate female athlete population and to be able to obtain two data points to assess the efficacy of the intervention. In addition, the activities in the curriculum would require that subjects are fluent in English.

Those individuals who met any of the following criteria were excluded from the study: (1) severe food allergies, in such a way that contact with specific foods would cause a life-threatening allergic reaction, (2) currently or planning to become pregnant during the intervention, (3) previously clinically diagnosed with an eating disorder (4) or diagnosed with any metabolic disorder, i.e. hemochromatosis, or taking medication that would affect nutritional status. Since the intervention included preparation and handling of foods, those with severe food allergies were eliminated to prevent exposure to a food allergen. Handwritten food logs were also collected, so those with previous diagnosed eating disorders were excluded in order to avoid any disordered eating or obsessive behaviors. Lastly, any subjects with a medical condition that could affect nutrient status were also excluded to prevent outliers in biochemical marker data.

Theoretical Framework of Intervention

The basis of the intervention design was centered on The Social Cognitive Theory, established by Albert Bandura in 1977. The Social Cognitive Theory is grounded in behavior, cognitive, personal, and environmental factors that interact to determent an individual’s actions. Particular outcomes can be affected by these factors, as a combination is said to lead to potential behavioral modifications.

I. **Modeling**: Considered the first step in developing competency in which skills are modeled, practiced, and observed. Modeling raises an individual’s belief about their own capabilities, as observing others similar to themselves instills competency in a specific situation.
II. **Performance Accomplishments**: Performance accomplishments provide the most instrumental source of efficacy, as efficacy is based on personal mastery.\textsuperscript{54} Self-efficacy can influence choice of activity and through the expectation of success, individuals will endure even through potential obstacles.\textsuperscript{54,55}

III. **Self-Efficacy**: The belief of an individual on how well they can successfully execute a behavior to produce a particular outcome.\textsuperscript{54,55} Efficacy differs from performance accomplishment as a strong efficacy will determine if the individual will manage the situation when faced with adversity.\textsuperscript{54}

IV. **Social Persuasion**: The more commonalities perceived between the observer and the model, the more likely the observer learns the modeled behavior.\textsuperscript{54} Motivating individuals will raise the belief in their capabilities, which in turn causes success to be measured in terms of self-improvement rather than the triumph over others.\textsuperscript{55}

The above constructs shaped the structure of our dietary intervention. The curriculum was also developed after reviewing trends in the literature and determining the sports nutrition topics that would be addressed. An example of material used in curriculum can be found in Appendix F. The structure and curriculum are as follows.

Each session included the following elements:

I. **Nutrition Education Portion** (10 minutes): This section consisted of a topic pertinent to collegiate athletes, such as macronutrients, meal timing, and meal planning (see Table 3 for a listing of all topics). Since dietary education has been found to improve overall intake,\textsuperscript{3,6,19} an education component was essential to this curriculum.

II. **Skill-Based Portion** (10 minutes): Incorporated modeling and self-persuasion constructs of Social Cognitive Theory to increase self-efficacy.\textsuperscript{54} Skill taught was incorporated into corresponding recipe for each class.
III. Recipe Preparation (90 minutes): Preparation of 2-3 recipes that were nutrient-rich, but could be easily prepared by individual with minimal kitchen skills. Performance accomplishments in this section also supported participant self-efficacy.

IV. Goal Setting (10 minutes): S.M.A.R.T goals were created at the conclusion of each session in order for the individuals to focus on a specific goal between the classes. This concept, from Paul J. Meyer’s *Attitude is Everything!*, breaks down achieving a goal into five categories: *specific, measurable, attainable, relevant, and time-based.* When writing a goal, each participant needed to ensure that it met the above five criteria. Each S.M.A.R.T goal pertained to the corresponding class educational topic and was reviewed at the beginning of the following class.

### Table 3: Bearcats in the Kitchen: Intervention Curriculum

<table>
<thead>
<tr>
<th>Topic</th>
<th>Education</th>
<th>Skill</th>
<th>Recipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Needs</td>
<td>Predictive equations, physical activity factors, Dietary Guidelines for American</td>
<td>Knife skills, vegetable preparation</td>
<td>Make your own seasonings, roasted vegetables</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>Carbohydrate function, sources, and timing <em>(Appendix F)</em></td>
<td>Stovetop carbohydrate preparation (pasta, rice, etc.)</td>
<td>Tomato spinach pasta, chicken stir fry</td>
</tr>
<tr>
<td>Protein</td>
<td>Protein function, sources, and timing</td>
<td>Ground meat preparation, burrito preparation</td>
<td>Breakfast burritos, various versions of chili</td>
</tr>
<tr>
<td>Fat</td>
<td>Fat function, sources, and timing</td>
<td>Protein breading, slicing of specific fruits and veggies</td>
<td>Chia and flax chicken nuggets, chia brown rice, guacamole</td>
</tr>
<tr>
<td>Antioxidants</td>
<td>AOX function and sources</td>
<td>Preparation of various fruits and veggies</td>
<td>Various smoothie bowls and toppings, grilled chicken and cranberry salad</td>
</tr>
<tr>
<td>Snacks</td>
<td>Snack pairings, sources, and timing</td>
<td>Making a stove top omelet</td>
<td>Make your own omelet and bar, various pancake recipes, peanut butter chip granola bars</td>
</tr>
<tr>
<td>Eating Out</td>
<td>Choices around campus, navigating menu items</td>
<td>Using a food processor</td>
<td>Black bean brownies, make your own Chipotle, oatmeal cookies</td>
</tr>
<tr>
<td>Meal Planning and Food Safety</td>
<td>Planning weekly meals, grocery list, and fridge organization</td>
<td>Mapping out weekly meals, creating a grocery list, preparing large meals</td>
<td>Cajun pasta, pasta and veggie bake</td>
</tr>
</tbody>
</table>
Data Collection Visits

Two data collection visits were conducted in this study, one prior to the commencement of the cooking classes and one at the completion of the 8-week curriculum. Data collection occurred in the Nutrition Assessment Lab, French East Building, room 221, at University of Cincinnati. Informed consent forms were completed at the initial data collection visit, prior to official study enrollment.

Dietary intake and anthropometric data collected at both study visits included 3-day food records, weight, body fat percentage, fat free mass, and fat mass. Venous blood samples were drawn at both study visits and biochemical data collected included hemoglobin, hematocrit, and ferritin to determine iron status.

Subject Anthropometry

Body Composition was measured via BOD POD® using air displacement plethysmography. This method provides a quick and reliable method to assess body composition and has minimal measurement error when compared to dual energy x-ray absorptiometry (DXA), the gold standard. Height and weight were also collected at the initial and final data collection appointment as part of the standard BOD POD® procedure. Prior to their initial and final data collection appointments, subjects were provided a handout containing the appropriate preparation protocol for the BOD POD® assessment. (Appendix D)

Dietary Intake

At the time of initial data collection, subjects were instructed on the proper methods of recording food intake using handwritten diet records (Appendix E). Subjects were asked to record 3-days of dietary intake, with at least one weekend day, and were provided three blank food logs. A hand-portion reference guide was given for aid in recording their portions (Appendix G). Subjects returned completed food logs on the first session of the cooking intervention. Pre-intervention, all participants also completed a Diet History Survey (Appendix H).
During the last session of the cooking intervention, subjects were instructed to record 3-days of dietary intake, with at least one weekend day, and were provided three blank food logs. Subjects returned completed food logs on their final data collection visit. Food record data was entered into SuperTracker (USDA) by research staff and records were analyzed for energy, macronutrient, and iron content. Three-day averages of those nutrients were determined both pre- and post-intervention.

Iron Status

Biochemical data collection occurred at the initial and final data collection visits at a University of Cincinnati Medical Center Phlebotomy site by a trained phlebotomist. Venous blood samples were collected in the fasted state. Biochemical data collected included hemoglobin, hematocrit, and ferritin after fasting and not exercising for the previous 8-hours.

Statistical Analysis

Pre- and post-intervention data are expressed as mean ± standard deviation, with the significance level set ≤ 0.05. Dependent variables included anthropometric measures (weight, body fat percentage, fat mass, and fat free mass), iron status indicators (ferritin, hemoglobin, and hematocrit), and dietary measures (energy, macronutrients, and iron). Shapiro-Wilk test of normalcy was run on all pre- and post-intervention outcome measures. All measures, except post-intervention carbohydrate intake (grams) were normally distributed. Paired t-tests were run for all outcome measures.

Data was analyzed using the software Statistical Package for the Social Sciences (Version 23, SPSS, Inc, Chicago, IL).

Results

Demographic and Anthropometric Data

Eleven female collegiate (n=11) athletes participated in the 10-week intervention, including the 8-week cooking curriculum in addition to pre- and post-data collection measures. The sample consisted of Caucasian (n=8, 72.7%) and African American (n=3, 27.2%), with one of the participants classified as an
international student. Collected from the Diet History Survey (Appendix H), the following gave more defining information to the research staff about the sample. In terms of supplements, seven participants reported not using supplements, while four reported taking supplements 4 or more days per week. Ten participants (n=10, 90.1%) reported spending $250.00 or less on groceries per month and all participants (n = 11) had access to a full kitchen, with participants living in on-campus (n = 4) and off-campus (n = 7) housing.

The demographic and anthropometric collected data are reported in Table 4. Anthropometric data from pre- to post-intervention are reported in Table 5. There were significant differences in Fat Free Mass from pre- to post-intervention (p ≤ 0.05) in conjunction with a change in the sample’s strength training program.

<table>
<thead>
<tr>
<th>Table 4. Participant Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Age (yr)</td>
</tr>
<tr>
<td>Height (cm)</td>
</tr>
<tr>
<td>Weight (kg)</td>
</tr>
<tr>
<td>Body Mass Index (kg/m²)</td>
</tr>
<tr>
<td>Body Fat Percentage (%)</td>
</tr>
<tr>
<td>Fat Mass (kg)</td>
</tr>
<tr>
<td>Fat Free Mass (kg)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5. Anthropometric Comparisons: Pre- to Post-Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthropometric Variable</td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>Weight (kg)</td>
</tr>
<tr>
<td>Body Mass Index (kg/m²)</td>
</tr>
<tr>
<td>Body Fat Percentage (%)</td>
</tr>
<tr>
<td>Fat Mass (kg)</td>
</tr>
<tr>
<td>Fat Free Mass (kg)</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± standard deviation. *Denotes significant difference from pre- to post-intervention (p ≤ 0.05)

Values are expressed as the difference between means from pre- to post-intervention.

Values are expressed as the mean percentage of change in intake among participants from pre- and post-intervention.

Iron Indices Data

All participants participated in blood sample data collection and the iron indices data are reported in Table 6. There were significant differences in hemoglobin and hematocrit levels from pre- to post-
intervention. A change in Hematocrit was strongly associated with a change in Hemoglobin from pre- to post-intervention \((r = 0.87, p = 0.001)\)

**Table 6. Iron Indices Comparisons**

<table>
<thead>
<tr>
<th>Iron Indices Variable</th>
<th>Recommendation</th>
<th>Pre-Intervention</th>
<th>Post-Intervention</th>
<th>Change(^a)</th>
<th>Percentage of Change(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferritin (ng/ml)</td>
<td>&gt; 15ng/ml</td>
<td>20.7 ± 13.0</td>
<td>14.2 ± 10.8</td>
<td>-6.45 ± 10.40</td>
<td>-21.9 %</td>
</tr>
<tr>
<td>Hemoglobin (g/dL)</td>
<td>&gt; 12g/dL</td>
<td>12.6 ± 0.99</td>
<td>13.1 ± 1.02</td>
<td>0.43 ± 0.51*</td>
<td>3.53 %</td>
</tr>
<tr>
<td>Hematocrit (%)</td>
<td>&gt; 35%</td>
<td>38.0 ± 2.8</td>
<td>40.0 ± 2.7</td>
<td>2.01 ± 1.45**</td>
<td>5.39 %</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± standard deviation. *Denotes significant difference from pre- to post-intervention \((p \leq 0.05)\). **Denotes significant difference from pre- to post-intervention \((p \leq 0.01)\).

\(^a\) Values are expressed as the difference between means from pre- to post-intervention.

\(^b\) Values are expressed as the mean percentage of change in intake among participants from pre- and post-intervention.

**Dietary History and Intake Data**

All participants \((n = 11)\) completed a handwritten 3-day food record pre- and post-intervention. The Diet History Survey (Appendix H) collected pre-intervention revealed that 72.7% of participants reported consuming meat once a day or less. Ten participants \((90.1\%)\) reported eating fast food or out at a restaurant at least 1-2 times per week, with six participants \((54.5\%)\) eating out more than 3 times per week.

Dietary intake results are reported as the mean intake of the 3-day food record for calories, carbohydrate, protein, fat, and iron. In Table 4, intake is reported pre- and post-intervention along with the Academy of Nutrition and Dietetics recommendation for comparison. Percentage of change is reported to express the trends in intake for all outcome measures. In Figures A-C, the range, 1\(^{st}\) and 3\(^{rd}\) quartiles, and mean are reported. There were no statistically significant differences between pre and post intervention intake in any of the dietary variables analyzed (energy, carbohydrate, protein, fat, iron) and can be seen in Table 7.
<table>
<thead>
<tr>
<th>Dietary Variable</th>
<th>Recommendation&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Pre-Intervention</th>
<th>Post-Intervention</th>
<th>Percentage of Change&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Intake (kcal)</strong></td>
<td></td>
<td>2155.6 ± 430.8</td>
<td>2329.5 ± 392.2</td>
<td>11.5%</td>
</tr>
<tr>
<td>Kcal/kg</td>
<td>(37 – 45kcal/kg) Minimum 30kcal/kg</td>
<td>28.8 ± 7.5</td>
<td>31.7 ± 5.0</td>
<td>17.4%</td>
</tr>
<tr>
<td><strong>Carbohydrate Intake (g)</strong></td>
<td></td>
<td>256.8 ± 49.4</td>
<td>270.3 ± 63.0</td>
<td>6.5%</td>
</tr>
<tr>
<td>CHO g/kg</td>
<td>(6 – 10 g/kg) Minimum 5g/kg</td>
<td>3.5 ± 0.7</td>
<td>3.7 ± 0.8</td>
<td>6.2%</td>
</tr>
<tr>
<td>% of total kcal</td>
<td>(45 – 65%) Minimum 55%</td>
<td>48.2 ± 6.6</td>
<td>46.2 ± 6.8</td>
<td>-2.8%</td>
</tr>
<tr>
<td><strong>Protein Intake (g)</strong></td>
<td></td>
<td>95.6 ± 19.7</td>
<td>109.9 ± 20.0</td>
<td>14.4%</td>
</tr>
<tr>
<td>Protein g/kg</td>
<td>(1.2 – 1.7g/kg) Minimum 1.2g/kg</td>
<td>1.3 ± 0.3</td>
<td>1.5 ± 0.3</td>
<td>20.2%</td>
</tr>
<tr>
<td>% of total kcal</td>
<td>(10 – 35%)</td>
<td>18.1 ± 2.8</td>
<td>19.7 ± 2.8</td>
<td>9.7%</td>
</tr>
<tr>
<td><strong>Fat Intake (g)</strong></td>
<td></td>
<td>82.3 ± 28.9</td>
<td>88.5 ± 24.4</td>
<td>20.3%</td>
</tr>
<tr>
<td>% of total kcal</td>
<td>(20 – 35%)</td>
<td>33.7 ± 7.3</td>
<td>34.2 ± 6.8</td>
<td>5.4%</td>
</tr>
<tr>
<td><strong>Iron Intake (mg)</strong></td>
<td>(RDA: 18mg)</td>
<td>15.1 ± 5.4</td>
<td>16.0 ± 3.5</td>
<td>15.4%</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± standard deviation.

<sup>a</sup>Values are expressed as the mean percentage of change in intake among participants from pre- and post-intervention

<sup>b</sup>Recommendations were determined based on the Academy of Nutrition and Dietetics Nutrition and Athletic Performance position paper.
Figure 1. Energy Intake Pre- and Post-Intervention

*Figure 1.* Energy intakes at pre- and post-intervention (n=11). Box plots represent the 75th and 25th percentiles, as well as the mean of the sample. Whisker plots represent the upper and lower adjacent values.
Figure 2. Carbohydrate Intake Pre- and Post-Intervention

Figure 2. Carbohydrate intakes at pre- and post-intervention (n=11). Box plots represent the 75th and 25th percentiles, as well as the mean of the sample. Whisker plots represent the upper and lower adjacent values.
Figure 3. Protein Intake Pre- and Post-Intervention

Protein Intake (g/kg)

Pre-Intervention

Post-Intervention

Grams per Kilogram of bodyweight

Figure 3. Protein intakes at pre- and post-intervention (n=11). Box plots represent the 75th and 25th percentiles, as well as the mean of the sample. Whisker plots represent the upper and lower adjacent values.
Discussion

This study contributes to the current literature that examines and attempted to influence dietary intake, nutrient status, and body composition in the female collegiate athlete population. It furthers the body of research that defines this population’s dietary intake and body composition, but it is unique in that it implements a hands-on cooking intervention approach in an effort to improve the selected outcome measures. The key significant differences observed from pre- to post-intervention were in body composition and nutrient status. No significant differences were observed in dietary intake of energy, carbohydrate, protein, fat, and iron from pre- to post-intervention, but these results further the existing literature that compares female collegiate athlete dietary intake to the recommendations in this population.

Significant differences in fat free mass were observed from pre- (56.1 ± 4.6kg) to post-intervention (56.8 ± 4.6kg, p ≤ 0.05) in conjunction with a change in their strength training program. Due to the fact that the relationship between body composition and performance is multifaceted and that no ideal body composition recommendation exists, comparison of means to other studies should not be made. However, other studies that examined body composition pre- and post-dietary intervention also reported a significant increase in fat free mass.\textsuperscript{3,6} In these previous studies, individualized feedback was used as the sole intervention, which, based on significant results, was shown to be an effective method for influencing body composition. Since our intervention did not use individualized feedback as part of our intervention, our results suggest that hands-on group education may also be an effective way to influence body composition in the athletic population. Neither of the aforementioned studies formally examined the relationship between dietary intake and changes in body composition, but attributed a possible significant increase in caloric intake to lean mass accrual. Exploring that association was not an objective of this study, but it calls for further examination of this relationship in future studies. A possible limitation in this area is that our participants did begin a new strength training program at the beginning of our intervention. Therefore, it is not possible to attribute the changes in lean mass to the dietary intervention alone.
Upon examining the dietary intake data, participants’ mean energy intake did not meet the recommendations or minimum (kcal/kg). This is congruent with current literature that reports female athletes fail to meet their energy needs.\textsuperscript{3,4,6,13,14,16,18,19} The same studies report up to 89\% of their female participants did not meet energy needs calculated by estimation equations.\textsuperscript{3,4} However, prior to our intervention, 55\% of the female participants (n=6) were not meeting the minimum 30kcal/kg energy recommendation, and that level decreased to 36\% (n=4) post-intervention.

Though improvements were made in the quantity of athletes that met the minimum recommendation, the mean intake of the participants was still below the 37-45kcal/kg sports nutrition recommendation post intervention (31.7 ± 5.0 kcal/kg). This is consistent with current findings, which report intake means between 29-33kcal/kg post-dietary intervention.\textsuperscript{3,4,6,13,14,16,18,19} As few studies exist that use the kcal/kg method as a standard of comparison for energy intake,\textsuperscript{4,6,27} utilizing that standard of comparison in this study aided in expanding the research defining athlete energy intake in that manner. Even though the sample was slightly above the minimum recommendation for energy intake, bodyweight did trend in the positive direction for 45\% (n=5) participants post-intervention. This demonstrates that even with an energy intake close to the minimum recommendation, it is still possible that caloric needs are being met enough to avoid weight loss. The present intervention did not result in a significant difference in energy intake from pre- to post-intervention. Similar studies that have employed dietary intervention strategies report mixed evidence.\textsuperscript{3,6,18,27} In a 2012 study by Valliant et al, individualized education led by a registered dietitian significantly improved energy, carbohydrate, and protein intake in female volleyball athletes (n=11), however, a study by Anderson et al reported individualized feedback did not significantly improve dietary intake of these same variables in a similarly designed study and population (n=8). However, as these studies did not implement a hands-on group intervention with efforts to improve dietary intake in this population it is difficult to directly compare to our results.

Since carbohydrates function as the primary energy fuel for most athletes and since our results revealed that the diets of these collegiate athletes were generally inadequate in carbohydrates, ensuring that they are counseled how to meet the minimum carbohydrate recommendation is imperative. College
students, in general, fail to meet daily recommendations for fruit and vegetables, while over-consuming fat and refined sugar. Other studies in collegiate female athletes, both observational and those that implemented an intervention to improve intake, have also reported athletes continue to fail in meeting the minimum carbohydrate recommendation of 5g/kg. In our sample, no participants met the minimum of 5g/kg carbohydrate recommendation pre- or post-intervention. These results match Wenzel et al (n=11), which reported none (n=0) of their female collegiate volleyball players met their carbohydrate needs of 7g/kg. Most studies report mean intakes less than 4g/kg of carbohydrate intake, which is congruent with our results (pre-intervention, 3.5 ± 0.7 g/kg, and post-intervention, 3.7 ± 0.8 g/kg). These results emphasize the need for continued carbohydrate education in this population as female athletes appear to be consistently failing to consume adequate carbohydrates. Care should be taken by a Registered Dietitian to appropriately prescribe carbohydrate needs based on athlete periodization and training.

Increasing protein intake was also an objective of our intervention due to its role in muscle recovery and the accrual of lean mass. Participants’ protein intake was within the 1.2 – 1.7g/kg recommendation for athletes both pre- (1.3 ± 0.3g/kg) and post-intervention (1.5 ± 0.3g/kg), however, a significant difference in these levels was not detected. Participants did increase their average protein intake (g/kg) by 20.2% from pre- to post-intervention. Five participants (n=5, 45%) were not meeting the minimum 1.2g/kg recommendation pre-intervention, however, that decreased to 27% (n=3) post-intervention. The percentage of participants that met the minimum protein recommendation was not disclosed in any similar design studies, but reported mean protein intakes were ≤1.2g/kg even after intervention implementation. Even though significant differences were not observed in protein intake (g/kg) pre- to post-intervention, our sample’s mean intake is higher than means reported in the literature, which potentially speaks to the effectiveness of our intervention. It is suggested that consistent adequate protein intake post-resistance training is the primary determinant for changes in lean body mass. Since adequate protein intake and timing was addressed as a weekly topic in this intervention, it is
possible that some dietary changes concerning protein could have contributed to the increase in lean mass in our study.

In Table 8, the most common protein choices pre- to post-intervention are listed. Though not an exhaustive list, these are the protein sources most common in the participants’ 3-day food records pre- and post-intervention. In general, pre-intervention protein sources consisted of ‘fried’ and ‘breaded’ proteins at the main meals. In addition, processed meats such as brats, deli meat, hotdogs, and bacon, were also included at most breakfast and lunch meals. When examining post-intervention protein options, participants self-reported protein options being ‘grilled’ or ‘baked’ and less processed meats were consumed during lunch meals. Items like chicken salad, sour cream, and processed meats were consumed observably less post-intervention and seemed to be replaced with items like grilled chicken, Greek yogurt, and lean deli meats (turkey).

**Table 8. Protein Sources Pre- and Post-Intervention**

<table>
<thead>
<tr>
<th>Pre-Intervention</th>
<th>Fried/breaded meats and fish, processed meats (brats/pepperoni/bacon), deli meat (ham/turkey), high fat dairy (sour cream), pre-made salads (chicken/tuna salad), eggs, peanut butter, beans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-Intervention</td>
<td>Eggs, grilled/baked meats and fish, lean deli meat (turkey), Greek yogurt, beans, peanut butter, lean red meat (steak, ground beef, shredded beef loin)</td>
</tr>
</tbody>
</table>

Fat intake was also assessed even though athlete fat recommendations in practice are typically made after ensuring carbohydrate and protein needs are met. The percentage of calories coming from fat in our sample was near the top of the AMDR of 35% (pre-intervention: 33.7 ± 7.3%, post-intervention 34.2 ± 6.8%). Most studies report ≤ 34% mean percentage of calories coming from fat, which is within the AMDR and is comparable to our results. However, the mean intake of fat (g) per day in our sample was well above those reported in literature, at 82.3 ± 28.9g pre-intervention and 88.5 ± 24.4g post-intervention compared to other studies reporting means as low as 65.9g in female collegiate athletes. It is also important to note that 45% (n=5) of participants, pre- and post-intervention, reported consuming fat intakes above the AMDR maximum of 35%. This is likely due in part to the higher fat content of processed foods eaten out at restaurants, which was common in our sample. On our initial Diet History Survey, 90.1% (n=10) self-reported eating fast food or out at a restaurant at least 1-2
times per week and 55% (n=6) eating out more than 3 times per week. The benefits of unsaturated fat consumption were discussed in our intervention, but further care should be taken to discuss the health risks associated with overconsumption of unhealthy saturated fats common in restaurant dishes.

Lack of significant change in dietary intake of macronutrients and dietary iron from pre- to post-intervention could be attributed to the small sample size of this study. In addition to suspected underreporting in the 3-day food records, the variability of the sample caused lack of significant differences in dietary intake pre- to post-intervention to be detected, even though the data were normally distributed. This is seen in the wide range of intakes examined in Figures 1-3.

The dietary iron intakes of the participants pre- and post-intervention were 15.1 ± 5.4mg and 16.0 ± 3.5mg, respectively, which are within the IOM recommendations for females of childbearing age (15-18mg). The mean iron intake of the sample did not meet the RDA requirement for this population (18mg), with only four participants (36%) meeting the RDA for iron intake of 18mg/day pre-intervention. That number decreased to one participants (9%) meeting the minimum intake recommendation post-intervention. On average, participants increased their iron intake by 15.4% from pre- to post-intervention, however, less participants were meeting the RDA. A wide range of dietary iron intake in female collegiate athletes has been reported (7.6 – 17.0mg), which is in line with our sample’s intake pre- and post-intervention.\(^\text{41-44}\) The most common iron-rich sources in the participants’ records were animal based protein sources (red meats/poultry), beans, eggs, and peanut butter. Fortified grains, such as breads, rice, and cereals, could be other possible iron-rich sources in our sample, but due to the lack of reporting specific brands, it is difficult to determine if iron can be attributed to those sources.

Significant differences were seen in hemoglobin and hematocrit from pre- to post-intervention, but no significant difference was seen in ferritin levels. Significant increases in both hemoglobin and hematocrit suggest an improvement in the functional iron status of the athletes in this study. Changes in hematocrit can be acutely and chronically influenced by changes in exercise intensity, training periodization, and as an acute response to exercise, thus stressing the importance of analyzing Hb in addition to Hct to understand functional iron status. Hemoglobin levels, on the other hand, are much
slower to respond due to the slow rate of erythropoiesis and are used in conjunction with Hct, as a reliable measure of oxygen transport capacity. This may suggest that significant improvements in hemoglobin and hematocrit levels, and thus functional iron status, could be beneficial for oxygen carrying capacity. However, at this time, there have been no observable benefits to athletic performance due to increases in hematocrit and hemoglobin related to oxygen carrying capacity. The post-intervention hemoglobin level in our sample (13.1 ± 1.02g/dL) was consistent with other reported levels in both collegiate and professional female athletes (11.8 – 15.7g/dL). Hematocrit was not reported in these studies.

No significant difference was seen in ferritin levels from pre- to post-intervention. However, post-intervention ferritin levels (14.2 ± 10.8ng/ml) were lower than reported means of other studies (21.0 – 57.0ng/ml). A study by Sandstrom et al reports 55% of their female soccer sample was iron deficient without anemia, with other studies reporting up to 77%. Seven participants in our sample (n=7, 63.6%) met the criteria for iron deficiency without anemia, which is comparable to other results. Iron deficiency can be attributed to inadequate dietary intake, loss from menses, and growths in muscle mass and blood volume in athletes. Since dietary iron intake was reported as inadequate in our sample, deficiency in our participants’ iron stores (ferritin) could possibly be attributed to loss from female menses, inadequate dietary iron intake, and their growth in fat free mass, however, no statistical analyses were run to examine this relationship. Other possible causes of low ferritin levels post-intervention could be lab error, gastrointestinal bleeding, or they may have been elevated pre-intervention due to an inflammatory state associated with infection or various disease states. However, participants were excluded if reported pregnant or diagnosed with any disorder that would affect their nutrient status, thus making these factors unlikely explanations for our results. A possible confounding factor in our biochemical analysis was that two separate labs analyzed our pre- and post-intervention iron samples, and there could have been due to differences in technician procedure, equipment, or controls used for calibration. However, both labs were UC Health affiliated locations and utilized the same method of analysis, and thus should be comparable.
Limitations

There are a few limitations to this study. First, the small sample size (n=11) could have reduced our ability to detect any small but statistically significant change in dietary intake of the nutrients of interest. Further, only six individual days of food records were collected per participant over seventy days with a wide range of intake reported. Thus the large standard deviation could have contributed to the lack of statistically significant results in those outcome measures. In addition, even though the participants were trained on proper food recording practices, it is possible that under-reporting could have also affected our dietary outcome measures. It should also be recognized that the new strength training program that began simultaneously with the start of the dietary intervention could have also contributed to the change in lean mass in the sample. Lastly, our biochemical analyses for iron status were conducted in two separate labs, and while the measures should be comparable, we cannot exclude the possibility that results were influenced by this difference.

Conclusion

Based on the results of this study, a hands-on group nutrition education intervention setting may be an effective tool to influence body composition and functional iron status of the female collegiate athlete. However, our data show that these athletes still failed to meet energy and carbohydrate needs and therefore these topics should be targets for future dietary interventions for this population.
References:


The Effect of a Food-Lab Based Cooking Intervention on the Body Composition and Nutrient Status of Collegiate Female Athletes

Recruitment Script

**Member of Research Team:** We are looking for individuals to participate in a food-lab based study to see how learning cooking techniques and healthy recipes can improve body composition and nutrient status.

If you are 18 years or older, can read/write/speak English, and are a University of Cincinnati Student Athlete, you are eligible to participate. Unfortunately, if you have a severe food allergy, are currently or planning to become pregnant, are clinically diagnosed with an eating disorder, or have a metabolic disorder that could interfere with your nutritional status, you are ineligible to participate.

The study will consist of (1) two-hour cooking class a week in the Ellen Rember Foods Lab in the French East Building at the University of Cincinnati. These sessions will consist of learning cooking techniques, healthy recipes, and participating in discussions about the food prepared. The hope of this study is that our participants will gain knowledge and skills that could improve their body composition and iron status.

The week prior and the week after the cooking classes, we will have a data collection period where we will draw a very small sample of blood, collect other body composition measures using a BodPod, and your resting metabolic rate using a BodyGem. There are minimal risks associated with all of the tests being performed in the data collection.

If you are interested in participating in this study, please leave your contact information on our CONTACT INFORMATION SHEET. A member of our research team will contact you to ensure that you are eligible for our study and set a time for you to complete our informed consent form and data collection. If you have any questions about the study, please feel free to ask me now or at any point during the consenting process.
Effect of a Food-Lab Based Cooking Intervention on the Dietary Intake and Nutrient Status of Collegiate Female Athletes
University of Cincinnati, College of Allied Health Sciences, Nutrition Department
Screening Questionnaire

PART A
1. Are you at least 18 years of age or older? Yes No
2. Are you currently an NCAA female collegiate athlete? Yes No
3. Are you able to attend (2) data collection periods, one in late May, one in late July? Yes No
4. Are you able to read, write, and speak English? Yes No

If the participant answered NO to any of the above, they are not eligible for the study.

If the participant answered YES to all of the questions above, proceed to PART B of the Screening Questionnaire.

PART B
1. Do you have any severe food allergies, in such a way that contact with specific foods could cause a life-threatening allergic reaction? Yes No
2. Are you currently or planning to become pregnant during this intervention? Yes No
3. Have you been previously diagnosed with an eating disorder? Yes No
4. Do you have a metabolic disorder or are on any medication that could affect your nutrition status? Yes No

If the participant answered YES to any of the above, they not eligible for the study.

If the participant answered NO to all of the questions in PART B in addition to answering YES to all of the questions in PART A, they are eligible for the study.
March 29, 2016

Robert Mangine, PT, AT, M.Ed
Associate Athletic Director of Sports Medicine
University of Cincinnati
2751 O’Varsity Way, Suite 265
Cincinnati, Ohio 45221

Angela Bruzina, B.M. CPT-NFPT
Nutrition Graduate Assistant
Department of Nutritional Sciences
College of Allied Health Sciences
Campus Recreation, University of Cincinnati

Dear Angela Bruzina:

The University of Cincinnati Women’s Volleyball Team is excited to be partaking in this new food-lab based cooking intervention as part of a College of Allied Health Sciences Nutrition Department research initiative.

All members of our team will have equal opportunity to be recruited for this study and participation will be entirely optional. Participation in this study will in no way affect the players’ status as a University of Cincinnati Athlete and all coaching staff are aware that athletes are not required to participate.

Our department will also provide funding for this initiative up to $1000.00 to cover expenses including food costs, materials, and equipment necessary to this project.

Sincerely,

Robert Mangine, PT, AT, M.Ed
Associate Athletic Director of Sports Medicine
University of Cincinnati
I. General Information
   A. Proper Attire: Subject must be properly dressed for testing accuracy purposes. If subject arrives at the test in attire that does not comply with specifications below, they will NOT be measured.
      i. Male Subjects
         a. No shirts, tees, or tanks are permitted
         b. Shorts may be spandex/lycra compression type or speedo type **without padding only**
      ii. Female Subjects
         a. No shirts, tees, or tanks are permitted
         b. Sports bras are permitted to be those **without padding or wires**
         c. Shorts may be spandex/lycra compression type or speedo type **only**
         d. A one-piece spandex/lycra swimsuit **without padding** is a permitted alternative to a sports bra with spandex or lycra shorts.
   B. Jewelry and Accessories
      i. All jewelry, watches, sunglasses, etc. **must be removed** during the testing session
         a. If you have jewelry on that you cannot remove, it must be worn during all follow-up tests
   C. Hair and Body Hair
      i. All test subjects will be asked to wear a lycra swim cap during the test; this swim cap will be provided or you may bring your own.
      ii. A hair tie may be used under the swim cap to pull back hair
      iii. If body hair is shaved the day before the test, it must be shaved in the same manner for any follow-up tests

II. Bod Pod Assessment Room
   A. Personal Belongings
      i. All personal belongings will be kept in the hallway adjacent to the assessment room
   B. Food and Drink
      i. **No food or drink** will be allowed in the assessment room at any time

III. Preparing for the BodPod Assessment
   A. Prior to the BodPod Assessment
      i. No food or drink **2-3 hours prior** to testing
   B. BodPod Testing Session
      i. Staff will instruct subject on directions during testing
      ii. Please **sit quietly and refrain from talking or moving** during the test
      iii. Expect the session to last approximately **10 minutes**

IV. **Forfeiture of Assessment**: Failure to follow The Department of Nutritional Science Bod Pod Policies and Procedures will result in immediate forfeiture of the test at that time. All subjects will be notified of Policies and Procedures prior to testing and are required to meet the department’s expectations at the time of the assessment.
Hey Bearcats! The first step in changing how you eat is to figure out what you are eating now. I am here to help you learn the RIGHT way to record your food!

Look at the GREAT example below. On your food record, you will record:
- The time you eat or drink anything
- What you ate or drank in detail
- The amount of what you ate or drank
- Where you ate this meal

This is a GREAT example of a food record!

<table>
<thead>
<tr>
<th>TIME</th>
<th>FOOD DESCRIPTION</th>
<th>AMOUNT</th>
<th>WHERE EATEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:30a</td>
<td>Honey Nut Cheerios</td>
<td>1 cup</td>
<td>Home</td>
</tr>
<tr>
<td></td>
<td>Skim Milk</td>
<td>1/2 cup</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Banana</td>
<td>1 medium</td>
<td></td>
</tr>
<tr>
<td>11:30a</td>
<td>Gatorade Recovery Shake</td>
<td>1 Shake</td>
<td>Training Room</td>
</tr>
</tbody>
</table>

...
This is a **NOT-SO-GREAT** example of a food record!

<table>
<thead>
<tr>
<th>TIME</th>
<th>FOOD DESCRIPTION</th>
<th>AMOUNT</th>
<th>WHERE EATEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:30a</td>
<td>Cereal</td>
<td>1 bowl</td>
<td>Home</td>
</tr>
<tr>
<td>12:00</td>
<td>Turkey Sandwich</td>
<td>1</td>
<td>Sandwich Place</td>
</tr>
<tr>
<td></td>
<td>Carrots</td>
<td>Handful</td>
<td></td>
</tr>
<tr>
<td>6:00p</td>
<td>Cookie</td>
<td>1 Cookie</td>
<td></td>
</tr>
</tbody>
</table>

Look at the **NOT-SO-GREAT** example below. **What is missing?**
- Are the **times** recorded correctly?
- How about the **food descriptions**?
- Is the ‘**where eaten**’ descriptive enough?

**Why is recording food so important?**
- It’s the **most valuable tool** for measuring food intake!
- It gives you an idea of where to make improvements, like eating more vegetables!
- It can help you **reach your daily intake goals**!

**Alright!** Now that you have learned how to properly record on a food record, it’s time to start recording **YOUR** food!
Bearcats in the Kitchen: Food Record Protocol

- You will record your food for (3) 24-hour periods from now until the first cooking class on Tuesday, June 7, 2016
- Make sure to be descriptive as possible and include all foods and drinks (including water) during that 24-hour period
- At least (1) 24-hour period should be a weekend day and (1) 24-hour period should be a week day
- Try to make sure the days that you record is a ‘typical day’ of food intake for you
- Make sure to log the DATE at the top of each food record
- YOU WILL TURN THIS COMPLETED FOOD RECORD IN ON THE FIRST DAY OF COOKING CLASS, June 7, 2016
Simply Carbs!

Carbohydrates act as your main energy source to fuel you through practices and competition so it is important to know which carbs to eat and when!

**Simple Carbohydrates**

- Carbs made of one or two sugar molecules

*Simple = Quick Energy*

**Simple Carbohydrates include:**
- Fruit drinks
- Candy
- Processed Grains
- Honey and Syrup
- Table Sugar

**Complex Carbohydrates**

- Carbs made up of three or more sugars such as fiber

*Complex = Long Term/Sustained Energy*

**Complex Carbohydrates include:**
- Green Vegetables
- Whole grain foods (pasta, oatmeal, rice)
- Starchy vegetables (potatoes, corn)
- Beans and Lentils *(also a GREAT source of protein)*
What Do I Eat Before My Early Workout?

Let’s say you have an early workout at 9:00am and you roll out of bed at 8:30am, what can you eat that is QUICK and will give you enough ENERGY to

Meal Options, less than 1 hour before:

- Half a plain bagel with ½ Tbs PB* or almond butter
- Sliced banana* with ½ Tbs PB or almond butter on 1 slice of toast
- 2/3 cup fruit* yogurt (1 container) with ½ cup granola
- 2 rice cakes with 1 medium apple*
- 1 cup cereal with milk and sliced banana*

Choosing a small meal LESS THAN 1 HOUR BEFORE:
Focus on QUICK energy sources: simple carbs*
Don’t eat anything TOO HEAVY: high fiber or high fat

What to eat AFTER your workout:
Grab a Recovery Shake from the Fuel Station
Go eat a full, balanced meal that focuses on protein and carbs

Meal Options, AFTER your workout:

- 1 Chicken breast (palm size) with 1 cup rice
- 4 slices of deli turkey between 2 slices of whole wheat bread (with condiments)
- 3-4 eggs and 1 cup breakfast potatoes
- (2) 4-inch pancakes and 3 slices of turkey bacon
Chicken Stir-Fry

5-6 oz. raw chicken breast, boneless and skinless
1 T. olive oil
2 T. low sodium soy sauce
1 tsp garlic, minced
1/8 tsp. salt
1/8 tsp. pepper
1 stalk broccoli, florets
1 red bell pepper, julienne
1 carrot, sliced or cut
1/8 tsp. red pepper flakes, if desired

Substitutions:
½ cup dry brown rice for stove top preparation (station one)
1 package ‘boil in bag’ rice (station two)
1 package microwavable brown rice (station three)

Directions

1. Prepare rice according to package directions. Wait until stovetop and ‘Boil in Bag’ until rice is halfway cooked to start the stir-fry component.
2. Spray a medium skillet with non-stick spray and heat over medium-high heat (6 on burner).
3. Cut chicken into bite-sized chunks and add to heated skillet.
4. Cook chicken in skillet about 3-4 minutes on each side, until chicken is browned on outside and no longer pink on the inside. Remove chicken from heat once cooked through.
5. Heat a separate medium skillet over medium heat (5 on burner) and add olive oil, soy sauce, garlic, salt and pepper. Add red pepper flakes if desired. Stir until well combined. NOTE: Do NOT add sauce mixture to the hot pan with the chicken or else it will splatter and may cause burns.
6. After 1 minute, add vegetables to the sauce mixture. Stir with a wooden spoon.
7. Add cooked chicken to the skillet with the vegetables and sauce. Continue to heat over medium heat until vegetables are cooked through and tender, about 5 minutes.
8. Serve stir-fry over cooked brown rice.
Creamy Tomato and Spinach Pasta

1/2 T. olive oil
1/2 yellow onion
1/2 tsp. minced garlic
1/2 can petite diced tomatoes
1/4 tsp. oregano
1/4 tsp. basil
1/8 tsp. red pepper flakes
1/8 tsp. salt (to taste)
1/8 tsp. pepper (to taste)
1 T. tomato paste
1/4 cup water
1/4 cup (2 oz.) frozen spinach
1/4 cup shredded parmesan cheese
1 box whole wheat penne/rotini

Substitutions:
- 2 Tbs light cream cheese (Station one)
- 2 Tbs coconut Milk (Station two)
- 1/4 cup Kale chopped (Station three)

Directions
1. Cook pasta according to package directions, drain and set aside in bowl.
2. In a large skillet with tall sides, heat olive oil over medium heat (5 on burner) for 2-3 minutes.
3. Add diced onion and heat 2-3 minutes until soft and translucent. Stir in garlic with a wooden spoon and heat 1 additional minute. Reduce heat to medium-low (3 on burner).
4. Carefully and slowly add the diced tomatoes (with juices) to the skillet. Stir to combine with onion and garlic.
5. Add oregano, basil, red pepper flakes, salt, and pepper to the skillet. Stir to combine.
6. Add the tomato paste and water to the skillet. Stir until the tomato paste is dissolved into the sauce.
7. Stir in cream cheese (station one & three) or coconut milk (station two) and shredded Parmesan. Stir until cream cheese/coconut milk is incorporated and smooth and Parmesan is melted.
8. Stir in frozen spinach (station one & two) or chopped kale (station three) and cook for 2 minutes until spinach is thawed and soft.
9. Mix in cooked pasta and serve dish warm.
Effect of a Food-Lab Based Cooking Intervention on the Dietary Intake and Nutrient Status of Collegiate Female Athletes

Demographic/Diet History Survey

<table>
<thead>
<tr>
<th>Hand Symbol</th>
<th>Equivalent</th>
<th>Foods</th>
<th>Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fist</td>
<td>1 cup</td>
<td>Rice, pasta</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fruit</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Veggies</td>
<td>40</td>
</tr>
<tr>
<td>Palm</td>
<td>3 ounces</td>
<td>Meat</td>
<td>160</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fish</td>
<td>160</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poultry</td>
<td>160</td>
</tr>
<tr>
<td>Handful</td>
<td>1 ounce</td>
<td>Nuts</td>
<td>170</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Raisins</td>
<td>85</td>
</tr>
<tr>
<td>2 Handfuls</td>
<td>1 ounce</td>
<td>Chips</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Popcorn</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pretzels</td>
<td>100</td>
</tr>
<tr>
<td>Thumb</td>
<td>1 ounce</td>
<td>Peanut butter</td>
<td>170</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hard cheese</td>
<td>100</td>
</tr>
<tr>
<td>Thumb tip</td>
<td>1 teaspoon</td>
<td>Cooking oil</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mayonnaise, butter</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sugar</td>
<td>15</td>
</tr>
</tbody>
</table>
Age: ____________________________

Ethnicity:
- African American/ African/ Black
- Caucasian
- Hispanic/Latino
- Native American
- Asian
- Other

State or Country of Birth: ______________________________________

Supplement Use:
- 5-7 days a week
- 4-6 days a week
- 1-3 days a week
- Do not use supplements

What kind of kitchen access do you have?
- Full kitchen access
- Just a microwave
- Just a refrigerator
- Microwave and refrigerator
- No kitchen access

How often do you consume meat?
- 2-3 times a day
- Once a day
- 3-5 times a week
- 1-2 times a week
- I do not consume meat

Do you have access to a car?
- Yes
- No

Average money per month spent on groceries:
- < $200 / month
- $250 / month
- $300 / month
- $350 / month
- > $400 / month

How often do you eat fast food/restaurant food?
- Never
- 1-2 times per week
- 3-4 times per week
- 5-6 times per week
- 7+ times per week

Do you live on or off campus?
- On campus
- Off campus