MACRONUTRIENT INTAKE AND FLUID STATUS OF ELITE FEMALE DISTANCE RUNNERS AT MODERATE ALTITUDE

by

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B.S., Central Michigan University, 2007

A THESIS

Submitted in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE

Department of Hospitality Management and Dietetics

College of Human Ecology

KANSAS STATE UNIVERSITY

Manhattan, Kansas

2015

Approved by:

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Abstract

The topic of athlete nutrition has been discussed amongst competitors, coaches, and nutrition professionals since the dawn of the Modern Olympic Movement in 1896 and has led to many strategies to help athletes compete at a higher level. Endurance athletes have been studied around the world. However, studies conducted with elite distance runners at altitude have focused mainly on male athletes in Kenya or Ethiopia. Despite the efforts of researchers over the years in the area of athlete nutrition there has been little research that specifically focuses on elite female distance runners and little evidence is available about the dietary habits and beliefs of these athletes. Therefore, the purpose of this study was to identify the macronutrient and fluid intakes of female distance runners and to determine if current fad diets and specific athletic events impact their eating habits.

Seven female elite distance runners (six of European and one of Asian descent) training at altitude completed the study. Their specific events ranged from the 5-K to ultra-marathon. The athletes entered their food, fluid and physical activity for six weeks and submitted a report weekly to the researcher. The data was entered by the researcher into *myfitnesspal.com* which tabulated the data. The results recorded into Excel spreadsheets for each athlete. At the end of the six weeks, all data was compiled to get a total intake for each athlete and the group as a whole. Mean, minimums, maximums, and standard deviations were used for data analysis. At the end of the six weeks, a telephone interview was conducted with each athlete to determine their eating habits, attitudes towards food, how others impacted their eating and if they were following a fad diet and why.

Results indicated that these athletes reported lower mean carbohydrate (51±19.4% of calories) and higher protein (19±6% of calories) intake than is recommended per the Joint Statement of the ADA, DC and ACSM (2009). Fat and fluid consumption were adequate, but overall calories taken in were a little lower than calories expended. The athletes avoided soy, high fructose corn syrup, artificial sweeteners, dairy, and fried foods and focused on eating more fruits and vegetables. Five of the seven athletes were following a gluten free diet because they felt it gave them a competitive edge, increased performance, and reduced GI distress. Based on the results of this study, coaches and athletes should focus on perceived exertion in workouts, macronutrient amounts and overall calories to ensure the athlete is able to compete at a high level.

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Acknowledgments

Completing my master's program and conducting my thesis has been a long and arduous journey. Along the way many people have helped me to realize my dream and I would like to thank all of them. Dr. Betsy Barrett who is my major professor has been an invaluable resource without whom this thesis would ever have been completed. Dr. Barrett showed kindness, patience and willingness to defend my thesis when it could have well been denied.

I would also like to personally thank Dr. Mark Haub who has been a great resource and mentor in the area of sports nutrition. His guidance and help has had an immeasurable impact on my professional career as well as this thesis. Without Dr. Haub also fighting for my thesis and ideas I may very well have conducted research with no interest to me personally.

Dr. Kevin Sauer also deserves a big thank you as he is the final member of my review board. Though we didn't speak much Dr. Sauer also has helped make my thesis a reality and has given his time and expertise to help guide me through this process.

Thank you to my wife Lesley for her support throughout this process. Though she never prodded me to complete or even start my master's program she always showed great support and understanding throughout this process.

I would also like to acknowledge that my master's degree would not have been possible without my undergraduate work at Central Michigan University, Dr. Leslie Hildebrandt who guided me through my first research while still in undergrad and Coach Jay Smith for allowing me access to his athletes for my undergraduate research.

Also, my attendance at Kansas State University would not be possible without recommendations from Dr. Dat Nguyen, Dr. Robert Tucker, Kathy Nannini, and Robin Rousch. Thanks to all of you for your help in pursuing my dreams. Also, thank you for giving me my first opportunity in the field of Dietetics I will never forget any of you.

Thank you also to the Kansas State GPIDEA Campus Coordinators for keeping my on task throughout my program. Amanda Gandt and Susan Miller, without you I would have been lost for sure.

Dedication

I would like to dedicate this work to my wife Lesly and to my parents Debbie and Jim. I finally paid for part of my education myself but I never would have gotten to this point without all of you. I can never thank you enough.

Chapter 1-Introduction

Brief History of Athlete Nutrition

The topic of athlete nutrition has been discussed amongst competitors, coaches, and nutrition professionals since the beginning of the Modern Olympic Movement in 1896. The role of nutrition in performance has led to many strategies to help athletes compete at a higher level. From the scant options at the First Modern Olympiad (Pelly et al., 2011) to the "two steaks per day" high protein diets of the 1930's (Schenk, 1937), the higher carbohydrate intakes noted in the 1970's and into today's current trends – such as Gluten Fee Diets (Bergstrom & Hultman, 1972), each generation of athlete has developed new attitudes about foods and then shared these ideas with their competitors at international events such as the Olympic Games (Pelly et al., 2011).

By the 1984 Olympics, the main nutritional issue was the consumption of isotonic sports drinks. Although research was available that showed the benefit of sports drinks (Costill, Kammer, & Fisher 1970), water was still preferred by the athletes. For the first time, the Official Report of the Olympic Games recommended the use of dietary specialists to assist with menu planning for the athletes of the Olympic Games (Official Report 1984 Olympic Games, 1985).

A dietetic research project was conducted at the 2000 Olympic Games in Sydney, Australia, which included the involvement of sports, clinical and food-service dietitians in the planning of meals served at the Olympic Village (Pelly, O'Connor, Denyer, & Caterson, 2009). The project incorporated increased kiosks to help athletes with food information, training for staff, and dietitian surveys to ensure that nutritional needs were met for all teams (Pelly et al., 2009).

The results of this research noted that athletes consumed between 180-190g of carbohydrates and between 130-225g protein per meal with breakfast being the primary point of consumption for protein foods (Pelly et al., 2009). The amount of protein eaten at the 2000 Sydney Olympics was in contrast to the protein consumed in previous Olympic Games. At the 1936 Berlin Olympics the average intakes were 320g protein, 270g fat, and 850g of carbohydrate per person per team (Schenk, 1937). Schenk measured these intakes by following the athletes in line at the commissary and ordering the same foods for lab analysis. It was noted in the 2000 study that each athlete consumed an average of 1.4L of fluid per day (Pelly et al., 2009).

Attitudes and trends in sports nutrition for endurance athletes are constantly changing and evolving with new ideas and research, similar to that of the general public. With many new diet trends or fads in today's general population, it is reasonable to question whether these new diet patterns are affecting the eating behaviors of elite endurance athletes as well.

Trends in dietary habits have been shown to differ greatly over the span of only a few years. Thus, the landscape of what foods elite athletes are eating is always changing as they experiment with their diets in hopes of increasing performance. However, scientific research does not always indicate that athletes will change their diets (Pelly et al., 2011). For example, despite evidence in the 1960's that high carbohydrate diets would be beneficial to endurance athletes this was not seen as a trend at the Olympic Games until the 1970's (Bergstrom & Hultman, 1972).

Trends in Diets

Many diets have pervaded the general population, with some making their way into the athlete population. A fad diet is defined as "any number of weight-reduction diets that either eliminate one or more of the essential food groups or recommend consumption of one type of food in excess at the expense of other foods" (McGraw-Hill Concise Dictionary of Modern Medicine). High protein, Paleo, gluten free and vegetarian/vegan are diets that have been tried by athletes to gain a competitive edge (Pelly et al., 2011). The Paleo Diet is one that has been used by the general population of the United States. W. L. Voegtlin's book *The Stone Age Diet: Based on In-Depth Studies of Human Ecology and the Diet of Man* (1975) discussed a Paleo Diet that has a macronutrient breakdown of approximately 39 percent of calories from fat, 38 percent from protein and 23 percent from carbohydrate (*US World and News Report*, 2013). The *Paleo Diet for Athletes* was published in 2012 and is a Paleo-type diet designed for and targeted to athletes. This particular diet allowed for more starches post exercise to refuel athletes and followed the principle of glycemic load and acid-base balance (Friel & Cordain, 2012).

The Gluten Free Diet has become more popular in the mainstream populace as well as with elite endurance athletes (Lis, Stellingwerff, Shing, Ahuja, & Fell 2014). Olympians such as Amy Yoder-Begley, Ryan Hall and the entire Garmin-Sharp elite cycling team have consumed a gluten free diet. Lis et al., (2014) found that 41% of 910 respondents followed a gluten free diet 50-100 per cent of the time. Of those responding to the survey, 18 were world or Olympic Medalists. Of the athletes who followed the gluten free diet 50-100% of the time, 70% were classified as endurance athletes (Lis et al., 2014). According to Shepherd and Gibson (2013) gluten free starches tend to be low in iron, zinc, and magnesium. A lack of any of these nutrients can have a severe impact on athletic performance (McDonald & Keen 1988). Moreover, many athletes are adhering to a gluten free diet without a diagnosis of Celiac Disease (Lis et al., 2014). According to Matthew Kadey (2010) when the switch to gluten free products is poorly planned, there is a risk of under-consuming complex carbohydrates, vitamins, minerals and fiber.

As there is no research that a gluten free diet has been helpful for endurance athletes it is not necessarily recommended. A switch to a gluten free diet for those without Celiac Disease could cause a decrease in athletic performance due to a lack of vital micronutrients (McDonald & Keen, 1988). At this time the scientific bodies are continuing to investigate to determine if there are any benefits to a gluten free diet in those without Celiac Disease (Lundin, 2014).

Vegetarian and vegan Diets have been around for some time and have been the subject of numerous studies over the past 30 years. For the current study, vegetarianism will be defined as a diet that is mainly vegetables but may also include eggs, milk and other dairy products and veganism as a diet with no animal products whatsoever (Merriam-Webster Dictionary, 2014).

The primary purpose of many studies conducted with vegetarianism or veganism was to determine if this was a safe dietary approach for women endurance athletes. Women athletes have been specifically targeted due to the possibility of the female athlete triad (amenorrhea, eating disorders and osteoporosis) and the dangers that the triad presents (Barrack & Van Loan, 2011). Barrack and Van Loan, 2011 noted that vegetarianism has been considered a way for female endurance athletes to restrict their diet to maintain weight though it can lead to decreased iron stores due to a lack of heme-iron in the diet. However, an article by Nieman (1999) noted:

> "The available evidence supports neither a beneficial nor a detrimental effect of a vegetarian diet on physical performance capacity, especially when carbohydrate intake is controlled for."

Several studies (Eisinger, Plath, Jung, & Leitzmann, 1994; Raben et al., 1992; Richter, Kiens, Raben, Tvede, & Padersen, 1991) confirmed the assertions made by Neiman (1999) that vegetarian diets do not enhance performance nor do they hinder it in endurance athletes when compared with standard Western Diets. However, the bioavailability of certain nutrients such as iron and zinc were lessened by a vegetarian diet and need to be monitored closely (Nieman, 1999) whether they are on a vegetarian diet or not (Eisinger et al., 1994). In conclusion, as long as the vegetarian diet is diverse and contains a variety of foods there should be no greater risk of deficiency of micronutrients than if the athlete was following a normal western diet.

Most of the information available for athletic performance and vegan diets has been either anecdotal or based on the studies already cited for vegetarianism. While many athletes have achieved high level success with a vegan diet (track and field star Carl Lewis and football star Tony Gonzalez are two examples) it has been proposed by Fuhrman and Ferreri (2010) that only with high micronutrient plant foods (vegetables, nuts, fruits, seeds and beans) will a vegan diet improve performance.

Fuhrman (2010) noted that the primary benefit of a vegan, or near vegan, diet is the increase in antioxidants, Omega-6 fatty acids, and polyunsaturated fatty acids which allows the athlete to miss less training days due to sickness. Also, a diet with added antioxidants and phytochemicals may decrease oxidative stress in athletes allowing for better recovery (Fuhrman & Ferreri, 2010). Peake, Suzuki, and Coombes (2007) found that consumption of antioxidant supplements does not have the same effect on the immune system as do antioxidants from food sources. In fact, it has been indicated that using antioxidant supplements may actually slow the recovery process (Hernandez, Cheng, & Westerbland, 2012).

Studies of Diet and Distance Runners

In a 2011 study performed by Beis et al., ten elite male Ethiopian distance runners took part in a month-long study. Dietary intake was assessed throughout the month and was directly observed by the researchers for one week. Total energy expenditure was calculated using training diaries and direct observation to obtain an Estimated Energy Expenditure. This was used to determine the needs of every individual athlete. It was found that fluids were under-consumed but the athletes met their estimated needs. However, by considering dietary water intake (water in foods) and metabolic water the athletes did indeed consume adequate amounts of fluid. In conclusion Beis et al. determined that the fluid needs of the athletes were over-estimated and that researchers needed to take other sources of fluid into consideration.

In a 2002 study, twelve male high school runners were examined over a two week period. Dietary intake was determined using a 24 hour recall tool; interviews for the 24 hour recall took place each day and were used to estimate activity level. All macronutrients were found to be adequately consumed but the runners were lacking in isoleucine and histidine (Christensen, Van Hall, & Hambraeus, 2002).

Onywera, Kiplamai, Tuitoek, Boi, and Pitsiladis, (2004) studied ten elite male Kenyan athletes. The study lasted seven days and all meals were weighed and recorded before and after cooking. Energy expenditure was estimated using physical activity ratios. It was found that the subjects under-consuming fluids and calories over the course of the study. In another study, fourteen elite Kenyan endurance runners were monitored over a five day period. The researchers looked specifically at the hydration levels and assessed athletes' urine (urine osmolality and specific gravity). It was found that though the athletes took in little fluid during their workouts their hydration levels remained adequate as they took fluids ad libitum (Fudge et al., 2008).

Justification

The literature reviewed demonstrates the need for further research specifically aimed at analyzing female endurance athletes' macronutrient, fluid and food intake patterns, and dietary habits. Most previous studies conducted with elite distance runners focused on males in East Africa. Since the dawn of the Modern Olympic Movement elite athlete nutrition has been constantly changing. While elite athletes do represent a small section of the population their decisions about racing, training, and food choices may be affected by the general population. Due to the inherent issues that have historically been present in female distance runners (i.e. the female athlete triad, eating disorders, bone issues) it is a group whose dietary habits are of great importance to their health.

In addition, none of the more recent studies on athlete nutrition was performed using athletes training inside the United States. Most altitude studies on elite endurance runners have been conducted in East Africa because they are dominant in the sport. Determining any differences in the eating patterns or habits of elite US distance runners when compared to East Africans could also aid athletes and their coaches in preparing for events.

Athletes have constantly looked for an edge in training or racing and this includes the diet. Therefore, it is important that the current dietary habits of elite athletes be determined to assist nutrition professionals in establishing where their focus must be in the future. Also, none of the studies exclusively studied women elite distance runners. A study focused on the eating and hydration habits of elite US women distance runners would be unique given the paucity of studies investigating this important issue.

Purpose

The purpose of this study was to determine the macronutrient composition, fluid habits and dietary tendencies amongst elite female distance runners. Dietary analysis investigated total calories, fluid, carbohydrate, protein, and fat intakes. When dietary tendencies were examined specific questions about diet trends were asked to determine if athletes were following fad diets.

Research Questions

1. What is the macronutrient composition of the elite female distance runner diet?
2. How much fluid does an elite female distance runner consume per day?
3. Do the diets of elite female distance runners change in response to fad diets?
4. Are the dietary changes made due to performance or issues with digestive health?
5. Does an athlete's preferred event play a part in changes in diet?
6. Does an athlete's preferred event change their macronutrient intake composition?

Limitations

Certain limitations of this study are acknowledged in interpreting results. First, the majority of the subjects in this study were of European descent and all lived at moderate altitude (5000-8000 feet). The food, fluid and exercises logs of participants were self-reported which may have led to the skewing of data (Burke et al., 2003). In addition, the qualitative data were self-reported via a telephone conversation and the questionnaire adapted from another study (Long, Perry, Unruh, Lewis, & Stanek-Krogstrand, 2011). Additional research may be needed to determine if the trends shown from the qualitative data set were accurate. Finally, the sample size was small and additional research is needed with a larger sample.

Definition of Terms

The following terms describe definitions specific to the proposed study.

Modern Olympic Movement: The time since the first Modern Olympic Games in 1896 through the present.

Gluten Free Diet: Any diet that excludes gluten (protein in wheat).

FODMAPS (Fermentable, Poorly Absorbed, Short-Chain Carbohydrates): osmotic carbohydrates found in foods and can be difficult to absorb by the body.

Paleo Diet: A diet with macronutrient breakdown of approximately 39 percent of calories from fat, 38 percent of calories from protein and 23 percent of daily calories from Carbohydrate.

Vegetarian Diet: Diet that is focused on vegetables with possible dairy or other animal products as well.

Vegan Diet: Diet that is focused on vegetables and fruits and includes no animal products at all.

High Protein Diet: any diet that recommends a protein intake greater than the dietary guidelines which is 10% of daily energy. Some high protein diets recommend as much as 30% of energy from protein to help with preserving muscle and increasing satiety.

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Chapter 2-History of Athlete Nutrition

This chapter summarizes the literature related to the objectives and topic of this study. The purpose of this study was to determine the macronutrient composition, fluid habits and dietary tendencies amongst elite female distance runners. This review of literature summarizes the history of athlete nutrition from the earliest days of the Modern Olympic Movement to the current trends seen in Olympic Catering, individual athletes and team diets.

History of Athlete Nutrition

The Modern Olympic Movement was the beginning of the evolution to our current elite athletes' food preferences. At the first Modern Olympic Games in 1896 there was no Olympic Village (this was created for the first time in 1932) and thus no central eating facility for athlete dining (Pelly, O'Connor, Denyer, & Caterson, 2011). Athletes were housed primarily in hotels and schools and took their meals at local restaurants or hotel dining rooms (Espagnac, 1997). Many athletes were unsure of the foreign cuisine and were hesitant to eat unfamiliar foods (Pelly et al., 2011). Some teams did travel with their own personal chefs but this was not commonplace (Mavrommatis, 1997). The main food provisions provided at the 1896 Olympic Games were for foreign dignitaries (Pelly et al., 2011).

Because of World War I, at the 1920 Olympic Games in Antwerp, Belgium there was a severe lack of food for athletes due to shortages of flour, sugar, and butter (Pelly et al, 2011). Due to the lack of food, many nations complained about the poor nutrition.

It was not until the 1932 Olympic Games in Los Angeles that the Olympic Village was constructed and purposed to cater to the needs of each country participating. Due to the individual requests of each country, 31 separate dining halls were constructed (Pelly et al., 2011). The following excerpt was provided by the official report of the 1932 Olympic Games (1933) in the chapter titled "The Olympic Village."

> "The menu was basic and included sausages, waffles, eggs, cream, milk, fruit, cheese, hot and cold cereals for breakfast, and beef, fish, vegetables, and fruit for lunch and dinner. Special dishes were available upon request. Athletes were provided with distilled water in their rooms, within the dining hall and at competition sites."

The first study conducted to identify the dietary habits of elite athletes was performed by Schenk at the 1936 Berlin Olympics where he sampled 4700 athletes at the Berlin Olympic Games to determine, "What do the best sportsmen in the world eat"? He found that the athletes focused on meat and regularly ate two steaks per meal and averaged approximately a half a kilogram of meat daily. The sizes of the steaks were not noted in the study. However, there were differences between national teams. It was found that the teams from England, Finland, Holland, United States and Italy consumed more carbohydrates from porridge, cold breakfast cereals, and pasta respectively and the Japanese team consumed nearly half a kilogram of rice per man daily (Schenk, 1936).

The studies of the Berlin participants found that the average intakes were 320g protein, 270g fat, and 850g of carbohydrate per person per team with an average of 211 participants per country. He noted that some athletes consumed up to 7300 kcal/day (Schenk, 1936). The general consensus at the time for intakes of a 70kg man was: 118g protein, 56g of fat, 500g of carbohydrate with a daily calorie intake of 3000 kcal/day (Grivetti & Applegate, 1997).

Schenk (1937) published a second study which focused more on the differences between national teams rather than individuals and sought again to determine the best nutritional practices. Schenk was able to tabulate results for 42 of the 49 national teams present at the Olympic Games in Berlin (Schenk, 1937). The results indicated that of the 42 nations studied, 50% consumed over 800g protein per person per day and 38% consumed 500-800g protein per person per day. The majority of the nations in the study (83%) consumed over 500g of fresh fruit per person per day and only 10% consumed over 250g of pasta. Glucose, lecithin, and malt were used as dietary supplements by athletes but in unknown amounts (Schenk, 1937).

The US Olympic Team members regularly consumed beefsteak, had an average daily intake of 125g of butter or other oils, ate an average of three eggs per day, and drank 1.5L of milk. The US Team also consumed a wide variety of fruits and vegetables but ate no citrus and limited their intake of sugar. It was noted that although the US Team liberally ate toasted white bread, their main source of carbohydrate was fruit (excluding citrus). This study did not note any comparison between dietary habits and performance, was strictly observatory in nature, and drew no conclusions about what type of diet was the best for athletes (Schenk, 1937).

Egle (1937) performed research at the 1936 Berlin Olympics and found that athletes from all countries tended to eat a higher percentage of their energy as protein. From his work, Egle suggested a macronutrient breakdown of 16% energy from protein, 37% from fat, and 48% from carbohydrate to be ideal for the competing Olympic athletes in 1936.

The next Olympic Games did not take place until 1948 after World War II. Food rationing in Europe was still in place causing some stress on the nutrition of athletes at the games. However, many foodstuffs were donated by other nations and athletes were grouped by ethnic background to ensure that similar foods could be prepared and served (Pelly et al., 2011).

During the London Olympics in 1948 Berry et al. (1949) collected and studied duplicated meals from 28 athletes for laboratory analysis and interviewed 20 athletes about their food habits during training and competition. The results were similar to those of the 1936 games; an increased importance on protein rich foods including milk, eggs, and meat with an average daily protein intake of 139g/day and an average carbohydrate intake of 390g/day (Berry et al., 1949).

Athletes in the study reported consuming a pre-event meal 3-4 hours prior to competition and some included a light snack 45 minutes prior to competition with protein rich meals and snacks predominating. Of the 20 athletes interviewed in this study, three were competing in the marathon. The marathon competitors reported eating steak or eggs and bacon four hours prior to competition and that athletes consumed glucose daily and/or larger amounts of sugars prior to competition for additional carbohydrate (Berry et al., 1949).

Berry et al. (1949) was aided by C.G. Daubney who was a government chemist. Together with their other colleagues they sought to use the 1948 London Olympics to study the nutritional intakes of athletes because there "were but few scientific data relating to the nutrition and physiology of athletes." They studied elite athletes from different countries who were all living in Royal Air Force Barracks outside of London and the study took place from breakfast on a Tuesday to dinner on a Friday (four days). Each athlete who was involved in the study was followed by a dietitian through the cafeteria line at the Olympic Village and the dietitian was served a duplicate meal used for laboratory analysis (Berry et al., 1949).

The researchers noted a protein intake range from 65 to 231g per day with an average of 139g per day, fat intake of 92 to 223g per day with an average of 137g per day, and a carbohydrate intake of 128 to 572g per day with an average of 390g per day. This was 59% of energy from carbohydrate, 21% from protein and 20% from fat on average. The athlete's events were not indicated, but they were all male (Berry et al., 1949).

At the 1956 Olympic Games in Melbourne, Australia carbohydrates started to become more prevalent in the Athlete Village although the high protein diet was predominant. Kevin Gosper who was a competitor in 1956 and an author for *The Olympic Review* reported that in 1956, "high protein foods were more fashionable than carbohydrates" (Gosper, 1997).

Gosper (1997) wrote that an underdone steak with vegetables was commonly consumed four hours prior to competition or training but that some athletes were adding in carbohydrates as well. Three-time Olympic Champion Betty Cuthbert consumed large plates of rice and honey on the days that she competed. At the Melbourne Olympic Games orange slices sweetened with glucose were used for energy and milk was avoided due to the lactic acid content (Gosper, 1997).

Dietitian Joan Steele (1970) investigated the dietary intakes of Australian athletes at the 1968 Olympics in Mexico City, Mexico and reported that athletes felt that large amounts of meat were necessary for muscular strength and endurance. In her study, Steele recruited 63 men and 14 women from the Australian team and all athletes completed a detailed seven day dietary record. Steele noted a wide range of dietary intakes (2000-6000 kcal/day) and body weights (two women and six men had body weights greater than 10% above standard body weight for height for Australians). Of the eight who were noted to be 10% above standard body weight, two were weight lifters and none of the eight performed well at the 1968 Olympics. Protein accounted for 14.4% of the total energy intake for men and 15.6% for women, fat was 43.4% and 44.6% respectively. It also was noted that during heavy training the men received significantly less energy from fat and more from carbohydrate than during light training. The belief that large amounts of meat were needed before competition persisted which indicated that, "many athletes were psychologically dependent on vitamin supplements" (Steele, 1970).

By the 1972 Olympic Games in Munich widely accepted studies produced by Bergstrom and Hultman (1972) showed the importance of carbohydrate consumption. In their 1972 work published by the *Journal of the American Medical Association* Bergstrom and Hultman noted that:

> “In competition periods of less than 20 minutes’ duration, normal glycogen stores in muscle tissue seem to be adequate, but liver glycogen deficiency can limit the performance via a hypoglycemic effect on the central nervous system.”

They concluded that a carbohydrate rich diet would be the best for athletes between and immediately before competition (Bergstrom & Hultman 1972). The study found that a diet high in carbohydrates following a planned depletion of muscle glycogen would increase not only muscle glycogen but also liver glycogen. This is now known as “carbo-loading” by endurance athletes and is an accepted nutritional practice to increase performance in long events (Gildersleeve, 2012).

Despite the current research, the Official Report of the Organizing Committee of the XXth Olympiad in Munich (1972) noted that athletes still requested diets higher in protein. As such, the sample menu documented in the Official Report makes note of meat based dishes with vegetables. However, unlike in previous Olympic Games there was also rice and pasta included in the meals and the athletes also had access to vending machines (Official Report of the 1972 Games, 1972).

As in the Munich Olympics and despite research to the contrary, the 1976 Official Report of the Olympic Games in Montreal stated there was a need for higher protein meals for athletes. The Official Report (1978) indicated that the calories of the main meals provided to the athletes in the Olympic Village were on average 5,000 kcal. However, per food consumption reports, athletes were consuming more carbohydrates than in Olympics past due to the amount of fruit consumed. According to the Official Report of the Montreal Games (1978) athletes were consuming 12 pieces of fruit per person per day which was double the predicted amount made by organizers.

By the 1984 Olympics the primary nutritional issue was the consumption of isotonic sports drinks. Although research was available that showed the benefit of sports drinks (Costill, Kammer, & Fisher 1970) water was still preferred by the athletes. For the first time the Official Report of the Olympic Games recommended the use of dietary specialists to assist with menu planning for the athletes of the Olympic Games (Official Report 1984 Olympic Games, 1984).

By the 1996 Olympic Games in Atlanta, the Olympic Village had kiosks staffed by clinical and sports dietitians to provide nutritional support for athletes (Official Report of the

1996 Olympic Games, 1997). The Official Report stated that there was an effort to provide a "high starch, low fat menu" to better accommodate athletes. In addition, foods were labeled and translated into different languages to ensure that all religious beliefs were honored in the dining halls (Official Report of the 1996 Olympic Games, 1997).

A dietetic research project which was conducted at the 2000 Olympic Games in Sydney, Australia included the involvement of sports, clinical and food-service dietitians in the planning of meals to be served at the Olympic Village (Pelly et al., 2011). Per the food-service data available from the 2000 Sydney Olympics it is noted that athletes consumed between 180-190g of carbohydrates per meal and between 130-225g proteins with breakfast being the primary point of consumption for protein foods (Pelly et al., 2011). The amount of protein consumed at the 2000 Sydney Olympics was in contrast to the amounts of protein consumed by athletes in previous Olympic Games. For example, at the 1936 Berlin Olympics average intakes of 320g protein, 270g fat, and 850g of carbohydrate per person, per team for an average total of 7300cal/day (Schenk, 1936). The studies at the 2000 Olympic Games also indicated that each athlete consumed an average of 1.4L of fluid per person per day (Pelly et al., 2011).

There have been great changes in the attitudes of athletes about their dietary needs and wants at the highest level as evidenced by Pelly et al. (2011). These changes have taken place due to trial and error by athletes and researchers alike. In today's world with new studies and methods for eating healthy instantly available, the issue is that athletes may become confused by the "right way to eat" (Lis et al., 2014). Athletes at the elite level will always search for an edge either in training, living conditions or diet. The will to win and compete at the best of their ability will tempt them to try many different things in their diet even if the research is not sound.

Diet Trends in Endurance Athletes

Diet trends are becoming popular among elite athletes and studies have been conducted that show the validity of these diets as helpful to athletes (Barrack & Van Loan, 2011; Fressetto et al., 2009; Fuhrman & Ferreri, 2010; Jonsson, et al., 2009; Lis et al. 2014; Raben, et al 1992).

Paleo Diet and Paleo Diet for Athletes

The Paleo Diet is one of the fastest growing diets in the United States; in 2013 it was the most searched diet on Google (Google Zeitgeist, 2013). The diet was originally popularized by Walter L. Voegtlin in the mid 1970's but has seen many re-incarnations since that time. Currently, Dr. Loren Cordain and Joe Friel, who is a noted triathlon coach, are the primary proponents and co-authors of *The Paleo Diet for Athletes*, which was published in 2005.

The Paleo Diet has a macronutrient breakdown of approximately 39 percent of calories from fat, 38 percent of from protein and 23 percent from carbohydrate (*US World and News Report*, 2013). According to *The Paleo Diet for Athletes*, the slow increase in the amount of carbohydrates consumed by top athletes is unhealthy as are the supplements that many athletes consume to rehydrate and replenish after workouts. The Paleo Diet encourages increased amounts of protein (from meat, eggs, and nuts), fiber, non-starchy fruits and vegetables, and healthful oils. *The Paleo Diet for Athletes* encourages athletes to "time the consumption of carbohydrates to specific times and many of the carbohydrate choices are based on glycemic load or glycemic index" (Friel & Cordain, 2005).

Studies on the Paleo Diet

Very little research with the general population or with athletes has been conducted with the Paleo diet; however, Frassetto, Scholetter, Mietus-Synder, Morris, and Sebastian (2009) conducted a study to determine the physiologic improvements from consuming a Paleo Diet. In the study, nine volunteers stayed on their normal diets for three days then went through a seven day increase in fiber and potassium and a 10 day Paleo Diet. The results found a significant reduction in blood pressure and plasma insulin, and decreases in total cholesterol, low-density lipoproteins, and triglycerides. There was no weight loss in the volunteers during the study. This research was short in duration and small in number but did show significant results. However, without a long term study on the effects of the Paleo Diet concerns about its side effects will remain (Frassetto et al., 2009).

In another study, 13 participants were involved in a randomized cross over study to test the impact of the Paleolithic Diet on cardiovascular disease and Type 2 diabetes. The participants were involved in two three month diet periods that ran consecutively - three months on the Paleolithic Diet and the second three months on a Diabetic Diet that met recommendations from the dietary guidelines. The participants showed a decrease in Hemoglobin A1c of 0.4% on the Paleolithic Diet and a significant decrease in weight (-3kg), waist circumference (-4cm), and an increase in HDL (+.08mmol/L). However, the researchers noted that in order to have a significance level of 15% which is what was desired they needed to enroll 15 subjects. As only 13 completed the study, the significance of the findings of this study may be questionable as the study's own authors admitted that the significance level was insufficient (Jonsson et al., 2009).

Another study was conducted that focused on insulin response in pigs fed the Paleo Diet versus pigs fed a cereal or grain diet. Over the length of the study (from weaning to 17 months) 12 piglets were fed a normal grain based diet and 12 a Paleolithic diet. At the end of the study the Paleolithic group weighed 22% less, had 43% lower subcutaneous fat thickness and also had a diastolic blood pressure that was 13% lower than the grain fed group (Jonsson et al., 2009)

Osterdahl, Kocturk, Koochek, & Wandell (2008) found that weight, Body Mass Index (BMI), waist circumference and systolic blood pressure were all significantly reduced over a three week period in healthy volunteers consuming the Paleo Diet. However, 14 volunteers finished the program, but a complete dietary assessment was only available for six.

While the short term results of the Paleo Diet are promising no study was longer than three months in duration or had a subject pool of over 15 at the end of the study. The high rate of attrition and the lack of long term research is cause for concern. Also, none of the studies specifically addressed athletes or exercise. Exercise and diet should be considered in the same study because exercise will have an effect on the bio markers noted in the above studies. With more research, the Paleo Diet may become a viable diet for athletes and the general population.

Gluten Free Diet

Recent estimations calculate that one in 133 people have gluten sensitivity (Dille, 2009). Currently the Gluten Free Diet is becoming more popular in the mainstream populace along with elite endurance athletes. Olympians such as Amy Yoder-Begley, Ryan Hall and even the entire Garmin-Sharp elite cycling team are following a gluten free diet. In some cases, the athletes decided to go gluten free after a diagnosis of celiac disease. There are a possible 1.5 million people in the U.S. with gluten intolerance who follow the diet to decrease the inflammation that gluten supposedly causes in their gastrointestinal tract. According to Cynthia Keefer of the Gluten Intolerance Group there are three types of gluten sensitivity: celiac disease, wheat allergies, and non-celiac gluten intolerance and not all are easily tested for. It also was noted that alternative health practitioners (such as chiropractors) are the primary source for many people who are changing to a gluten free diet (Dille, 2009).

At this time there is only anecdotal evidence of the benefits of the Gluten Free Diet in athletes or non-athletes who have not been diagnosed with celiac disease. Clinical research is severely lacking but this has not stopped many athletes from going gluten free. In addition to the possible lack of performance enhancement that comes with switching to a Gluten Free Diet there is also the chance of harm to the body if the change to gluten free is poorly planned. According to Matthew Kadey (2010) there is a risk of under-consuming complex carbohydrates, vitamins, minerals, and fiber.

As there is no research that a Gluten Free Diet is helpful for endurance athletes at this time it is not necessarily recommended. However, a carefully planned change to a Gluten Free Diet is not harmful and should not be discouraged. Scientific bodies are continuing to investigate to determine if there are any benefits to a Gluten Free Diet as well as determining stricter criteria for Non-Celiac Gluten Sensitivity (NCGS) (Lundin, 2014).

Vegetarian and Vegan Diets

Vegetarian and Vegan Diets have been around for some time and thus have been the subject of numerous studies over the past 30 years. For the purposes of this study, vegetarianism will be defined as a diet that is mainly vegetables but may also include eggs, milk and other dairy products and veganism will be defined as a diet with no animal products whatsoever (Merriam-Webster, 2014).

Vegetarian Diet

The primary purpose of many studies with endurance athletes has been to determine if vegetarianism or veganism is a safe dietary approach. Women athletes have been specifically targeted due to the possibility of the female athlete triad (amenorrhea, eating disorders and osteoporosis) and the dangers that the triad presents (Barrack & Van Loan, 2011). In fact they noted that vegetarianism is considered a way for female endurance athletes to restrict their diet to keep weight down though it can lead to a decrease in iron stores due to a lack of heme-iron in the diet. However, Nieman (1999) notes that

> "The available evidence supports neither a beneficial nor a detrimental effect of a vegetarian diet on physical performance capacity, especially when carbohydrate intake is controlled for."

Raben et al. (1992) performed a 12 week cross over study with eight male endurance athletes. The athletes spent six weeks on a lacto-ovo vegetarian diet (58% calories from carbohydrate, 27% calories from protein, and 15% calories from fat) then performed an endurance challenge. Following the first six weeks the athletes then maintained a meat rich diet (58%, 28%, and 14%) for six weeks and performed the same endurance challenge. The authors noted no significant difference in athletic performance between the diets but did note a "minor decrease in total testosterone" on the vegetarian diet.

Richter, Kiens, Raben, Tvede, and Padersen (1991) conducted a 12 week crossover design study where male participants spent six weeks on a lacto-ovo vegetarian diet and six weeks on a meat rich diet to identify immune parameters. The breakdown of the macronutrient content of the diets was as follows: 57% energy from carbohydrate, 14% energy from protein, and 29% energy from fat. The authors noted no difference in training volume or maximal aerobic capacity during the endurance challenges at the end of each six week diet period. They found no significant difference in pan T-cells, T suppressor cells, T helper cells, natural killer cells, or monocytes when the athletes were on the vegetarian diet versus the meat rich diet (Richter et al., 1991).

Another study examined the performance of 55 endurance athletes assigned to either a lacto-ovo vegetarian diet or a "western diet" during a 1,000km running race over 20 days. Both diets provided the athletes with 4500 kcal per day and had an identical energy breakdown of 60:30:10. They identified that a lacto-ovo diet is appropriate to cover the nutritional needs of endurance athletes but that iron levels should be monitored in all groups. Athletes on the lacto-ovo vegetarian diet consumed more dietary fiber and polyunsaturated fatty acids along with less cholesterol (Eisinger, Plath, Jung, & Leitzmann, 1994).

While Barrack and Van Loan (2011) noted that vegetarianism was a possible warning sign for an eating disorder tied to the female athlete triad, Nieman (1999) noted that it is actually negative energy balance that is the cause of oligoamenorrhea or amenorrhea. Other studies (Bagga 1995; Barbosa et al., 1990; Goldin et al., 1982; Pedersen et al., 1991) noted a relationship between a high fiber low fat vegetarian diet and menstrual irregularity in female athletes. However, five to twenty percent of women who exercise regularly and vigorously as well as 50-65% of competitive athletes develop oligoamenorrhea (Nieman, 1999). Two additional descriptive studies reported (Brooks et al., 1984; Loucks et al., 1992) that more female vegetarian athletes have amenorrhea. But according to the study performed by Dueck, Matt, Manore, and Skinner (1996), the main culprit of amenorrhea is negative energy balance and once balance is restored, menstruation resumes.

These studies confirm the assertions made by Neiman (1999), that vegetarian diets do not enhance performance nor do they hinder it in endurance athletes. However, the bioavailability of certain nutrients such as iron and zinc are lessened by a vegetarian diet and need to be monitored closely. Iron and other nutrients must be monitored closely for athletes whether they are on a vegetarian diet or not per Eisinger et al. (1994). In conclusion, as long as the vegetarian diet contains a variety of sources there should be no deficiency of any micronutrients.

Vegan Diet

Most of the information available for athletic performance and Vegan Diets is either anecdotal or based on the studies already cited for vegetarianism. While many athletes have achieved high level success with a vegan diet (track and field Star Carl Lewis and football star Tony Gonzalez are two examples) it has been proposed by Fuhrman and Ferreri (2010) that eating only high micronutrient plant foods (vegetables, nuts, fruits, seeds and beans) will a vegan diet help with performance.

Fuhrman and Ferreri (2010) noted that the primary benefit of a vegan or near vegan diet is the increase in antioxidants, Omega-6 fatty acids, and polyunsaturated fatty acids which allows the athlete to miss less training days due to sickness. Also, a diet with a large amount of antioxidants and phytochemicals may also decrease oxidative stress in athletes allowing for better recovery (Fuhrman & Ferreri, 2010). Peake, Suzuiki, and Coombes (2007) found that the consumption of antioxidant supplements does not have the same effect on the immune system as do antioxidants from food sources. In fact using antioxidant supplements may actually slow down the process of recovery.

It was noted that while the bioavailability of calcium and iron is lower on a vegan diet there is more consumed and therefore supplementation is not necessarily needed in vegan athletes. Higher protein needs are needed due to the increase in protein oxidation during exercise and a branch chain amino acid supplement may be desirable for vegan athletes (Fuhrman & Ferreri, 2010). Fuhrman and Ferreri also suggest the supplementation of iodine, zinc, Vitamin D, Vitamin B12, and Docosahexaenoic Acid (DHA).

While the bioavailability of calcium and iron is lower on a vegan diet, there is more consumed and therefore supplementation is not necessarily needed in vegan athletes. Higher protein intake is required due to the increase in protein oxidation during exercise and a branch chain amino acid supplement along with supplementation of iodine, zinc, Vitamin D, Vitamin B12, and Docosahexaenoic Acid (DHA) (Fuhrman & Ferreri, 2010).

It is possible for an elite endurance athlete to maintain performance on a vegetarian or vegan diet plan, but the possibility of an increase in performance is not supported by research at this time. For a vegan or vegetarian athlete to maximize their diet an enhanced intake of beans, greens, seeds, nuts, and whole grains are recommended (Fuhrman & Ferreri, 2010). However, these suggestions hold true for any endurance athlete. The vegetarian and vegan athlete may also experience a decrease in cardiovascular risk because of their diet (Position of the American Dietetic Association and Dietitians Canada: Vegetarian Diets, 2003).

High Protein Diet

The definition of a high protein diet varies by the author of the diet. High protein diets for the purposes of this paper are any diet that recommends a protein intake greater than the dietary guidelines which is 10% of daily energy. Some high protein diets recommend as much as 30% of energy from protein to help with preserving muscle and increasing satiety (Von Bibra, Wulf, St. John Sutton, Pfutzner, Schuster, & Heilmeyer, 2014).

The high protein diet came to be more popular in the early to mid-1990’s due to the low fat craze of the 1980’s. As a result, people ate lower fat diets and consumed more processed carbohydrates which led to problems with blood pressure from sodium, blood sugar from refined starches, and triglyceride issues due to an increase in starches. Thus many high protein diets such as the Atkins diet capitalized on the fear of carbohydrates which still permeates the dietary habits of Americans today and the general population is more worried about consuming carbohydrates than protein or fat in their diet even though most are not sure why (Fitzgerald, 2009).

It is also interesting that through the years of the Olympic Movement which were outlined earlier in this paper the attitudes toward carbohydrates and protein shifted through the 1940’s to the 1990’s and early 2000’s in endurance athletes (Pelly et al., 2011). However, now somewhat mirroring the general public, higher protein diets are seen as a desirable nutrition alternative.

Matt Fitzgerald Author of *Racing Weight* (2009) notes that protein is the macronutrient that is seen as “good” and the public and athletes like to think that carbohydrates and fat are both “bad.” Fitzgerald (2009) notes that an increase in protein will help athletes to decrease weight without decreasing muscle mass and that an increase in protein intake to 1.36g/kg body weight can aid recovery and causes less of a drop in performance during a hard training block with endurance athletes.

Studies on High Protein in Endurance Athletes

Rowlands and Hopkins (2002) investigated whether a high carbohydrate, high fat or high protein meal would have an effect on the performance of endurance cyclists. Twelve cyclists were involved in this three week trial with a 50km time trial and 1km and 4km sprints performed each week. The meals were consumed 90 minutes before the test and a carbohydrate beverage was drunk throughout the 50km time trial. There was no clear effect on the pre-race meal on either the overall 50km trial or the sprints within the trial and the high carbohydrate meal decreased fat oxidation by half compared with the protein and fat meals which suggested that a high protein meal will increase fat lipolysis (Rowlands & Hopkins 2002).

Meredith, Zackin, Frontera, and Evans (1989) sought to determine the most beneficial protein intake by studying 12 endurance trained males. The subjects consumed 0.6, 0.9, or 1.2g/kg/day of protein over three different ten day periods. Training and consistent body weights were maintained throughout the study and nitrogen balance was monitored through diet, urine, stool and sweat estimation. They estimated protein needs at 0.94 +/- .05g/kg/day and these results indicated that the endurance athlete needs a greater amount of protein than the Dietary Allowance of 0.8g/kg/day (Meredith et al., 1989).

Tarnopolsky (2004) found that due to amino acid oxidation, which is increased during endurance exercise from 4-7% at rest to approximately 25% during exercise, protein needs are increased in endurance athletes. Also, for low to moderate endurance exercise 1g/kg/day of protein is sufficient but for maximal effort 1.6g/kg/day may be required to offset the effects of increased amino acid oxidation in the skeletal muscles.

Tarnolpolsky, MacDugall, and Atkinson (1988) found similar results in a study that compared the protein needs and nitrogen balance of six elite body builders, six elite endurance athletes and six sedentary controls. The subjects followed 10 days of normal protein intake followed by 10 days of altered protein intake. Through the nitrogen balance data it was shown that bodybuilders required 1.12 times more daily protein than sedentary individuals while endurance athletes required 1.67 times the daily protein to maintain lean body mass and offset protein catabolism during exercise which was due to the increased urea excretion in the endurance athletes versus the bodybuilders.

As the realization of the need for protein in endurance athletes increased it was postulated that perhaps protein during exercise would assist recovery and also help performance. With muscle turnover via protein synthesis occurring during exercise it was suggested that adding protein to carbohydrate sports drinks would aid performance (Beelen, et al., 2011).

Blomstrand, Hassmen, Ek, Ekblom, and Newsholme (1997) found that the consumption of Branch Chain Amino Acids (BCAA) added to a carbohydrate drink during an exercise trial of 60 minutes showed no difference in performance when compared to a carbohydrate drink alone. Further study by Watson, Shirreffs, and Maughan (2004) utilizing a longer trial of greater than two hours showed similar results when BCAA was added to carbohydrate drinks during exercise.

Beelen et al. (2011) studied 12 male cyclists during a two hour fasting period followed by a two hour cycling trial at 55% maximum effort. During the two hour cycling effort the subjects were given either a carbohydrate drink of 1g/kg body weight carbohydrate or a mixed carbohydrate and protein drink with 0.8g/kg body weight carbohydrate and 0.2g/kg body weight protein hydrolysate. There was a significant increase in protein synthesis and oxidation in the cyclists who consumed the mixed carbohydrate and protein drink compared with the carbohydrate drink only. They concluded that ingesting protein with carbohydrate does not increase muscle protein synthesis significantly more than carbohydrate alone.

High protein diets have been shown to be necessary by scientific studies to help with muscle recovery of endurance athletes. It has even been indicated that endurance athletes may need more protein per kg than bodybuilders (Tarnolpolsky, MacDugall, & Atkinson, 1988). While 40% of energy from protein may be excessive an increased amount of protein that would be considered “high” by the dietary guidelines has been shown to be necessary for endurance athletes to consume in order to maintain lean muscle mass.

Studies of Diet and Distance Runners

In a 2011 study performed by Beis et al. ten elite male Ethiopian distance runners took part in a month-long study. Dietary intake was assessed throughout the month and was directly observed by the researchers for one week. Total energy expenditure was calculated and used to determine the needs of every individual athlete. It was found the fluids were under-consumed but that the athletes met their estimated needs. In conclusion, Beis et al. (2011) determined that the fluid needs of the athletes were over-estimated. Another possibility is that the athletes consumed small amounts of water ad libitum throughout the day to keep their hydration stable.

In a 2002 study, twelve male high school runners were examined over a two week period. Dietary intake was determined using a 24 hour recall tool. Interviews for the 24 hour recall took place each day and were also used to estimate activity level. All macronutrients were found to be adequately consumed but the runners were lacking in isoleucine and histidine (Christensen, Van Hall, & Hambraeus, 2002).

Onywera et al. in 2004 studied ten male elite Kenyan athletes. The study lasted seven days and all meals were weighed and recorded before and after cooking. Energy expenditure was calculated using physical activity ratios. It was found that the subjects under-consumed fluids and calories over the course of the study. In another study, fourteen elite Kenyan endurance runners were monitored over a five day period. The researchers looked specifically at the hydration levels and performed tests on the athletes' urine (urine osmolality and specific gravity). It was found that though the athletes took in little fluid their hydration levels were accurate as they took fluids ad libitum (Fudge et al., 2008).

Current Nutritional Guidelines

Most current nutritional guidelines pertain to both men and women with regards to endurance competition. According to Beis, Wright-Whyte, Fudge, Noakes, & Pitsiladis, (2012) it is recommended that male marathon runners consume .4-.8 liters of water per hour during competition. Per the joint position statement of the American Dietetic Association (ADA), Dietitians Canada (DC) and the American College of Sports Medicine (ACSM) (2009), it is only recommended that the athletes consume enough fluid to keep up with their sweat rate as a water deficit in excess of 2-3% of body mass can result in a major detriment to performance. The Joint Statement (2009) also recommends drinking 16-24oz of fluid per every pound of weight lost during exercise.

Burke, Kiens, & Ivy (2004) noted that for a person starting with marathon training 5-7 grams (g) of carbohydrate per kilogram (kg) of body weight (BW) is recommended whereas an athlete in the middle of their buildup phase should be consuming 7-12g/kg BW. Burke and colleagues also noted that just prior to competition as much as 10-12g/kg BW carbohydrate is acceptable. The Joint Statement of the ADA, DC, and ACSM (2009) also recommended a level of 6-10g/kg BW of carbohydrate. The Dietary Reference Intakes (DRI) of 2002 note a range of 45-65% of calories from carbohydrate to be in the acceptable range.

The Joint Statement of the ADA, DC and ACSM (2009) stated that a protein intake of 1.2-1.7 grams/kilogram BW. The DRI of 2002 notes a range of 10-35% of calories from protein to be acceptable. The Joint Statement of the ADA, DC, and ACSM (2009) notes a recommendation of 20-35% total energy from fat. The recommendations by the Joint Statement of the ADA, DC, and ACSM (2009) are determined for both male and female endurance and strength athletes.

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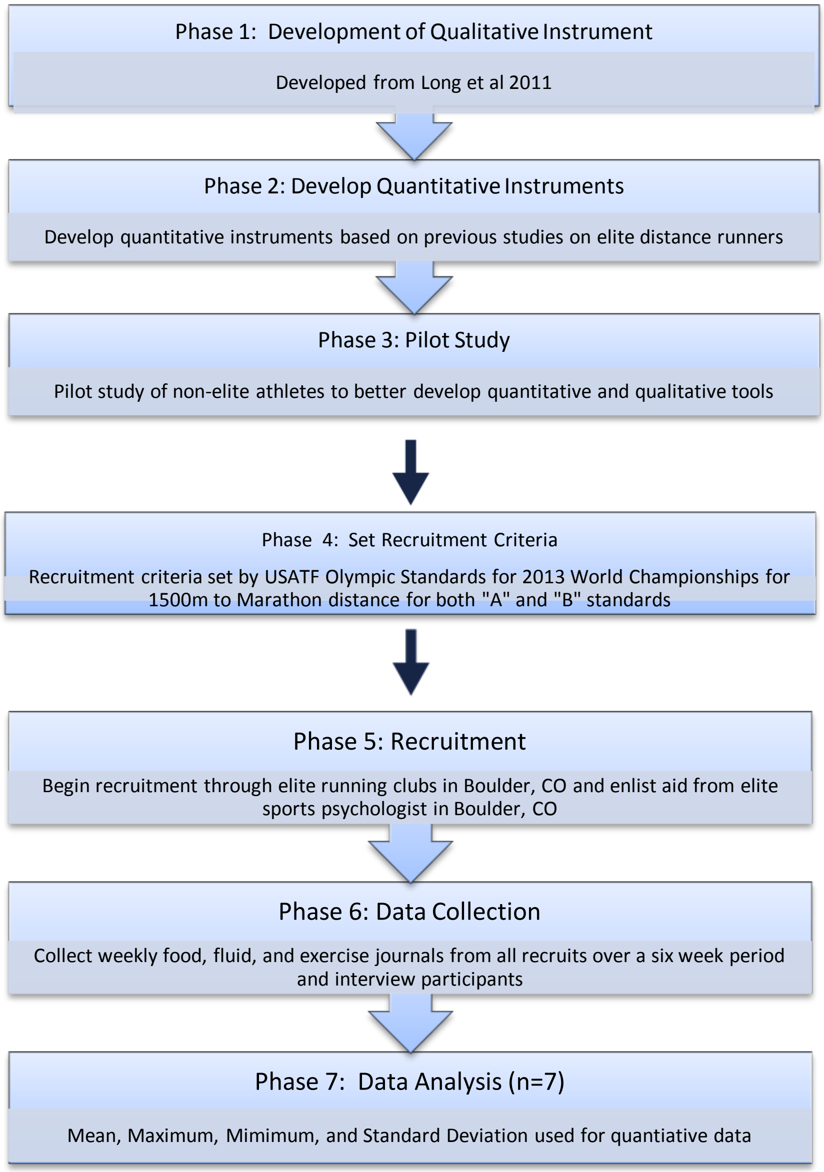
Chapter 3-Methodology

Introduction

This chapter describes the research design as well as the data analysis techniques used in this study. The purpose of this study was to determine the macronutrient composition, fluid habits and dietary tendencies amongst elite female distance runners focusing on fad diets. The procedures for this research study have been outlined in figure 3.1. The flow chart includes the recruitment, population, methodology and finally the statistical analyses used to obtain the quantitative data. The qualitative data was gathered through telephone interviews with participants.

Figure 3.1-Study Flow Chart



Population and Sample

The population for this study was elite female distance runners training at altitude. The basis for "elite" was set as attaining at least a "B" standard time for the 2013 World Championships, which was established by the USATF (United States Association for Track and Field). Age of the participants was irrelevant as long as they met the "B" Standard as noted in table 3.1. The athletes targeted were female, as most studies conducted with elite endurance athletes have focused primarily on male athletes (Beis et al., 2011; Fudge et al., 2008; Long et al., 2011; Onywera, et al., 2004). Also, altitude was included in the criteria because many endurance athletes have chosen to do cycles of training at altitude in order to increase their fitness.

To achieve the "B" standard, athletes must have run a specific distance (1500 m to the marathon) within a defined time (Table 3.1). Standards were developed by the USATF Qualifying Standards for the 2013 USA Outdoor Track and Field Championships and can be found at www.usatf.org. Most athletes recruited for this study qualified for the marathon distance since this is one of the fastest areas of growth in distance running due to the larger monetary awards. According to *Running USA (*2014), 451,000 athletes completed a marathon in 2013 with 232,000 (43%) being female which was the highest recorded number and percent ever.

Table 3.1-"B" Standard qualifying marks for 2013 World Championships

Distance	A	B	
Marathon	2hr:37 minutes	2hr:43 minutes	½ Marathon: 1hr:15 min. (B)
10,000m	33:20 minutes	33:50 minutes	
5,000m	15:46 minutes	15:50 minutes	
1,500m	4:13.50 minutes	4:16.50 minutes	

The goal was to recruit 10-15 elite female distance runners training at altitude for a distance event that would be held within the next six months. The number of athletes recruited would lend validity to the study and allow for greater identification of trends in dietary habits among elite female distance runners.

Instrument Development

The quantitative instruments used in the study to collect food and intakes, fluid and training data from the athletes were modeled after similar studies. Beis et al. (2011) and Onywera et al. (2004) used macronutrient collection techniques with elite distance runners while Fudge et al. (2008) studied fluid intake. The tables found in the appendices are the food, fluid and exercise journals that were submitted weekly by the participants (See Appendices A, B, and C).

The qualitative instrument used in the interviews was adopted from Long, Perry, Unruh, Lewis and Stanek-Krogstrand (2011). Their study conducted with football players found that a qualitative measure is useful when determining dietary habits and attitudes of athletes. Table 3.2 shows an adapted version of their questionnaire.

Table 3.2-Qualitative Interview Probe and Follow up Questions

Interview and Probe Questions			
Demographic Information			
What events do you run?			
What is your ethnic background?			
Interview Questions			**Follow up Probe Questions**
Do you have any food, drink, or meal			Something you really like to
preferences, traditions or superstitions in			eat before training or racing.
relationship to training or races?			
			Something that you feel gives
			you a competitive edge.
Describe a typical day in terms of eating and drinking			What meals do you eat?
			When do you usually eat meals?
			How many times a day do you eat something?
What sort of self-talk do you engage in			Do you find yourself thinking about
when you are choosing foods through a			some aspect of nutritional content?
typical day?			(fat, protein, carb, or calorie content)
How is your self- talk regarding food			Home is where you are currently training
choices different when you are on the road			
than when you are at home?			
How have your approaches to eating and drinking changed, if at all since you became a professional distance runner?			
What sort of strategies do you use to plan			Do you give meals and snacks any
your meals and snacks?			forethought?
			Do you use different strategies
			depending on workouts?

			Do you use different strategies
			on a race day?
			Do you use different strategies
			when workouts are at different times?
How do people around you influence your			Are you influenced by what other people
food choices?			are eating or drinking?
What thoughts go through your mind about			Do you judge people around you by
the food choices made by people around you?			their food choices?
With whom do you eat most of your meals?			Do you eat with family or teammates
			on a regular basis?
Where do you eat most of your meals?			
			Where are you most likely to eat?
Do you avoid any types of foods?			

Pilot Study

To test the quantitative instrument, a pilot study was conducted with four non-elite women recruited from a local running club to determine if the tools developed were useable for the athletes. Two weeks of data were collected from each individual. No pilot data was used for the final study because none of the participants were defined as "elite" athletes (attaining a "B" standard for a distance from 1500m to the marathon). Based on feedback from the pilot study, changes were made to the final instruments, including making the journals each a full seven days and adding in spaces for cross training to the exercise journal.

Validity and Reliability

Validity was tested in the small pilot study by assuring that the data collected could be used to derive macronutrient composition, fluid consumption and calories expended. After the completion of the pilot study the changes were made to the quantitative collection tools. Also, all of the tools to be used were validated by previous studies (Beis et al., 2011; Fudge et al., 2008; Long et al, 2011; Onywera et al,. 2004). To preserve validity, contact was maintained with all participants on a weekly basis. The reliability of the tools to be used was also validated by previous studies (Beis et al., 2011; Fudge et al., 2008; Long et al, 2011; Onywera et al,. 2004).

Data Collection Procedure

Once the 10-15 participants were enrolled and submitted their consent forms, weekly emails containing the fluid, food, and exercise logs were sent to each. Each participant returned the logs at the end of the week. Athletes were encouraged to record everything that they ate, drank and expended via exercise for the most accurate tabulation. All data from the food and exercise logs were entered into an Excel spreadsheet. From these weekly journals data for calories, fluid and macronutrient intake and calories expended were determined by the lead researcher using *myfitnesspal.com*.

This continued for a total of six weeks during the summer, which is the most important training time for distance runners preparing for fall competition. After the six weeks were complete, the researcher then called each participant who answered the qualitative questions. The interview discussed the athletes' eating habits and attitudes towards food and took 15-20 minutes depending on the depth of the answers.

Research Compliance

Kansas State University's Institutional Review Board for Research with Human Subjects reviewed this research proposal, permission was granted prior to any information being solicited from all participants in the study. Documentation is included in Appendix F.

Data Analysis

Means, standard deviations, medians, maximums, minimums, and variance were run using Microsoft Excel on all the macronutrient, fluid, and exercise data. Calories, carbohydrate, protein, and fat were determined individually. Qualitative data were tabulated and divided into sections to identify demographics, food choices/superstitions, and food aversions.

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Chapter 4- Macronutrient Intake and Fluid Status of Elite Female Distance Runners at Moderate Altitude

Introduction

The topic of athlete nutrition has been discussed amongst competitors, coaches, and nutrition professionals since the dawn of the Modern Olympic Movement in 1896 and has led to many strategies to help athletes compete at a higher level (Pelly, O'Connor, Denyer, & Caterson, 2011). From the scant options at the First Modern Olympiad to the "two steaks per day" high protein diets of the 1930's (Schenk, 1937), the high carbohydrate intakes of the 1970's and into today's current trends – such as gluten free diets (Bergstrom & Hultman, 1972), each generation of athlete has developed new attitudes about foods and then shared these ideas with their competitors at international events such as the Olympic Games (Pelly et al., 2011). However, despite the concerted efforts of researchers over the years in the area of athlete nutrition there has been a dearth of research specifically focusing on elite female distance runners and little evidence is available about the dietary habits and beliefs of these athletes. Therefore, it is important to apply not only quantitative but also qualitative tools to better understand what these athletes are eating and why they are consuming certain foods.

Beis, et al., (2011) studied ten elite male Ethiopian distance runners, assessed dietary intake for a month and directly observed their eating habits for one week. Total energy expenditure was calculated and used to determine the needs of every individual athlete. It was found that fluids were under-consumed but the athletes met their estimated needs. In conclusion, Beis et al. determined that the fluid needs of the athletes were over-estimated. Another study examined twelve male high school runners over a two week period. Dietary intake was determined using a 24 hour recall tool; interviews for the 24 hour recall took place each day and were used to estimate activity level. All macronutrients were found to be adequately consumed but the runners were lacking in isoleucine and histidine (Christensen, Van Hall, & Hambraeus, 2002). Onywera, Kiplamai, Tuitoek, Boi, and Pitsiladis (2004) studied ten elite male Kenyan athletes for seven days. All meals were weighed and recorded before and after cooking and energy expenditure was calculated using physical activity ratios. The results indicated that the subjects under-consumed fluids and calories over the course of the study. Fudge et al., (2008) monitored fourteen elite Kenyan endurance runners over a five day period. The researchers looked specifically at the hydration levels and performed tests on the athletes' urine (urine osmolality and specific gravity). It was found that though the athletes ingested little fluid their hydration levels were adequate as they took fluids ad libitum. Although all of these athletes were training at altitude and some of the studies did involve female athletes, none identified qualitative reasoning for the athletes' food choices.

One reason that data on food habits and dietary influences of athletes is important is that many new diets and diet trends are emerging. With an abundance of new diets and a lack of pertinent research on the adequacy of these diets, it is becoming more and more difficult for athletes to make appropriate food decisions. Many different diets currently pervade the general population with some making their way into the athlete population. High protein, Paleo, Gluten Free and Vegetarian/Vegan are diets that have been tried by athletes to gain a competitive edge (Barrack & Van Loan, 2011; Blomstrand, Hassmen, Ekblom, & Newsholme, 1997; Eisinger, Plath, Jung, & Leitzmann, 1994; Friel & Cordain, 2012; Lis, Stellingwerff, Shing, Ahuja, & Fell, 2014; Meredith, Zackin, Frontera, & Evans, 1989; Nieman, 1999; Raben et al.; Richter, Kiens, Raben, Tvede, & Padersen, 1991; Rowlands & Hopkins, 2002; Voegtlin, 1975). The Paleo diet is currently in use among the general population of the United States. W. L. Voegtlin's book *The Stone Age Diet: Based on In-Depth Studies of Human Ecology and the Diet of Man* (1975) discussed a Paleo diet that has a macronutrient breakdown of approximately 39 percent of calories from fat, 38 percent from protein and 23 percent from carbohydrate (*US World and News Report*, 2013). The *Paleo Diet for Athletes* was published in 2012 and is a Paleo-type diet designed for and targeted to athletes. This particular diet allows for more starches post exercise to refuel athletes and follows the principles of glycemic load and acid-base balance (Friel & Cordain, 2012).

Currently the gluten free diet is becoming more popular in the mainstream populace as well as with elite endurance athletes. Olympians such as Amy Yoder-Begley, Ryan Hall and even the entire Garmin-Sharp elite cycling team consume a gluten free diet. Lis, Stellingwerff, Shing, Ahuja, and Fell (2014) found that 41% of 910 respondents followed a gluten free diet 50-100 per cent of the time and of those responding, 18 were world or Olympic Medalists. Of the athletes who followed the gluten free diet, 70% were classified as endurance athletes. Per Shepherd and Gibson (2013), gluten free products tend to be low in B vitamins, iron, calcium, zinc, magnesium and fiber. A lack of any of these nutrients can have a severe impact on athletic performance. However, many athletes have started adhering to a gluten free diet without a diagnosis of Celiac Disease (Lis et al., 2014). According to Matthew Kadey (2010) when the switch to gluten free products is poorly planned, there can be a real risk of under-consuming complex carbohydrates, vitamins, minerals and fiber. As there is no research that a gluten free diet is helpful for endurance athletes it is not necessarily recommended; however, a carefully planned switch to a gluten free diet is not harmful. At this time the scientific community has continued to investigate if there are any benefits for an athlete to follow a gluten free diet (Lundin, 2014).

Vegetarian and vegan diets have been around for some time and have been the subject of numerous studies over the past 30 years (Barrack & Van Loan, 2011, Nieman, 1999, Eisinger, Plath, Jung, & Leitzmann, 1994; Raben et al., 1992; Richter, Kiens, Raben, Tvede, & Padersen, 1991). For the current study, vegetarianism will be defined as a diet that is mainly vegetables but may also include eggs, milk and other dairy products and veganism is a diet that contains no animal products (Merriam-Webster Dictionary, 2014). The primary purpose of many athletic studies conducted with vegetarianism or veganism is to determine if this is a safe dietary approach for women endurance athletes. Women athletes have been specifically targeted due to the possibility of the female athlete triad (amenorrhea, eating disorders and osteoporosis) and the dangers that the triad presents (Barrack & Van Loan, 2011). They noted that vegetarianism is considered a way for female endurance athletes to restrict their diet to maintain weight though it can lead to a decrease in iron stores due to a lack of dietary heme-iron. However, Nieman (1999) noted that if carbohydrate intake is controlled, there is no effect on the physical performance of the athlete. Several studies (Eisinger, Plath, Jung, & Leitzmann, 1994; Raben et al., 1992; Richter, Kiens, Raben, Tvede, & Padersen, 1991) confirm the assertions made by Neiman (1999) that vegetarian diets do not enhance performance nor do they hinder it in endurance athletes. However, the bioavailability of certain nutrients such as iron and zinc are lessened by a vegetarian diet and need to be monitored closely. Iron and other nutrients must be examined for athletes whether they are on a vegetarian diet or not (Eisinger et al., 1994). In conclusion, as long as the vegetarian diet is diverse and contains a variety of sources there should be no deficiency of micronutrients. Lack of menstruation with female athletes who are vegetarians has been an issue of some debate though.

For vegan diets, most of the information available for athletic performance is either anecdotal or based on studies already cited for vegetarianism. While many athletes have achieved high levels of success with a vegan diet (track and field star Carl Lewis and football star Tony Gonzalez were two examples) it has been proposed by Fuhrman and Ferreri (2010) that only with high micronutrient plant foods (vegetables, nuts, fruits, seeds and beans) will a vegan diet help with performance. Fuhrman and Ferreri (2010) noted that the primary benefit of a vegan or near vegan diet is the increase in antioxidants, Omega-6 fatty acids, and polyunsaturated fatty acids which allows the athlete to miss less training days due to sickness. Also, a diet with added antioxidants and phytochemicals may decrease oxidative stress in athletes allowing for better recovery (Fuhrman & Ferreri, 2010). Peake, Suzuiki, and Coombes (2007) found that consumption of antioxidant supplements does not have the same effect on the immune system as do antioxidants from food sources. In fact, they indicated that using antioxidant supplements may actually slow the recovery process.

Several studies have been conducted to determine the amounts of protein needed for endurance events as well as the best amounts and time that they should be eaten. However, very few of these studies were conducted with runners and even fewer with female athletes (Blomstrand, Hassmen, Ekblom, & Newsholme, 1997; Meredith, Zackin, Frontera, & Evans, 1989; Rowlands & Hopkins, 2002).

In 2002, Rowlands and Hopkins investigated high carbohydrate, high fat, and high protein meals and their effects on cyclists during an exercise test. It was shown that higher fat oxidation took place in the cyclists who consumed a high fat or high protein meal. All cyclists in this study were male. A study that focused on endurance trained middle-aged men found that the protein needs for sustained endurance training were greater than the suggested Recommended Daily Allowance (RDA) for protein of .8-1g/kg body weight (Meredith et al, 1989). In 1997, Blomstrand et al. measured the perceived exertion of seven male endurance cyclists after ingesting Branched-Chain Amino Acids (BCAA) prior to exhaustive exercise. No difference in performance was found with the ingestion of the BCAA's.

To date there has been very little research conducted with female distance runners. Beis et al, 2011 had two female distance runners in their study but the focus was on male athletes. In addition, there has been no research that has strictly focused on the dietary or fluid habits of elite female distance runners. Further, most studies that have been conducted with male athletes have taken place in sub-Saharan Africa with very little research conducted in the United States. This study attempted to begin to fill the knowledge gap.

Research Questions

At this time there is little research that focuses on female distance runners and their dietary habits. With the risk of vitamin and mineral deficiencies being so different between the sexes the reliance on information from studies of the dietary habits of males is inadequate. In addition no studies have concentrated on U.S. female distance runners. With the different types of diets that athletes have to choose from it is important for coaches, trainers, dietitians, and other medical personnel to recognize what meets the needs for these athletes and what does not. Therefore, the purpose of this study was to answer the following questions as they relate to elite female distance runners.

1. What is the macronutrient composition of the elite female distance runner's diet?
2. How much fluid does an elite female distance runner consume per day?
3. Do the diets of elite female distance runners change in response to societal diet trends?
4. Are the dietary preferences made due to performance or issues with digestion?
5. Does an athlete's preferred event play a part in changes in diet?
6. Does an athlete's preferred event change their macronutrient intake composition?

Methodology

Sample

The target population for this study was elite female distance runners with at least a "B" Standard performance. The "B" Standard used as per the USATF (United States of America Track and Field) Qualifying Standards for the 2013 Outdoor World Track and Field Championships is a measure of performance set forth by the International Association of Athletics Federation (IAAF) for the Olympics and World Championships. A "B" standard mark would permit the respective athlete to qualify to compete in the World Track and Field Championships or Olympics and would allow the athlete to qualify for their country's national championship. All distances and events in track and field were included. However, for this study the focus was on events ranging from the 1500m to the Marathon.

Athletes training at altitude were chosen because more and more elite distance runners have been electing to train at altitude and the researcher wanted to compare the results to previous studies that had focused on athletes training at altitude. The reason for this was that with lower partial pressure of oxygen at altitude the human body adjusts to use oxygen more efficiently. When these athletes that have acclimated to altitude and then compete at sea level they have a lower level of exertion and thus can better compete. This theory is traced to the "train high race low" theory of training for endurance athletes (Levine, 2001).

The recruitment took place in the cities surrounding Boulder, Colorado because there were a large number of elite female distance runners in this area. Also, the researcher had personal connections to local running clubs and a sports psychologist who worked with many of the elite runners. The group recruited for this study was "B" Standard female distance runners who specialized in different events but all trended towards the marathon distance. This particular cohort was chosen due to the lack of reported research about their dietary habits. Initially 10-15 participants were recruited with 10 starting the study. Due to injury and change in training schedules only seven elite female distance runners completed the six-week study. Six of the athletes were of European descent with one of Japanese descent. All athletes were in their late 20's to mid-30's in age, trained at a moderate altitude of 5000-8000 feet above sea level, and were in their "build-up" phase of training for a target event. Kansas State University's Institutional Review Board gave human subjects approval for this project (Appendix F).

Instrument Development

The process of instrument development began with a review of literature. For the quantitative portion (food journal, fluid journal, exercise journal) previous studies on diets of elite distance runners were used (Beis, et al., 2011, Christensen et al., 2002; Fudge et al., 2008; Onywera et al., 2004). The instrument or journals for this study contained spaces for each day of the week and the respondent recorded their food and fluid intake or exercise. The food journal contained spaces for breakfast, lunch, dinner, snacks and/or any other calories consumed while training. The fluid journal contained areas for the three main meals as well as a section to add in miscellaneous fluid intake. The exercise log had space for each day of the week. Additionally, the exercise log had three sections, one for running (including the distance, time and type of run), one for strength/flexibility training and one section for other cardio (hikes, walks, cross training). In each log it was noted to "indicate amounts" which allowed for less guesswork when tabulating and recording the intakes in the food and fluid database (See Appendix C).

Food intakes were recorded in multiple forms. Ounces were used for protein sources (chicken, beef, fish, etc.) and for drink powders; cups or fractions of cups for salads, grains, cereals, etc.; and serving sizes for single serving items like bars, raw vegetables (carrots, broccoli, etc.). The type of measurement used in the food journal was left up to the athletes. All fluid intakes were recorded in fluid ounces and fluid consumed counted towards the total intake for the day for that particular athlete.

The qualitative instrument which was originally developed by Long et al., (2011) to better understand the food choices of male division II football players was designed to determine the types and reasoning of food choices for athletes and therefore ideal for the purposes of this study. The instrument for the current study was revised to make the questions applicable to female distance runners. This was done by focusing on events instead of position groups, pre-race food choices, how choices changed since becoming a professional runner, and adding food avoidances. The first section asked demographic information about their events and ethnic background, the second section dealt primarily with food habits around competition, how the habits of the participants differed when at home versus on the road traveling for races, and delved into any superstitions about foods or particular pre-race foods or foods that were avoided close to competition. Questions about meal planning also were asked. The third section focused on the influences of others on their meal choices. The primary emphasis of these questions was to determine whether eating habits of others would change the eating habits of the athletes. The final section specifically asked whether there were any foods that the athlete avoided and why (see Appendix D for final instrument).

Pilot Study

A pilot study with four non-elite female distance runners was conducted using volunteers from a local running club. As none of the participants in the pilot study had a "B" standard for the 2013 World Track and Field Championships, no data collected in this initial study were used for the final study. The purpose of the pilot study was to streamline the quantitative data collection tool to allow for ease of use for the participants and the researcher. From the feedback, the quantitative collection tools were modified to enhance the process. The journals were re-calibrated to reflect a full seven day week (where previously the journal needed to be filled out every three days) and added spaces for other activities such as weight training, cross training, and yoga to the exercise journal.

Data Collection

The instrument was distributed to the athletes by e-mail with attached Excel files, completed by the participants and returned to the researcher via email once each week for six weeks. Each athlete was given instructions to measure their food and to be as specific as possible with the amounts included in their logs. This allowed for easier data entry into the database for food, fluid and exercise. Athletes were encouraged to record everything that they ate, drank and expended via exercise for the most accurate tabulation. From these journals, data for fluid, calorie, and macronutrient intake and calories expended were determined by the researcher.

Data Entry

All records collected from the food, fluid, and exercise journals were entered by the researcher into *myfitnesspal.com* (chosen because of its extensive food list of over five million foods and calories expended from exercise that could be calculated) which tabulated the data and then it was recorded into Excel spreadsheets for each athlete. Every food, supplement, and calorie containing drink was found in the data-base and entered into the participant's specific meal for the six weeks. See table 4.1 for an example of how data was entered. Calories consumed and macronutrient (carbohydrate, protein, fat) breakdown in grams was obtained from *myfitnesspal*. To determine percent of calories from the macronutrients the grams ingested for each were multiplied by their known calories per gram (4 calories per gram for protein and carbohydrate and 9 calories per gram of fat) and divided by the total calories consumed (see Appendix E for example).

Table 4.1 Sample of Food Journal and Input Into Myfitnesspal Database

From Athlete Food Journal
Breakfast
2 large baked eggs, 2 turkey sausage links (store bought)
Lunch
3c romaine green salad with olive oil, 2oz grilled chicken and 1/3c mozzarella cheese
Dinner
2 scoops Isopure protein powder, 2 tbsp coconut oil
Snacks
2 scoops Isopure protein powder, 1 scoop Dynamic Greens, 1 avocado, 1 tbsp cinnamon

Entered Into *Myfitnesspal*
Breakfast
2-baked eggs, large, 2 eggs; sausage-turkey, fresh, cooked, 100g
Lunch
salad greens-spring mix 3 cups; oil-olive, 0.5 tablespoons; chicken-chicken breast only, cooked, 1.98oz; cheese-mozzarella cheese grated, 1/3 cup
Dinner
Isopure-unflavored protein powder, 2 scoopful; oil-coconut, unrefined, 2 tablespoons
Snacks
Isopure-unflavored protein powder, 2 scoopful; Dynamic Greens-Strawberry & Kiwi, 1 scoop; Avocados-Raw, 1 avocado, NS as to Florida or California; Spices-cinnamon, ground, 1 tablespoon

For exercise, athletes recorded the type as well as the intensity and time spent per day. Each exercise (running, lifting, yoga, cross training, etc.) was entered into the *myfitnesspal* database by the researcher. *Myfitnespal* which had a large database for different types and intensities of exercise was then used to calculate the amount of calories expended each day and week. This amount was entered into the athlete's individual spreadsheet and tabulated to determine the maximum and minimum as well as the average number of calories the athlete expended over the course of the study. These were combined to determine the mean, maximum, and minimum calories expended for the entire group.

Participants had three spreadsheets, one each for their food, fluid and exercise totals which were tabulated after each week and an aggregate was obtained at the end of the six weeks. At the conclusion of the study three composite spreadsheets (one each for food, fluid and exercise) were created to better determine overall trends in the group.

After all qualitative data were collected; each participant had a telephone interview with the lead researcher. The interview discussed the qualitative questions about the athletes' eating habits and attitudes towards food. The interview took 15-20 minutes depending on the depth of the answers.

Table 4.2: Sample Interview Questions
Demographic Information What events do you run? What is your ethnic background?
Interview Questions Do you have any food, drink, or meal preferences, traditions or superstitions in relationship to training or races? What sort of strategies do you use to plan your meals and snacks? Do you avoid any types of foods?

Statistical Analysis

Means, standard deviations, medians, maximums, minimums, and variance were run using Microsoft Excel on all the macronutrient, fluid, and exercise data. Calories, carbohydrate, protein, and fat were determined individually. The macronutrients (carbohydrate, protein, and fat) were further delineated into grams per day as well as percent of daily calories. Calories expended was determined as a mean number of calories expended per participant, average time exercising per day and mean calories per person per day. All calories expended were determined by inputting the activities noted in the athletes' exercise journals into *myfitnesspal.com*. Qualitative data were tabulated and divided into sections to identify demographics, food choices/superstitions, and food aversions.

Results

The participants of this study were primarily of European descent (six out of seven) and one was of Japanese descent, all were female, focused on events from the 5k distance to ultramarathons with an emphasis on the marathon distance, and were at least partially dependent on running for their income. Also, all were in the "build-up" phase of their training, where their mileage was the heaviest in preparation for a goal event. The mean height and weight for the athletes was 65.7±2 inches and 122.1±8.4 pounds which resulted in a mean BMI of 20.2±1.3 kg/m^2. Basal Metabolic Rate (BMR) was determined for each athlete by using the Harris Benedict Equation (*healthfitonline.com*). For women the equation is: 655 + (4.35 x weight in pounds) + (4.7 x height in inches) – (4.7 x age in years) (*healthfitonline.com*). The range of BMR for the athletes was noted to be 1291 to 1395 with a mean BMR of 1344.1±42.6. See tables 4.3 and 4.4 for demographics and height, weight, BMI and BMR of athletes.

Table 4.3: Demographics of Participant Athletes

	Age	Ethnicity	Event
Athlete 1	33	European	5k-Marathon
Athlete 2	34	European	1/2 Marathon-Marathon
Athlete 3	28	European	10k-Marathon
Athlete 4	29	European	5k-Marathon
Athlete 5	26	European	1/2 Marathon-Marathon
Athlete 6	35	Japanese	Marathon-Ultra
Athlete 7	36	European	Marathon-Ultra

Table 4.4: Height, Weight and BMI of Participant Athletes				
	Height (In)	**Weight (lbs.)**	**BMI (kg/m2)**	**Basal Metabolic Rate (calories)**
Athlete 1	67	120	18.8	1337
Athlete 2	67	135	21.1	1393
Athlete 3	67	118	21.6	1291
Athlete 4	62	127	21.8	1372
Athlete 5	64	110	19.5	1307
Athlete 6	66	117	18.9	1314
Athlete 7	67	128	20	1395
Mean	**65.7**	**122.1**	**20.2**	**1344.1**
	±2.0	**±8.4**	**±1.3**	**±42.6**

As noted in table 4.5 the athletes in this study had an average caloric intake of 2062±504.2 calories per day. The lowest mean of calories consumed was 1555.7±345.2 and the highest 2403.6±622.1 calories. The mean carbohydrate intake was 267.9g±125.8/day or 50.9% of their calories. According to Burke, Kiens, and Ivy (2004), an athlete in the middle of a buildup should consume 7-12g carbohydrate/kg body weight (BW) or 45-65% of calories. Using these standards the mean amount of carbohydrate consumed would only be adequate for an athlete weighing 22.3-38.3kg (49-84.3 lbs). None of the athletes weighed this during their build up phase; therefore, carbohydrates for this group of athletes were under-consumed.

The mean intake of protein per athlete was noted as 98.5±6.0 g/day. Per the Joint Statement of the ADA, DC and ACSM (2009) the recommended protein intake for athletes is 1.2-1.7g/kg BW or 10-35% of calories per the Institute of Medicine (2002). This would equate to 98.5g protein/day which is adequate for a 58-82kg (127-180lb) athlete or 19.4% daily intake per the Institute of Medicine (2002). This would suggest that at least some of the athletes in this study were overconsuming protein. The amount of fat per day recommended by the Joint Statement of the ADA, DC and ACSM (2009) is 20-35% of total energy. The mean percent of total energy from fat by these athletes was noted to be 29.8±17.6% (79.7±41.1g) which falls in line with recommendations.

Table 4.5: Calorie and Macronutrients by Mean and Standard Deviation per Day							
	Calories	**Carb G**	**Carb %**	**Pro G**	**Pro %**	**Fat G**	**Fat %**
Athlete 1	2403.6	313.7	54.7	93.9	16.3	80.3	29
	±622.1	±76.2	±6.4	±20.6	±4.5	±36.7	±6.6
Athlete 2	1695.2	193.1	41.2	71.9	17.3	82.1	43.7
	±511.1	±65	±7.5	±24.8	±4.8	±29.0	±8.5
Athlete 3	2019	73.2	14.5	123.3	25.3	134.8	60.4
	±479.4	±28.3	±4.6	±37.4	±7.1	±37.2	±6.1
Athlete 4	1740.7	136.1	32.7	105.6	24.4	83.0	42.2
	±372.9	±75.4	±18.1	±54	±10	±43.1	±18.3
Athlete 5	1555.7	214.1	55.6	65.1	16.8	44.9	25.6
	±345.2	±54.5	±9.3	±20.3	±3.9	±20	±8.6
Athlete 6	2214.5	359.5	65.1	120.1	21.7	32.9	13.4
	±184.2	±30.8	±2.4	±15.9	±2.0	±3.5	±0.9
Athlete 7	2354.6	383.0	64.9	96.2	16.4	69.0	19.3
	±377.7	±73.7	10.3	±21.0	±3.5	±23.9	±8.9
Overall Mean	**2062**	**267.9**	**50.9**	**98.5**	**19.4**	**70.7**	**29.8**
	±505.4	**±125.8**	**±19.4**	**±33.4**	**±6.0**	**±41.1**	**±17.6**

As noted in table 4.6, fluid intake among the athletes was a mean of 84±39.8 oz. per day while the greatest intake was 142.4±21.4 oz. and the lowest was 39.3±12.1 oz. There are no specific guidelines for fluid intake during training or competition with the primary recommendation being that athletes consume enough fluid to maintain their sweat rate (Joint Statement of the ADA, DC and ACSM, 2009). Fudge et al. (2008) stated that athletes can do very well taking fluid ad libitum to maintain their hydration status. The ad libitum fluid intake noted by Fudge et al. was not measured but observed by the researchers who concluded that no athletes showed dehydration via their urine samples though they were consuming less fluid than was recommended.

Table 4.6: Mean and Std. Dev., Maximum and Minimum Daily Fluid Intakes by Athletes (in fl oz)			
	Mean Std. Dev.	**Maximum**	**Minimum**
Athlete 1	142.4 ±21.4	192	72
Athlete 2	70.8 ±11.7	92	54
Athlete 3	80.3 ±10.4	98	68
Athlete 4	87.0 ±23.1	150	58
Athlete 5	86.1 ±29.2	160	48
Athlete 6	73.5 ±20.7	128	26
Athlete 7	39.3 ±12.1	64	16
Overall	**84.0 ±39.8**	**126 ±44.5**	**49 ±20.9**

Table 4.7 shows the mean calories expended per day as well as the maximum and minimum number of calories spent from exercise and each athlete used an average of 773.4±698.7 calories per day during the six weeks. This would equate to running roughly eight miles per day. Also, these athletes took part in other activities such as yoga, weight training, boot camps, Pilates, hiking, ice skating, and swimming. The minimum amount of calories expended via exercise was zero which would indicate that the athletes had days when they did not exercise. The maximum amount of calories expended was 5263 which may have been a day with two workouts and strength training. The athletes were expending 1344.1±42.6 calories per day (Table 4.4) via their BMR and 773.4±698.7 calories via physical activities during the course of the study which equates to a mean of 2117.5±741.3 calories per day. The athletes consumed 2062±505.4 calories per day based their food logs. Therefore the average intakes and average expenditures are quite close while some days the athletes expended more calories than they took in which is not surprising as the study took place during their most intensive times of training.

Table 4.7: Mean and Std. Dev. With Maximum and Minimum Calories Expended Per Day Per Athlete During Exercise			
	Mean Std. Dev.	**Maximum**	**Minimum**
Athlete 1	1450 ±543.3	2262	150
Athlete 2	1299 ±714.3	3279	0
Athlete 3	1158.6 ±566.6	1835	23
Athlete 4	517.3 ±719.2	2376	0
Athlete 5	1294.3 ±1131.5	5263	0
Athlete 6	907 ±484.6	1034	0
Athlete 7	1373 ±612.8	2343	28
Overall	**773.4 ±698.7**	**5263**	**0**

In looking at differences in eating habits by specific events, it was found that athletes two and three who were training for the ultra-marathon consumed 193.1±65g and 73.2±28.3g of carbohydrate per day (41.2% and 14.5% of calories) which was lower than the overall mean of 267.9±125.8g or 50.9±19.4% of calories. Athlete three consumed a mean of 123.3±37.4g of protein per day (25.3±7.1% of calories) which was above the group mean of 98.5±33.4g (19.4±6%) per day. Athlete two and three ate 82.1±29g and 134.8±37.2g of fat per day (43.7±8.5% and 60.4±6.1% of calories). The mean of all participants was 70.7±41.1g (29.8±17.6% of calories) fat per day. Therefore athletes two and three were consuming well above the average amount of fat of all participants in the study.

Qualitative (Interview) Results

The interview results indicated that prior to the events the athletes focused on increased vegetable and lean protein intake up to and including the night before their target event. On the day of an event before the race, athletes focused on lower fiber content. This is due to the possible impact of stomach upset with intake of higher fiber meals before longer distance events. This was confirmed by Oliveira and Burini (2011) who noted that the chances of stomach upset increased with higher fiber, fat and protein as well as more concentrated carbohydrate solutions. All responses from the qualitative interview can be found in the appendix G.

Food choices at home and when traveling

The athletes focused on increased fruits and vegetables in the diet. This helped the athletes to consume large amounts of vitamins and antioxidants and to decrease the intake of less healthy foods. All of the food choices of the athletes either at home or when traveling tied into their training. Many of the athletes had internal self-talk where they would ask themselves "will eating this help me run faster?" Some of the athletes brought their own foods on the road when traveling for competitions. This included bars, shakes, other snacks, or even full meals to be prepared on site One athlete preferred to rent a house or a hotel room with a kitchen so she could prepare her own meals and not risk going to a restaurant prior to a competition.

Athletes used nutritional powders as recovery aids or meal replacements for better muscle recovery. Most of the powders had a 3:1 carbohydrate to protein and content ranged from soy based protein sources to whey protein sources. Some of the supplements contained vegetable and fruit extract for additional vitamins and minerals. According to Froiland, Koszewski, Hingst, and Kopecky (2004), female athletes were more likely to take supplements due to an inadequate diet. According to Maughan, Depiesse, and Geyer (2007) 85% of elite track and field athletes take supplements as part of their routine with protein being one of the most common. Maughan et al., (2007) also noted that most athletes felt that they must take supplements in order to perform well though a varied diet sufficed to meet nutritional needs.

Social Influences

All of the athletes involved in this study were collegiate distance runners, but moved to being at least partially financially dependent on their running. Due to the added pressure, they made changes in their eating since becoming a professional athlete. Five of the seven athletes stated they had decreased the "junk food" in their diet and increased fruits and vegetables. Two of the runners kept daily food, fluid and exercise journals to ensure that they stayed in balance. Weekly meal planning was popular among the athletes as five of the seven noted doing so. Additionally, two of the seven athletes kept "staple" foods and used these particular foods to build their meal plans for the day or the week. Examples of staple foods included: avocado, salad mixes, nut butters (almond, sunflower), fruits, granola/protein bars, low fat meats (turkey, chicken, tuna, etc.), and rice pasta. All of the athletes used a powdered supplement either for workout recovery or to sustain energy during workouts.

The attitude toward foods and others' food choices was asked to determine if the athletes judged others for their food choices or if they were influenced by the food choices of others. Most of the athletes stated that they don't judge others by what they eat. Five of the seven stated that they ignore the food choices of others. Two athletes noted that they will eat less healthy if those around them do so as well. However, two of the athletes (one of which was a Registered Dietitian) indicated that they do judge the food choices of others when eating in a group.

The athletes were asked if there were any particular foods that they avoided. This was requested because previous studies have shown that certain fad diets are becoming popular amongst the general population and some athletes are starting to follow them. Five of the seven athletes avoided or were trying to decrease their consumption of gluten, three avoided dairy products, one avoided artificial sweeteners, and one soy products. Two athletes did not eat foods with high fructose corn syrup and fried foods. All of the changes in diet were made by the athletes themselves either to increase performance or decrease GI distress. No allergies were noted by any of the athletes

The athletes did not eat specific foods for two primary reasons: GI upset and performance. This was determined after the athletes experimented with their diets and found that a gluten free diet increased performance and decreased GI upset. Those citing performance pointed to possible low-grade inflammation from ingesting gluten and dairy which might affect their performance. The change to gluten free came from the athlete rather than the influence of others and no athletes had been diagnosed as gluten intolerant. None of the athletes were currently following either a Paleo or Vegetarian/Vegan Diet at the time of the study. However, one participant knew of another athlete who had tried the Paleo Diet. Another participant was preparing to start the Paleo Diet for Athletes for better blood sugar control to prevent energy crashes during training.

Athletes two and three were training for longer distance events and were noted to be eating differently than those focused on shorter distances. These two athletes were both following gluten free diets and were avoiding dairy products. Athlete two did not eat dairy, high fructose corn syrup, and processed foods when possible and athlete three avoided soy products. Also they used nutritional supplements as meal replacements to help obtain more calories after hard workouts or long runs. As both of these athletes were training for longer events this trend may indicate that runners training for longer distances tend to consume less gluten, soy, dairy and processed foods (including high fructose corn syrup) and were consuming more protein and fat with less carbohydrate than those training for shorter distance events.

Discussion and Conclusions

Discussion

The purpose of this study was to determine the macronutrient composition, fluid habits and dietary tendencies amongst elite female distance runners. Dietary analysis investigated total calories, fluid, carbohydrate, protein, and fat intakes. In looking at dietary tendencies of the athletes specific questions about their diets were asked to determine if the athletes were following fad diets.

The overall mean calorie intake of 2062±505.4 was likely to be below the needs of the athletes on a daily basis with a combined BMR and calories expended. However, with days off and the fact that this was the hardest part of the athletes' training cycles before an event the caloric difference may not be a concern. Some of the athletes could have lost weight during the heavy training period but the weight loss may be negated by the days off taken when the calorie intake was higher than their BMR. As shown in Table 4.8, the minimum number of calories expended via exercise per athlete during the study ranged from zero to 150 calories. Although the overall intakes were less than calories expended, this may be due to under-reporting on the part of the athletes in the food journals. It was noted by Burke, Slater, Broad, Haukka, Modulon, and Hopkins (2003) that athletes tend to under-report on food diaries and this was especially true of female athletes.

Based on the quantitative data collected, these athletes were not consuming enough carbohydrate. This was determined by using the formula for grams of carbohydrate per kilogram set forth by Burke, Kiens, and Ivy (2004). According to their recommendations, an athlete in the middle of a hard training cycle should be consuming 7-12g of carbohydrate per kilogram body weight. The athletes in this study were taking in an average of 4.8 g per kg body weight. While no adverse effects from lower carbohydrate consumption were noted by the athletes, lack of carbohydrates may result in a risk of Overtraining Syndrome (OTS) which has been associated with lower amounts of carbohydrate intake (Robson, 2003), is defined as a maladapted response to excessive exercise or training and can manifest as neurologic, endocrine, immunologic or mood disturbances (Kreher & Schwartz, 2012). Increasing carbohydrate consumption to average at least 7g/kg BW would decrease the risk of overtraining syndrome and its effects. This could be done with an increase of whole grains, gluten free grains, and/or fruits.

The athletes were consuming more grams protein per kilogram body weight than was recommended by the Joint Statement of the ADA, DC and ACSM (2009). The athletes were taking in an average of 98.5±33.4g of protein per day. According to the Joint Statement (2009) the recommended protein intake for endurance athletes was 1.2-1.7g per kilogram body weight. The mean intake for the athletes in this study was 1.8g per kilogram body weight. This puts the average amount consumed at the higher end of the amount of protein suggested and indicates that the athletes in this study may have been exceeding the recommendation for protein at certain times.

However, it appeared that the athletes were taking in an adequate amount (30% of calories) from fat with the joint statement recommending (Joint Statement of the ADA, DC and ACSM, 2009) 20-35% of calories from fat. Of the three macronutrients that were studied, this was the only one where the mean intake met the recommendations. However, some of the athletes were exceeding the recommendations for fat. It was noted that athletes two, three, and four exceeded recommendations for fat as percent of total calories; yet they did not meet recommendations for carbohydrates. This may be the reason that consumption of carbohydrates was noted to be not meeting recommendations for the cohort as a whole. However, athletes six and seven were not meeting recommendations for fat but consumed the highest amounts of carbohydrate.

The fluid status of the athletes appeared to be adequate as none of them complained of dehydration throughout the course of the study. On average the athletes consumed 84±39.8 fl. oz. of fluid per day during the six week collection period. The only recommendation noted for fluid is to take in enough fluid to compensate for their sweat rate according to the Joint Statement of the ADA, DC, and ACSM (2009).

There was some indication that the athletes in this study had changed their eating habits after becoming professional runners: three had decreased dairy, two high fructose corn syrup, and two fried foods. However, five of the seven (71%) athletes were avoiding gluten which confirmed the results of Lis, Stellingwerff, Shing, Ahuja, and Fell (2014) who found that 41% of athlete respondents followed a gluten free diet at least 50% of the time. However, Lis et al., 2014 did not note the reason for the avoidance of gluten. The interviews in this study indicated that the athletes followed a gluten free diet because it provided a performance advantage rather than reducing GI discomfort since three of the athletes (2, 3, and 7) did note improvements in their times and quality of training after changing to a gluten free diet.

The respondents who were training for and participating in the longer races (i.e., ultra-marathons) had different diets than those who were focused on shorter distances. The two athletes (athletes 2 and 3) noted that they follow a gluten free diet. In addition, athlete two was avoiding dairy, high fructose corn syrup and was decreasing processed foods. Athlete three was avoiding gluten, dairy and soy. This trend may indicate that athletes competing in longer distances specifically ultras may tend to consume more protein and fat with less carbohydrate than their counterparts in shorter distances. The athletes who were training for ultras also were more likely to use a powdered protein and/or supplement mix as a meal replacement and after exercise.

Conclusions

No previous studies with athletes have focused on US female distance runners. As more and more diets are available for athletes to choose from it is vital that coaches, trainers, dietitians, and doctors recognize what diets meet the needs for these athletes and which do not. Also, it is important that those monitoring the athletes and the athletes' diets (food and supplements) are aware of current guidelines when supervising the diets.

The athletes on average were consuming less carbohydrate and more protein per day than recommended by The Joint Statement of ADA, DC and ACSM (2009) while the mean fat and fluid intakes were adequate. Based on their exercise and BMI, it appeared that athletes were consuming enough calories, but overall calories ingested were a little lower than calories expended.

This group of female athletes was avoiding gluten, soy, high fructose corn syrup, artificial sweeteners, dairy, soy, and fried foods. Overall, the athletes were confident in their food choices and planned their menus on a daily or weekly basis, focused on eating more fruits and vegetables, eliminated "junk food" from their diet. Also, due to the increases in the intensity and distance of their training many of the athletes were using powdered supplements for better recovery.

The only fad diet the athletes used was the gluten free diet as five of the seven athletes were following a form of this diet. None of the athletes noted a gluten allergy thus it can be assumed that they changed their diets because they felt it gave them an edge competitively, increased performance and reduced GI distress. All of the athletes noted in their interviews that their diets were carefully planned each day. Also, many of the athletes were taking supplements that would give them adequate B Vitamins, Iron, Zinc, and Magnesium that would reduce the risks of a gluten free diet. Both of the athletes who were training for Ultra Marathons were following a gluten free diet and noted no decrease in performance and actually observed an increase in performance after switching to a gluten free diet. Vegetarian/Vegan and the Paleo diets were not being followed by the athletes, but one did state that she was going to shift to a Paleo Diet for Athletes in hopes that it would control blood sugar and prevent crashes during training.

From the trends noted in this study it may be prudent for athletes to try a carefully controlled gluten free diet to determine if it increases performance. As there was no evidence that gluten free is harmful if the athlete is monitored correctly the chances of nutritional concerns were small. Also, the possible placebo affect alone may be enough to increase performance on its own or could increase performance due to a lack of GI issues. Monitoring carbohydrate and protein along with a carefully controlled trial of a gluten free diet for either performance or GI issues would be prudent given the results in this study. However, a general recommendation for following a gluten free diet can only be made after further, larger studies are conducted.

With the different types of diets that athletes have to choose from it is important for coaches, trainers, dietitians, and other medical personnel to recognize what meets the needs for these athletes and what does not. Coaches and trainers should be aware of the intakes of the athletes to ensure that they are taking in enough calories and macronutrients to support their workload. Under-consuming calories can lead to decreased levels of performance while inadequate amounts of carbohydrates can lead to Overtraining Syndrome. Coaches and athletes should use the guidelines set forth by the Joint Statement of the ADA, DC, and ACSM (2009) as a basis for an adequate diet for elite athletes.

If an athlete chooses to follow a gluten free diet or has to due to a medical condition monitoring the diet for intake of B Vitamins, Iron, Zinc, and Magnesium should be done to ensure that it is adequately meeting the needs of the athlete. With any diet change, coaches and athletes should monitor energy levels, workouts, macronutrient amounts and overall calories to ensure the athlete is able to compete at a competitive level.

Limitations of the Study

Certain limitations of this study are acknowledged in interpreting results. First, the majority of the subjects were of European descent and all live at moderate altitude. The data in this study was self-reported by the subjects in the form of their food, fluid and exercise logs. The self-reported nature of the data collection could lead to skewing of the data by the subjects. In addition, the qualitative data was self-reported via a telephone conversation. The questionnaire was adapted from another study which may have made some of the questions confusing for the athletes. Additional research is needed to determine if the trends shown from the quantitative and qualitative data sets were valid. The use of *myfitnesspal.com* and the need to translate amounts of foods eaten by the athletes into different measures was also a limitation of this study. Finally the sample size was small and cannot be generalized to other populations.

Future Research

Recommendations for future research include conducting this study with a larger number of athletes to determine if the trends from this study hold true. Particular trends to look for would be: gluten free diets, under-consumption of calories, over-consumption of protein and fat by runners training for longer distance events. Also it will be important to determine if athletes were truly following a gluten free diet to enhance performance. A controlled setting for this study with meals provided by the research team as well as urine measures taken to determine hydration status would produce a more valid study. Studying the sources and types of carbohydrates consumed by the athletes should also be researched. Additionally, all athletes training for the same event or on the same team would make future research more reliable. Use of validated software to calculate the macronutrient intake would also be useful for future research. The use of a device to measure actual energy expenditure would produce a more valid study as well.

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Chapter 5-Summary and Conclusions

This final chapter includes the major findings of the study and evaluation of the objectives and research questions stated in Chapter 1. Practical implications for the dietary habits of the athletes in this study are discussed along with study limitations and future research.

Summary of Study

Elite athletes are a segment of the population that has been constantly striving to improve and push their athletic limits. With training methods for athletes changing little, food and hydration habits have been viewed as a way to gain a competitive edge. As was noted by Pelly et al, (2011) there have been numerous changes to the diets of elite athletes since the dawn of the Modern Olympic Movement. Since so little research has been conducted that specifically focuses on female elite distance runners it was time to study this group. Also, because many distance runners have been training at altitude to improve their racing it is important to focus on athletes training at altitude. Therefore the purpose of this study was to examine the macronutrient intake and fluid status of elite female distance runners training at moderate altitude. A series of research questions served as a basis for the study.

A total of seven elite female distance runners participated. Six of the seven athletes were Caucasian, all were primarily focused on the marathon distance, and were in their late 20's to mid-30's.

Summary of Major Findings

Research Question 1: What is the macronutrient composition of the elite female distance runner diet?

Per the quantitative data analysis the average female distance runner in this study consumed 2062 calories per day. In addition, the average runner ingested 267.9g of carbohydrate (50.9% of calories), 98.5g of protein (19.4% of calories), and 70.7g of fat (29.8% of calories). From the results, it appears that these seven athletes under-consumed carbohydrate and overconsumed protein. Three athletes ate 20-25% of their calories from protein and three athletes consumed 40-60% of their calories from fat.

Research Question 2: How much fluid does an elite female distance runner consume per day?

According to the data tabulated for this study the average elite female distance runner consumes a mean of 84 oz. of fluid per day with a maximum one day total of 192 oz. of fluid.

Research Question 3: Do the diets of elite female distance runners change in response to fad diets?

According to the data collected, five out of the seven athletes avoided gluten. Also, as noted above the athletes ate on average 50.9% of calories from carbohydrate which is low according to Burke et al, 2004. The trend shown in this study seemed to indicate that elite female distance runners were changing their eating in response to fad diets. This was especially true for gluten free diets as five of the seven athletes were following a gluten free diet plan.

Research Question 4: Are the dietary changes made due to performance or issues with digestion?

For most of the athletes in this study dietary changes were primarily performance driven. In this cohort, five of the athletes avoided gluten. These athletes were split on whether they avoided gluten due to performance issues or digestive problems. Three of the five noted that they felt a gluten free diet helped their performance and training while the other two noted a decrease in digestive issues.

Research Question 5: Does an athlete’s preferred event play a part in changes in diet?

This study found that elite female athletes focusing on longer distances (i.e. Ultra-Marathons) ate differently than the other athletes. Both of the athletes who were focusing on longer distance events were far more restrictive with the types of foods they were eating. Both of these athletes consumed a largely gluten free diet while athlete two also was avoiding dairy, high fructose corn syrup and processed foods. Athlete three did not eat gluten, dairy and soy.

Research Question 6: Does an athlete’s preferred event change their macronutrient intake composition?

The two athletes in this study who were focused on Ultra-Marathons were noted to be consuming higher levels of protein and fat when compared to the rest of the cohort. Athlete 2 was consuming 1695.2±511.1 calories per day, 3.1g/kg BW carbohydrate, 1.2g/kg BW protein, and 1.3g/kg BW fat. Athlete 3 was eating 2019±479.4 calories per day, 1.4g/kg BW carbohydrate, 2.3g/kg BW protein, and 2.5g/kg BW fat. This trend shows that athletes focused on longer distance events tend to consume higher amounts of fat and protein in their diets and lower amounts of carbohydrate. Also, athletes two and three were the only athletes in the study to use a protein supplement as a meal replacement.

Study Limitations

Certain limitations of this study are acknowledged in interpreting results. First, the majority of the subjects in this study were of European descent and all live at moderate altitude. The data in this study was self-reported by the subjects in the form of their food, fluid and exercise logs. The self-reported nature of the data collection could have led to skewing of the data by the subjects. In addition, the qualitative data was self-reported via a telephone conversation. The questionnaire was adapted from another study and that may have made some of the questions confusing for the athletes. Additional research is needed to determine if the trends shown from the quantitative and qualitative data sets are reflective of female distance runners as a whole. The use of *myfitnesspal.com* and the need to translate amounts of foods eaten by the athletes into different measures is also a limitation of this study. Finally the sample size was small and additional research may be needed with a larger sample. Lack of urine measures to determine hydration status and controlled meals also were limitations of this study.

Future Research

Recommendations for future research are listed below:

1. Conduct same study with an increased number of participants
2. Conduct a similar study with a greater diversity of events
3. Conduct a similar study with specific urine measures
4. Conduct a similar study looking at sources and nature of carbohydrate intakes

Conclusions

The athletes involved in this study were under-consuming carbohydrates on average though individuals varied. The athletes were taking in 50.9±19.4% of carbohydrate per day or 4.8 g/kg BW. Per The Joint Statement of ADA, DC and ACSM (2009) each athlete should eat 7-12g/kg BW of carbohydrate per day. The amount consumed would only be enough for a 49-84 pound person and is far below the weight range of the athletes in this study. In addition, there was an overall overconsumption of protein. Each athlete was consuming on average 19.4±6% of caloric intake or 1.8g/kg BW of protein per day. The Joint Statement of ADA, DC and ACSM (2009) recommended a daily intake of 1.2-1.7g/kg BW. However, the average fat intake of the athletes was adequate per the recommendations of The Joint Statement of the ADA, DC and ACSM (2009). The average intake of fat was 29.8±17.6% of calories while The Joint Statement of the ADA, DC, and ACSM recommends 20-35% of calories from fat.

Overall the fluid intake of the athletes appeared to be adequate. None of the athletes noted any issues with dehydration over the course of the study and on average the athletes were taking in 84±39.8 oz. of fluid per day. This is the opposite of what was observed in elite distance runners by Beis et al., 2011, and Onywera et al., 2004. Both of these studies conducted in sub-Saharan Africa found that the athletes in their studies under-consumed fluids. However, as noted by Fudge et al., 2008 ad libitum fluid intake throughout the day was sufficient for hydration. Also, according to the Joint Statement of the ADA, DC, and ACSM in 2009 the athletes needed only to keep up with their sweat rate during exercise to stave off dehydration. This leads to the conclusion that the athletes in this study were consuming adequate amounts of fluid.

The athletes in this study were expending over 700 calories per day on average via exercise and consuming an average of 2062±505.4 calories per day. A difference this large between calories consumed and calories burned would lead to weight gain. However, when considering days off, the athletes were expending an average of 891 calories per day. Also, the athletes were expending an average of 1344.1±42.6 calories per day via BMR. This indicates that the athletes were expending approximately 2044 calories per day on average (2235 calories when controlling for days off during the study). Previous research found that athletes consumed adequate calories daily no matter the gender or age of the athlete (Beis et al., 2001; Christensen, 2002; & Onywera et al., 2004). These results hold true for this study as no athlete complained of weight loss over the course of the study.

The respondents noted avoiding soy, high fructose corn syrup, artificial sweeteners, dairy, and fried foods. Not all of the athletes gave reasons for their avoidance of certain foods. For most it was a belief that if they avoided these foods close to competition they would have better performances. This was especially true with those who chose a gluten free diet, however; GI distress was an issue with two athletes.

All of these athletes used some form of powdered drink supplement to augment their diets. According to Maughan, et al. (2007) 85% of elite track and field athletes use supplements to enhance their diets and improve performance. It was also noted by Maughan, et al. that a well-planned, varied diet could meet the needs of the endurance athlete without supplementation.

Interview results from this study indicate that the majority of the athletes were confident in their food choices, planned their menus on a daily or weekly basis, focused on eating more fruits and vegetables, eliminated "junk food" from their diet, and some avoided gluten, dairy, artificial sweeteners, high fructose corn syrup, soy and fried foods.

Based on the results of this study coaches, dietitians, and other medical professionals working with athletes must be cognizant of all of the foods and supplements an athlete is consuming to ensure that nutritional needs are met and must be aware of the recommended guidelines for macronutrient intake to ensure peak performance for their athletes. Per the results of this study athletes may be consuming less than recommended amounts of carbohydrate set forth by the Joint Statement of the ADA, DC, and ACSM in 2009 of 7-12g/kg BW because in this study the average amount of carbohydrate consumed was 4.8g/kg BW. Also, athletes may be overconsuming protein based on the Joint Statement of the ADA, DC, and ACSM (2009) which was noted to be 1.2-1.7g/kg BW (mean was 1.8g/kg BW). The risk of overtraining syndrome from lack of carbohydrate is very real (Robson, 2003) and therefore carbohydrate intake must be monitored by medical professionals to ensure adequate consumption. Lack of calories is a may be a concern based on the results as the athletes were expending 2117 calories per day but only consuming an average of 2062 calories per day. However, it is likely not a problem as Burke et al., (2003) noted that female athletes were more likely to underreport their calories in a food log. Therefore, a small reported calorie deficiency via food logs should not be a concern for coaches, dietitians, trainers and other athlete support staff.

Coaches and dietitians must be aware of the most recent trends in diets not only for athletes but for the general population. As was shown in this study and in previous studies (Lis, et al., 2014) more and more athletes have been experimenting with a gluten free diet. If done correctly this change has no impact on performance but there has been a noted risk of deficiencies of certain micronutrients (iron, calcium, fiber, zinc, and magnesium) (Shepherd and Gibson, 2013). Intermittent food journals can be used to determine an athlete's macronutrient and micronutrient intake. Also, discussions on any diet changes should be made with the input of the athlete's entire support system to ensure adequate macro and micronutrient intake for peak training and racing.

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Appendix A-Food Journal

Weekly Food Journal (Please Indicate Amounts)

	Breakfast	Lunch	Dinner	Snacks/Fuel on Runs
Monday				

	Breakfast	Lunch	Dinner	Snacks/Fuel on Runs
Tuesday				

	Breakfast	Lunch	Dinner	Snacks/Fuel on Runs
Wednesday				

	Breakfast	Lunch	Dinner	Snacks/Fuel on Runs
Thursday				

	Breakfast	Lunch	Dinner	Snacks/Fuel on Runs
Friday				

	Breakfast	Lunch	Dinner	Snacks/Fuel on Runs
Saturday				

	Breakfast	Lunch	Dinner	Snacks/Fuel on Runs
Sunday				

Appendix B-Fluid Journal

Weekly Fluid Log (Please Indicate Amount and Type)

	Breakfast	Lunch	Dinner	Runs/Other
Monday				

	Breakfast	Lunch	Dinner	Runs/Other
Tuesday				

	Breakfast	Lunch	Dinner	Runs/Other
Wednesday				

	Breakfast	Lunch	Dinner	Runs/Other
Thursday				

	Breakfast	Lunch	Dinner	Runs/Other
Friday				

	Breakfast	Lunch	Dinner	Runs/Other
Saturday				

	Breakfast	Lunch	Dinner	Runs/Other
Sunday				

Appendix C-Exercise Journal

EXERCISE LOG

WEEK _____ / ___ / ___ to ___ / ___ / ___

OTHER CARDIO

ACTIVITY	TIME / DIST	SETS / REPS	INTENSITY*	NOT ES

STRENGTH/FLEXIBILITY TRAINING

EXERCISES	SETS / REPS	WEIGHT	REST TIME	NOT ES

RUNNING

DAY/TYPE OF RUN*	Time	Distance	INTENSITY	NOTES

*EASY RUN, TEMPO, LONG RUN, INTERVALS, ETC

Appendix D-Interview Questions

Table D.1 Interview Questions For Qualitative Data Collection

Interview and Probe Questions			
Demographic Information			
What events do you run?			
What is your ethnic background?			
Interview Questions			**Follow up Probe Questions**
Do you have any food, drink, or meal			Something you really like to
preferences, traditions or superstitions in			eat before training or racing.
relationship to training or races?			
			Something that you feel gives
			you a competitive edge.
Describe a typical day in terms of eating and drinking			What meals do you eat?
			When do you usually eat meals?
			How many times a day do you eat something?
What sort of self-talk do you engage in			Do you find yourself thinking about
when you are choosing foods through a			some aspect of nutritional content?
typical day?			(fat, protein, carb, or calorie content)
How is your self- talk regarding food			Home is where you are currently training
choices different when you are on the road			
than when you are at home?			
How have your approaches to eating and drinking changed, if at all since you became a professional distance runner?			
What sort of strategies do you use to plan			Do you give meals and snacks any
your meals and snacks?			forethought?
			Do you use different strategies

			depending on workouts?
			Do you use different strategies
			on a race day?
			Do you use different strategies
			when workouts are at different times?
How do people around you influence your			Are you influenced by what other people
food choices?			are eating or drinking?
What thoughts go through your mind about			Do you judge people around you by
the food choices made by people around you?			their food choices?
With whom do you eat most of your meals?			Do you eat with family or teammates
			on a regular basis?
Where do you eat most of your meals?			
			Where are you most likely to eat?
Do you avoid any types of foods?			

Appendix E-Example of Food Journal and Entry into Myfitnesspal

Figure E.1 Sample Daily Food Journal

Weekly Food Journal (Please Indicate Amounts)

	Breakfast	Lunch	Dinner	Snacks/Fuel on Runs
Monday	2 baked eggs 2 turkey sausage links	Large green salad Olive oil 2oz grilled chicken 1/3 cup grated mozzarella cheese	Isopure pro powder (2 scoops) coconut oil (2tbsp)	Isopure pro powder (2 scoops) 1 scoop Dynamic Greens 1 avocado 1tbsp cinnamon

Figure E.2 Example of How Data Was Entered Into *Myfitnesspal.com*

Breakfast	Calories	Carbs	Fat	Protein	Sodium	Sugar
2 - Baked Eggs, Large, 2 eggs	140	0	10	12	130	0
Sausage - Turkey, fresh, cooked, 100 g	196	0	10	24	665	0
Add Food | Quick Tools	336	0	20	36	795	0
Lunch						
Salad Greens - Spring Mix, 3 cups	30	6	0	2	143	2
Oil - Olive, 0.5 tablespoon	60	0	7	0	0	0
Chicken - Chicken Breast Only, Cooked, 1.98 z	57	0	3	7	21	0
First Street - Mozzarella Cheese Grated, 1/3 cup	80	1	5	7	200	0
Add Food | Quick Tools	227	7	15	16	364	2
Dinner						
Isopure - Unflavored Protein Powder, 2 scoopful	220	0	0	52	340	0
Spectrum - Coconut Oil, Unrefined, 2 Tbsp	248	0	28	0	0	0
Add Food | Quick Tools	468	0	28	52	340	0
Snacks						
Isopure - Unflavored Protein Powder, 2 scoopful	220	0	0	52	340	0
Dynamic Greens - Strawberry & Kiwi, 1 scoop	40	9	0	0	20	3
Avocados - Raw, 1 avocado, NS as to Florida or California	322	17	29	4	14	1
Spices - Cinnamon, ground, 1 tbsp	18	5	0	0	2	0
Add Food | Quick Tools	600	31	29	56	376	4
Totals	**1,631**	**38**	**92**	**160**	**1,875**	**6**

Appendix F-IRB Approval

KANSAS STATE UNIVERSITY University Research Compliance Office

TO: Mark Haub
Human Nutrition
212 Justin Hall

Proposal Number: 7136

FROM: Rick Scheidt, Chair
Committee on Research Involving Human Subjects

DATE: 03/28/2014

RE: Proposal Entitled, "Determining factors that affect dietary habits of elite female distance runners"

The Committee on Research Involving Human Subjects / Institutional Review Board (IRB) for Kansas State University has reviewed the proposal identified above and has determined that it is EXEMPT from further IRB review. This exemption applies only to the proposal - as written – and currently on file with the IRB. Any change potentially affecting human subjects must be approved by the IRB prior to implementation and may disqualify the proposal from exemption.

Based upon information provided to the IRB, this activity is exempt under the criteria set forth in the Federal Policy for the Protection of Human Subjects. **45 CFR §46.101, paragraph b, category: 2, subsection: ii.**

Certain research is exempt from the requirements of HHS/OHRP regulations. A determination that research is exempt does not imply that investigators have no ethical responsibilities to subjects in such research; it means only that the regulatory requirements related to IRB review, informed consent, and assurance of compliance do not apply to the research.

Any unanticipated problems involving risk to subjects or to others must be reported immediately to the Chair of the Committee on Research Involving Human Subjects, the University Research Compliance Office, and if the subjects are KSU students, to the Director of the Student Health Center.

203 Fairchild Hall, Lower Mezzanine, Manhattan, KS 66506-1103 | 785-532-3224 | fax: 785-532-3278 | k-state.edu/research/comply

Appendix G-Athlete Interviews

Athlete 1

Demographic Information

What events do you run?

1. 5k-Marathon (5k-1/2 Marathon is "Happy Zone")

What is your ethnic background?

2. Caucasian

Interview

1. **Do you have any food, drink, or meal preferences, traditions, superstitions in relationship to training or racing?**
   I don't have any particular superstitions. In shorter races I don't feel the need to fuel during event so will take 1 swallow of a sports drink prior to the race. My focus is mainly on getting in calories instead of certain types of foods before a race. I also focus on electrolyte intake.
2. **Describe a typical day in terms of eating and drinking**
   I base my intake on my activity level. I shoot for a 3:1 carb to protein ratio in my daily food intake. I try to get in more protein d/t being female. I usually focus on more simple meals and carbs for digestion. I try to get a variety of vegetables. Iron is also a focus of mine. I try to get in more "real" (i.e. unprocessed) food.
3. **What sort of self-talk do you engage in when you are choosing foods throughout a typical day?**
   I focus on finding best places to eat on the road. If I'm competing or just competed I will focus on quality carbs and carb/protein ratio (3:1) as well as a variety of vegetables when on the road. I usually will not go to same restaurant each time and I try to stick to whole foods as much as possible. I focus on lower fiber if pre-race and may just do a smoothie.
4. **How is your self-talk regarding food choices different when you are on the road than when you are at home?**
   I'm more cognizant of my overall intake. I try to eat the best types of fuel foods for training if possible. I'm mindful of intakes (95%/5% rule-tries to keep good habits 95% of the time). I may eat more overall but I make better choices. I also plan meals more when at home.
5. **How have your approaches to eating and drinking changed, if at all since you became and professional distance runner?**

I focus more strategy now that I have my own business. I plan out entire week ahead of time to get better meals. I make things up beforehand. I have things available to make big bowls of meals and packaged for whole week.

6. **What sort of strategies do you use to plan your meals and snacks?**
   I'm more tempted to have things that are not normally in my rotation. Most people focus on amounts versus quality but I don't. I try to keep away from certain friends who have more desserts. I try to not be overly hungry when going out also. Better fueling gives me greater self-belief.
7. **How do people around you influence your food choices?**
   I try not to think about what others eat but sometimes will. Not around them all the time so it isn't super hard. I take their personalities into account.
8. **What thoughts go through your mind about the food choices made by the people around you?**
   I generally try not to judge and just focus on own meal choices and take into account my friends and family as well as their personalities.
9. **With whom do you eat most of your meals?**
   My husband is who I eat with most.
10. **Where do you eat most of your meals?**
    I eat at home unless I'm traveling for a race.
11. **Do you avoid any particular foods?**
    I avoid: fried foods, heavily processed foods, HFCS, hydrogenated oils, artificial sweeteners, high sugar foods.

Athlete 2

Demographic Information

What events do you run?

1. Marathons/Ultras

What is your ethnic background?

2. Japanese American

Interview

1. **Do you have any food, drink, or meal preferences, traditions, superstitions in relationship to training or racing?**
   I focus on protein and vegetables pre-race. Focus more on higher fat foods during racing/training for fuel. Mostly water when competing unless it is hot then will drink pickle juice for sodium balance.
2. **Describe a typical day in terms of eating and drinking**
   Focus on higher fat for fueling. I have cut most of the gluten now out my diet now and feel this has increased my performance. I focus on protein and vegetables pre-race. My fluids are mostly water and almond milk or coconut water. I will drink pickle juice if it is hot outside during training/racing.
3. **What sort of self-talk do you engage in when you are choosing foods throughout a typical day?**
   This year I have been focusing more on decreasing muscle inflammation after runs. I am consuming more ginger, iron, good fats like avocado and peanut butter, higher fiber, more protein and no processed foods.
4. **How is your self-talk regarding food choices different when you are on the road than when you are at home?**
   I travel with my fiancé. It is much harder to find gluten free foods on the road and there are more processed foods on the road as well. I usually pack foods when traveling and also will choose more shelf stable options as well.
5. **How have your approaches to eating and drinking changed, if at all since you became and professional distance runner?**
   My diet changes nearly yearly. This is the first year I am paying more attention to nutrition as part of my performance. I have been experimenting with algae, more fats and proteins with less processed foods.
6. **What sort of strategies do you use to plan your meals and snacks?**

I have habits that I will stick to for a while then change. I have basic staples that are always consumed and then I fill in around these.

7. **How do people around you influence your food choices?**
   My fiancé will influence me with his choices at meals. My choices will also change more when eating out.
8. **What thoughts go through your mind about the food choices made by the people around you?**
   I try to influence my fiancé to eat better but nothing beyond that.
9. **With whom do you eat most of your meals?**
   I usually eat alone but does eat dinner with fiancé.
10. **Where do you eat most of your meals?**
    I eat at home except for when training/racing (when training will eat lunch while running).
11. **Do you avoid any particular foods?**

    No: dairy, gluten, HFCS and decreased processed foods.

Athlete 3

Demographic Information

What events do you run?

1. Marathons/Ultras

What is your ethnic background?

2. Irish and Italian

Interview

1. **Do you have any food, drink, or meal preferences, traditions, superstitions in relationship to training or racing?**
   I focus on protein (chicken and turkey), low fiber vegetables (squash and asparagus), protein shakes, nut butter and bacon. Gluten free as well for better performance.
   a. Water and electrolyte capsules while I am racing
   b. Good nutrition is a competitive edge for me and helps me compete
   c. Focus on moderate to low carbohydrate, high fat and moderate protein for fuel
   d. Electrolyte and caffeine supplements when needed while training/racing
2. **Describe a typical day in terms of eating and drinking**
   I have fat and protein for Breakfast, protein and vegetables for Lunch and carbohydrate, vegetables, fat and protein for Dinner.
3. **What sort of self-talk do you engage in when you are choosing foods throughout a typical day?**
   I try to find my best options for recovery; weight management and what different choices will do for me.
4. **How is your self-talk regarding food choices different when you are on the road than when you are at home?**
   I try to make food choices standard. I will research restaurants if I'm on the road or I will get a house/room with a kitchen when on the road for a competition.
5. **How have your approaches to eating and drinking changed, if at all since you became and professional distance runner?**
   My education was different in school (RD)-focused on carbohydrate loading and food guide pyramid (now plate). Now that I have more education as well as personal testing I have found what is best for me. I have found carbohydrates are not as important for me. I started current way of eating 4-7 years ago: high fat/low carbohydrate versus high carbohydrate and low fat.
   a. **No: Gluten, Soy, Milk/Dairy (noted for performance/feels better)**

6. **What sort of strategies do you use to plan your meals and snacks?**
   I use what was purchased and plan out day for protein and vegetables. I start to plan meals the day before-what will be for pre-run and what to pack for training run that day.
7. **How do people around you influence your food choices?**
   People normally do not influence my food choices. I will eat differently when out (appetizers with friends for example)
8. **What thoughts go through your mind about the food choices made by the people around you?**
   Try not to judge others on their food choices or remain neutral. This is hard for me as I am an RD. I may judge people more if I know them or if they ask my opinion as a professional
9. **With whom do you eat most of your meals?**
   I normally eat by herself (especially when training and kids in school). My Breakfast is eaten in the car on way to work. My Lunch is with co-workers. My Dinner is by myself.
10. **Where do you eat most of your meals?**
    I will eat in the car or at my desk. I’m trying to eat at the table more right now.
11. **Do you avoid any particular foods?**
    Gluten, Soy, Milk/Dairy

Athlete 4

Demographic Information

What events do you run?

1. 5k-Marathon (5k-1/2 Marathon is "Happy Zone")

What is your ethnic background?

2. Caucasian

Interview

1. **Do you have any food, drink, or meal preferences, traditions, superstitions in relationship to training or racing?**
   I avoid pop, drink lots of water, get in 15g carb or so prior to run for energy and to help digest faster. During my competitions I will take: 2 Gu Gels during race only sports drink in the last 12mi.
2. **Describe a typical day in terms of eating and drinking**
   My breakfast is carb and calcium. Fruit is my snack. Lunch is a lean meat, fruit, vegetable, healthy fat, cheese, and yogurt. Granola bar as a snack. Dinner is salad and a complex carb source.
3. **What sort of self-talk do you engage in when you are choosing foods throughout a typical day?**
   I keep my goals in mind to not overeat on calories. I will ask: "Will this help with my training?"
4. **How is your self-talk regarding food choices different when you are on the road than when you are at home?**
   It is more difficult on the road so I may be less vigilant. I will bring healthy choices with me if possible for snacks.
5. **How have your approaches to eating and drinking changed, if at all since you became and professional distance runner?**
   My desserts are significantly decreased and this has led to a decrease in weight as well. I'm more aware of food choices than before and I eat more fruits and vegetables.
6. **What sort of strategies do you use to plan your meals and snacks?**
   I determine my activity and match up meals accordingly. I have meals planned out before-hand (week in advance for L and D).
7. **How do people around you influence your food choices?**
   My husband has similar goals and we motivate each other to make good choices. If those around me are making bad choices it is harder to resist.

8. **What thoughts go through your mind about the food choices made by the people around you?**
   If a food is healthy I will want to try it. If it isn't healthy I think: "how can anyone be eating that?"
9. **With whom do you eat most of your meals?**
   Husband
10. **Where do you eat most of your meals?**
   Home, at work
11. **Do you avoid any particular foods?**
   Crackers (too easy to eat too many).

Athlete 5

Demographic Information

What events do you run?

1. ½ and full marathon

What is your ethnic background?

2. Caucasian

Interview

1. **Do you have any food, drink, or meal preferences, traditions, superstitions in relationship to training or racing?**
   I have no particular superstitions related to food. I do try to stay away from spicy foods the day before a race and focus on more plain foods.
2. **Describe a typical day in terms of eating and drinking**
   When training I will determine if I need it or not. If I don't need it I will try to find something else.
3. **What sort of self-talk do you engage in when you are choosing foods throughout a typical day?**
   I ask myself: how can I get in more vegetables. I also will ask myself if I need something and if I don't I get something else.
4. **How is your self-talk regarding food choices different when you are on the road than when you are at home?**
   When I'm on the road for a race will stay away from junk food (I can have it after a race). Also, when on the road in general think "good, better, best" for choices.
5. **How have your approaches to eating and drinking changed, if at all since you became and professional distance runner?**
   I used to eat more candy and junk food earlier in career. Then I realized the need to make better choices for performance but I still have treats on occasion.
6. **What sort of strategies do you use to plan your meals and snacks?**
   I pack a lunch in advance and plan out my meals. I try to plan out dinner better by getting better foods into the house.
7. **How do people around you influence your food choices?**
   I eat less healthy around family or if I go to other people's houses but will do the best that I can with the situation. There is a group mentality when going out and this is hard. I will try to influence boyfriend with good choices.

8. **What thoughts go through your mind about the food choices made by the people around you?**

   I try not to judge others as they are not training so it is not as big of a deal for them.

9. **With whom do you eat most of your meals?**

   Roommate/boyfriend

10. **Where do you eat most of your meals?**

    Home

11. **Do you avoid any particular foods?**

    I am cutting back on gluten but not gluten free (I'm hoping it will clear up some GI issues).

Athlete 6

Demographic Information

What events do you run?

1. ½ and full marathon

What is your ethnic background?

2. Caucasian

Interview

1. **Do you have any food, drink, or meal preferences, traditions, superstitions in relationship to training or racing?**
   I have no red meat day before a race, also low fiber keep it simple for digestive issues.
2. **Describe a typical day in terms of eating and drinking**
   I use a drink for breakfast (shake with complex carbs for fuel) especially important if a workout or long run. I fuel during long run if needed (power bar, drink, and/or gels). I have lunch with protein and veggies my dinner is more of the same. Light snack after work of higher carb if going to do workout after work.
3. **What sort of self-talk do you engage in when you are choosing foods throughout a typical day?**
   I look for good, better, best choices. I really try to get in fruits and vegetables to weed out worse choices.
4. **How is your self-talk regarding food choices different when you are on the road than when you are at home?**
   When I'm on the road for a race like to plan out where I am staying to coordinate with meal options and choices. When I'm at home I have all of my usual things at my disposal so it isn't as hard. I always bring some things with me in case of travel issues.
5. **How have your approaches to eating and drinking changed, if at all since you became and professional distance runner?**
   I was a lot more carb centric in college but have developed tastes to include more protein and healthy fats in the diet as well as more vegetables for decreased inflammation and recovery.
6. **What sort of strategies do you use to plan your meals and snacks?**
   I pack lunch in advance and plan out my meals. I have things available for healthy D also.
7. **How do people around you influence your food choices?**

I really try to focus more on good choices when eating out especially around others. I also try not to let the choices of others influence my choices.

8. What thoughts go through your mind about the food choices made by the people around you?

I try not to judge them because a lot of friends aren't currently training for a competitive marathon.

9. With whom do you eat most of your meals?

Husband

10. Where do you eat most of your meals?

Home/work

11. **Do you avoid any particular foods?**

I am decreasing gluten for digestive issues but not cut out totally.

Athlete 7

Demographic Information

What events do you run?

1. 10k to Marathon

What is your ethnic background?

2. Caucasian

Interview

1. **Do you have any food, drink, or meal preferences, traditions, superstitions in relationship to training or racing?**
   I have no dairy prior to races or workouts. Low gluten diet (60-80% GF) for performance. I always eat salmon the day before a race.
2. **Describe a typical day in terms of eating and drinking**
   I get up 1 hour before run to eat, I have decaf coffee or caffeinated if workout, GF rounds with PB, and I run with water. I have a recovery drink and water after the run. My Lunch is the biggest meal of the day (1 hour post run). I have brown rice pasta with vegetables and protein, more water with Nuun (electrolyte drink). I have a snack prior to my nap/second run (apple with GF pretzels or nuts). My Dinner is a vegetable, starch, protein, water with dark chocolate or snack after if needed.
3. **What sort of self-talk do you engage in when you are choosing foods throughout a typical day?**
   I have different foods throughout the day unless craving a banana (may have 2 in the day) otherwise I will not repeat foods in a day. I always have fruit or vegetable with each snack.
4. **How is your self-talk regarding food choices different when you are on the road than when you are at home?**
   I tell self to be flexible with foods and to not fixate on certain things. I don't stick to things at home usually. I try to focus on what will settle well. Also, I will pack my own snacks for travel.
5. **How have your approaches to eating and drinking changed, if at all since you became and professional distance runner?**
   I'm more conscious of calories and fats. I give myself some leeway but I was all over the place in college with regards to weight and intake which led to injuries. I keep a food diary and try to make healthy choices 90-95% of the time.
6. **What sort of strategies do you use to plan your meals and snacks?**

I do what is best with what is available at home. I always have: fruit, protein, healthy fats in my "circle of food" but will bring in other things; I plan in protein and red meat for diet also.

7. **How do people around you influence your food choices?**
   Everyone around me eats healthy so not a lot of negative influences with regards to food. I will add in more vegetables if needed to less healthy meals.
8. **What thoughts go through your mind about the food choices made by the people around you?**
   I can be judgmental if people are eating fast food or other unhealthy things. I try to be more sympathetic about others' food choices.
9. **With whom do you eat most of your meals?**
   Self and Husband
10. **Where do you eat most of your meals?**
    Home: table, counter, couch
11. **Do you avoid any particular foods?**
    Gluten (performance), dairy (GI issues), cashews