Gender differences in collegiate cross-country runners in regards to nutrition intervention

A thesis submitted in partial fulfillment of the requirements
For the degree of Master of Science in
Family and Consumer Sciences

by

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May 2016
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ACKNOWLEDGEMENTS

I would like to acknowledge and thank all involved in making this thesis possible. Thank you to my family and friends, especially to my best friend, Heather, and my husband, for supporting me through this process. I would like to acknowledge the research teams at UCLA and Stanford University, as well as the study participants for their involvement. I would like to extend my deepest gratitude to my committee members, Dr. Lisagor, Dr. Herman, and Dr. Barrack-Gardner. All have helped immensely during this complete process and I am forever grateful to each of them for getting me to this point. I would especially like to thank Dr. Barrack-Gardner for allowing me to be a part of her research team and guiding me through this entire process.
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ABSTRACT

GENDER DIFFERENCES IN COLLEGIATE CROSS-COUNTRY RUNNERS IN
REGARDS TO NUTRITION INTERVENTION

by

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Master of Science in Family and Consumer Sciences

The purpose of this study was to assess whether gender has an effect related to a
nutrition intervention improving the endurance runners’ energy intake, nutritional status,
and anthropometric indicators. In Fall 2013, runners from NCAA Division I Cross-
Country teams (n=23) completed baseline questionnaires to collect information regarding
baseline health history, anthropometric information, menstrual history (for female
athletes), history of athletic participation, and sports performance. Runners also
completed three 24-hour dietary recalls, which were used to analyze nutritional status,
and a 7-day exercise log, which was used to determine their average daily exercise
energy expenditure. After collection of data, the subjects participated in a nutrition
intervention created by the team dietitians, including individualized and group sessions
emphasizing nutrition for the endurance athlete. Dietary intakes and energy expenditures
were collected in Fall 2014 to assess the success of the intervention program. Using
paired sample t tests to compare pre- and post-intervention data, the results showed no
significant differences in nutritional intakes and energy expenditure between the genders.
Using independent $t$ tests within the genders, the results for the males showed significant differences in energy intake in g/day and g/kg ($-395.8\pm183.1, p=0.04$; $-6.5\pm2.7, p=0.03$), carbohydrate intake in g/day and g/kg ($-74.8\pm29.8, p=0.02$; $-1.9\pm0.4, p=0.02$), exercise energy expenditure ($+255.8\pm113.5, p=0.04$), and weekly running mileage ($+11.3\pm3.8, p=0.01$). The findings in this study point to the need for more research on nutrition education programs for collegiate endurance athletes that can benefit both genders equally.
CHAPTER I
INTRODUCTION

Cross-country is considered an endurance sport where the athletes run for varying lengths between 3,000 to 10,000 meters for collegiate competitions (National Collegiate Athletic Association [NCAA], 2012). Cross-country can also be defined as a leanness sport where the athletes are more lean and may experience internal or external pressure to maintain their weight within a certain low range (Torstveit & Sundgot-Borgen, 2005). The in-season training program for these endurance athletes includes running up to 70 miles per week, as well as cross-training, and some weight bearing resistance exercises. Due to the amount of training involved, adequate energy intake (EI) and proper macronutrient balance is needed to ensure that the athlete is meeting the demands of the sport. Inadequate intake of energy and essential nutrients can lead to impaired performance, loss of focus, and potentially injury (Burke & Deakin, 1994).

Regarding macronutrients, adequate carbohydrate intake is important for maintaining and replenishing the muscle glycogen and blood glucose levels needed to fuel continuous running performance. When endurance athletes exert themselves at 85% of VO$_{2\text{max}}$ or above, carbohydrates, primarily stored in muscle glycogen, are the main fuel source for the body. If the athlete does not get enough carbohydrates through the diet during training and competition, then the overall athletic performance declines from fatigue due to depleted muscle glycogen levels. For this reason, daily carbohydrate consumption should range between 6-10 g carbohydrate per kg of body weight (Rosenbloom & Coleman, 2012; ACSM, 2000).
For another important macronutrient, protein intake should range between 1.2-1.7 g per kg body weight in order to maintain the body’s nitrogen balance and to keep the body from using muscles as a source of protein, leading to muscle wasting. Protein is not a significant source of energy during exercise; therefore, the amount of protein is much lower than the carbohydrates needed for optimal performance (Rosenbloom & Coleman, 2012). For the third major macronutrient, fat, dietary recommendations are set at 1-2 g per kg of body weight for endurance runners corresponds to the Acceptable Macronutrient Distribution Range (AMDR) for all healthy adults as 20-35% of total energy intake as stated by the Food and Nutrition Board of the Institute of Medicine (2005). The role of fat in exercise is important because it provides energy, vitamins, and essential fatty acids (ACSM, 2000). While there have been studies that look at the effects of high-fat diets on endurance athletes (Zajac et al., 2014; Paoli et al., 2012), the results may be limited to due sample size and duration of the studies.

For the micronutrients, the Adequate Intake (AI) or Recommended Dietary Allowance (RDA) as specified by the Food and Nutrition Board of the Institute of Medicine is the standard that is used to quantify the healthfulness of an athlete’s diet. Ingesting a nutrient-dense diet which includes a variety of vegetables, fruits, whole grains, and lean proteins, can increase micronutrient intakes allowing for optimal athletic performance. For example, calcium and vitamin D are important for healthy bones, and iron for oxygen delivery in blood to the muscles (Rosenbloom & Coleman, 2012).

Specific to endurance runners, there is evidence that under-fueling is a prominent issue. Due to the amount of exercise that endurance runners participate in, from training runs to strength training sessions, most athletes are not compensating their EI for their
EEE. Because under-consumption of micronutrients does not produce the same hunger cues as under-eating would, most athletes are unaware that they are under-fueling; this deficit can lead to health issues and injuries (Loucks, 2007). One study looking at Kenyan endurance runners (Onywera, Kiplamai, Boit, & Pitsiladis, 2004) noted that in the week before a competition, the runners’ EEE was higher than their EI resulting in a negative EB and an energy deficiency. However, in this study, the athletes consumed the recommended amount of carbohydrates by consuming an average of 607 g, which averaged to be 10.3g/kg body weight. Even with the sufficient amount of carbohydrates ingested, having consistently negative EB can impair performance and health of athletes. Understanding the macro- and micronutrients that athletes consume will determine whether the athletes involved in this study benefitted from a nutritional intervention by looking at their nutrition pre- and post-intervention.

**Purpose**

The study from which data is used looks at the relationship between a nutrition intervention among elite competitive NCAA Division I cross-country and their energy intake, nutritional status, anthropometric data, bone mineral density, and menstrual functions (among the female athletes). Using data from the previous study, the purpose of this study was to assess whether gender has an effect related to a nutrition intervention for improving the endurance runners’ energy intake, nutritional status, and anthropometric indicators. It is hypothesized that male athletes will respond more favorably to the nutrition education intervention compared to female athletes by displaying more significant improvements in 1) energy status; 2) macronutrient intake;
and 3) body weight due to various factors such as societal pressures and competition within peer groups for women as well as incidence of the Female Athlete Triad (Triad).

**Definitions**

- **Amenorrhea**: The absence of a menstrual cycle for more than 90 days (Nattiv, et al., 2007).
- **Energy Balance (EB)**: The condition in which the amount of energy consumed equals the amount of energy expended, including basal metabolic rate and exercise (ACSM, 2000).
- **Energy Deficiency**: For the current study, defined as energy intake <90% of TDEE.
- **Energy intake (EI)**: The sum of all energy derived from foods, fluids, and/or supplements (ACSM, 2000).
- **Exercise Energy Expenditure (EEE)**: The amount of energy used when performing any type of exercise, with amount based on frequency, duration, and type of exercise performed (Rosenbloom & Coleman, 2012).
- **Expected Weight**: The ideal body weight using the Hamwi equation, which uses a base of 100 pounds for 5 feet of height, and adds 6 pounds for every additional inch (both genders), and subtracts 5 or 6 pounds (women and men, respectively) for every inch under 5 feet (Mahan, Escott-Stump, & Raymond, 2012).
- **Eumenorrhea**: Menstrual cycles that occur at a median interval of 28 days with a SD of 7 days (Nattiv et al., 2007).
- **Female Athlete Triad**: The interconnected relationships between spectrums of energy availability, menstrual function, and bone mass density with clinical
expressions including eating disorders, amenorrhea, and osteoporosis (Nattiv, et al., 2007).

• Low Body Mass Index (BMI): A BMI of less than 18.5 kg/m² (Mahan et al., 2012).

• Low Body Weight: For the current study, defined as <85% and <90% of expected weight.

• Macronutrient: Large molecular structures that provide energy for the body; includes carbohydrates, proteins, and fats (Gropper, Smith & Groff, 2009).

• Micronutrient: Organic compounds that are essential for the body’s functions but do not supply energy; includes vitamins and minerals (Gropper et al., 2009).

• Oligomenorrhea: Menstrual cycle that occur for intervals longer than 35 days (Nattiv, et al., 2007).

• Resting Metabolic Rate (RMR): The amount of energy needed to maintain basic physiological functions of the body when at rest (Rosenbloom & Coleman, 2012).

• Total Daily Energy Expenditure (TDEE): The amount of energy expended daily, which includes a person’s resting metabolic rate, the thermal effect of food, non-exercise activity thermogenesis, and EEE (Rosenbloom & Coleman, 2012).

• VO_{2max}: The maximum oxygen uptake, representing the peak rate of aerobic energy production an individual can achieve (Rosenbloom & Coleman, 2012).

**Theoretical Framework**

This study uses the Human Ecological Theory as a framework for the research. The Human Ecological Theory, as explained by Bronfenbrenner (1996), states that an individual is influenced and, therefore, a product of all factors that surround it in the
environment. While an individual has one’s own thoughts and ideas, many factors influence the individual ranging from those close to the individuals to more abstract influences from media, government, and economic influences. For this study, the subjects’ dietary habits will be examined before and after a nutrition intervention, which can explore the various social factors that can influence the athletes in their lives.

**Assumptions**

Results of this study are based on the following assumptions:

1) The participants involved are male or female runners from NCAA Division I Cross-Country teams.

2) The participants understood the primary study and agreed to participate as evidenced from their completed consent form.

3) Self-reported data was reported accurately.

4) Data was collected and analyzed accurately.

**Limitations**

Some limitations to this study include:

1) Sample size – the sample size of the study may be considered small which can skew data results.

2) Generalizability – the sample included cross-country athletes from two NCAA Division I universities and, therefore, the results might not be generalizable to athletes in other sports or to the general population.

3) Sample attrition – the results might be skewed due to athletes who dropped out of the study.
4) Study design – the uncontrolled experimental design may not account for other influences on an athlete’s diet rather than the study’s intervention, which can skew the data and results.

5) Self-reported data – information that the athletes provided may not be accurate whether known or unknown to the athletes.
CHAPTER II
REVIEW OF LITERATURE

General Nutrition for Athletes

The nutrition of the athlete can affect not only the health of the athlete, but also the performance of the athlete in one’s particular sport. In a joint position paper from the American College of Sports Medicine (ASCM), the American Dietetic Association (now known as the Academy of Nutrition and Dietetics [AND]), and the Dietitians of Canada (2000), having proper nutrition, especially in regards to having adequate EI, can positively affect the athlete’s performance. Inversely, negative energy balance can lead to increased risk of injury or sickness, loss of muscle mass, low bone density, and, for female athletes, menstrual dysfunction. In addition to these issues, the low energy intake leads to lower intake of macro- and micronutrients which can lead to other health issues from these deficiencies (ACSM, 2000). Low energy intake in female athletes can lead to further complications related to the Triad. Athletes with some or all of the signs of the Triad have more medical complications regarding major organ systems in the body such as the cardiovascular, skeletal, and central nervous systems and the occurrence of stress fractures are more common in amenorrheic athletes as compared to eumenorrheic athletes (Nattiv et al., 2007). Whether athletes are restricting their EI intentionally or unintentionally, there may be more pressure on athletes to present themselves in a certain way that is more societally representative of the culture’s ideals of a typical athlete, particularly if their sport emphasizes a lean physique, such as cross-country running (Byrne & McLean, 2001). Because of this pressure, many athletes have issues with
disordered eating and/or eating disorders that can further complicate their performance and health.

**Disordered Eating in Athletes**

There are numerous studies that look at the prevalence of disordered eating (DE) in athletes as compared to non-athletes. One study by Sundgot-Borgen (1993) compared two groups of female subjects only relative to the prevalence of eating disorders between them. The study did not include any data regarding dietary intakes of the subjects and used the Eating Disorder Inventory (EDI) and a questionnaire designed by the author to assess behaviors that could be categorized as DE. The study found that while more controls than athletes were deemed “at-risk” for eating disorders (22% vs. 26%, respectively, \( p=0.08 \)), more athletes in the “at-risk” category actually met the criteria for an eating disorder (ED) than the “at-risk” controls (89% vs. 20%, respectively, \( p<0.01 \)).

The author also categorized the athletes according to sports type and found that while endurance athletes had lower prevalence of ED than athletes in aesthetic sports (e.g. gymnasts; [20% vs. 34%]), within the endurance cohort, the middle/long distance runners exhibited more signs of ED than other endurance athletes (\( p<0.05 \)).

The author continued researching prevalence of DE in athletes compared to non-athlete controls in a study that looked at ED including anorexia nervosa (AN), bulimia nervosa (BN), anorexia athletica (AA) and eating disorders not otherwise specified (ED-NOS) (Sundgot-Borgen & Torstvet, 2004). The criteria of these EDs were based on the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV). Again, a questionnaire and the EDI were used to determine “at-risk” subjects, as well as an interview with an eating disorder specialist to determine the amount of subjects that fit
the DSM-IV criteria of eating disorders. There was no use of dietary intakes to determine whether the subjects had low energy availability or a negative energy balance. The study included a larger sample size than the previous study (n=2,462 vs. 970, respectively), however it did include male subjects in addition to female athletes. After the initial questionnaire and the use of the EDI, 182 athletes and 103 controls were deemed to be at-risk of ED; after the interview, 170 athletes and 55 controls met the diagnostic criteria of the DSM-IV for ED. These results mirror the results of the earlier study where the prevalence of ED was greater in athletes than in the non-athlete controls. In addition to those results, the study found that female athletes had a higher prevalence of ED than male athletes with 20% of females athletes meeting the criteria for ED compared to 8% of male athletes \( (p<0.001) \). The study categorized the athletes into different sports groups mirroring the earlier study and found that both males and female athletes involved in endurance sports had high prevalence of all types of EDs, which indicates that a lean body type in the sport is more desirable for the athletes.

Other studies have corroborated these findings that female athletes are more likely than male and that athletes in thin-build or leanness sports are more likely than other types of athletes to exhibit signs of ED, whether clinical or subclinical (Byrne & McLean, 2001; Byrne & McLean, 2002). However, another study comparing athletes and non-athlete control subjects found that, while all females met the criteria of ED, more of the non-athletes met the criteria of ED or showed more signs of subclinical ED than the athletes. The study also found no correlation between the type of sport played and the clinical or subclinical signs of ED. However, a limitation of the study was the cross-
sectional design, in which the athletes were interviewed during different times in their respective seasons; this might skew the results (Sanford-Martens et al., 2005).

These findings do not necessarily mean that athletes are more susceptible to ED and/or DE than the general population; however, they might not have the proper nutrition knowledge to realize that they are not getting enough energy through food to counteract the energy they spend through exercise. The following set of studies looks at how much nutrition knowledge athletes have and are exposed to and how their attitudes towards food and nutrition affect their intake.

**Nutrition Knowledge and Attitudes in Athletes**

Studies that examine how much nutrition knowledge athletes possess have been conducted for at least 30 years. Two studies published in the 1980s looked at the nutrition knowledge female athletes had regarding nutrition and their attitudes and behaviors regarding nutrition (Barr, 1987; Perron and Endres, 1985). The earlier study looked at high school women volleyball players and used 24-hour dietary recalls for 2 days to determine dietary intake and then used a knowledge test for nutrition knowledge. The subjects scored a mean score of 65% (105 out of 160 possible points). The low score indicated that athletes were not familiar with understanding the basic tenets of nutrition.

In the later study, female college athletes’ nutrition knowledge and understanding was compared to non-athlete females and also used a knowledge test to determine understanding of nutrition. Part of the questionnaire also asked for dietary habits of the participants. The study found that there was no significant difference between the athletes and non-athletes regarding nutrition education and both the athletes and controls had a mean score of 34% on the test. Also, Barr (1987) indicated in her study that there
was no positive relationship between participating in athletics and nutrition knowledge, showing that athletes did not have an edge over non-athletes in nutrition knowledge.

The study further broke down the scores based on the type of sport played. The cross-country/track-and-field athletes had a mean score above the total athlete score with a score of 38%, showing lack of understanding the basics of nutrition. The study conducted by Barr (1987) also looked at sources the subjects used to gain nutrition knowledge and which ones they deemed as useful and both magazines and books ranked high as most useful for both groups (21 vs. 14%, students vs. athletes; 20 vs. 20%, respectively). Only 7% of the controls and 2% found dietitians as the most useful.

Studies looking into the nutrition knowledge of athletes continued over the next 30 years and the results from these studies are comparable to the studies by Barr (1987) and Perron and Endres (1985). A study conducted by Jacobson, Sobonya, and Ransone (2001) used a 39-item survey that were sent to various Division 1A universities for a random sample of athletes to complete and mail back to the authors. While the authors do not publish the mean score of the entire survey, they provided information regarding some of the questions asked. For example, they noted that only 29% of the athletes accurately indicated the correct percentage of calories that should come from carbohydrates and only 3% and 11% answered correctly for protein and fat intakes, respectively. Jacobson et al. also looked at the different sources of nutrition knowledge also finding that the nutritionist/dietitian ranks lower than other sources at 10% of knowledge for athletes. As a source of nutrition information, magazines ranked equally with the nutritionist, while the strength and conditioning coach (SCC) and athletic trainer were ranked the highest, with 21.9 and 19.0%, respectively.
Another study that looked at Division I athletes and their nutrition knowledge saw results that were similar to previous studies. Jonnalagadda, Rosenbloom, & Skinner (2002) used athletes from one particular university where a full time registered dietitian is employed and where the athletes attend numerous nutrition seminars and have individual nutrition counseling made available to them. The athletes completed a self-administered questionnaire with 11 general nutrition statements regarding macronutrients, fluids and hydration, and vitamins and minerals. The mean score for all the athletes was 5.8 with no significant difference between the male and female athletes (5.9 vs. 5.7, respectively). To point out individual statements on the questionnaire, 47% of males and 43% of females believe that protein is the main source of energy for the muscle and approximately a third of both sexes believe that protein supplements are necessary. Also, 67% of males and 53% of females believed that vitamin and mineral supplements help increase energy. These findings suggest that, even with a registered dietitian actively involved in the athletes’ training, their nutrition knowledge is deficient in certain areas.

This trend continues in a study by Dunn, Turner, & Denny (2007) in which athletes of various sports answered the Nutrition and Knowledge Questionnaire that was developed by Parameter and Wardle (2000). This found that the mean score for the questionnaire (n=190 athletes) was 51.49% (SD 13.57%). Once again, this shows that knowledge regarding nutrition in collegiate athletes is lacking. Unlike the study by Jonnalagadda et al. (2002), Dunn et al. found a significant difference in knowledge scores between male and female athletes (p<0.01), with the female athletes scoring higher overall, as well as in each individual section of the questionnaire. Looking at the answers given for the questionnaire, the athletes seemed to correctly guess broader concepts as
opposed to specific items. For example, about 75% of the athletes correctly identified the recommendations to lower salt, sugar, and fat intake and increase the amount of fiber, fruit and vegetables in the diet. However, only 32% of the athletes correctly guessed the recommended daily amounts of fruits and vegetables.

There have been various studies that look at the nutrition knowledge of sport-specific athletes as opposed to athletes in general. Reading, McCargar, and Marriage (1999) focused on male hockey players to determine whether a nutrition knowledge intervention improved scores on a questionnaire in a pre-test/post-test study design. The study involved 175 Canadian hockey players, aged 10 to 21 years. Only 33 subjects completed the pre-test and post-test. The subjects were participants in a summer hockey school where nutrition education is part of the program. The nutrition intervention consisted of lectures, group discussions and activities, individual activities, and use of videos. The pre-test scores (n=175) were 20.4 out of 45 (SD 4.8), which is a mean score of 45%. After the intervention, the test scores (n=33) were 22.0 (SD 4.7), which is 49%. Looking at the pre-test scores just the 33 individuals that took the post-test, the scores were 19.9 (SD 5.5), which the authors found statistically significant ($p<0.001$). This results mirror the previous studies discussed with scores hovering around the 50% range, indicating that athletes are lacking in proper nutrition knowledge.

Abood, Black, & Birnbaum, (2004) used a nutrition intervention with two separate women’s teams (swimming and soccer). One of the teams was randomly selected to be the control group. Both groups took a pre-test and post-test questionnaire at baseline and then at the 9-week point and completed a 3-day diet record, with the experimental group going to 8 weekly nutrition education sessions, while the control
group went to a supervised study hall. The results show that out of 42 questions, the experimental and control groups scored almost the same on the pre-test (29.5[SD 0.54] vs. 28[SD 0.32], respectively). However, the experimental group increased their scores significantly after the intervention compared to the control group (32[SD 0.68] vs. 27.5 [SD 0.61], respectively, \(p<0.05\)).

These results were similar to what Valliant, Emplaincourt, Wenzel, & Garner found with a team of female volleyball players at a NCAA university where a nutrition intervention was administered (2012). This study used only one group with a pre- and post-test study design. As with most of these research studies, the questionnaire focused mainly on sports nutrition knowledge, rather than general nutrition information. The researchers found that the athletes’ performance on the questionnaire improved significantly after the intervention, where the pre-test scores were 24.7 (SD 5.9) and the post-test scores were 31.5 (SD 6.1) out of 55 points \((p=0.001)\). However, as seen with the other studies, the mean post-test score was still in the 50-60% range (57%), which indicates that athletes do not have a proper grasp on basic nutrition knowledge.

Zawila, Steib, & Hoogenboom (2003) focused on female collegiate cross-country runners specifically. Here, too, the results suggest echoed that athletes are lacking knowledge in nutrition, which can affect their athletic performance and overall health. Subjects completed a questionnaire where both general nutrition knowledge and nutrition for the athlete were assessed. The athletes scored a 57% on the questionnaire with a mean score of 37.2 out of 65 total points. The study also asked the subjects from where they obtained their nutritional information and the top four sources were magazines, parents, coaches, and teammates, while fewer than half stated physicians and fewer than 20%
stated athletic trainers; the study did not indicate the percentage of those who used a
dietitian as a source of nutrition knowledge.

Rash, Malinauskas, Duffrin, Barber-Heidal, & Overton (2008) looked at male and
female collegiate track athletes and had them complete a nutrition questionnaire and a
food frequency questionnaire to assess the athletes’ dietary intake. Again, results suggest
that athletes are lacking in nutrition knowledge with a mean score of 58% (SD 13%) and
no significant difference between the genders. The researchers also compared dietary
intake with the knowledge scores and found no significant correlation between the two
factors. However, because this study was a cross-sectional study, the correlation factor
is weaker to show than an experimental study design.

In addition to having athletes take tests to gauge general nutrition knowledge,
some of the studies also compared the knowledge the subjects had to their reported
dietary intakes to determine if there was any correlation between the two. Neither Barr
(1987) nor Perron and Enders (1985) found a correlation between nutrition knowledge
and dietary intake, indicating that having more access to nutrition information did not
improve an athlete’s diet. Abood et al. (2004) looked at the dietary intake for both groups
after the intervention. For the experimental group, while there were no significant
differences in their dietary intakes pre- and post-intervention, the overall trend was
significantly positive ($p>0.03$). With the significant increase in nutrition test scores, the
athletes’ knowledge correlated to their dietary intake. The non-athlete controls did not
show any increase in knowledge and did not show any change in their diets, other than a
decrease in the amount of carbohydrates and fiber consumed. Valliant et al. (2012) also
tracked the dietary intake of the athletes with a 3-day diet record that was tracked
throughout the intervention period. Results showed significant differences in the intake of energy, carbohydrate, and protein intakes ($p<0.05$) in the positive direction. This could indicate a direct correlation between the increased test scores and improved dietary intake. However, looking at the percentage of total needs in those categories, the athletes were still ingesting less than the recommended amounts for athletes, showing that there is still need for improvement in their diet.

These results suggest that all athletes can benefit from more nutrition education in order to enhance their health and performance. The subjects in these studies still had low test scores in nutrition knowledge following an intervention, suggesting need to increase athletes’ understanding and knowledge of nutrition on a consistent basis.

**Nutrition Interventions and Effects on Body Composition**

While there are many studies that look at nutrition interventions and their effects on athletes’ knowledge on the subject of nutrition and some studies looking at both knowledge gained and the changes in dietary habits, fewer studies look at the effects of nutrition interventions on the body composition of subjects. Leblanc et al. (2014) investigated dietary intake and body composition in non-athletes after a nutritional intervention that focused on the Mediterranean diet. The purpose was to investigate differences between the genders, and whether one gender benefitted more than the other. While not using athletes specifically, the study can help illuminate techniques to benefit both genders in future research. The study used a 12-week intervention with group and individual counseling while focusing on the main tenets of a Mediterranean diet with a 3 and 6 month post intervention follow-up. The researchers looked at dietary intake and habits, anthropomorphic measurements, and metabolic measurements at all subjects.
before and after the 12-week period and a portion of subjects at the 3-month and 6-month period after the intervention (participation was not required at these times). The researchers found that there was no significant difference between the gender regarding changes in dietary habits and intake, or in percentage of body fat and body mass. However, the men had a significantly greater change in cholesterol and triglyceride levels than females.

Lagowska, Kapczuk, and Jeszka (2014) looked at the results of a nutritional intervention with female athletes, including ballet dancers, in restoring menses. While the emphasis on menses restoration is not central to this thesis’s focus, the effects of a nutritional intervention on female athletes can be useful when developing strategies to improve the health and performance of all athletes. The researchers looked at resting metabolic rates (RMR), total energy expenditure, and energy availability at baseline and after 3, 6, and 9 months of the nutritional intervention. Dietitians obtained dietary intakes from the athletes and dancers, considered as two distinct groups, using consecutive 7-day dietary records and then created individualized diets for each participant based on their nutritional deficiencies. While this individual attention can be extremely helpful for athletes to obtain ideal health and performance, for dietitians and/or other health practitioners working with large amounts of athletes at a university setting, it could prove to be overwhelming and unrealistic.

The dancers and other female athletes in the study showed significant increases in energy intake, protein, and carbohydrates, as well as energy balance and energy availability post-intervention. Also, both the dancer and athlete groups saw subjects restore menses, from 0 eumenorrheic subjects to 10 at the end of the 9-month period (3
dancers, 7 athletes). However, the athletes saw no significant change in body weight, fat mass, and fat-free mass as opposed to the dancers who did see significant changes in their body weight. This study is useful because the results show that increase in energy intake and energy availability does not equate to weight gain and change in body composition, which some female athletes might fear can harm their athletic performance.

Cialdella-Kam, Guebels, Maddalozzo, & Manore (2014) looked at female athletes, restored menses, and body composition comparing a control consisting of eumenorrheic athletes to an experimental group of athletes with exercise-related menstrual dysfunction (ExMD) (i.e. their energy intake was less than their energy expenditure. The experimental group in this study was given a carbohydrate-protein supplement (a Gatorade drink), adding an additional 360 calories daily, with no change to their exercise program. While the mean energy balance remained in the negative after the intervention (-44, SD 707 kcal/day), it did increase from the baseline measurement (-510, SD 361 kcal/day). The same trend occurred with the energy availability with an increase in the amount of kcal per day. There was very little change in weight, fat free mass, and percentage of body fat. However, it was observed that all the participants in the experimental group had restored menses and 7 of the 8 athletes were ovulating after the 6-month intervention.

Two studies, using the same group of elite athletes, aged 17-31 years, explored the effects of nutritional interventions on body composition with elite athletes. Garthe, Raastad, & Sundgot-Borgen (2011) focused on whether the athletes gained in body mass and lean body mass after nutritional counseling comparing them to a control group who did not receive any counseling. The meal plans for the experimental group added a mean
total of 506 kcal/day and had the athletes participate in weekly nutritional counseling sessions; the control group received no counseling, no guidance and no diet plan. While the experimental group increased the mean energy intake during the intervention, the intake returned to the baseline amount post-intervention. However, the body mass goal for the experimental group was nearly met at the end of the intervention and throughout the follow-up period. For the control group, energy intake did not significantly change throughout the study period and none of the athletes in this group reached their body mass gain goal during the intervention. After the follow-up periods, three of the athletes in the control group had lost body mass, while none in the experimental group lost body mass.

In the second study, Garthe, Raastad, Refsnes, & Sundgot-Borgen (2013) again randomized the athletes into an experimental and control group, with the experimental group receiving a meal plan that provided them with additional calories leading to a positive energy. The control group was given no meal plan and could consume as many calories as they wanted. The subjects were then evaluated after 10 weeks for body composition and performance on various exercises, (e.g. 40-meter sprint and weighted exercise movements [squats, bench press, and bench pull]). Results showed a positive and significant change in body mass between the pre- and post-intervention in the experimental group and there was a significant difference between the two groups. This was also seen in the lean body mass of the upper body area, and the total fat mass. The experimental group significantly increased the amount of energy intake in the 10-week period, while the control group saw a decrease, though not a significant amount. However, the difference between the two groups was significant.
These studies showed that a nutritional intervention can help achieve specific goals of athletes with desired weight gain, but the studies did not state the gender of the athletes involved. If there were no female athletes included in these 2 studies, then the results might not be generalizable to all athletes. Also, by including older athletes, the results may not be generalizable as well because they have more experience with nutrition for performance and could be more apt to be compliant to increase performance than younger athletes in a collegiate environment.

Overall, all these studies show that all types of athletes could increase the amount of nutrition knowledge made available to them, which could help improve their overall health, body composition, and athletic performance. More studies using comprehensive dietary analysis in tandem with nutritional interventions can help assess how successful the interventions can be between genders and whether certain incentives can be introduced to increase success rates.
CHAPTER III

METHODS

Study Design

This non-randomized quasi-experimental interventional study was designed to assess whether gender has an effect related to a nutrition intervention aimed to improve the energy intake, nutritional status, and anthropometric indicators among a sample of NCAA Division I male and female cross-country athletes. We obtained written consent from all athletes prior to their participation in the study. The study was approved by the UCLA Institutional Review Board.

Data Collection

After obtaining written consent, the athletes completed a written questionnaire to collect information regarding baseline health history, anthropometric information, menstrual history (for female athletes), history of athletic participation, and sports performance. The athletes also completed an Eating Disorders Examination Questionnaire (EDE-Q) and were asked about current or prior diagnosis of an eating disorder. Also, at baseline and approximately 12-months post-baseline, to evaluate nutritional status, runners completed three phone-based 24-hour recalls and completed an evaluation of current exercise activity. The nutrition intervention, consisting of team nutritional talks and/or one-on-one nutritional counseling sessions, was implemented during the 12-month period between the baseline and 12-month post-baseline nutrition assessments.

Dietary Intake and Energy Status
Athletes’ nutrition information was obtained using 3-day 24-hour recalls over the course of a 2-week period. These recalls occurred at baseline and at 9 months post-baseline with the dietary information collected for 2 weekdays and one weekend day to obtain an accurate account of the athletes’ dietary intake and nutritional status. The recalls used a modified multiple pass technique (Appendix A) wherein the athletes were asked about their dietary intakes at least 3 times on one phone call with the first pass focusing on general dietary information, the second pass becoming more detailed with quantities and measurements, and the third pass focusing on specific information such as the brand of food item or from where the food item came, how the food item was prepared, and if there were any missing items from the day (Cox, 1996). The data was recorded using the 24-hour Food Log (Appendix B) and then imported into the ESHA Food Processor Nutrient Analysis Program (Salem, OR) for analysis. The athletes were also asked if they avoided certain foods, had any allergies, used any supplements (at least 3 times a week), and whether the intake for that day was typical or atypical.

An exercise log (Appendix C), administered by phone and inquiring about all purposeful exercise, was also obtained at the same time as the recalls to calculate exercise energy expenditure (EEE). On the third day of recalls for the baseline and follow-up recall period, the athlete was asked to estimate their exercise performed during the past 7 day. This only included purposeful aerobic, strength, or power-based exercise performed relative to any strength training and the amount of miles run during the 7-day period, excluding habitual physical activities of daily living, such as walking to and from class.

**Nutrition Intervention**
After collecting dietary intakes and EEE for all participating athletes, a mean EI was calculated using the information entered in the Food Processor Software. Total daily energy expenditure (TDEE) was calculated using the Harris-Benedict equation for BMR, plus the EEE (using the ACSM Compendium MET equivalents equation above), and the addition of an activity factor of 1.5 (to the RMR, therefore RMR x 1.5). The EB of each athlete was obtained by subtracting the TEE from the EI, with an energy deficiency (or negative EB) considered as an EI < 90% of the TEE. Other risk factors considered were low BMI (BMI of <18.5 kg/m²), low body weight (<85% of expected weight), amenorrhea or oligomenorrhea in females, and signs/symptoms of ED or DE.

With all the data compiled, the team dietitians created a nutrition intervention for all members of the team regardless of indication of risk factors. All the participants had a 15-30 minute one-on-one session to discuss healthy habits based on their individual assessment. With the athletes that that met criteria for an energy deficiency (EI < 90% TDEE), the dietitians provided specific education during these runners’ one-on-one sessions geared at increasing energy intake, macronutrient needs, and overall energy status. For those not at risk, the individual session focused on general nutrition information to increase performance and general health. In addition to the individual meetings, some participants also attended a team nutrition talk lead by the dietitians at the beginning of each endurance running season to discuss nutrition needs for endurance runners.

**Statistical Analysis**

Independent t tests were performed for all baseline and follow-up data to evaluate differences in energy, macronutrients, and micronutrients between the male and female
participants. Paired sample $t$ tests evaluated the differences in nutritional data pre- and post-intervention between males compared to females to ascertain whether one gender experienced a greater benefit from the intervention over the course of the study. An alpha value of 0.05 was used for statistical significance and all data was prepared using the Statistical Package for Social Sciences (SPSS) software (Chicago, IL).
CHAPTER IV
RESULTS

Sample

The purpose of this study was to assess whether gender has an effect related to a nutrition intervention improving the endurance runners’ energy intake, nutritional status, and anthropometric indicators. In Fall 2013, at the baseline time point of the study, prior to the intervention, among the 93 eligible runners, 49 runners (19 females & 30 males) agreed to participate in the study (Figure 1). At this time point, three 24-hour dietary recalls and self-report information regarding sports participation, eating attitudes and behaviors, injury history and other health history items were collected. At the follow-up in Fall 2014, after the intervention, data from 23 subjects (7 females & 16 males) of the original 49 runners were collected (Figure 1). Figure 1 details the flow of runners’ participation for the current study.
Sample Characteristics

The descriptive characteristics of the subjects are featured in Table 1. These include the anthropometric, training information, and menstrual information data (females only) among the runner participants. The sample included 23 cross-country athletes from UCLA and Stanford University. Females represented 30% (n=7) and males represented 60% (n=13) of the sample. Of the female athletes 71% (n=5) identified themselves as White/Caucasian and 29% (n=2) identified themselves as Other. Of the male athletes, 88% (n=14) self-identified as White/Caucasian, 6% (n=1) self-identified as Latino, and 6% (n=1) self-identified as Other. At baseline, the men exhibited significantly higher BMI compared to the women (Table 1).

Table 1.

<table>
<thead>
<tr>
<th>Description</th>
<th>Females (n=7)</th>
<th>Males (n=16)</th>
<th>Total (n=23)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>19.1±0.7</td>
<td>20.0±0.3</td>
<td>19.8±0.2</td>
<td>0.08</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>56.1±0.9</td>
<td>67.5±1.5</td>
<td>64.1±1.5</td>
<td>0.04*</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>169.3±2.4</td>
<td>176.2±1.8</td>
<td>174.1±1.6</td>
<td>0.00*</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>19.7±0.6</td>
<td>21.7±0.5</td>
<td>21.1±0.4</td>
<td>0.03*</td>
</tr>
<tr>
<td>Running mileage/week</td>
<td>53.4±2.9</td>
<td>60.9±3.9</td>
<td>58.3±2.9</td>
<td>0.22</td>
</tr>
<tr>
<td>Age of Menarche</td>
<td>13.7±0.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Number of menses in last 12 months</td>
<td>5.7±1.4</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
At baseline, among the 7 female athletes, 42.9% (n=3) met the baseline criteria for amenorrhea, 57.1% (n=4) had a current weight less than 90% of the expected weight, and 14.3% (n=1) had a current weight less than 85% of the expected weight. Among the males, 50% (n=8) has a current weight less than 90% of the expected weight and 31.3% (n=5) has a current weight less than 85% of the expected weight.

**Baseline Nutrition Characteristics**

The baseline nutrition characteristics for the subjects are featured in Table 2. This includes caloric intake, macronutrient intake, selected micronutrient intake, TDEE, EEE, and total energy balance.

<table>
<thead>
<tr>
<th>Table 2.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline Nutrition Characteristics of Female &amp; Male Cross-Country Runners</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td>Kcal/day</td>
</tr>
<tr>
<td>Kcal/kg</td>
</tr>
<tr>
<td>Carb (g/day)</td>
</tr>
<tr>
<td>Carb (g/kg/day)</td>
</tr>
<tr>
<td>Protein (g/day)</td>
</tr>
<tr>
<td>Protein (g/kg/day)</td>
</tr>
<tr>
<td>Fat (g/day)</td>
</tr>
<tr>
<td>Fat (g/kg/day)</td>
</tr>
<tr>
<td>Vit D (IU/day)</td>
</tr>
<tr>
<td>Calcium (mg/day)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>Iron (mg/day)</td>
</tr>
<tr>
<td>TDEE (kcal/day)</td>
</tr>
<tr>
<td>EEE (kcal/day)</td>
</tr>
<tr>
<td>EB (kcal/day)</td>
</tr>
</tbody>
</table>

Note. Mean ± SEM, SEM – standard error of mean, TDEE – total daily energy expenditure, EEE – exercise energy expenditure, EB – energy balance, *p value <0.05

Between the male and females subjects, there was a significant difference seen only in the TDEE, with the male athletes having a significant daily energy expenditure, on average, than the female athletes (Table 2). While not significant, there is a trend towards the male athletes are eating more calories per day than the female athletes (Table 2).

**Post Intervention Nutrition Differences Between Genders**

In Fall 2014, researchers collected the post-intervention nutrition recall information (Table 3). Comparisons between the baseline and post-intervention nutrition data were analyzed using paired samples and independent samples t-tests. The paired samples t-tests were used to compare pre- and post-nutrition intervention data within the genders, while the independent samples t-tests were used to compare data between the genders. Table 3 shows the change in dietary intake among men and women and whether there are any significant differences between the genders. Table 3 also includes select descriptive characteristics that may have been affected by the intervention, such as weight and BMI, as well as any change in weekly running mileage.
### Table 3.

**Post Intervention Nutrition Characteristics for Male and Female Cross-Country Runners Showing Gender Differences**

<table>
<thead>
<tr>
<th></th>
<th>Females (n=7)</th>
<th>Males (n=16)</th>
<th>p value between genders¹</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight (kg)</strong></td>
<td>56.1±1.5</td>
<td>68.4±1.4</td>
<td>0.016</td>
</tr>
<tr>
<td><strong>BMI (kg/m²)</strong></td>
<td>19.8±0.6</td>
<td>22.1±0.6</td>
<td>0.07</td>
</tr>
<tr>
<td><strong>Kcal/day</strong></td>
<td>2781.7±246.8</td>
<td>3134.4±136.8</td>
<td>0.04*</td>
</tr>
<tr>
<td><strong>Kcal/kg</strong></td>
<td>48.7±3.6</td>
<td>45.9±2.0</td>
<td>0.03*</td>
</tr>
<tr>
<td><strong>Carb (g/day)</strong></td>
<td>370.9±46.5</td>
<td>386.9±23.4</td>
<td>0.02*</td>
</tr>
<tr>
<td><strong>Carb (g/kg/day)</strong></td>
<td>6.5±0.7</td>
<td>5.7±0.3</td>
<td>0.02*</td>
</tr>
<tr>
<td><strong>Protein (g/day)</strong></td>
<td>124.9±9.4</td>
<td>139.9±7.1</td>
<td>0.65</td>
</tr>
<tr>
<td>**Protein (g/kg/day)</td>
<td>2.2±0.1</td>
<td>2.0±0.1</td>
<td>0.55</td>
</tr>
<tr>
<td><strong>Fat (g/day)</strong></td>
<td>97.0±11.7</td>
<td>118.0±7.6</td>
<td>0.15</td>
</tr>
<tr>
<td><strong>Fat (g/kg/day)</strong></td>
<td>1.7±0.2</td>
<td>1.7±0.1</td>
<td>0.10</td>
</tr>
<tr>
<td><strong>Vit D (IU/day)</strong></td>
<td>172.0±70.3</td>
<td>198.2±26.4</td>
<td>0.13</td>
</tr>
<tr>
<td><strong>Calcium (mg/day)</strong></td>
<td>1387.7±168.5</td>
<td>1307.2±117.4</td>
<td>0.16</td>
</tr>
<tr>
<td><strong>Iron (mg/day)</strong></td>
<td>22.7±3.3</td>
<td>24.0±2.4</td>
<td>0.07</td>
</tr>
<tr>
<td><strong>TDEE (kcal/day)</strong></td>
<td>2847.1±113.9</td>
<td>3381.3±143.2</td>
<td>0.65</td>
</tr>
<tr>
<td><strong>EEE (kcal/day)</strong></td>
<td>723.2±90.5</td>
<td>1076.0±137.0</td>
<td>0.04*</td>
</tr>
<tr>
<td><strong>EB (kcal/day)</strong></td>
<td>-65.5±160.6</td>
<td>-246.9±187.0</td>
<td>0.18</td>
</tr>
<tr>
<td><strong>Mileage/week</strong></td>
<td>58.7±4.1</td>
<td>72.0±4.2</td>
<td>0.01*</td>
</tr>
</tbody>
</table>

*Note.* Mean ± SEM, SEM – standard error of mean, TDEE – total daily energy expenditure, EEE – exercise energy expenditure, EB – energy balance,

*¹p value <0.05

*p value denotes the significance of differences between the male and female subjects
Among the sample, male runners reported significantly lower intake of overall calorie intake (kcal/day & kcal/kg/day) and carbohydrate intake (g/day & g/kg/day) during the Fall 2014, post-intervention compared to the Fall 2013, baseline time point (Table 3). Also, male runners exhibited a significantly higher daily EEE and reported running more miles at the post-intervention time point (Table 3). The female subjects saw no significant changes to their data after the intervention took place. Comparing the data between the genders, as illustrated in the last column of Table 3, there were no significant differences for any of the daily intake variables. Both genders exhibited a decrease in calorie intake and an increase in EEE and weekly running mileage at the post-intervention time point, leading to a reduction in EB.
CHAPTER V
DISCUSSION

Summary of Findings

The purpose of this study was to assess whether gender has an effect related to a nutrition intervention improving the endurance runners’ energy intake, nutritional status, and anthropometric indicators. Results showed that male runners exhibited a significantly lower total energy (kcal/day & kcal/kg/day) and carbohydrate intake (CHO/day, CHO/kg/day) at the post-intervention time point, while the females did not exhibit significant differences. However, when comparing the change in dietary intake between the men and the women, results were not significantly different. However, this may be a result of the small sample size. There was no significant change in body weight or BMI for male and female participants. Results showed an overall negative trend in nutritional status and energy intake with all subjects having consumed lower energy amounts and increased energy expenditure, which led to a decreased energy balance.

Discussion

Baseline Descriptive Characteristics

The baseline characteristics showed significant differences between the males and females’ height, weight, and BMI (Table 1). The data for height and weight are consistent with the idea that males generally are taller and have more body mass than females. Relative to BMI, this data is consistent with other studies showing that females have lower BMI values than males (Hinton, Sanford, Davidson, Yakushko, & Beck, 2004; Leblanc et al., 2014). The data shows that while females have lower BMI values, a higher percentage of male athletes compared to females weighed less than their expected
weights. These results are comparable to other studies that found that athletes participating in endurance sports have more pressure to maintain a leaner physique as compared to other sports (Sundgot-Borgen, 1993; Sundgot-Borgen & Torstvelt, 2004; Byrne & McLean, 2001; Byrne & McLean, 2002). However, this is a novel finding for males as few studies have reported on weight status and the percent of low body weight in male collegiate runners. Hinton et al. (2004) underscored this finding by noting that, related to body weight, a majority of female athletes perceived weight loss more desirable while male athletes perceived weight gain to be desirable in order to achieve better athletic performance.

**Baseline Nutrition Characteristics**

The baseline nutrition characteristics of the subjects (Table 2) indicate a significant difference between the genders for mean TDEE, with the males expending significantly more calories than the females. While not significant, males trended toward consuming more total calories per day than female runners; however, relative intake (kcal/kg/day) did not differ. At the baseline, the energy balance for both genders were positive, meaning they were consuming, on average, more calories than they were expending. Additionally, the carbohydrate intake for both genders are within the 6-10 g/kg body weight recommended (ACSM, 2000); the fat intake for both genders are within the 1-2 g/kg body weight recommended (ACSM, 2000); but the protein intake for both genders are higher than the 1.2-1.7 g/kg body weight recommended (ACSM, 2000). Jonnalagadda et al. (2002) found that most athletes believe that protein is the most important macronutrient for energy; these results are consistent with that idea. There is
an overemphasis on protein in the diet for athletes, especially for increasing muscle mass and less emphasis on the importance of carbohydrates for performance.

When evaluating the male and female runners’ daily intake of calcium and vitamin D, the study found that both genders consumed about 120% of the RDA for calcium (1300 mg), but neither gender consumed the AI of 600 IU of vitamin D (IOM, 2011). The data does not show this to be a significant difference. Both the genders far exceeded the RDA for iron, with the females consuming 140% of the RDA (18 mg), and the males consuming approximately 356% of the RDA for men (8mg) (IOM, 2005).

The data in the current study as compared to the study by Hinton et al. (2004), which also evaluated male and female athletes, shows some similarities in the athletes’ nutritional profile. Both studies showed the subjects had adequate amounts of fat, protein, calcium, and iron and both studies showed the subjects having less than recommended RDA of vitamin D; however, the carbohydrate intake was much lower than in the current study. The differences could be a result of the previous study using various types of athletes, including runners, rather than focusing on endurance athletes.

**Post-Intervention Nutrition Characteristics**

Comparing the post-intervention nutrition data to the pre-intervention data (Table 3), the independent $t$ tests between males and females showed no significant difference in the nutritional intake. This indicates that, relative to the current study, gender is not a factor on the effectiveness of a nutrition intervention. However, according to the data both males and females exhibited a lower intake of calories relative to exercise energy expenditure at the post-intervention time point, leading to a negative energy balance. Also, both genders decreased their calcium and iron intakes. Females reported a slight
increase in vitamin D and the males decreased their intake of vitamin D. The data from the paired sample $t$ tests within the genders showed that the females did not have any significant differences between the pre- and post-intervention data, but the males did exhibit several significant differences. The males’ overall calories per day, calories per kg, carbohydrates per day, and carbohydrates per kg were decreased significantly, while weekly mileage and total EEE increased significantly after the intervention. Although these were significant, it did not affect the significance of the data between the genders, which will be discussed in the limitations below.

The data of the current study corroborates with some prior studies performed, though contrasts with other prior reports. Barr (1987) evaluated dietary intakes of athletes of varying sports compared to non-athletes and Perron and Endres (1985) evaluated female volleyball players and found no correlation between the amount of nutrition information an athlete possessed and their dietary intake. The outcome of the current study is similar to these studies in that the additional nutrition information given to the subjects through the intervention did not positively affect the nutrition intake. Other studies that investigated dietary intakes and nutrition information among female collegiate swimmers and soccer players (Abood et al, 2004) and volleyball players (Valliant et al, 2012) and elite athletes including both genders (Garthe et al, 2011; Garthe et al, 2013) saw a positive trend in post-intervention data compared to before the interventions. An explanation for these findings is that, unlike the current study, some of these studies included a specific meal plan for the athletes to follow along with providing nutrition counseling. This could have led to more positive results since they were following a specific diet as opposed to making their own food choices as in the current
study. To note, even though one of the studies showed improved dietary intake relative to certain nutrients (Valliant et al., 2012), the values were still lower than the recommended amounts for athletes, which is a similar result found in the current study.

**Limitations**

As stated in the above section, the post-intervention data showed significant differences within the male subjects as compared to the pre-intervention data, but there was no significant difference between the genders. The data could be underpowered due to the small sample size, which is a limitation in the current study. As shown in Figure 1, the amount of athletes participating in the study is only a small fraction (25%) of athletes that were eligible to participate. Also, the male subjects outnumber the female subjects, which do not reflect the population of collegiate endurance athletes. Another limitation of the study was the timing of the recalls in the pre- and post-intervention periods. The pre-intervention data was collected later in the season in which the athletes were at the end of the season and running fewer miles, which could affect the results. Self-reported data for dietary intakes and daily exercise values could lead to potential errors in data collection whether intentional or unintentional.

**Implications and Conclusion**

This is one of the first studies to focus on the role of gender as a factor in the success of a nutrition intervention in collegiate endurance athletes. While the findings did not support the hypothesis that males would respond more favorably than females, the study showed that nutrition education for endurance athletes should be continued in order to promote overall health and improve athletic performance. Endurance athletes of both genders have increased energy needs due to the amount of exercise performed during
training and competition seasons and without the proper amount of energy, the body will use lean muscle mass as fuel. This can lead to overall muscle loss and impair the strength and endurance of the athletes (ASCM, 2000).

There are few prior studies that evaluate nutritional data for both male and female endurance athletes concurrently; therefore the findings of the current study are novel. Further studies could be conducted to explore factors that influence changes in dietary habits and whether those influences are different between genders. A quasi-experimental study that follows the current study’s framework but includes a meal plan or menu preferences to establish higher energy intake could be conducted. Researchers could also conduct a non-randomized experimental study using a control group that does not follow a meal plan. These studies would pinpoint various factors that influence athletes’ energy intakes and help create nutrition programs that benefit endurance athletes by enhancing nutrient intake and athlete performance.
REFERENCES


diet does not affect strength performance in elite artistic gymnasts. *Journal of the International Society of Sports Nutrition, 9*(1), 34.


APPENDIX A

Multiple Pass Procedure

PROCEDURES FOR COLLECTING 24-HOUR FOOD RECALLS

When taking a 24-hour recall, it is important for the interviewer to follow certain procedures to insure the following:

- That all foods and beverages consumed are listed.
- That amounts of foods are as accurate as possible.
- That homemaker is not influenced to say he/she ate foods that were not eaten.

It is recommended that staff and volunteers, who take recalls, be thoroughly trained in standard techniques. At the end of this section, please find "A Method for Training EFNEP Staff and Volunteers On Collecting 24-hour Recalls." At a minimum, paraprofessionals and volunteers should practice taking food recalls on each other before using the method with homemakers.

Note: The following techniques are written specifically for individual interviews. At the end of this section, you will find a list of ways to alter these techniques for group settings in which homemakers record their own food recalls.

Setting the stage for the interview

The following steps will help in eliciting truthful and complete information:

1. Explain to homemaker that you need to know only what she/he actually ate. She/he should not feel embarrassed about any food, as there are no "good" or "bad" foods. No one eats just the right foods all the time.

2. Do not express in words or facial expressions either approval or disapproval of foods which homemaker mentions.
3. Do not ask leading questions that would lead homemaker to feel she/he “should” have had a certain item and, thus, say she/he did.

**During the food recall interview**

1. Use your FOOD RECALL KIT to determine the amounts of foods consumed.
   
   (Food Recall Kit described below under "24-Hour Food Recall Kit"). Homemakers may not be able to give amounts of ingredients in their portions of mixed dishes, salads and casseroles. If a home recipe was used, obtain a copy. If food was eaten in a restaurant, record the name or type of restaurant.

2. Start with the most recent meal or snack that the homemaker consumed. Work backwards to cover all foods and beverages eaten or drunk in the last 24 hours.

3. First, get a complete list of all foods eaten without trying to determine amounts. Use the following types of probes to find **what foods** were eaten:

   A. The first type of probing is related to time. Examples: "At what time was this? Did you eat or drink anything before or after that?" "What did you have at that time?" "At what time did you go to bed?"

   B. The second type of probe is related to the homemaker's activities.
   
   Examples: "What did you do this morning?" "While you were working around the house, did you take a break to have something to eat or drink?" "Did you watch TV last night? When you watched TV, did you eat anything?" "Did you have anything to drink with this?"

   C. The third type of probe tries to get more complete information about foods already reported. Examples: "Do you remember anything else that you ate or drank with this food?" "What else did you have at this meal?" "Was the
(bread, vegetable) eaten plain or did you put something on it?" "Did you have anything in your coffee?" "Did you have a second helping?"

4. Second, after all foods are named by the homemaker, go back over the lists to get additional descriptions and amounts of the food. Also determine if all of the food was eaten or if some was left on the plate.

To get more information on the type of food:

A. Encourage the homemaker to describe foods as clearly as possible. The interviewer may have to restate questions to get more information.

B. Describe combination dishes carefully. Mixtures such as sandwiches, soups, stew, pizza, casseroles, etc. can be prepared in many ways.

C. Ask to see packages, if available, on pre-packaged foods, and record brand name and other pertinent information.

To determine the amount of food eaten:

A. Amounts of a food may be given in

1. NUMBERS, such as eggs, donuts, apples

2. SHAPES, such as a pat of butter, stalk of celery, slice of pie (or the shapes included at the end of this section.)

3. DIMENSIONS, such as size of models in Recall Kit, or size of cornbread, cake, etc. using a ruler.

4. VOLUME, such as liquids, cooked vegetables, pudding, ice cream

5. WEIGHT, such as meat, cheese, candy bar, (3 oz. meat equals size of deck of cards, or palm of woman's hand)
B. In measuring spoons, ruler, raw rice, beans, etc. in Food Recall Kit. Have homemaker show you how much they had by pouring raw rice or dry beans on a plate or by identifying some item in your Recall Kit. A ruler can also be used to show size of certain items.

C. When appropriate, ask homemaker to bring in the serving container (bowl, cup, glass, etc.) that was used and determine the amount it holds by using rice and a standard measuring cup.

5. If nutrition questions are being asked by the homemaker during the time the recall is being taken, ask homemaker if you may answer them later when you have completed the recall.

6. After the homemaker has given a recall of foods and amounts for the entire 24 hours, read the list back to him/her and ask homemaker to tell you anything else that he/she may have forgotten before.

7. Thank the homemaker for his/her cooperation. Do not comment on the recall at this time, unless homemaker asks a specific question. Wait and address deficiencies, excesses, etc. when lessons are taught that deal with that area of the diet.
APPENDIX B

24-Hour Food Log

Day 1

NAME:_______________________

<table>
<thead>
<tr>
<th>Description of Food Item</th>
<th>Time of Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please include:</td>
<td></td>
</tr>
<tr>
<td>1) all details of the meals and snacks you eat throughout the day, ex. brand name, type of milk or bread, beverages, etc.</td>
<td></td>
</tr>
<tr>
<td>2) the size and amount of each food or beverage you ate (in parentheses)</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C

Exercise Log

Record all exercise activities completed in the past seven days. Note all structured exercise activities occurring in practice. Also include weight lifting and any other physical exercise occurring outside of practice.

Day 1: ______________________ (Date)

Structured Exercise

Day 2: ______________________ (Date)

Structured Exercise

Day 3: ______________________ (Date)

Structured Exercise

Day 4: ______________________ (Date)

Structured Exercise

Day 5: ______________________ (Date)

Structured Exercise

Day 6: ______________________ (Date)

Structured Exercise

Day 7: ______________________ (Date)

Structured Exercise
Additionally:
Record the total number of miles run in the past 7 days (including long runs, recovery runs, tempo or speed workouts, warm-ups/cool downs, etc.) ➔ ______________________

Average speed for all miles run ➔ ______________________