Nutritional Knowledge and Dietary Habits of College Cross-country Runners

An Interactive Qualifying Project Report
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements for the
Degree of Bachelor of Science
by:

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Abstract

The purpose of this IQP was to assess the nutritional knowledge and dietary habits of college cross-country runners. Participants from NCAA varsity cross-country programs across the United States completed a nutritional questionnaire, and a population of WPI runners completed dietary and exercise logs. Findings indicated athletes to be lacking in nutritional knowledge, and even athletes with sufficient nutritional knowledge did not adhere to these guidelines. This research was presented for publication in the United States Sports Academy's *The Sport Journal.*

Table of Contents

1. Introduction

Endurance sports are commonly accepted as some of the most grueling activities in the world. Whether it's biking over a hundred miles a day for weeks, running anywhere from a five kilometer race to an ultra-marathon, or cross-country skiing, there is one common factor: extensive amounts of spent energy. When it comes to racing, the difference of a few seconds can oftentimes make a huge difference in the outcome. Therefore, it is necessary for athletes to do everything in their power to be the best they can possibly be when it comes time for competition. This includes the obvious requirements of training hard for a long period of time leading up to the event and being well-rested before the event. However, one very important aspect is often overlooked and underappreciated: nutrition.

Eating well can have a significant positive impact on athletic performance, and conversely, eating poorly will hinder an athlete's achievement. In order to maximize potential, an athlete must practice good nutritional habits consistently while preparing for an event. Giving the body what it needs to refuel and reenergize is just as critical as the training itself. Everything humans consume has a use, but it is difficult to find the right level at which to consume each category of food, as well as which foods will provide high amounts of valuable nutrients while minimizing less useful ones. There is a lot of literature on the subject of general nutrition, but not much on the more specific topic of how it relates to endurance sports. This IQP will attempt to uncover any misconceptions about proper nutrition for endurance athletes, as well as document proper dietary habits and the benefits they provide.

2. Objectives

The primary goals of this IQP were as follows:

- Evaluate the dietary needs of endurance athletes.

    Due to their increased physical activity, distance runners have different nutritional requirements than the average person. These include increased caloric and fluid intake, specific dietary composition, and greater emphasis on certain micronutrients. The exact extent of these needs will be determined.

- Evaluate athletes' knowledge of proper nutritional habits.

    There is an abundance of information regarding nutrition in contemporary media, much of which is contradictory, depending on the source and target audience. It may be easy for athletes to receive misleading data intended to benefit a different demographic. It is important to determine the level of nutritional knowledge an average collegiate athlete possesses.

- Determine if athletes are eating adequately.

    There is a large difference between having knowledge of proper nutrition and actually putting it to use. It is possible that even athletes who understand the greater dietary needs of their bodies do not satisfy them. The food consumption of college distance runners must be evaluated.

- Recommend possible options for improving athletes' nutritional knowledge and habits.

Once data has been collected towards the first three objectives, observations and recommendations will be made to improve upon any weaknesses in both nutritional knowledge and habit. Speculations will be made as to the cause of those weaknesses and the best course of action to reduce them in the future.

3. Methodology

To gain a comprehensive knowledge on the subject of nutrition and its effects on the human body, an extensive literature review was performed. This included learning about the biochemistry behind each dietary component, such as macronutrients, micronutrients, and vitamins. Noteworthy information regarding fluid intake can be found in Appendix A. Once the background information had been thoroughly researched, nutritional surveys were developed with the intent to assess athlete's knowledge had about dietary habits. A list of 95 colleges and universities and from both NCAA Divisions I and III with varsity cross country programs was developed. The surveys were sent to the coaches of these programs, who obtained approval from the institutions' athletic director before relaying the surveys to their athletes. The responses were compiled and statistically analyzed, looking for significant differences in knowledge based on a number of factors.

To determine the actual composition of runners' diets, volunteers from the WPI cross country team were asked to complete online nutritional logs for a four week period. The information was analyzed and compared to existing data on athletes' dietary breakdown. The data gathered from the food consumption journals was used in conjunction with the survey results to make conclusions regarding any possible correlation between knowledge and habit.

3.1 Journal Selection and Submission

Research such as this has not yet been compiled on the specific subject of college cross-country runners, so it was decided that an article should be constructed for publication in a scientific journal. Research was conducted online to find prospective sports, health, and fitness journals for submission. It was narrowed down to five possibilities, based on content, style, and impact factor. They are listed below:

- Journal of Strength and Conditioning Research
- ACSM Health & Fitness Journal
- The Sport Journal
- Nutrition & Sport
- Strength and Conditioning Journal

Of these journals, the United States Sports Academy's *The Sport Journal* was deemed the most feasible for article submission. Listed below is a letter to its editor, Kelly Flanagan, inquiring whether the content would be appropriate:

Dear Dr. Flanagan,

My name is Mitchell Giroux and I am a student in my junior year at Worcester Polytechnic Institute. This year I have been conducting research on the nutritional needs of endurance athletes. I submitted nutritional surveys to 95 college cross country teams to help determine athletes' knowledge of nutrition. In addition, members of the cross country team here at WPI helped to further my study by tracking their dietary habits. Statistical analysis of the collected data has suggested that athletes do not receive enough information regarding the importance of nutrition to their training. Do you think that a topic such as this could qualify to be in your journal?

Thank you for your time.

Respectfully,
Mitchell Giroux

The following response was received from Dr. Flanagan:

Dear Mr. Giroux,

I am sorry it has taken so long to reply. I do think your topic would be *appropriate for The Sport Journal. When your manuscript is complete, just email it as a word document attached. To pay the $40 reader's fee, just mail a check, made out to The United States Sports Academy, to:*

Editor

The Sport Journal

United States Sports Academy

One Academy Drive

Daphne, AL 36526.

Upon receiving the above response, the article was submitted to *The Sport Journal* for publication.

3.2 Journal Article

“Nutritional Knowledge and Dietary Habits of College Cross-country Runners” submitted to *The Sport Journal*, 5/4/2010.

Nutritional Knowledge and Dietary Habits of College Cross-country Runners

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Abstract

Though studies have determined nutrition to be a key factor in optimizing athletic performance, research indicates student-athletes lack knowledge on the subject. The goal of this study was to measure the nutritional knowledge and examine the dietary trends of college cross-country runners. Collegiate runners from NCAA sanctioned programs were invited to complete an online survey consisting of questions assessing nutrition knowledge and dietary habits in the areas of caloric, macro/micronutrient and fluid intake. Additionally, a sample population of 10 college cross-country runners maintained dietary and exercise journals, which were analyzed to observe nutritional behavior. Overall most athletes understood the importance of caloric intake; however their knowledge of macronutrient and fluid intake was less evident. Significant differences in nutritional knowledge were found between male and female athletes. There also proved to be little correlation between athlete's knowledge of nutritional requirements and their actual dietary intake.

Introduction

The study of sports nutrition has demonstrated that the nutritional needs of a highly competitive athlete far exceed the dietary recommendations released by the FDA and the USDA, which are aimed at individuals who are significantly less active (Revised Dietary Guidelines to Help Americans Live Healthier Lives, 2005). The rigorous training schedule of a full time student-athlete places extra stress on the human body, and therefore requires greater nutritional intake in order to regulate body functions and replenish depleted nutrient stores. Nutritional reviews published yearly, such as *The Journal of the International Society of Sports Nutrition'*s (JISSN) exercise and sports nutrition review, provide an up-to-date source of information about improving athletic performance through smarter dietary choices (Kreider *et al*, 2010). These journals, however, do not receive the same amount of publicity popular magazines receive. As a result, most athletes do not benefit from this research; when polled on who they consult for nutritional guidance, athletes did not list scientific journals as a source for nutritional information (Burns *et al*, 2004). Additionally, athletes lack sufficient time to research what they should be eating and drinking, and as a result are unable to make healthy choices consistently during meal time (Barr et al, 1997; Evans et al, 2000).

Though there is a population of college athletes who understand the impact of their food choices on athletic performance, there are a greater number of athletes who lack this knowledge (Rosenbloom *et al,* 2002). Studies have shown athletes from a wide variety of sports have an insufficient understanding of the dietary necessities of the human body (Hickson *et al,* 1987; Rosenbloom *et al*, 2002). Though all athletes' bodies have very similar nutrient requirements, there can be variations between sports, especially those of endurance and power. Therefore, it is necessary to determine the depth of a specific athletic group's knowledge, so that they can receive the relevant information on their specific nutritional needs. The purpose of this study was to assess the nutrition knowledge of cross-country runners from collegiate programs around the country through the use of a nutritional survey. In addition, the dietary intakes of volunteer athletes in the cross-country program at the authors' host institution (WPI) were recorded for analysis. The principle research objectives were: (a) to measure nutritional knowledge with regard to caloric, macronutrient and fluid intake; (b) to determine the number of athletes who used vitamins, supplements and other ergogenic aids in this population; (c) to compare the local survey population with those from other regions; (d) to evaluate dietary intake of local college runners; and (e) to ascertain whether the local runners' nutritional knowledge influenced their dietary intake. These assessments provide data pertaining to the level of understanding the athletes possess about the necessities of nutrition so that the appropriate recommendations for improvements in athlete nutritional knowledge may be instituted.

Methodology

Nutritional knowledge was assessed with a survey pertaining to nutritional needs of cross-country athletes. Participation approval was consented through athletic administration of target cross-country programs. The survey, located in Table 1 below, included topics of caloric intake, energy distribution percentages, and fluid intake in order to determine the level of knowledge which the athlete possessed regarding fundamental aspects of health and nutrition. The survey was distributed via Survey Monkey (www. surveymonkey.com).

*Table 1. Survey Questions and Possible Responses**

Question:	Option 1	Option 2	Option 3	Option 4
Are you male or female?	male: **41.7%**	female: **58.3%**		
Is there a nutritionist available at your school?	yes: **69.4%**	no: **30.6%**		
Is a 2000 calorie diet adequate for an everyday athlete?	yes: **18.3%**	no: **81.7%**		
What should a proper diet consist of, based on percentages?	45% carbs, 10% fat, 45% protein: **36.5%**	33% carbs, 33% fat, 33% protein: **2.4%**	60% carbs, 25% fat, 15% protein: **44%**	I don't know: **17.1%**
Do you take a daily multi-vitamin?	yes: **59.1%**	no: **40.9%**		
Do you take any other supplements?	yes: **49.6%**	no: **50.4%**		
Do you consume caffeinated beverages?	yes: **77.0%**	no: **23.0%**		
How much fluid should an athlete who burns 3000 calories a day consume daily?	4-6 glasses: **8.3%**	7-9 glasses: **24.6%**	10+ glasses: **67.1%**	
Have you ever been on a diet or strict dietary regimen?	yes: **34.1%**	no: **65.9%**		

** Actual response percentages of surveyed population shown in bold.*

Runners from different regions of the country were contacted via email with a link to the online survey. A total of 95 Varsity Cross-country Programs in NCAA Divisions I and III were contacted. A total of 305 participants received the survey and 262 student athletes completed the survey. The overall participation rate was 86% (n= 262). A total of 43 surveys were excluded due to incompleteness. Demographic distribution of the survey population is listed below in Table 2.

Table 2. Survey Demographics (n=262)

Variable	**Group**	**Percentage**
Division	1	37%
	3	63%
Gender	Male	44%
	Female	56%
Region	Northeast	51%
	Southeast	14%
	Midwest	29%
	West	6%

Volunteers from the WPI Men's Varsity Cross-country Program were asked to maintain a Dietary record of their food consumption. The student-athletes completed online journals via Fit Day (www.fitday.com), cataloging their food and fluid intake over a 4 week period. In addition, these runners maintained an online exercise log through *Running Ahead* (www.runningahead.com) for the duration of the study. The dietary logs were evaluated in the following areas: a) a comparison of caloric intake versus calories burned; b) a breakdown of macronutrients in runners' daily diets; c) an analysis of their vitamin and mineral intake compared to FDA guidelines for micronutrient intake; and d) participant fluid consumption.

The data from participant logs and surveys were analyzed through standard statistical methods. Chi squared analyses was conducted to determine the significance of survey responses when comparing nutritional knowledge of demographic groups. Results from this study were compared with those from other published works to determine if the data are consistent with past studies. The information obtained from athletes participating in both the survey and the dietary journal was investigated further to determine if there was any correlation between an athlete's knowledge of ideal nutrition and their actual nutritional intake.

Results & Discussion

This study aimed to assess the cross-country athlete's nutritional habits and understanding of dietary requirements for highly competitive athletes. Caloric intake is a very important aspect of nutrition for distance runners, as a low intake will not provide enough energy to sustain a high level of training and competition. According to Daily Reference Intake Tables released by the USDA (United States Department of Agriculture, 2005), energy requirements exceed 2,000 calories for very active persons of any weight or gender (albeit more so for a heavier male runner than a light female runner). However, contrary to these explicit stipulations, 17% (n=46) of athletes surveyed believed 2,000 calories was adequate energy intake for a college runner. Of these 46, 39 were female. While 2,000 calories comes closer to meeting sufficient energy requirements for females than for males, it may have negative repercussions. Weight loss and disrupted hormone production, especially for females, is a concern when consuming 2,000 or less calories per day while maintaining vigorous workout regimens (American College of Sports Medicine, American Dietetic Association, and Dietitians of Canada, 2000).

Dietary composition is another fundamental aspect to consider when taking a holistic approach to nutritional intake. Because runners are primarily burning glycogen during exercise, especially in sessions lasting over an hour, stores of glucose become depleted. As a result, there is a greater need for carbohydrates in the diet. A caloric distribution consisting of around 60% carbohydrates, 25% fat, and 15% protein provides ample quantities of glycogen, which can be stored in muscle and liver tissues, supplying enough protein to sustain muscle repair. It also yields enough fat to aid aerobic respiration, as well as providing essential fatty acids and lipids for maintaining bodily functions and absorbing essential vitamins (Prevost, 1999, Kreider *et al*, 2004). When given the choice between this diet, two diets dissimilar to the recommended diet, and an "I don't know" option, 48% (n=121) of the surveyed runners chose the desirable nutrient proportions. Of the 141 athletes that selected one of the other answers, the majority chose the diet consisting of: 45% carbohydrates, 10% fat, 45% protein. Other studies had noted that athletes believed protein to be a primary source of energy during exercise; those findings may be the reason for the observed result (Rosenbloom *et al*, 2002). Forty-three participants answered that they were unsure which caloric distribution was most accurate.

Maintaining adequate daily fluid intake is also important for an athlete. Failure to do so renders the body much less efficient, thus causing poor performance while running. Almost 67% (n=176) of participants said that 10 or more glasses of 8oz fluid were necessary to stay properly hydrated on a day to day basis. Considering that much of the water the body needs may be found in food, 10 or more 8oz glasses of fluid can be seen as enough to supply an athlete who loses around 2 Liters (or 68 fl oz) of fluid per day as a result of working out.

The results of a gender comparison in regards to nutritional knowledge revealed some differences. 94% of males responded that a 2000 calorie diet was inadequate for a distance runner's needs, while only 74% of females responded with the same choice. These results indicate a significant difference in gender knowledge (p <0 .05). The male and female response as to which diet breakdown was ideal for endurance runners was closer, at 50 and 43% respectively. The p-value in the chi-squared test was 0.65, indicating that there is no gender difference in this population on this subject. The difference in knowledge on fluid intake was equally insignificant (p =0.60). Responses of 10+ 8oz glasses of fluid per day were 66% of male and 68% of female respondents.

As for overall nutritional knowledge, males averaged a score of 2.05 on a 3 point scale, while females averaged 1.84. After performing a t-test on the individual scores, the difference in knowledge was significant (p= 0.045). In other survey populations, it has been found that females often had a greater awareness of nutritional information than their male counterparts (Dunn *et al*, 2007).

Differences in knowledge based on whether the surveyed athletes had access to a nutritionist and whether participants had dieted in the past were also considered. It was found that there was not a significant difference in knowledge between those who had access to a nutritionist and those who did not (p=.188). Comparing the responses from those students who had dieted with those who had not showed that there also was not a statistically significant difference in these two groups (p=0.07).

Focusing on dietary trends of the athletes, 59% of all those surveyed took a daily multivitamin. 28% consumed a minimum of 3-4 caffeinated beverages per week. The most frequently consumed supplement was iron, with 60 runners (24%) regularly consuming iron. The other common supplements were calcium, vitamin C, and vitamin D, at 19%, 7%, and 5% respectively.

Of the 262 surveyed, 175 students said that there was a nutritionist available at their school. However, this does not necessarily mean that the students for whom a nutritionist was available had used the resource. There was also some discrepancy in the responses from athletes from the same school. Some students said that a nutritionist was available, while other athletes from the same institution believed that they were not provided an opportunity for nutritional counseling. This finding is evidence of the lack of communication between the athletic staff and their athletes.

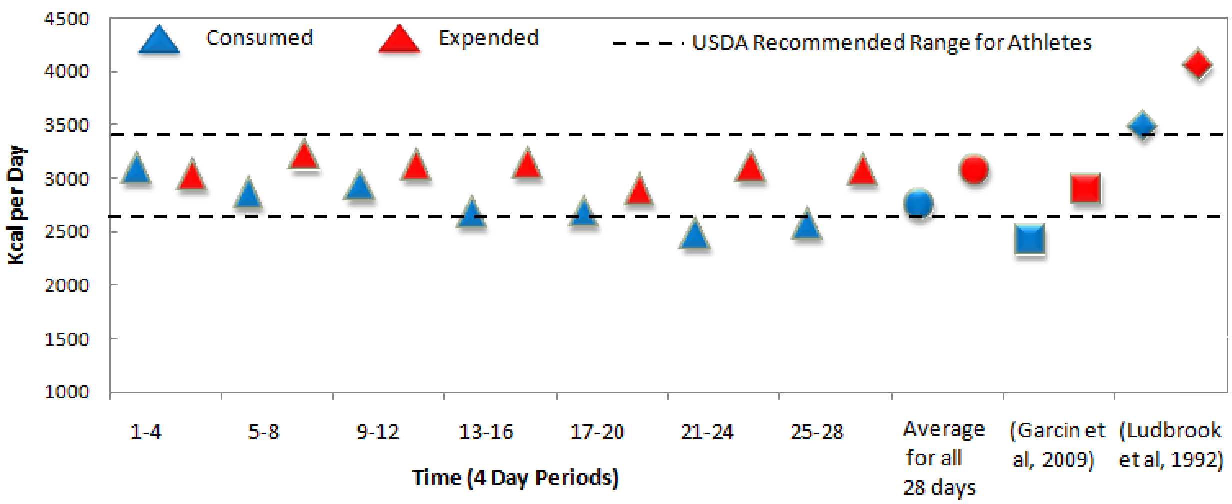

Figure 1. *Average calories consumed and expended over 7-4 day periods.* **The USDA recommended range for athletes is indicated (USDA, 2005). Caloric consumption and expenditure from other published studies are shown for comparison.**

As shown in Figure 1, athletes participating in the study averaged a daily caloric expenditure of 3077 ± 255 cal/day, while consuming 2752 ± 808 cal/day. All participants averaged a daily caloric intake greater than 2000 calories; however, each participant had at least one day where they took in less than 2000 calories. Notably, 66% of the athletes took in less calories than they expended over a 4 week period. Athletes who train consistently in caloric deficit are more likely to develop chronic fatigue, body mass loss, and/or experience impaired performance (Bernardot, 2000).

Participants consumed 405g ± 103g of carbohydrates daily, or about 6 g carbohydrate per kg of body weight (BW). Six participants averaged less than 7 g/kg of BW per day in carbohydrates. It has been recommended that athletes who are involved in rigorous training 2-3 hours per day 5 or 6 days a week should be eating between 5-8 g Carbohydrates per kg BW (Kreider *et al*, 1994).

Protein intake was measured at 127g ± 41 g per day, or about 2 g/kg of body weight. It is prescribed that athletes are advised to eat between 1-2 g of protein/kg BW daily. All participants consumed at least 1g/kg of BW each day, with 7 participants eating > 1.5g protein per kg of body weight, and 4 consuming above 2 g/kg of body weight daily. Athlete's fat intake averaged 106 g ± 27 g per day, or 1.6 g/kg of BW.

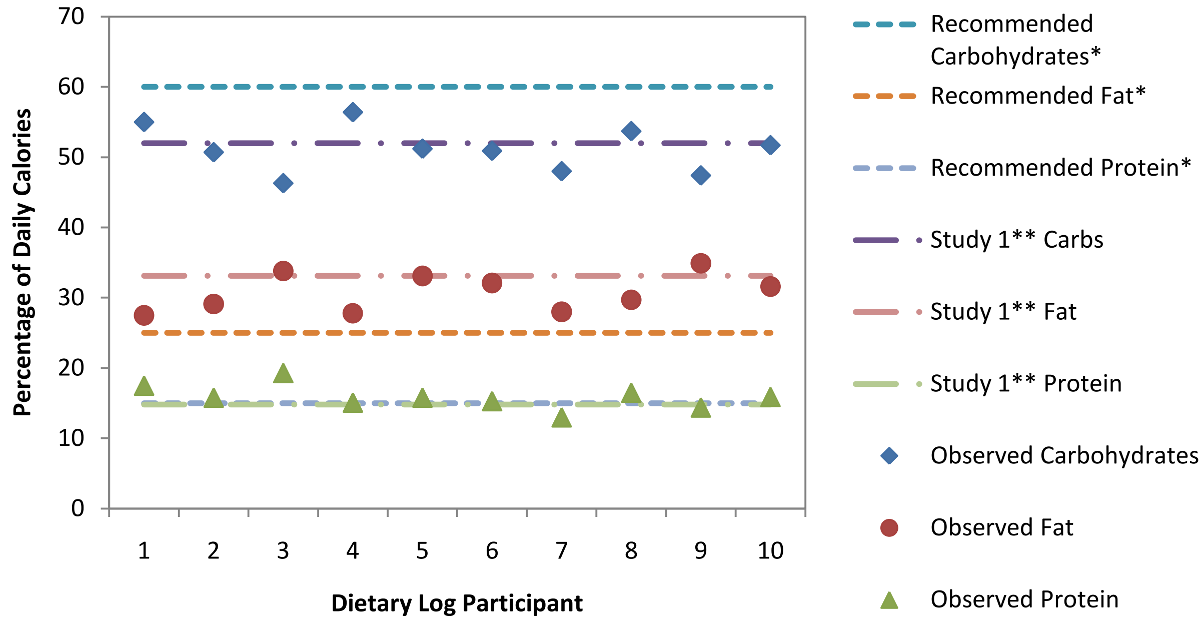

Figure 2. *Contributions of various food constituents to the overall energy consumption (calories) in various athletes who participated in the dietary survey.* **Recommended percentages for athletes of carbohydrates, fat, and protein are displayed. In addition, comparable data from other published dietary logs are plotted for comparison. *Recommended Values based on Nutrition for Serious Athletes (Bernardot, 2000) ** (Garcin *et al*, 2009)**

Figure 2 represents the recommended consumption of carbohydrates, fat, and protein compared to that of both the participants in this study and those in other similar studies. All participants' caloric intake for protein was at least 13% of their total caloric intake daily, with the average intake of 16%. Participants averaged 31% of their calories from fat, with all participants receiving >27% of their calories from fat. All participants received <60% of their caloric energy from carbohydrates daily, with an average of 53% calories coming from carbohydrates. The recommended range of carbohydrate intake for energy distribution is from 55%-65% depending on the level of activity (Kreider *et al*, 1994). This population averaged lower carbohydrate intake than the minimum recommended level for athletes of their disposition, with this energy being redistributed primarily to fat calories. While fat is burned upon participation in aerobic exercise, runners training for longer intervals at higher intensities primarily utilize glycogen stores to fuel anaerobic respiration. Previous studies have shown that training sessions lasting to the point of exhaustion were three times longer in duration for people whose diet consisted of high amounts of carbohydrates than for people whose diets are high in fat (Prevost, 1999).

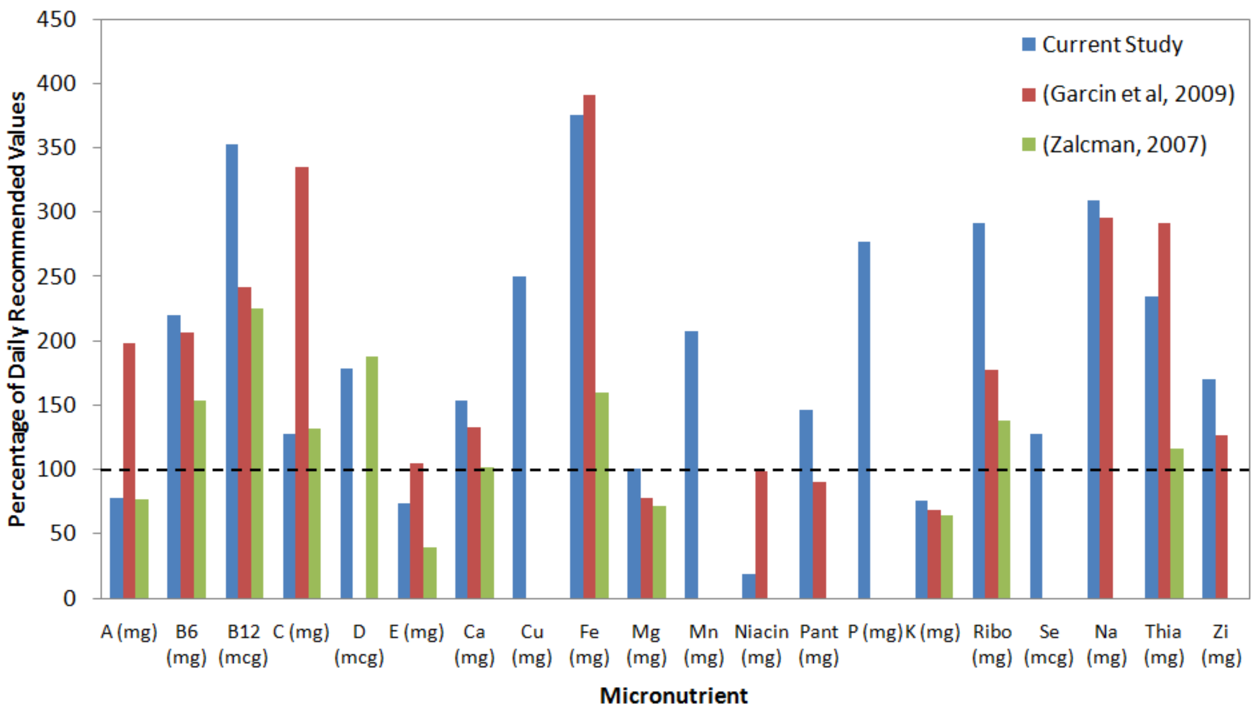

Figure 3. *Average Daily Intake Percentages of Micronutrients for Participants.*

Daily vitamin and mineral intake ranged from 76%-373% when compared to the USDA recommended micronutrient intakes for a 2,000 calorie diet. Ideally, a population of runners would have micronutrient daily intake percentages of around 135% because they consume an average of 750 calories more than a 2000 calorie diet. Over the course of the study, athletes were found to be deficient in Vitamin A, E, and Niacin (B_3), based on their average micronutrient intake. Each participant had a deficiency found in at least one of the 20 micronutrients cataloged. Seven of the 10 participants had a deficiency in 3+ micronutrients. Of the 20 micronutrients observed, 11 had at least one athlete with a deficiency. Three or more athletes were deficient in 9 of these nutrients. Participants who took a multivitamin daily (n=5) averaged 2 deficiencies in their micronutrient intake, while the remaining participants (n=5) who did not take a multivitamin averaged 7 deficiencies. Notably, the 5 athletes who consumed the least amount of calories were also those who did not take a multivitamin.

Average athlete micronutrient intake was twice the recommended daily values. Because these athletes are eating significantly more than 2000 calories daily, these micronutrient intakes are acceptable. However, in cases where athletes were receiving less than or close to 100% of the daily recommended values, these deficiencies may prove problematic. Potassium, which is vital to the maintenance of cellular fluids and the regulation of blood pressure, fell well short of 100% in not just this study but both of the comparable studies as well (Appel *et al,* 2003).

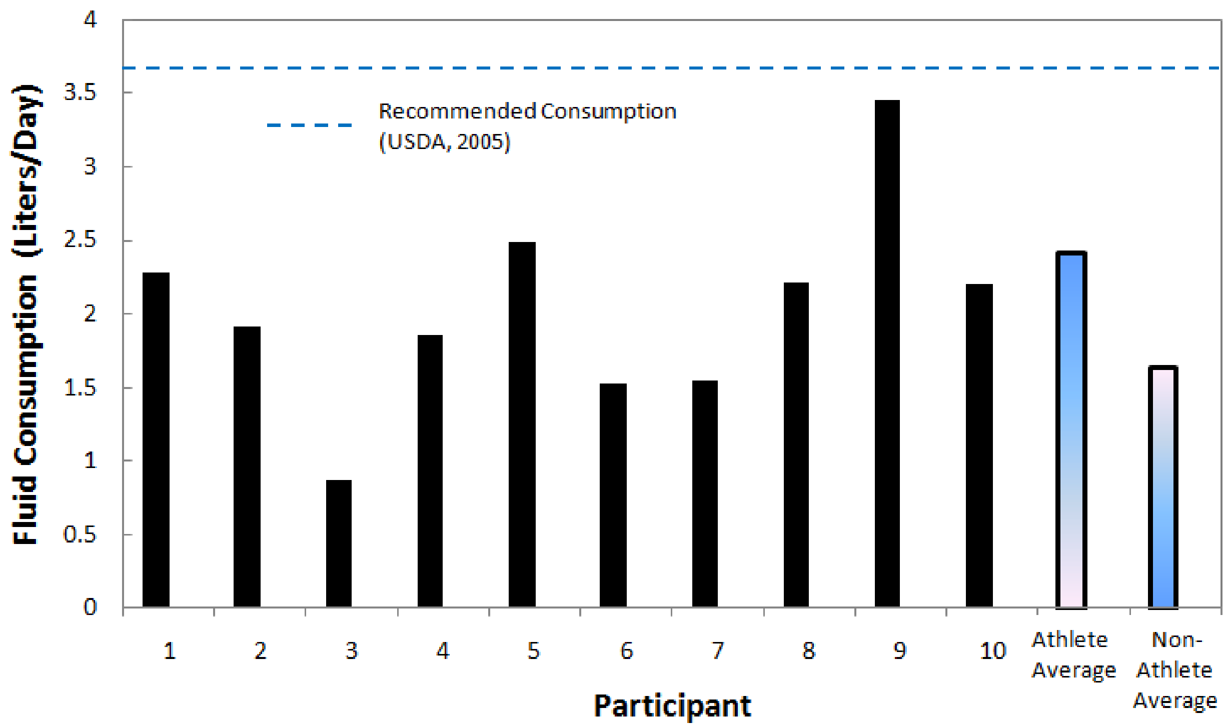

Figure 4. Participant fluid consumption averages (L/Day) ***(Garcin *et al*, 2009)**

The average fluid consumption of the surveyed athletes was about 2 liters per day. This includes the actual liquid consumption as well as the water derived from food. Dehydration occurs when the body has lost 2% of its weight from water loss, and in some cases, more than 2% of fluids are lost, depending on factors such as workout intensity and the temperature of the surroundings. For these athletes, a 2% loss in water averages roughly 1.3 liters of fluid. For this reason, it is apparent that these athletes are not drinking enough fluids to maintain adequate levels of hydration. FDA recommendations of 3.7 liters of water from food consumption and liquid intake are based on healthy, but sedentary individuals. An athlete who may lose 2 liters of fluid in a rigorous workout must consume 5.7 total liters of water in order to have enough water to regulate the functions in the body. It is evident that this population is not meeting the necessary water intake requirements.

Athletes who maintained fitness and diet logs had their overall intakes compared with their survey responses to determine if they considered nutritional requirements when making dietary choices. All participants (n=10) recognized that a diet of 2000 calories was insufficient for providing enough energy to maintain body function and optimize performance. Accordingly, all participants averaged intakes above 2000 calories for the duration of the study. All athletes who returned a response for distributions of macronutrient constituents (n=9) believed that a diet consisting of 60% carbohydrates, 25% fat, and 15% protein was the most effective of the possible choices, with one athlete unsure of which distribution was most desirable. A comparison of these responses with their actual macronutrient intake showed that only 2 participants had intakes which were close to the recommended percentages, one of these participants being the athlete who responded he was unsure of recommended caloric distributions. Participant responses to fluid intake were less knowledgeable, with only 7 participants believing 10+ 8oz glasses of fluid were necessary to stay hydrated. Of these seven participants, only 1 averaged above their response. There was no perceived correlation between the athletes' nutritional knowledge and actual dietary intake. Athletes who completed the survey and the diet and exercise log showed that, although they may possess the correct nutritional views, they often do not consider these factors when making food choices.

Summary

Research indicates that athletes' nutritional knowledge, even on the most fundamental levels, is generally lacking. While it seems logical that athletes would be well-informed on basic nutritional requirements and their relation to competitive performance, this was not the case in the majority of students who participated in this study. Furthermore, the athletes who demonstrated an understanding of nutrition showed no indication of personally adhering to these guidelines. Regardless of the depth of understanding athletes possess about nutritional necessities, it is evident that they are not inclined to make consistently healthy food choices.

Though there are significant amounts of nutritional data in easily accessible formats, often it is overlooked because athletes' mindsets are not focused upon healthier dietary choices. It is apparent that there should be consistent guidelines when it comes to supplying athletes with accurate information about the proper diet for optimal performance. This requires that the athletic staff should be well trained in nutritional necessities so that athletes who seek help receive proper information. Even though coaches and other athletic staff may provide the data, it is ultimately the responsibility of each athlete to monitor his or her own dietary behavior.

Several studies (present included) have shown that there is a need for increased knowledge of nutrition in all running programs, regardless of region or caliber. By educating athletes about their dietary requirements and the importance of adhering to those requirements, sports programs will not only improve the competitive performance of their students, but also help prevent potential health complications which may occur in post-collegiate settings.

Further investigation of athletes' nutritional knowledge might explain why the majority of athletes consume calories and nutrients without considering their dietary requirements. Surveys assessing athlete awareness on the biological roles of macronutrient and micronutrient function may lead to evidence pertaining to trends in nutrient intake. While the overall caloric intake of athletes is important, there is evidence that additional factors such as the time of day that the athlete eats or drinks can have a significant influence on nutrient metabolism and subsequent availability of energy (Kersick *et al,* 2008). Therefore, future surveys should be designed to evaluate the degree to which athletes understand when macronutrient intake is ideal for optimizing energy levels.

There may also be future possibilities for studying the diet quality of athletes. Assessments implementing the USDA food pyramid allow for closer examination of an athlete's specific food intake, as the types of carbohydrates, types of protein and types of fats may be quantified.

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This concludes the journal article

4. Conclusions

The overall conclusions for the IQP are briefly summarized below:

A proper diet for a runner was found to be based on a complicated set of variables. The ideal number of calories consumed is equal to the number burned. This is calculated based on athlete weight, gender, height, and daily activity level, as well as the duration and pace of their training sessions. Caloric breakdown for an endurance athlete is ideally 60% carbohydrates, 25% fat, and 15% protein. Necessary fluid intake is based on a number of factors. It can be calculated from the duration and intensity of training, the athlete's body weight, and the air temperature.

Two considerable problems were revealed as a result of the research conducted. According to this study and other comparable published works, college athletes are significantly lacking in nutritional knowledge. This problem in itself is a daunting one, as finding a way to educate already busy student-athletes could prove difficult. However, of possibly even greater concern is the fact that the correlation between knowledge and habit was found to be low to non-existent. Even athletes scoring high in knowledge did not demonstrate good eating habits. A solution is needed which addresses both of these problems.

It is evident that not enough information is passed from coaches to athletes regarding eating habits. Sports programs at NCAA institutions should implement some form of regulation for educating their athletes about nutrition. Information sessions at the beginning of each season on the proper diet for distance runners would increase athlete awareness and knowledge. It is important that these sessions stress the importance of adhering to the prescribed guidelines. To make it easier to follow the recommendations, sample daily eating habits could be handed out to the athletes, giving them healthy choices for what to consume. In addition, a meeting with an oncampus nutritionist could be suggested (not mandatory) with an emphasis on optimizing the athletes' athletic performance.

These suggestions, if followed, would undoubtedly lead to an increase in athletes' knowledge of nutrition, and hopefully to an improvement in their dietary habits as well. All collegiate sports programs, not just cross-country and track and field, should consider implementing nutritional training in some form. It would not only increase athlete performance, but also help prevent possible health problems in a post-collegiate setting.

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*All other sources listed on page 21 as a part of the submitted journal article.

Appendices

Appendix A: Fluid Intake

Fluid intake is one of the most important things for an athlete, especially an endurance athlete. Drinking enough fluids before, during, and after an athletic activity will greatly benefit performance. Consuming too little will hurt the body's ability to perform, and, depending on how severe the lack of liquid is, possibly cause consequences as severe as death. Even drinking too much liquid is bad for the body, so it can be tough to find a level that is adequate. Many people forget that a fairly large amount of water is needed daily without having intense physical activity, so it can be easy to get dehydrated from sports without realizing it.

The reason that humans need to consume fluids at a greater rate before and during periods of activity is perspiration. When the body is moving around more vigorously than normal, it naturally begins to heat up. Sweat is the cooling system; it is released when body temperature begins climbing higher than normal. So, perspiration is essential to prevent over-heating of the body. A number of factors determine the rate of sweating, the most obvious being the intensity of the activity performed. The more intense it is, the more heat is generated and the more sweat will be released to combat that heat. Another factor is the air temperature wherever you are working out. If the temperature is warmer, the athlete will perspire more to balance out the difference between body heat and his or her surroundings. Also, a small amount of water is released as vapor in the breath. This happens more in lower temperatures, but nonetheless, it is another reason it's essential to have enough water in your system.

Water is not only used to cool the body; it is also essential to its function even while sedentary. The heart pumps blood because it refuels the muscles by carrying oxygen, which is the essential component of cell respiration. Blood contains plasma, the liquid that the other components of blood (such as red and white blood cells) are transported by. Plasma is composed of 90% water (3). So, if not enough water enters the body, there will not be enough to maintain that 90% needed in the plasma. As a result, the viscosity of blood increases, reducing its flow rate. The heart then has to work harder to pump the same amount of blood as it would under normal, hydrated circumstances. Not only does this make it harder for the muscles to reenergize, but it also hinders the muscles' supply of important minerals that are essential for periods of activity.

So, when the body is sweating at a high rate, fluid intake has to be enough to compensate for all the liquid lost. The consequences of not doing so depend on the severity of dehydration. If the body loses 2% of its weight in fluid, the effect on performance is quite evident, decreasing it by 10-20% (1). This is a significant problem for any sport, but it is magnified with one such as cross country. When every second counts and the difference between first and fifth can easily be less than ten seconds out of a twenty-five minute race, a 20% decrease is huge. When fluid loss exceeds 3%, the effects can easily be more severe. When the blood flow gets thicker from the decreased plasma volume, it cannot move through the smallest blood vessels, known as capillaries. This will prevent it from reaching the skin. Once this happens, the body can no longer sweat at all, inevitably causing heat exhaustion or heat stroke.

Good hydration habits are extremely important, not only for an athlete's performance but for his or her own health. It is easy to forget to drink enough before activity, partially due to the fact that people will not even notice a sense of thirst until they have lost 500ml of fluid (3). So, it's important to plan hydration not on an as-needed basis, but as a schedule worked out beforehand, starting as far as the day before an athletic event.

Appendix B: Nutrition in Cellular Respiration

Cellular respiration is divided into two components: aerobic respiration and anaerobic respiration. Both processes are vital to human survival, as each is necessary for different situations. Each of these processes creates a molecule known as ATP, or adenine tri-phosphate. This is the molecule that the body uses for energy. So essentially, for humans to function, ATP must be generated.

The main process by which ATP is generated is aerobic respiration. This occurs during a period when oxygen is present, meaning that the body's need for oxygen can be met. In athletic terms, this means that the athlete is not going fast enough so that he or she would be in oxygen debt. Aerobic respiration is the more efficient method of cell respiration. Through glycolysis, the Krebs cycle, and the electron transport chain, the body can create 36 ATP molecules from just one molecule of glucose, when oxygen is available. The secondary process used to create ATP is called anaerobic respiration. This is used when oxygen is not present, meaning that the demand for oxygen is more than the lungs can intake and the heart can pump. For athletes, this occurs while sprinting or lifting weights. An activity which cannot be sustained for a long period of time is mostly fueled by anaerobic respiration. Not enough oxygen can be taken in to fuel the muscle when they are moving so fast and outputting so much power, so the body must create energy without the benefit of oxygen. The point at which the main method of respiration switches depends on the athlete. A new athlete with little training will transition to the anaerobic stage at speeds where a better athlete will still be moving aerobically. This is because a well-trained athlete will have trained his or her lungs and heart to be more efficient with oxygen. Anaerobic respiration takes a molecule of glucose and turns it into a mere 2 molecules of ATP, not nearly the amount which aerobic respiration does.

Carbohydrates are the main fuel of cellular respiration. Fats and proteins, the other nutrients which the body ingests through food, will provide energy, but only when the store of carbohydrates has depleted. Carbohydrates, or carbs, as they are commonly known by, are divided into two basic categories: simple carbs and complex carbs. Simple carbs include monosaccharides and disaccharides, which are simply glucose or fructose molecules. This basically means sugars, such as the ingredients you would find in candy or soda. Complex carbs include polysaccharides, which are many glucose molecules linked together. You would find these in healthier foods, such as pasta and bread. But, at the base of it, the important component of all types of carbohydrates is glucose.