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THE EFFECT OF A NUTRITION EDUCATION PROGRAM ON NUTRITION KNOWLEDGE, DIETARY INTAKE, BODY COMPOSITION AND PERCEIVED SPORT PERFORMANCE AMONG HIGH SCHOOL ATHLETES

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THESIS

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ABSTRACT OF THESIS

THE EFFECT OF A NUTRITION EDUCATION PROGRAM ON NUTRITION KNOWLEDGE, DIETARY INTAKE, BODY COMPOSITION AND PERCEIVED SPORT PERFORMANCE AMONG HIGH SCHOOL ATHLETES

Nutrition knowledge, dietary intake, body composition and perceived sport performance were measured before and after an eight week nutrition intervention. The sample consisted of eleven male high school football athletes aged 14-18 years old. Baseline nutrition knowledge was higher than anticipated but fruit and vegetable intake was low. As a result of the nutrition intervention, vegetable intake improved from 0.94 servings per day to 2.02 servings per day (p=0.02). Of the eleven subjects in the study, eleven conceded to both performing and feeling better as a result of the nutrition intervention. The present study suggests that a nutrition intervention can improve dietary intake and perceived sport performance among adolescent athletes.

KEYWORDS: Adolescent Athletes, Sport Performance, Nutrition Knowledge, Dietary Intake, Nutrition Education Program

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Introduction

Nutrition education among athletes is essential for maximizing performance. It is recognized that physical activity, athletic performance and recovery from exercise are all improved with the proper nutrition (Rodriquez, DiMarco & Langley, 2009). In fact, Dr. David Costill, one of the most recognized and respected researchers in the field of exercise science, is quoted saying, "other than the limits imposed by heredity and training, no single factor plays a greater role in optimizing performance than diet" (Costill, 2013).

Background

It has been well documented that high school athletes lack the knowledge to make good nutritional decisions to improve health, performance and growth (Douglas, 1984; Cotugna, 2005; Shifflett, 2002). Not surprisingly; one survey suggests that high school athletes believe their parents are the best source of nutrition information (Douglas, 1984). High school athletes also rely on coaches and trainers for nutrition education (Shifflett, 2002; Rosenbloom, 2000). Other sources of nutrition information include magazines, health food store personnel, coaches and gym owners (Cotugna, 2005). Also, extensive research has proven that there is a deficiency in nutrition knowledge among coaches, parents and trainers at the high school and collegiate level (Shifflett, 2002; Graves, 1991; Bedgood, 1983; Parr, 1984). High school athletes and the sources they seek out are not nutritionally literate which may lead to sub-optimal nutrition for these athletes ultimately impacting performance and health.

Many different studies have demonstrated that nutrition education will improve nutrition knowledge among high school athletes (Douglas, 1984; Zawila, 2003; Cupisti, 2002; Reading, 1999; Chapman, 1997; Wiita, 1996). However, it is still unclear if the improved knowledge turns into improved eating behavior; though it is believed that people with a basic knowledge of nutrition will apply that knowledge when choosing foods (Perron, 1985).

For nutrition education to be effective, it is important to tailor a program for the specific audience (Glanz, 1993). There are two main motivating factors for improving the young athletes' diet: weight control and level of performance (Chapman, 1997; Wiita, 1996). Reading et al., (1999) studied the effects that a nutrition education program had on adolescent hockey players. Those researchers found that small-group discussions were important when working with adolescents as they provide less distraction and more time for questions, clarifications and review. Furthermore, the learning activities with adolescents should emphasize motivational, simple and practical "how to" knowledge that can be applied to improving performance (Reading, 1999).

Consequences of improper nutrition intake in adolescence can jeopardize growth and hinder puberty. It may also lead to an increase in fractures and anemia as well as a lack of energy to perform in athletic competitions (Cotugna, 2005; Litt, 2004; Zawila, 2003). Therefore, it is essential for high school athletes to receive appropriate nutrition education.

Problem Statement

Consequences due to poor food choices and a lack of nutrition knowledge negatively impact performance and health of high school athletes.

Purpose Statement

The purpose of this study is to determine if a nutrition education program tailored specifically toward adolescent athletes will improve nutrition knowledge, fruit and vegetable intake, body composition and perceived sport performance.

Objectives

1. To determine the baseline nutrition knowledge of high school athletes.

2. To determine whether a nutrition intervention among high school athletes improves nutrition knowledge, dietary intake, body composition and perceived sport performance.

Research Questions

Does an eight-week nutrition intervention among high school athletes improve nutrition knowledge, dietary intake, body composition and perceived sports performance?

Hypotheses

1. Nutrition knowledge will be low for high school athletes before beginning a nutrition intervention and will increase over an eight week intervention.
2. The nutrition intervention will improve dietary intake.

3. The nutrition intervention will improve body composition.
4. As a result of the nutrition intervention, high school athletes will have a high perceived sport performance.

Justification

The Academy of Nutrition and Dietetics, Dietitians of Canada and the American College of Sports Medicine believe that “physical activity, athletic performance, and recovery from exercise are enhanced by optimal nutrition” (Rodriquez, DiMarco & Langley, 2009). Implementing a nutrition education program among high school football players could improve nutrition knowledge and therefore could improve the diet of these players. With an improved diet, these players will see an improvement in perceived athletic performance. This study will evaluate the effectiveness of a nutrition education program among high school athletes.

Assumptions

It is assumed that the subjects used in this study represent the population of all high school athletes. It is assumed that the NCI Fruit and Vegetable Screener is a good representation of dietary intake and that the surveys used were a good representation of nutrition knowledge and perceived sport performance. It is assumed that the answers subjects gave on the surveys were answered to the best of their ability.

Limitations

The following limitations may be applied to this study: the small sample size; the study is not randomized; all subjects were male; subjects used in the study attended a private school and had resources that do not reflect the population of interest in its entirety; the data is self-reported and therefore needs to be taken at face value.

Chapter Two

Literature Review

Nutrition Considerations for Adolescent Athletes

Nutrition plays a significant role in the performance of athletes. In 2009, a comprehensive review of nutrition and athletic performance was published by three governing organizations related to the field of nutrition. Their position on nutrition and athletic performance is stated as follows: “It is the position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine that physical activity, athletic performance, and recovery from exercise are enhanced by optimal nutrition. These organizations recommend appropriate selection of foods and fluids, timing of intake, and supplement choices for optimal health and exercise performance.” (Rodriguez N., DiMarco N., Langley S., 2009).

Energy

Adequate energy intake is essential for maximizing performance. Without adequate calorie consumption, the body will use lean muscle tissue for energy during exercise resulting in poor performance, a greater recovery period will ensue, and a reduction in strength over time will occur. Not only will performance be compromised without proper energy intake but the athlete would be at risk for nutrient deficiencies that could lead to osteoporosis, anemia and stunted growth.

Many factors influence energy expenditure making it difficult to establish individual energy needs. Age, gender, heredity, body size, the amount of fat free mass (FFM) and type, duration and frequency of exercise all directly influence energy expenditure (Donahoo W., Levine J., Melanson E., 2004). In general, males have higher energy needs than females; additionally, energy needs are greatest in adolescence, decrease with age and increase as greater muscle mass increases. The Dietary Guidelines for Americans (2010) and the Institute of Medicine, have established Dietary Reference Intakes (DRI) for different age, gender and physical activity using Estimated Energy Requirements (EER) equations. These are displayed below in Table 2.1.

Table 2.1 EER based on age and activity, modified from the Dietary Guidelines for Americans (2010)

Age	Male / Moderately Active	Male / Active
12	2200	2400
13	2400	2600
14	2600	2800
15	2800	3000
16	2800	3200
17	2800	3200
18	2800	3200

(DGA, 2010)

Carbohydrates

Carbohydrates are the most efficient source of energy for the body and are the only source of energy available for anaerobic activity. For this reason, inadequate intakes of carbohydrates will greatly impede sport performance. Additionally, carbohydrates spare muscle tissue, are the primary energy source for the nervous system and help improve and maintain intestinal health (Rosenbloom, C. 2000). The Dietary Reference Intake (DRI) for carbohydrate consumption among adolescent males (ages 14-18 years old) is 100 grams per day (DGA, 2010). The DRI is established as the minimum amount of carbohydrates needed to supply the brain adequate energy to function appropriately. This DRI does not take into consideration the carbohydrates needed to maintain blood glucose during exercise or the need to maintain adequate skeletal muscle glycogen (Petrie H., Stover E., Horswill C., 2004). The more physically active the athlete is, the more carbohydrates that athlete needs to consume. Additionally, the amount of carbohydrates required is dependent on the athlete's total energy expenditure, gender, type of sport and the environmental condition in which the athlete is competing (Rodriguez N., DiMarco N., Langley S., 2009).

The recommended intake of carbohydrates for athletes ranges from 6 to 10 g/kg/day (Rodriguez N., DiMarco N., Langley S., 2009). In general, athletes competing in endurance activities have higher carbohydrate needs than athletes competing in strength activities. It is recommended that an athlete consume no less than 50% of their calories as carbohydrates (Rodriguez N., DiMarco N., Langley S., 2009).

Protein

Protein supports the growth, maintenance and repair of body tissues, particularly muscle. Protein makes up enzymes that are needed to facilitate chemical reactions within the body. Protein helps maintain fluid balance, transport nutrients and helps defend the body against disease (Rosenbloom, 2000). For the athlete, protein plays an essential role for muscle growth and recovery following intense training (Phillips S., Moore D., Tang J., 2007). The DRI for protein for 14 to 18 year old males is 0.73 g/kg/day and the Acceptable Macronutrient Distribution Range (AMDR) for protein is 10-35% of total calories (DGA, 2010). Dietary protein requirements are increased with exercise and adequate energy intake is essential to maximize utilization of protein specifically for muscle growth and repair (Rosenbloom, 2000).

Both endurance and strength exercises influence the protein needs of an athlete. For the endurance athlete, an increase in protein oxidation during exercise provides the basis for an increased protein need. The recommended protein intake for endurance athletes range from 1.2 to 1.4 g/kg/day. For athletes participating in strength and resistance exercises, adequate protein is essential to support muscle growth and repair. The recommended protein intake for strength athletes range from 1.2 to 1.7 g/kg/day (Phillips S., Moore D., Tang J., 2007).

Extensive research has unveiled differences in absorption rates of specific proteins, whey and casein and their relation to sport performance, namely muscle anabolism (Boirie, 1997 & Dangin, 2001). These proteins are both derived from milk but have distinct differences in digestion and absorption. Whey protein is considered a “fast” protein. Whey is a soluble protein that is emptied from the stomach rapidly resulting in a large increase in plasma amino acids over a short duration (Boirie, 1997). Whey protein is therefore ideal for stimulating rapid protein synthesis and is most effective when consumed directly before and after a workout (Dangin, 2001). Casein protein is relatively insoluble and clots in the stomach, significantly delaying gastric emptying. Casein is considered a “slow” protein (Boirie, 1997). A continual supply of amino acids are released over time as a result of this delayed gastric emptying creating an environment characterized by a positive protein balance over a longer duration (Boirie, 1997).

Fat

Fat provides energy to the body, serves as an abundant energy reserve and protects and insulates internal organs. Fat is a structural component of cell membranes, a precursor to the hormones testosterone and estrogen and is the carrier of fat soluble vitamins A, D, and E (Rosenbloom, C. 2000). The Acceptable Macronutrient Distribution Range (AMDR) for fat is 20% to 35% of calorie intake (IOM, 2002).

Despite the overwhelming evidence of the quintessential role carbohydrates have on exercise performance, researchers have delved into a concept that consuming a high fat, low carbohydrate diet could improve performance to a greater extent. Unlike glycogen, the body has an essentially unlimited storage of energy in the form of lipids (Berning and Steen, 59-72, 2006). Additionally, as the duration of exercise increases, the reliance on lipid energy also increases. The theory is that a high fat diet could improve muscle lipid metabolism during exercise thus sparing muscle glycogen and vastly improving endurance performance (Berning and Steen, pp.59-72, 2006). For example, Vogt and colleagues (2003) found that cycling work output and half-marathon run time were consistent when subjects consumed a high fat diet with a significantly greater contribution of lipids for energy compared to a high carbohydrate diet (Vogt, 2003). Another study demonstrated that a 2-week high fat diet significantly improved moderate intensity exercise to exhaustion when compared to a 2-week high carbohydrate diet. Moreover, subjects on the high fat diet demonstrated a significant sparing effect of muscle glycogen during exercise (Lambert, 1994).

In contrast, Helge et al., (1996) concluded that consuming a high fat diet is unfavorable to endurance exercise performance. Over the course of seven weeks, time to exhaustion was 36% greater in subjects consuming a high carbohydrate diet compared to those consuming a high fat diet. Additionally, when subjects consuming a high fat diet were introduced to a high carbohydrate diet, time to exhaustion improved 15% in just one week (Helge, 1996). Langfort et al., (1997) measured the effects of a low carbohydrate, high fat diet on anaerobic exercise. Mean power output and muscle glycogen stores were significantly lower in the low carbohydrate, high fat diet.

An in-depth and critical review of the research on a high fat diet compared to a high carbohydrate diet concluded that there is insufficient evidence supporting any benefit a high fat diet could have on sport performance (Jeukendrup, 2003). By virtue of a reduction in muscle and liver glycogen, a high fat, low carbohydrate can be detrimental to performance and should not be warranted (Jeukendrup, 2003). Additionally, the health risks associated with athletes consuming a high fat diet are unknown and additional research should be conducted (Jeukendrup, 2003).

Hydration

During physical activity the body generates heat and responds by sweating to maintain temperature homeostasis. The sweat evaporates and through this physiological process provides a method to maintain temperature homeostasis during physical activity. The water that is lost through sweat needs to be replaced and this makes hydration critical to the athlete's performance and health. Dehydration is defined as a water deficit that is greater than 2% of body weight (Sawka M., et al., (2007). Dehydration reduces both aerobic and anaerobic performance as well as cognitive performance (Rodriguez N., DiMarco N., Langley S., 2009).

There are many factors that are involved when calculating an athlete's fluid needs. The environment the athlete is in, the type of clothing the athlete is wearing and the duration and intensity of exercise all influence the rate of sweat lost. In addition, body weight, metabolism and genetics also influence the rate at which an athlete will sweat. In fact, sweat rates can range from 0.3 to 2.4 liters/hour (Sawka M., et al., 2007). The high variability of fluid needs make it difficult to determine a general recommendation of how much fluid the adolescent athlete needs.

According to the American College of Sports Medicine, the best way athletes can monitor hydration status is through urine and/or body weight measurements. First morning urine specific gravity (USG) of less than or equal to 1.020 is considered euhydration. Obtaining a base-line body weight representing euhydration can be done simply by multiple morning body weights. Changes in body weight can reflect water loss through sweat and can be used to calculate fluid replacement needs (Sawka M., et al., (2007).

Prior to exercise, an athlete should consume fluid in the amount of approximately 5 to 7 mL/kg body weight at least four hours before exercise (Sawka M., et al., 2007). Hydrating during exercise is critical to the athlete and, as discussed above, specific recommendations are difficult to generate (Sawka M., et al., 2007). Godek and colleagues (2005) attempted to determine the sweat rate of American football players during exercise. The average sweat rate of sixty-two summer training male football athletes was 2.14 L/hr. The average intake of fluid was 1.42 L/hr. resulting in a 1.58 pound decrease in body mass per hour of activity. Researchers concluded that football athletes have a high sweat rate, particularly during practices in the summer, making it essential to replace what is lost to reduce risk of dehydration and loss in performance (Godek S., Bartolozzi A., Godek J., 2005). After exercise, the athlete should consume between 16 to 24 ounces of fluid for every one pound of body weight lost during exercise (Rosenbloom, 2000).

Adolescent athletes may not be consuming adequate amounts of fluids to compensate for what they lose through exercise. Horswill (2005) compared fluid consumption of adolescent athletes with adult athletes in similar exercise conditions. The adult group consumed significantly more fluid compared to that of the adolescent group. Interestingly however, adults had a significantly greater sweat rate as well (Horswill, 2005).

Nutrient Timing

Before exercise

It is well established that glycogen stores are directly correlated with the intensity and work output of exercise. Endogenous glycogen storage is limited and is most directly affected by the athlete's nutritional status therefore making the timing of nutrition prior to exercise crucial to performance. Traditionally, carbohydrate intake has been at the forefront of research in the realm of improving glycogen storage prior to exercise. However, more recent research is beginning to surface supporting the consumption of protein and amino acids along with carbohydrates prior to exercise to further maximize sport performance (Kerksick 2008).

Kavouras et al., (2004) compared the effects of a high carbohydrate versus a low carbohydrate diet on a 45 minute cycling workout (Kavouras, 2004). The study included twelve well-trained male cyclists. The diet for these cyclists was controlled for six days. On the first three days, participants consumed a diet consisting of 50% carbohydrates, 25% fat and 15% protein. The next three days, half the cyclists consumed a high carbohydrate diet with at least 600 grams of carbohydrates and 46 grams of fat per day while the other half consumed a low carbohydrate diet with 100 grams of carbohydrates and 245 grams of fat per day. On the seventh day, cyclists performed a 45 minute intense cycling exercise at 82% VO_2 max. Muscle glycogen levels were significantly (45%) higher in the high carbohydrate group. Additionally, serum glucose during and after exercise was significantly higher in the high carbohydrate group (Kavouras, 2004).

Bussau et al., (2002) studied the effects of a three day carbohydrate load on muscle glycogen levels (Bussau, 2002). Researchers had eight endurance trained male athletes consume a high carbohydrate (10 g/kg/d) diet for three days while abstaining from physical activity. Muscle biopsies on the first and third day were taken and glycogen stores were recorded. Glycogen levels nearly doubled, increasing from 95 to 180 mmol/kg. Researchers concluded that a high carbohydrate diet paired with physical inactivity greatly increases glycogen storage over three days (Bussau, 2002).

Researchers at the University of Texas investigated the effects a pre-exercise meal had on muscle glycogen utilization, blood substrates and respiratory exchange ratio (Coyle, 1985). The design consisted of seven male endurance cyclists who completed a cycling test in a fasting and a fed state. The fasting state consisted of a 16-hour fast, prior to exercise. The fed state consisted of a breakfast meal four hours prior to exercise providing 2.0 g/kg carbohydrate and 0.3 g/kg protein. The fed state produced a 42% elevation in muscle glycogen at the start of exercise compared to the fasting state.

During the fed state, cyclists also had a 45% greater rate of carbohydrate oxidation. (Coyle, 1985)

A recent review summarized the research on pre-exercise carbohydrate consumption on exercise performance (Ormsbee, 2014). A total of nineteen research articles were reviewed of which nine showed an increase in performance, nine showed no increase or decrease in performance and one showed a decrease in performance. The authors concluded that, after reviewing the literature, consuming a meal abundant in carbohydrates prior to exercise appears to benefit performance (Ormsbee, 2014).

The effects of adding protein to carbohydrates prior to exercise on sport performance has been more recently examined. Tipton et al., (2001) studied the effectiveness of consuming amino acids and carbohydrates on protein synthesis before and after resistance exercise. This study consisted of six subjects, three male and three female. On different occasions, each subject consumed an amino acid and carbohydrate solution (6 grams of amino acids and 35 grams of carbohydrates) before and after completing a one-repetition maximum leg press and leg extension. Researchers concluded that the consumption of the amino acid and carbohydrate solution before resistance exercise has a greater impact on muscle protein synthesis than when consumed after (Tipton K., 2001).

Candow D. et al., (2006) compared the effects of consuming soy versus whey protein with carbohydrates before and after exercise over an eight week resistance training (Candow, 2006). The study consisted of twenty-seven young adults, both male and female, who consumed either a whey and carbohydrate solution, soy and carbohydrate solution or a carbohydrate placebo solution before and after resistance exercise. Both the whey and soy groups showed a significant increase in lean muscle mass and strength compared to that of the placebo group. There were no significant differences between the whey and soy groups. These findings suggest that consuming protein and carbohydrates together prior to exercise can significantly improve muscle protein synthesis (Candow, 2006).

Coburn et al., (2006) examined the effects of supplementing with whey protein and leucine on performance before and after exercise (Coburn, 2006). The study consisted of thirty-three men who consumed either 20 g of whey and 6.2 g of leucine, 26.2 grams of maltodextrin (placebo) or nothing (control), thirty minutes before and immediately after resistance training for eight weeks. Subjects who consumed the whey and leucine had a significantly greater impact on strength compared to that of the placebo and control. Strength in this group was 34% greater than the placebo at the end of the eight weeks (Coburn, 2006).

Based on the most recent research, the International Society of Sports Nutrition recommends consuming 600-1000 grams of carbohydrates daily or 8-10 g/kg/d to maintain maximal storage of glycogen (Kerksick C., 2008). In regards to nutrient timing, it is optimal to consume 1-2 g/kg carbohydrate and 0.15-0.25 g/kg protein, 3-4 hours before exercise (Kerksick C., 2008).

During exercise

It is well known that consuming carbohydrates during exercise maintains blood glucose and carbohydrate oxidation, thus directly improving the muscles capacity to do work efficiently (Tarnopolsky 2005). The body can utilize exogenous sources of carbohydrates at a rate of 1.0-1.1 g/min., roughly 60-66 grams of carbohydrates every hour (Jeukendrup, 2000). This rate is limited by the intestinal absorption capacity, consuming carbohydrates at a higher rate can cause gastrointestinal distress whereas consuming less could risk hindering performance (Jeukendrup, 2005). Therefore, nutrient timing during exercise is critical for maintaining and improving performance.

Febbraio M. et al., (2000) analyzed the effect of ingesting carbohydrates before, during or both on exercise metabolism and performance (Febbraio, 2000). The study consisted of seven endurance-trained males who were given a controlled, high carbohydrate (71% of calories) diet 24 hours before a cycling exercise test. The test consisted of 2-hours cycling at 63% of the subjects peak power output, followed by a time trial. Subjects received a total of four supplement regiments, each separated by at least a week duration: a placebo 30 minutes before and during cycling, a placebo 30 minutes before and 2 g/kg of carbohydrates during, 2 g/kg of carbohydrates 30 minutes before and a placebo during, or 2 g/kg of carbohydrates before and during. Carbohydrate consumption before exercise was associated with high plasma glucose levels before the exercise. During the first 80 minutes of exercise, plasma glucose levels declined among all groups similarly. After the 80 minutes, the groups consuming carbohydrates during exercise maintained their blood glucose and those receiving a placebo continued to decline. The groups that received the carbohydrate during exercise had significantly better time trial performance compared to those who did not. A compelling conclusion of this study was that the consumption of carbohydrates before exercise improves performance only when carbohydrate consumption is maintained throughout exercise (Febbraio, 2000).

Another study analyzed the effects of consuming carbohydrates during a cycling exercise test (McConell, 1999). Subjects cycled at 70% VO_2 max until volitional fatigue and received either a carbohydrate solution or a placebo before and every fifteen minutes during exercise. Subjects consuming the carbohydrate solution were able to cycle forty-seven minutes longer than compared to the placebo (McConell, 1999). A similar study examined the effects of consuming carbohydrates on performance during high-intensity intermittent shuttle running (Patterson, 2007). Seven, trained male subjects completed five intermittent variable speed running followed by a run to exhaustion. Subjects consumed either a carbohydrate gel or a placebo before the exercise and every 15 minutes during exercise. Blood glucose levels and the run time to exhaustion were both significantly higher in the carbohydrate group. Researchers concluded that consuming carbohydrates both before and during exercise, improved performance (Patterson, 2007).

Widrick J., et al., (1993) studied carbohydrate consumption during exercise and its effects on muscle glycogen and performance (Widrick, 1993). Endurance trained subjects were required to cycle for 70 kilometers. The subjects were under four different conditions: high muscle glycogen with carbohydrates administered during exercise, high muscle glycogen without carbohydrates administered during exercise, low muscle glycogen with carbohydrates administered during exercise and low muscle glycogen without carbohydrates administered during exercise. Either a 9% carbohydrate solution or an identical tasting drink sweetened with aspartame was given every 10 kilometers. Blood glucose was significantly reduced in the two conditions where carbohydrates were not administered during exercise. Elapsed performance time completing the 70 kilometers was four percent lower in the high muscle glycogen with carbohydrates compared to the low muscle glycogen without carbohydrates administered during exercise. Additionally, during the final 14% of the trial, power output and pace was significantly lower in the low muscle glycogen without carbohydrates administered during exercise compared to the other three conditions. The authors concluded that carbohydrate consumption during exercise improves performance, specifically in individuals who, at the beginning of exercise, have lower levels of muscle glycogen (Widrick, 1993).

More recently, combining protein with carbohydrates during exercise has been studied as a potential for improving performance and reducing post-exercise muscle damage. Koopman R., et al., (2004) studied eight endurance-trained athletes during a six hour endurance exercise session (Koopman, 2004). Subjects either consumed carbohydrates only during exercise or carbohydrates paired with a protein during exercise. Subjects consuming carbohydrates and protein had an improved net protein balance during and after exercise compared to carbohydrates only (Koopman, 2004).

Another similar study in 2004 measured whether performance or muscle damage was effected when pairing carbohydrates with protein during exercise (Saunders, 2004). Subjects were asked to cycle to volitional exhaustion twice separated by 12-15 hours. Subjects consumed either a carbohydrate only or a carbohydrate and protein supplement every fifteen minutes during exercise. Subjects consuming a carbohydrate and protein supplement had a significant reduction in muscle damage, measured by plasma CPK levels after exercise. Interestingly, subjects consuming a carbohydrate and protein supplement had a 29% and a 40% longer ride time to exhaustion ($p < 0.05$) on each respective test (Saunders, 2004).

Blood glucose and muscle glycogen during exercise are two major determinants of fatigue, therefore impacting performance (Jeukendrup 2000, Jeukendrup 2005 & Kerksick 2008). Muscle glycogen is limited and as exercise duration increases, proper nutrition becomes increasingly important. To avoid any potential for gastrointestinal stress without sacrificing performance, consuming 1.0-1.1 g/min of carbohydrates during exercise is recommended (Jeukendrup, 2000). Limited research has suggested consuming protein with carbohydrates at a carbohydrate to protein ratio of 3-4:1. More research is needed (Kerksick, 2008).

After Exercise

Net muscle protein balance is the difference between muscle protein uptake and muscle protein breakdown. Exercise has a positive influence on both muscle protein breakdown and, to a lesser extent, muscle protein uptake resulting in a negative muscle protein balance (Phillips, 1999, Pitkanen, 2003 & Tipton, 2013). Striving for a positive net muscle protein balance is essential for promoting muscle hypertrophy and reducing fatigue and soreness that can occur as a result of exercise (Kerksick, 2008). Proper timing of nutrition, specifically amino acids from protein, greatly influences the uptake of muscle protein thus resulting in a more positive net protein balance (Tipton, 2013 & Borsheim, 2001).

Borsheim E., et al (2001) analyzed the effects that consuming essential amino acids had on blood essential amino acid levels and muscle protein balance (Borsheim, 2001). Subjects consumed 6 grams of essential amino acids one and two hours after exercise. Both blood essential amino acids and muscle protein balance increased significantly with the consumption of the supplement. Researchers concluded that there is a dose-dependent effect of essential amino acids on muscle protein uptake (Borsheim, 2001).

Another study involving six untrained subjects measured the relationship between resistance exercise and hyperaminoacidemia and their effect on skeletal muscle (Biolo, 1997). Hyperaminoacidemia is a condition in which there is excess amounts of amino acids in the bloodstream. Subjects first went through a rest study in which they received infusions of amino acids without exercise. One to four weeks after the rest study, subjects received an exercise study that consisted of infusions of amino acids directly after exercise. Muscle protein synthesis in the exercise group increased by 291% compared to 141% in the rest group. Furthermore, amino acid transport was 30-100% higher in the exercise group when compared to the rest group. It was concluded that improvement in muscle protein uptake is related to exogenous amino acids is further amplified when consumed directly after exercise (Biolo, 1997).

Additional research has demonstrated that adding carbohydrates with protein after exercise can further stimulate muscle protein uptake. After exercise, muscles are highly sensitive to insulin (Holloszy J., 2005). Therefore, increasing insulin secretion by way of consuming carbohydrates with protein can further improve protein uptake into the muscle cells. Moreover, the addition of carbohydrates improves muscle glycogen re-synthesis (Tarnopolsky, 2005 & Kerksick, 2008). For example, Tipton K., et al (1999) found that when subjects consumed 13.4 g of essential amino acids along with 35 grams of sucrose after exercise, net nitrogen balance changed from -495 nmol/mL to 416 nmol/mL within 10 minutes of consumption. Researchers concluded that consuming protein along with carbohydrates is an adequate catalyst for muscle anabolism (Tipton, 1999).

Consuming protein, specifically essential amino acids, immediately after exercise has been shown to improve muscle protein uptake thus increasing the overall net muscle protein balance. Though the ideal time of consumption and amount of amino acids has yet to be determined, the International Society of Sports Nutrition recommends consuming 6-20 grams of essential amino acids along with 30-40 grams of carbohydrates within three hours after exercise (Kerksick, 2008).

Fruit and Vegetable intake of High School Athletes

Adolescence is a unique stage of life that requires special attention to nutrition. Other than that of birth, adolescence is the only period of life where the acceleration of growth increases (Spear, 2002). During this stage, the adolescent goes through puberty exhibiting physical, cognitive, emotional and hormonal changes. During the time of adolescence 15% of the adult height, 45% of the skeletal mass and about 50% of the ideal adult weight is gained (Spear, 2002). These changes, particularly the physical growth and development, make it critical for adequate nutrient intake. Additionally, adolescents who are involved in sporting activities have an even greater nutrient need (Lytle, 2002).

An increased consumption of fruit and vegetables is associated with many health benefits. Fruit and vegetables provide essential nutrients that are not being met through a diet characterized by low consumption of fruits and vegetables; this includes vitamins A, C and K, folate, magnesium, potassium and fiber. Increasing fruit and vegetable intake reduces the risk of multiple chronic diseases such as obesity and cardiovascular disease, and may help reduce the risk of cancer. Furthermore, because of the low calorie content of fruits and vegetables, an increased consumption can help maintain an adequate and healthy weight (DGA, 2010).

The United States Department of Agriculture Dietary Guidelines for Americans (2010) has established fruit and vegetable recommendations for adolescents. The active adolescent male should consume at least two cups of fruit and three cups of vegetables per day (DGA, 2010).

The Centers for Disease Control and Prevention (CDC) released the State Indicator Report on Fruits and Vegetables in 2013 providing state information on fruit and vegetable intake using data from the Behavioral Risk Factor Surveillance System (BRFSS) (CDC, 2013). The BRFSS is the world's largest telephone health survey system. The median adolescent is consuming fruit about 1.0 times per day and consuming vegetables about 1.3 times per day indicating that consumption of fruit and vegetables among adolescents in the United States is lower than recommended. Specific to Kentucky, the median adolescent is consuming fruit 1.0 time per day and consuming vegetables 1.1 times per day (CDC, 2013).

The Youth Risk Behavior Surveillance System (YRBSS) is a national school-based survey that monitors health risk behaviors contributing to the leading causes of death among youth and adults. The most recent YRBSS survey data affirmed poor fruit and vegetable intake among adolescents. In 2011, 63.5% (n=7242) of high school males in the United States reported eating fruit or drinking 100% fruit juice fewer than two times per day. The majority of high school males (83.4%) reported eating vegetables less than three times per day. Specifically in the state of Kentucky, 75.6% (n=892) of high school males reported eating fruit or drinking 100% fruit juice less than two times per day. 87.2% (n=895) of high school males reported eating vegetables less than three times per day (CDC, 2011).

The CDC investigated data using the 2010 National Youth Physical Activity and Nutrition Study (NYPANS). A report was published in 2011 reviewing the fruit and vegetable consumption specifically among high school students in the United States. In the year 2010, high school students, both male and female, had a median fruit and vegetable consumption of 1.2 times per day (n=10,765). High school students consuming less than one serving of fruit was 28.5% and less than one serving of vegetables was 33.2%. High school students consuming four or greater servings of fruit was 16.8%. High school students consuming four or greater servings of vegetables was 11.2%. It was concluded that the majority of high school students are not meeting the daily fruit and vegetable recommendations.

The 2003-2004 National Health and Nutrition Examination Survey (NHANES) revealed a mere 0.9% of adolescents are meeting both the recommended fruits and vegetable recommendations. Of the adolescent's surveyed, only 6.2% are meeting fruit recommendations and 2.2% are meeting non-fried vegetable recommendations (Kimmons J., 2009).

Cavadini and colleagues (2000) compared the food habits and dietary intakes of athletic and non-athletic adolescents in Switzerland (Cavadini, 2000). There were 3,450 subjects who completed a self-reported questionnaire, had anthropometry measurements and received a physical fitness test. Researchers observed low fruit and vegetable intake among all subjects. Only 30% of males consume fruit daily and 10% consume vegetables daily, though no significant differences were seen between athletic and non-athletic individuals. Overall, athletic adolescents had healthier food habits based upon higher intakes of dairy products, fruit, 100% fruit juices and salad when compared to non-athletic (Cavadini, 2000).

Another study by the same researcher compared trends in adolescent food intake from the year 1965 to 1996 using four United States Department of Agriculture (USDA) surveys in the years 1965, 1977-78, 1989-91 and 1994-1996 (Cavadini, 2000). Overall fruit intake, per serving, remained the same at 1.4 servings per day. However, raw fruit consumption decreased and fruit juice consumption increased. Vegetable intake surprisingly went up from 2.7 servings per day in 1965 to 3.3 servings per day in 1994-96. However, dark green and orange and low fiber and medium fiber vegetable consumption decreased whereas high-fat potato consumption increased. In fact, in 1965 white potatoes accounted for one third of the overall vegetable consumption and by 1996 this went up to half of the overall vegetable consumption (Cavadini, 2000).

A study published in 1997 reviewed food intakes of adolescents and compared them to what is recommended using the now antiquated, Food Guide Pyramid (Munoz K., 1997). The food intake was examined using the USDA's 1989-1991 Continuing Surveys of Food Intakes by Individuals (CSFII). In these years, families were sampled by trained interviewers to collect diet information from a 24-hour diet recall and to teach the subject on how to complete a two-day food record. The percentage of males aged 12-19 (n=618) that met or exceeded recommendations for fruit and vegetables were 17.1% and 50.3% respectively. The average number of servings of fruit and vegetables consumed by males aged 12-19 was 1.1 and 3.4 respectively. The percentage of children that met vegetable recommendations was positively correlated with age however the percentage of children meeting fruit recommendations was negatively correlated with age. Additionally, males aged 12-19 had higher intakes of vegetables and lower intakes of fruit compared with females and other age groups (Munoz K., 1997).

Nutrition Knowledge of High School Athletes

It is well documented that high school adolescent athletes lack the necessary nutrition knowledge to make sound nutritional decisions. In a study conducted by Douglas P, et al. (1984), a three part questionnaire was sent to ten different high schools to assess nutrition knowledge and food practices. The purpose of the questionnaire was to gather information on the athlete's sport, food practices and nutrition knowledge. The sample consisted of 943 male and female athletes. The mean score for nutrition knowledge was 55%. The mean food practice score was 2.21 out of a possible 5. Male athletes had a higher food practice score but females had a significantly higher nutrition knowledge score. The higher food practice scores seen by males were attributed to the fact that young males tend to eat more in general making more likely that nutrient needs will be fulfilled. It is relevant to note that football players scored slightly lower on the nutrition knowledge portion at 52% and slightly higher on the food practice score at 2.40 compared to the overall mean (Douglas P., 1984). The low nutrition knowledge and food practice scores demonstrate a deficiency in nutrition knowledge among high school athletes.

Pirouznia M. (2001) studied nutrition knowledge and eating behavior of adolescents to determine if any correlations existed between the two (Pirouznia, 2001). The sample consisted of 532 six, seventh and eighth grade students between the ages of 11 and 13, who attended thirteen different schools. Students were asked to complete a questionnaire designed to measure nutrition knowledge and eating behavior. Nutrition knowledge scores on the questionnaire for sixth grade boys and girls were 69% and 67%, respectively. Nutrition knowledge scores on the questionnaire for seventh and eighth graders (both male and female) was 47% and 46%, respectively. Though there was no correlation between nutrition knowledge and food practice in the younger, sixth grade boys or girls, the data did support a positive correlation between nutrition knowledge and food choices for both boys and girls in seventh and eighth grade (Pirouznia M., 2001). This serves as an indicator that nutrition knowledge may have a positive influence on diet practices.

Researchers at the University of Alberta, Edmonton studied the effect of a nutrition education program on adolescent hockey players. In 1991 an interactive sports nutrition intervention program called Sport Nutrition for the Athletes of Canada (SNAC) was developed by the Sport Medicine and Science Council of Canada. This nutrition education program consisted of lectures, large-group discussions, video presentations and activities administered to 30-40 hockey players at a time. The SNAC questionnaire was used to identify nutrition knowledge before and after the intervention. A total of 175 hockey athletes between the ages of 10 and 21 years old participated in the study. Due to "unpredictable circumstances", only 33 completed the study. The average nutrition knowledge score was 45% indicating a deficiency in nutrition knowledge and only a modest improvement in scores, to 49%, were seen after the nutrition education program was implemented. Researchers concluded that nutrition knowledge among this population is low and that the SNAC nutrition education intervention was not effective (Reading K., 1999).

Wiita B. and Stombaugh I. (1996) studied elite adolescent female runners over a three year longitudinal period to investigate the changes in nutrition knowledge, eating attitudes and physical status. The sample consisted of 22 elite female adolescent runners who completed a nutrition knowledge test, an Eating Attitudes Test (EAT) as well as a 3-day food record to assess nutrient intake at the start of the study and then again three years later. The mean score on the nutrition knowledge test was 66.2% at the start of the study and 66.9% at the end of the study, demonstrating a consistent lack of nutrition knowledge among adolescent athletes (Wiita B., 1996).

Chapman P., et al. (1997) studied the effectiveness of a nutrition education program among high school female athletes. The sample consisted of 72 female athletes between the ages of 14-18 years old from eight different high schools. All subjects completed a nutrition knowledge questionnaire to determine baseline nutrition knowledge. Subjects were divided into an experimental group and a control group. The experimental group received a nutrition education treatment. The nutrition education treatment consisted of two sport nutrition lectures each week in addition to flyers, handouts and demonstrations for the subjects. The mean nutrition knowledge score on the pre-test for both the control group and experimental group was 68%. The mean score on the post-test was 67% for the control group and 76% for the experimental group (Chapman, 1997). This study reveals not only that there is a deficiency in nutrition knowledge among adolescent athletes but that a nutrition education program can improve this deficiency.

A study in Italy examined nutrition knowledge and dietary composition of athlete and non-athlete adolescent females. Cupisti (2002) studied 119 adolescent females between the ages of 14 to 18 years old, 60 of which were elite athletes in the field of gymnastics, tennis and fencing. Nutrition knowledge was measured using a questionnaire and diet composition was measured using a three-day food recall. The average nutrition knowledge score for athletes and non-athletes was 77.6% and 71.6%, respectively (Cupisti, 2002). Though these scores were notably higher than previous studies examined, this study still demonstrates a deficiency in nutrition knowledge among adolescents.

Chapter Three

Methodology

The purpose of this study was to determine if a nutrition education program tailored specifically toward adolescent athletes would improve nutritional knowledge, fruit and vegetable intake, body composition or perceived sport performance. An eight-week nutrition education program was implemented among high school adolescents. Body composition, nutrition knowledge, diet quality and perceived sport performance were measured before and after the nutrition intervention.

This study received approval from the University Of Kentucky Office Of Research Integrity Institutional Review Board in August, 2013.

Research Design

This study was a quantitative research design. All members of the high school football team were offered a chance to receive the intervention. Informed consent from parents and assent of high school football players was obtained. The intervention lasted eight weeks. All participants had their body composition measured using a Bod Pod™ at the University of Kentucky, completed a pre-intervention survey consisting of questions related to nutrition knowledge, and completed the NCI fruit and vegetable screener to assess dietary intake. The intervention consisted of a sport nutrition education presentation that was created and presented by the researcher to all high school football athletes, parents of athletes and coaches of athletes. Over the course of eight weeks, subjects received one nutrition education newsletter via email and hard copy and attended an educational meeting to discuss the week's sports nutrition topic. After the eight-week intervention, subjects completed the survey post-test. The post-test matched the pre-intervention survey discussed above with the addition of three questions related to perceived sport performance and effectiveness of the nutrition education program they received. Participants again had their body composition measured using the Bod Pod™ at the University of Kentucky, Department of Dietetics and Human Nutrition.

There was no deception involved in this study. The study measured the pre and post changes that occur among the subjects who received the nutrition intervention, who signed the assent forms, and whose parent signed consent forms.

Subjects

At an introductory meeting set up by the team football coach, all football players and parents were given an overview of the study. There were a total of 32 eligible football players and 11 signed assent forms whose parents also signed consent forms. The number of subjects that completed the study was 11. All subjects were high school football players. As such, all subjects (n=11) were male and between the ages of 13 to 19 years old. There were no exclusion criteria for this study.

Instruments and Procedures

The Bod Pod™ was used to measure weight and body composition of subjects. The Bod Pod™ is a computerized, egg-shaped compartment that measures body composition through Air Displacement Plethysmography using whole body densitometry.

A nutrition education survey was created using questions from surveys in previous survey-based literature related to this topic. To assess diet quality, the National Cancer Institute Fruit and Vegetable Screener was used (DHHS, 2013). The survey was administered at the start of the program and the same survey with three added questions regarding perceived sport performance created by the researcher, was given at the conclusion of the study.

Intervention

The nutrition education program began with a nutrition presentation given to athletes, parents of athletes and coaches. The nutrition education presentation contained basic nutrition information relevant to high school athletes. Following the initial session, a regular group meeting was scheduled each week for eight weeks for all high school football athletes. Each week, a newsletter on a specific nutrition topic was sent to subjects via email. A small group discussion was held during the week to explain and discuss the information presented in the newsletter. The nutrition topics discussed included: Hydration, carbohydrates, protein, fat, healthy weight gain, a balanced diet, healthy choices when eating out and a review at the end. The groups were led by a registered and Kentucky licensed dietitian and lasted 30 minutes. The sessions were held in the workout room at the high school. The intervention took place from September 2013 to December 2013.

Data Analysis

SPSS statistical software version 22 was used to analyze the data. Paired sample t-tests were used to investigate the relationship of the pre- and post- data. Paired sample t-tests were used for pre- and post- nutrition knowledge, pre- and post- fruit intake, pre- and post- vegetable intake, pre- and post- body composition, pre- and post- BMI score. An alpha score of 0.05 or less was used to determine a level of statistical significance.

Chapter Four

Results

Demographics

The sample consisted of eleven high school football players. Eleven (100%) of the participants were male. Eleven (100%) of the participants were Caucasian. The mean age of participants was 16.6 ± 1.1 years, with a range of 14-18 years.

Body Mass Index (BMI)

BMI was calculated for each high school football player before the intervention. One participant (9%) did not have his height or weight measured before or after the intervention. The average BMI for participants prior to intervention was 25.8 kg/m^2 ± 2.6. Four participants (36%) were classified as normal weight (BMI ≤ 24.9) and six participants (55%) were classified as overweight (BMI 25-29.9). The average BMI for participants after the intervention was 26.1 kg/m^2 ± 3.0. Four participants (36%) were classified as normal weight, four participants were classified as overweight and two participants were classified as obese (BMI ≥ 30). A paired sample T-test was conducted to measure the change in BMI as a result of the nutrition education program. Mean BMI increased 0.33 however this was not statistically significant (p-value= 0.12)

Table 4.1 Mean BMI

Mean BMI (n=10)			
	Before intervention	After intervention	p-value
	25.8 kg/m^2	26.1 kg/m^2	0.12

Attendance

There were a total of eight nutrition education meetings. The mean attendance at each session was 9.0 ± 1.2 participants. The range of attendance each week was 6-10 participants.

Nutrition Knowledge Questionnaire

The nutrition knowledge questionnaire consisted of 25 true/false and multiple choice questions. The mean score prior to the nutrition intervention was 17 ± 2.3. The range of scores prior to the nutrition intervention was 11-19 (44%-76%). The mean score after the nutrition intervention was 18.2 ± 1.7 (72.7%). The range of scores after the nutrition intervention was 15-21 (60%-84%). A paired sample T-test was conducted to measure if the nutrition education program changed nutrition knowledge. Mean score improved 4.7% (1.2 questions) after the nutrition education program. The change was not statistically significant (p-value= 0.12).

Table 4.2 Mean nutrition knowledge

Mean Nutrition Knowledge (n=11)			
	Before intervention	After intervention	p-value
Score	17 (68%)	18.2 (72.7%)	0.12

Dietary Intake

Fruit and vegetable consumption was measured using the National Cancer Institute Fruit and Vegetable Screener.

Fruit consumption

Prior to the nutrition intervention, the mean serving of fruits consumed per day was 1.48 ± 1.56 servings. After the nutrition intervention, the mean serving of fruits consumed per day was 1.52 ± 1.89 servings. A paired sample T-test was conducted to measure the effect of the nutrition education program on fruit consumption. Mean fruit consumption improved 0.04 servings per day after the nutrition education program. This was not a statistically significant change (p-value= 0.96).

Vegetable consumption

Prior to the nutrition intervention, the mean serving of vegetables consumed per day was 0.94 ± 0.55 servings. After the nutrition intervention, the mean serving of vegetables consumed per day was 2.02 servings. A paired sample T-test was conducted to measure effectiveness of the nutrition education program at improving vegetable consumption. Mean vegetable consumption improved by 1.08 servings per day after the nutrition education program which was statistically significant (p-value= 0.02).

Table 4.3 Mean fruit and vegetable intake

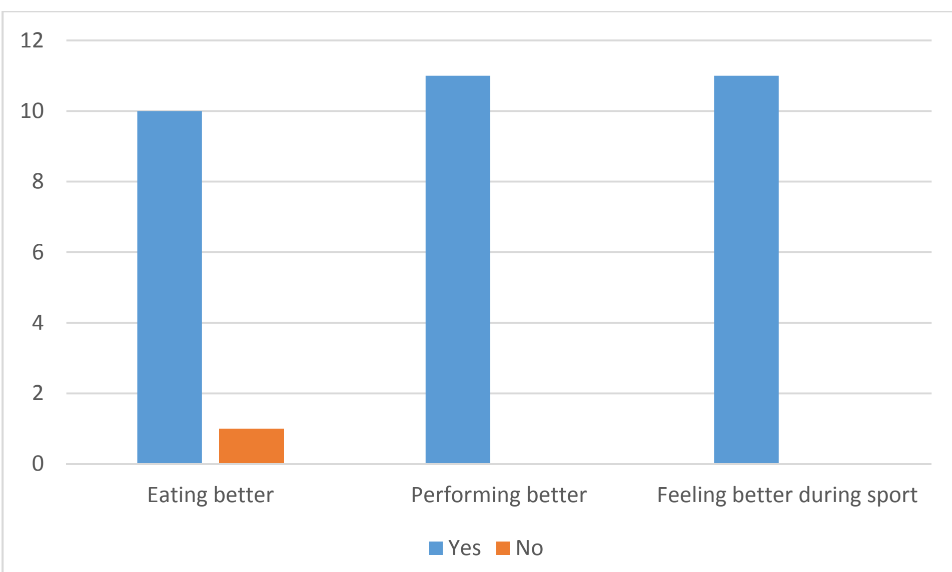
Mean Fruit and Vegetable intake (n=11)			
	Before intervention	After intervention	p-value
Fruit consumption	1.48	1.52	0.96

(servings)			
Vegetable consumption (servings)	0.94	2.02	0.02

Perceived Sport Performance

After the nutrition intervention, participants were asked three questions regarding perceived sport performance. Participants were asked, if, after receiving the intervention, they were eating better. Ten (90.9%) participants answered yes and one (9.1%) answered no. Participants were asked if, after receiving the intervention, they believe they are performing better at their sport. Eleven (100%) participants answered yes and zero (0%) participants answered no. Participants were asked if, after receiving nutrition education, they felt better during sporting activities. Eleven (100%) participants answered yes and zero (0%) participants answered no.

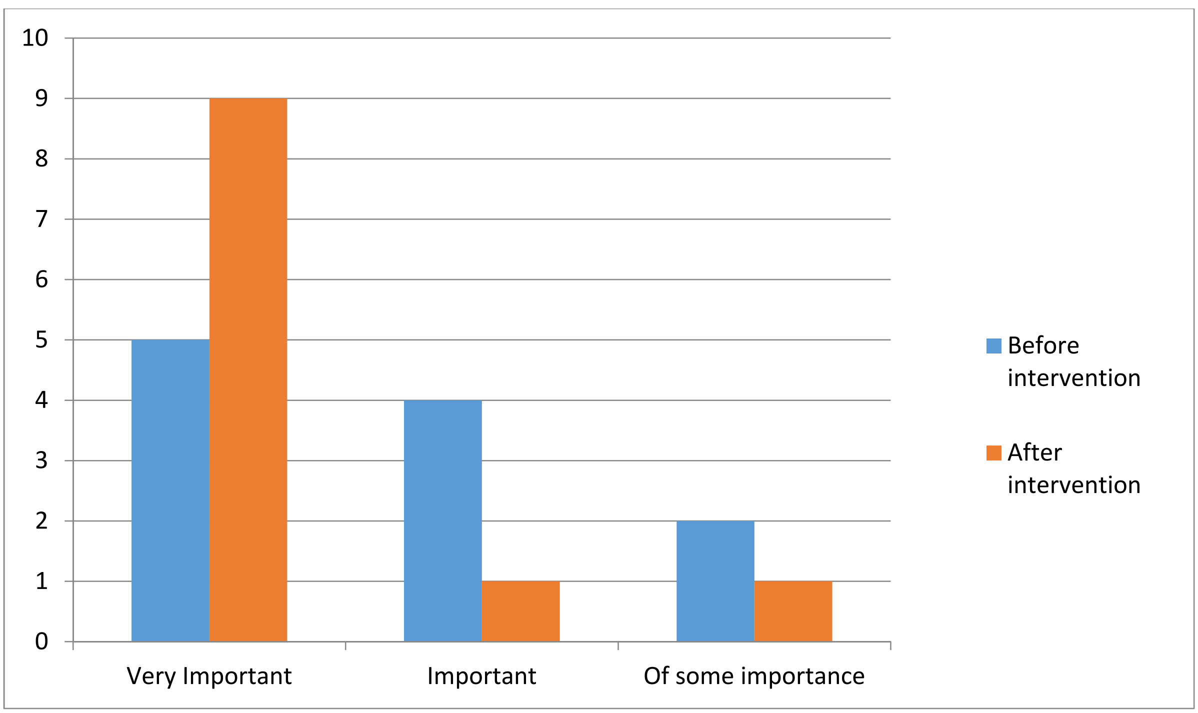
Figure 4.1 Perceived performance



Nutrition Advice

Participants were asked to rate the importance of what they ate and drank as it relates to their sport performance. Prior to the nutrition intervention, five (45.5%) students selected “Very Important”, four participants (36.3%) selected “Important” and two participants selected “Of some importance”. After the nutrition intervention, nine (81.9%) participants selected “Very Important”, one (11.1%) selected “Important” and one (11.1%) selected “Of some importance”. A chi-squared test was conducted to determine if the change in importance of nutrition advice from prior to the intervention to after the intervention was significant (p-value=0.37).

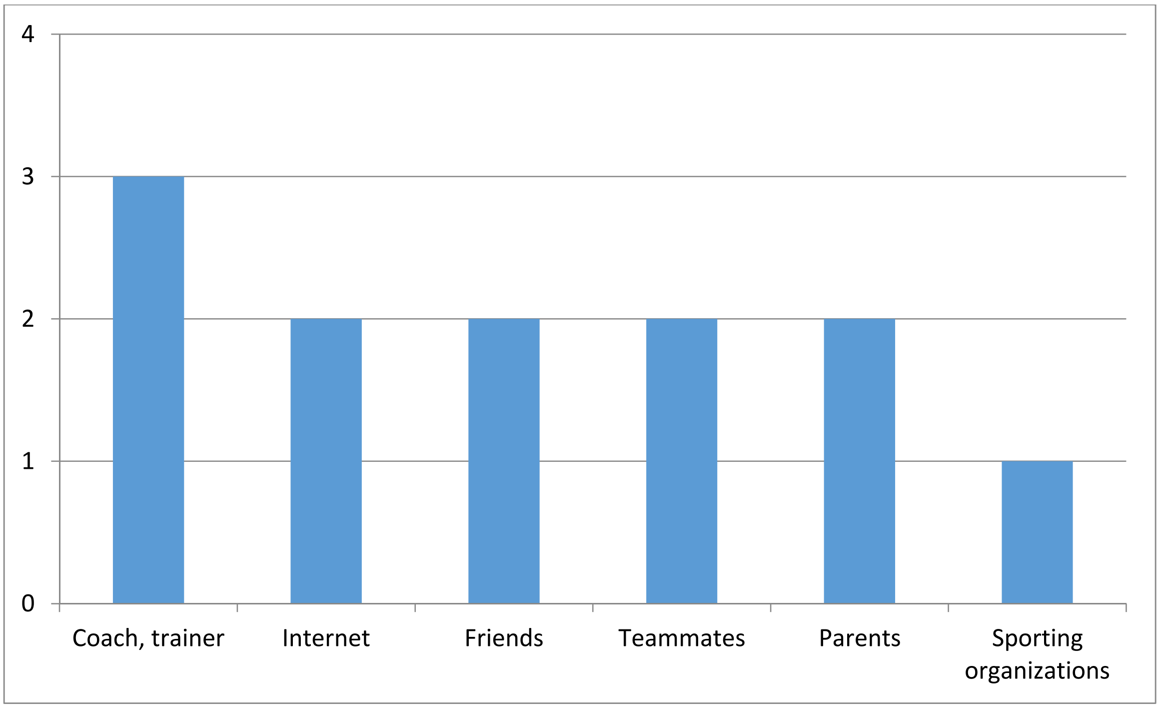
Figure 4.2 Importance of nutrition



Prior to the nutrition intervention, participants were asked if they have looked for dietary advice to increase performance and if so, where did they look. Three (27.2%)

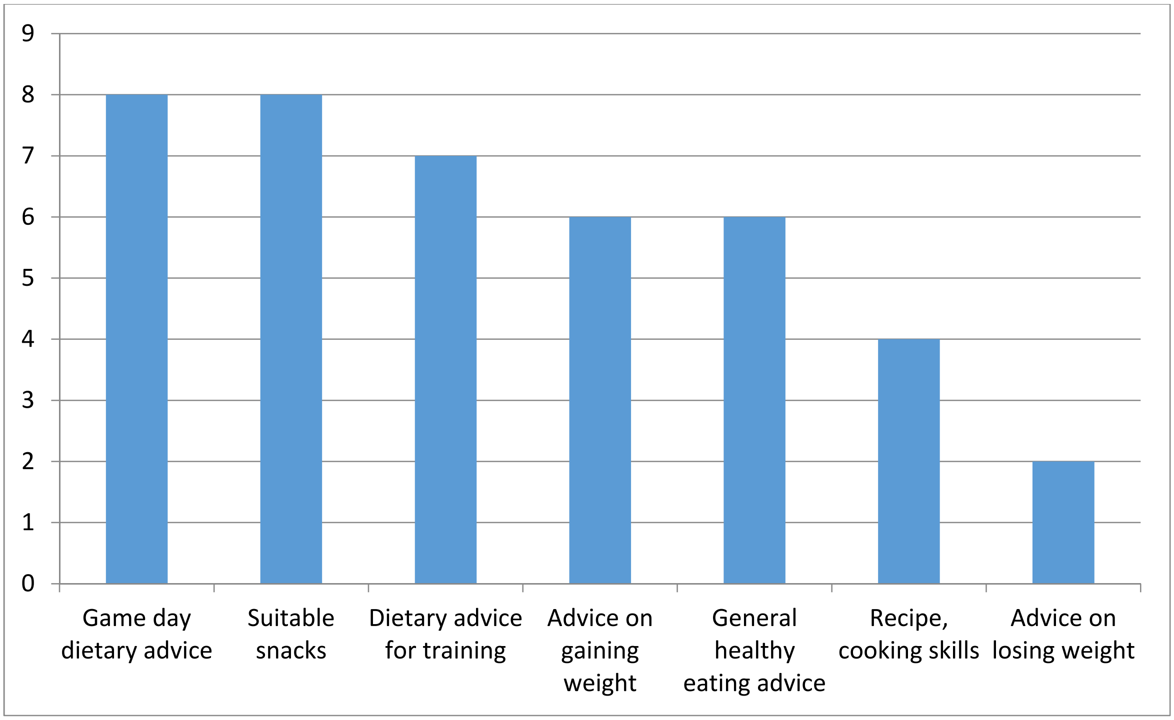
students answered yes and eight (72.8%) students answered no. Of the three students, 100% (n=3) selected “coach, trainer” as a resource for dietary advice. Two students selected “internet”, “friends”, “teammates”, & “parents” as a resource for dietary advice. One student selected “sporting organizations” as a resource for dietary advice.

Figure 4.3 Sources of dietary advice



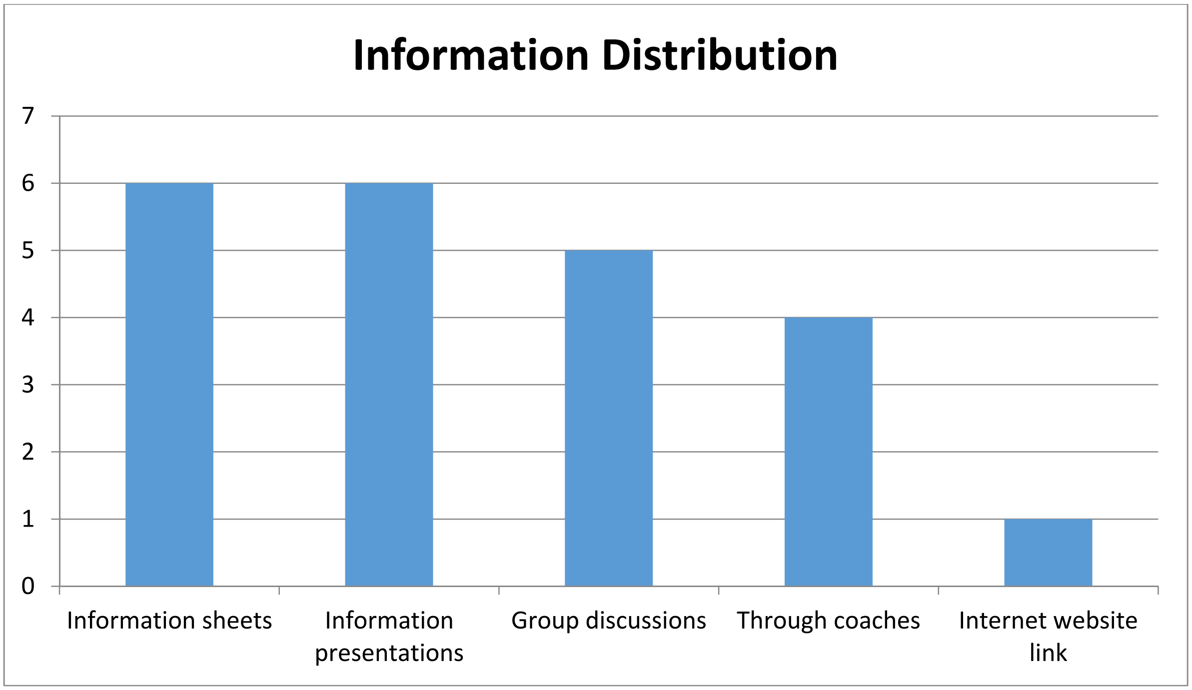
Prior to the nutrition intervention, participants were asked if they felt they could benefit from advice about nutrition, if they selected yes, they were prompted to answer what areas they needed more information. Eleven (100%) participants answered yes, zero (0%) participants answered no. Eight (72.7%) of the participants selected “Game-day dietary advice” and “Suitable snacks”. Seven (63.6%) of the participants selected “Dietary advice for training/practice”. Six (54.5%) of the participants selected “Advice on gaining weight” and “General healthy eating advice”. Four (36.4%) of the participants selected “Recipe, cooking skills”. Two (18.2%) of the participants selected “Advice on losing weight”.

Figure 4.4 Requested information topics



Prior to the nutrition intervention, participants were asked how they would like nutrition information delivered. Six (54.5%) participants answered “Information sheets” and “Information talks/presentations”. Five (45.4%) participants answered “Group discussions”. Four (36.4%) participants answered “Through coaches”. One (9.1%) participant answered “Internet website links”.

Figure 4.5 Preferred method for distribution of information


Information Distribution
7
6
5
4
3
2
1
0
Information sheets
Information presentations
Group discussions
Through coaches
Internet website link

Chapter Five

Discussion

Findings

The purpose of this study was to determine if a nutrition education program tailored specifically toward adolescent athletes would improve nutrition knowledge, fruit and vegetable intake, body composition or perceived sport performance in those athletes. The study was able to assess nutrition knowledge and fruit and vegetable consumption before and after the educational intervention. Due to unreliable data from the Bod Pod™, body composition was not accurately assessed in all study subjects and was therefore omitted.

The first objective of this study was to determine the baseline nutrition knowledge of high school athletes. It was hypothesized that baseline nutrition knowledge would be low. Of the eleven high school athletes that completed the baseline nutrition knowledge questionnaire, the mean score was 68%. Previous studies have demonstrated similar results. For example, Pirouznia (2001), Wiita & Stombaugh (1996), Chapman (1997) & Cupisti (2002) found that baseline nutrition knowledge of adolescent's was 69%, 66.2%, 68% and 77.6%, respectively. Additionally, Cupisti and colleagues, (2002) found that baseline nutrition knowledge for athletes was greater than non-athletes suggesting that, despite a lack of nutrition curriculum in high school, athletes have access to nutrition information from coaches and trainers (Cupisti, 2002). On the contrary, only three athletes (27.2%) in the present study admitted to seeking out dietary advice for performance, of which all three selected "coach, trainer" as their primary source.

The second objective of this study was to determine whether a nutrition intervention among high school athletes improved nutrition knowledge, dietary intake or perceived sport performance.

After exposure to an eight week nutrition education program, nutrition knowledge of high school athletes improved only marginally. Mean score on the posttest rose 1.2 correctly answered questions or 4.7%. This improvement was not statistically significant ($p=0.12$). This marginal progress could have been due to pre-test scores already being high at 68%. Additionally, the nutrition education program consisted of a once per week class for only 20-30 minutes. Additional teaching each week would be ideal to allow for better clarification or to answer questions more in-depth. Moreover, participants did not take advantage of asking questions or communicating via electronic mail. However, marginal improvements in nutrition knowledge after a nutrition education program is implemented have also been demonstrated in previous studies. Reading and colleagues (1999) exhibited a mere 4% improvement after implementation of a nutrition education program among adolescent hockey players. Researchers concluded the need for smaller, more intimate group settings for nutrition education to be effective in young athletes (Reading, 1999).

Fruit and vegetable intake was measured using the National Cancer Institute (NCI) Fruit and Vegetable Screener. The intent of the present study was to determine if a nutrition education program would improve fruit and vegetable intake. It was hypothesized that fruit and vegetable intake would improve after the intervention. Mean fruit and vegetable consumption prior to the nutrition education program was 1.48 and 0.94 servings per day, respectively. These results are comparable to the 2011 BRFSS data that document fruit and vegetable consumption for adolescent's in Kentucky at 1.0 and 1.1 times per day respectively (CDC, 2013).

Ten participants (90.9%) reported eating better as a result of the nutrition intervention. Fruit consumption improved to 1.52 servings per day but this was not significant (p=0.96). Vegetable consumption significantly improved to 2.02 servings per day (p=0.02). This was the most significant finding of the study, of which has been demonstrated in previous research as well. For example, Cohen (2013) and colleagues found that after one year of a nutrition intervention, vegetable intake among children improved 0.08 cups per 1000 calories. Interestingly, fruit intake did not significantly improve. However it was trending that way (Cohen, 2013). Similarly, another study measured fruit and vegetable intake among American Indian children (Govula, 2007). After a six session nutrition intervention, vegetable intake significantly improved from 1.0 servings per day to 2.2 servings per day. However, fruit intake did not (Govula, 2007). Finally, Spiegel and Foulk, (2006) found that a seven-module nutrition intervention improved vegetable intake by 0.45 servings per day and fruit intake by 0.1 servings per day (Spiegel and Foulk, 2006). Despite the aforementioned research, a recent meta-analysis of school-based nutrition interventions on improving fruit and vegetable intake among children concluded that overall, these nutrition interventions only moderately improve fruit intake and minimally improve vegetable intake (Evans, 2012).

One possible explanation for the significantly greater improvement in vegetable intake compared to fruit was that fruit intake prior to the intervention was already much higher than vegetable intake. Vegetable intake among the participants had a much greater room for improvement. Additionally, overall intake was higher among participants as evidenced by mean BMI increasing 0.3 units over the eight weeks, indicating weight gain. An increase in overall intake could further explain the increase in both fruit and vegetable intake.

Perceived sport performance was measured at post-test only by three additional questions. It was hypothesized that high school athletes would have a higher perceived sport performance as a result of the nutrition intervention. After the eight week nutrition intervention, eleven participants (100%) believed they were performing better at their sport than at baseline. Additionally, eleven participants (100%) believed they were feeling better during sporting activities. Based solely on perception alone, performance improved as a result of the nutrition intervention.

The intent of the study was to measure body composition with the Bod Pod™, however, due to unreliable data, body composition could not be obtained. Study subjects' BMI was calculated. Although this was not a research objective, BMI results are interesting. The mean BMI prior to the nutrition intervention was 25.8 kg/m^2. After the nutrition intervention, BMI rose 0.3 units to 26.1 kg/m^2 however this change was not statistically significant ($p=0.12$). This rise in BMI could potentially be explained by the interest high school football players expressed in gaining weight. In fact, six (54.5%) of the eleven subjects felt they could benefit from nutrition information as it is related to healthy weight gain, whereas only two (8.2%) requested advice on losing weight.

Strengths, Limitations, and Future research

A strength of the present study was that small, intimate group meetings were used for the nutrition intervention. These smaller group situations allowed for a more personalized approach to education. Another strength of this study was the design of the nutrition intervention, which was tailored to the desires of the research subjects. Nutrition information newsletters, presentations and group discussions were the top three selected answers when subjects were asked how they would most like to receive nutrition information.

There were several limitations to the present study, most prominently, the small sample size. The small sample size made it more difficult to find any relationships in the data that were statistically significant. Additionally, this sample was pooled from one high school football team which may not represent all high school athletes. Another limitation is the data are self-reported which means there could be response bias and therefore needs to be taken at face-value. Level of maturity was not measured. Growth and maturity during adolescence is very individualized and can have a significant impact on BMI. Finally, the limited amount of time available for the nutrition intervention was a limitation. Based on the modest improvement in nutrition knowledge 20-30 minutes once per week may not be enough to adequately improve nutrition knowledge.

Future studies should focus on having a stronger involvement of parents and coaches. Based on the present study as well as previous studies, adolescents are more apt to change when listening to their coaches and parents. Coaches serve as figures that adolescents revere and trust, while parents are responsible for the availability of their food. Educating both the parents and coaches along with the adolescents will ensure accurate dissemination of nutrition information improving the likelihood that effective changes can be made. More frequent exposure to nutrition information is needed. Currently, most high school athletes are not exposed to a nutrition curriculum.

Additionally, based on the present study, eight (72.7%) of the athletes are not receiving any nutrition information whereas three (23.7%) are receiving information from varied sources, though primarily from coaches and parents. Therefore, repeated exposure of accurate nutrition information from a variety of sources amounting to more than 20-30 minutes weekly, could be noticeably beneficial.

Conclusion

An eight-week nutrition intervention was implemented among eleven high school football athletes in hopes of achieving improved nutrition knowledge, dietary intake and perceived performance. Presently, these high school athletes are not receiving nutrition education from reliable or credentialed sources. The findings of the present study agree with previous research suggesting that nutrition knowledge and fruit and vegetable intake of adolescent athletes is deficient.

As a result of the nutrition intervention, vegetable intake improved. This generates hope that a nutrition education program is beneficial in this particular population. An improved nutrition knowledge and dietary intake can positively impact sport performance resulting in more competitive high school sport teams. Additionally, improving the diets of adolescents may help reduce nutrient deficiency related to injuries, such as stress fractures. Moreover, improving the diets of adolescents can establish a foundation for a healthier future reducing the risk of diet related illnesses such as obesity and diabetes.

Careful consideration should be taken when developing a nutrition education program for adolescent athletes. Coaches and parents should be more intimately involved due to their substantial role for facilitating change. Educational materials should be presented to adolescents emphasizing motivational and practical knowledge that focus on improving performance and weight control. Finally, the intensity of the intervention should also be maximized.

Appendices

Pre Nutrition Education Survey

Name: ______________________________

Date: ______________________________

Email: ______________________________

Research Assistant: Aaron Schwartz

Instructions

Please read each question carefully and, to the best of your ability, answer each one honestly and with what you believe to be is the correct answer. Please only select **<u>one</u>** answer for each question unless otherwise indicated.

Part I: Demographics

1) ______ **How old are you?**

2) ______ **What is your ethnic background?**

   a. White / Caucasian
   b. Hispanic / Latino
   c. Asian
   d. Native Hawaiian / Other Pacific Islander
   e. Black / African American
   f. American Indian / Alaska Native
   g. Other

Part II: Nutrition Knowledge

1) ______ **The main energy source for the athlete is:**

   a. Carbohydrates
   b. Proteins
   c. Fats
   d. Don’t know

2) ______ **The best "healthy fat" is:**

a. Butter

b. Margarine

c. Olive oil

d. Don't know

3) ______ **Fruits are important because they supply:**

a. Fats

b. Proteins

c. Vitamins

d. Don't know

4) ______ **How many cups of fruit are needed daily for boys aged 14-18 years old?**

a. 1 cup

b. 2 cups

c. 3 cups

d. 4 cups

5) ______ **How many cups of vegetables are needed daily for boys aged 14-18 years old?**

a. 1 cup

b. 2 cups

c. 3 cups

d. 4 cups

6) ______ **Fresh, frozen, and canned vegetables all have similar nutrient values**

a. True

b. False

7) ______ **Nutrients can be destroyed if vegetables are overcooked.**

a. True

b. False

8) ______ **How do you rate the importance of what you eat and drink to your performance?**

a. Very Important

b. Important

c. Of some importance

d. Of no importance

e. Not sure

9) ______ **During exercise last longer than 1 hour, sport drinks are better than water (e.g. PowerAde and Gatorade)**

a. True

b. False

10) ______ **During activity, thirst is an adequate guide to the need of fluids**

a. True

b. False

11) ______ **Dehydration can reduce performance.**

a. True

b. False

12) ______ **An athlete should drink no water during practice, but rather rinse out his/her mouth or suck on ice cubes.**

a. True

b. False

13) ______ **It is better to get vitamins and minerals from supplements than from foods.**

a. True

b. False

14) ______ **Foods such as potatoes and honey are best eaten after exercise.**

a. True

b. False

15) ______ **Protein is the primary source of muscular energy for the athlete.**

a. True

b. False

16) ______ **No more than 15% of calories in the diet should be provided by fat.**

a. True

b. False

17) ______ **During exercise, mass ingestion of large amounts of fluid is preferred over frequent ingestion of small amounts.**

a. True

b. False

18) ______ **A muscular person expends more energy at rest than a non-muscular person of the same age, sex and weight.**

a. True

b. False

19) ______ **A sound nutritional practice for athletes is to eat a wide variety of different food types from day to day.**

a. True

b. False

20) ______ **The type of food an athlete eats affects his/her performance**

a. True

b. False

21) ______ **What the athlete eats is only important if the athlete is trying to gain or lose weight.**

a. True

b. False

22) ______ **Nutrition is more important during the competitive season than during the off-season for the athlete.**

a. True

b. False

23) ______ **Food advertisements are a very reliable source of nutritional information.**

a. True

b. False

24) ______ **Learning about nutrition is not important for athletes because they eat so much food they always get the nutrients their bodies need.**

a. True

b. False

25) ______ **Learning facts about nutrition is the best way to achieve favorable changes in food habits.**

a. True

b. False

26) ______ **Nutritional counseling would only be important to the athlete who is trying to change her weight**

a. True

b. False

Part III: Nutrition Advice

1) ______ **Have you ever looked for dietary advice to increase performance?**

a. Yes

b. No

2) ______ **If you answered yes to part III question 1, where did you look for this advice? (Select all that apply)**

a. Magazines, books
b. Internet
c. Sporting organizations
d. Friends, teammates
e. Parents
f. Coach, trainer

3) ______ **Do you feel you could benefit from advice about nutrition?**

a. Yes
b. No

4) ______ **If you answered yes to part III question 3, what areas do you think you need most information on? (Select all that apply)**

a. Advice on losing weight
b. Game-day dietary advice
c. Advice on gaining weight
d. General healthy eating advice
e. Suitable snacks
f. Recipe, cooking skills
g. Dietary advice for training/practice

5) ______ **How would you like this information to be delivered? (Select all that apply)**

a. Information sheets
b. Internet web site links
c. Information talks/presentations
d. School magazine
e. Group discussions
f. Through coaches

INSTRUCTIONS

- **Think about what you usually ate last month.**
- **Please think about all the fruits and vegetables that you ate last month. Include those that were:**
  - **raw and cooked,**
  - **eaten as snacks and at meals,**
  - **eaten at home and away from home (restaurants, friends, take-out), and**
  - **eaten alone and mixed with other foods.**
- **Report how many times per month, week, or day you ate each food, and if you ate it, how much you usually had.**
- **If you mark "Never" for a question, follow the "Go to" instruction.**
- **Choose the best answer for each question. Mark only one response for each question.**

1. Over the last month, how many times per month, week, or day did you drink **100% juice** such as orange, apple, grape, or grapefruit juice? **Do not count** fruit drinks like Kool-Aid, lemonade, Hi-C, cranberry juice drink, Tang, and Twister. Include juice you drank at all mealtimes and between meals.

○	○	○	○	○	○	○	○	○	○
Never (Go to Question 2)	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 times per day	5 or more times per day

1a. Each time you drank **100% juice**, how much did you usually drink?

○	○	○	○
Less than ¾ cup (less than 6 ounces)	¾ to 1¼ cup (6 to 10 ounces)	1¼ to 2 cups (10 to 16 ounces)	More than 2 cups (more than 16 ounces)

2. Over the last month, how many times per month, week, or day did you eat **fruit**? Count any kind of fruit—fresh, canned, and frozen. **Do not count** juices. Include fruit you ate at all mealtimes and for snacks.

○	○	○	○	○	○	○	○	○	○
Never (Go to Question 3)	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 times per day	5 or more times per day

2a. Each time you ate **fruit**, how much did you usually eat?

○	○	○	○
Less than 1 medium fruit	1 medium fruit	2 medium fruits	More than 2 medium fruits

OR

○	○	○	○
Less than ½ cup	About ½ cup	About 1 cup	More than 1 cup

3. Over the last month, how often did you eat **lettuce salad (with or without other vegetables)**?

○ Never (Go to Question 4)	○ 1-3 times last month	○ 1-2 times per week	○ 3-4 times per week	○ 5-6 times per week	○ 1 time per day	○ 2 times per day	○ 3 times per day	○ 4 times per day	○ 5 or more times per day

3a. Each time you ate **lettuce salad**, how much did you usually eat?

○ About ½ cup	○ About 1 cup	○ About 2 cups	○ More than 2 cups

4. Over the last month, how often did you eat **French fries** or **fried potatoes**?

○ Never (Go to Question 5)	○ 1-3 times last month	○ 1-2 times per week	○ 3-4 times per week	○ 5-6 times per week	○ 1 time per day	○ 2 times per day	○ 3 times per day	○ 4 times per day	○ 5 or more times per day

4a. Each time you ate **French fries** or **fried potatoes**, how much did you usually eat?

○ Small order or less (About 1 cup or less)	○ Medium order (About 1½ cups)	○ Large order (About 2 cups)	○ Super Size order or more (About 3 cups or more)

5. Over the last month, how often did you eat **other white potatoes**? Count **baked, boiled**, and **mashed potatoes, potato salad,** and **white potatoes that were not fried.**

○ Never (Go to Question 6)	○ 1-3 times last month	○ 1-2 times per week	○ 3-4 times per week	○ 5-6 times per week	○ 1 time per day	○ 2 times per day	○ 3 times per day	○ 4 times per day	○ 5 or more times per day

5a. Each time you ate **these potatoes**, how much did you usually eat?

○ 1 small potato or less (½ cup or less)	○ 1 medium potato (½ to 1 cup)	○ 1 large potato (1 to 1½ cups)	○ 2 medium potatoes or more (1½ cups or more)

6. Over the last month, how often did you eat **cooked dried beans**? Count **baked beans, bean soup, refried beans, pork and beans** and **other bean dishes.**

○ Never (Go to Question 7)	○ 1-3 times last month	○ 1-2 times per week	○ 3-4 times per week	○ 5-6 times per week	○ 1 time per day	○ 2 times per day	○ 3 times per day	○ 4 times per day	○ 5 or more times per day

6a. Each time you ate **these beans**, how much did you usually eat?

○ Less than ½ cup	○ ½ to 1 cup	○ 1 to 1½ cups	○ More than 1½ cups

7. Over the last month, how often did you eat **other vegetables**?

DO NOT COUNT:
- Lettuce salads
- White potatoes
- Cooked dried beans
- Vegetables in mixtures, such as in sandwiches, omelets, casseroles, Mexican dishes, stews, stir-fry, soups, etc.
- Rice

COUNT:
- All other vegetables—raw, cooked, canned, and frozen

○	○	○	○	○	○	○	○	○	○
Never (Go to Question 8)	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 times per day	5 or more times per day

7a. Each of these times that you ate **other vegetables**, how much did you usually eat?

○	○	○	○
Less than ½ cup	½ to 1 cup	1 to 2 cups	More than 2 cups

8. Over the last month, how often did you eat **tomato sauce**? Include tomato sauce on pasta or macaroni, rice, pizza and other dishes.

○	○	○	○	○	○	○	○	○	○
Never (Go to Question 9)	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 times per day	5 or more times per day

8a. Each time you ate **tomato sauce**, how much did you usually eat?

○	○	○	○
About ¼ cup	About ½ cup	About 1 cup	More than 1 cup

9. Over the last month, how often did you eat **vegetable soups**? Include tomato soup, gazpacho, beef with vegetable soup, minestrone soup, and other soups made with vegetables.

○	○	○	○	○	○	○	○	○	○
Never (Go to Question 10)	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 times per day	5 or more times per day

9a. Each time you ate **vegetable soup**, how much did you usually eat?

○	○	○	○
Less than 1 cup	1 to 2 cups	2 to 3 cups	More than 3 cups

10. Over the last month, how often did you eat **mixtures that included vegetables**? Count such foods as sandwiches, casseroles, stews, stir-fry, omelets, and tacos.

○	○	○	○	○	○	○	○	○	○
Never	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 times per day	5 or more times per day

Thank you for taking the survey!!!

Post Nutrition Education Survey

Name: ______________________________

Date: ______________________________

Email: ______________________________

Research Assistant: Aaron Schwartz

Instructions

Please read each question carefully and, to the best of your ability, answer each one honestly and with what you believe to be is the correct answer. Please only select **one** answer for each question unless otherwise indicated.

Part I: Demographics

1) ______ **How old are you?**

2) ______ **What is your ethnic background?**

   a. White / Caucasian
   b. Hispanic / Latino
   c. Asian
   d. Native Hawaiian / Other Pacific Islander
   e. Black / African American
   f. American Indian / Alaska Native
   g. Other

Part II: Nutrition Knowledge

1) ______ **The main energy source for the athlete is:**

   a. Carbohydrates
   b. Proteins
   c. Fats
   d. Don't know

2) ______ **The best "healthy fat" is:**

a. Butter
b. Margarine
c. Olive oil
d. Don't know

3) ______ **Fruits are important because they supply:**

a. Fats
b. Proteins
c. Vitamins
d. Don't know

4) ______ **How many cups of fruit are needed daily for boys aged 14-18 years old?**

a. 1 cup
b. 2 cups
c. 3 cups
d. 4 cups

5) ______ **How many cups of vegetables are needed daily for boys aged 14-18 years old?**

a. 1 cup
b. 2 cups
c. 3 cups
d. 4 cups

6) ______ **Fresh, frozen, and canned vegetables all have similar nutrient values**

a. True
b. False

7) ______ **Nutrients can be destroyed if vegetables are overcooked.**

a. True
b. False

8) ______ **How do you rate the importance of what you eat and drink to your performance?**

a. Very Important
b. Important
c. Of some importance
d. Of no importance
e. Not sure

9) ______ **During exercise last longer than 1 hour, sport drinks are better than water (e.g. PowerAde and Gatorade)**

a. True
b. False

10) ______ **During activity, thirst is an adequate guide to the need of fluids**

a. True
b. False

11) ______ **Dehydration can reduce performance.**

a. True
b. False

12) ______ **An athlete should drink no water during practice, but rather rinse out his/her mouth or suck on ice cubes.**

a. True
b. False

13) ______ **It is better to get vitamins and minerals from supplements than from foods.**

a. True
b. False

14) ______ **Foods such as potatoes and honey are best eaten after exercise.**

a. True
b. False

15) ______ **Protein is the primary source of muscular energy for the athlete.**

a. True

b. False

16) ______ **No more than 15% of calories in the diet should be provided by fat.**

a. True

b. False

17) ______ **During exercise, mass ingestion of large amounts of fluid is preferred over frequent ingestion of small amounts.**

a. True

b. False

18) ______ **A muscular person expends more energy at rest than a non-muscular person of the same age, sex and weight.**

a. True

b. False

19) ______ **A sound nutritional practice for athletes is to eat a wide variety of different food types from day to day.**

a. True

b. False

20) ______ **The type of food an athlete eats affects his/her performance**

a. True

b. False

21) ______ **What the athlete eats is only important if the athlete is trying to gain or lose weight.**

a. True

b. False

22) ______ **Nutrition is more important during the competitive season than during the off-season for the athlete.**

a. True

b. False

23) ______ **Food advertisements are a very reliable source of nutritional information.**

a. True

b. False

24) ______ **Learning about nutrition is not important for athletes because they eat so much food they always get the nutrients their bodies need.**

a. True

b. False

25) ______ **Learning facts about nutrition is the best way to achieve favorable changes in food habits.**

a. True

b. False

26) ______ **Nutritional counseling would only be important to the athlete who is trying to change her weight**

a. True

b. False

Part III: Nutrition Advice

1) ______ **Have you ever looked for dietary advice to increase performance?**

a. Yes

b. No

2) ______ **If you answered yes to part III question 1, where did you look for this advice? (Select all that apply)**

a. Magazines, books
b. Internet
c. Sporting organizations
d. Friends, teammates
e. Parents
f. Coach, trainer

3) ______ **Do you feel you could benefit from advice about nutrition?**

a. Yes
b. No

4) ______ **If you answered yes to part III question 3, what areas do you think you need most information on? (Select all that apply)**

a. Advice on losing weight
b. Game-day dietary advice
c. Advice on gaining weight
d. General healthy eating advice
e. Suitable snacks
f. Recipe, cooking skills
g. Dietary advice for training/practice

5) ______ **How would you like this information to be delivered? (Select all that apply)**

a. Information sheets
b. Internet web site links
c. Information talks/presentations
d. School magazine
e. Group discussions
f. Through coaches

Part IV: Perceived Performance

1) ______ **After receiving nutrition education, I am eating better.**
   a. True
   b. False

2) ______ **After receiving nutrition education, I believe I am performing better at my sport.**
   a. True
   b. False

3) ______ **After receiving nutrition education, I feel better during sport activities.**
   a. True
   b. False

INSTRUCTIONS

- **Think about what you usually ate last month.**
- **Please think about all the fruits and vegetables that you ate last month. Include those that were:**
  - **raw and cooked,**
  - **eaten as snacks and at meals,**
  - **eaten at home and away from home (restaurants, friends, take-out), and**
  - **eaten alone and mixed with other foods.**
- **Report how many times per month, week, or day you ate each food, and if you ate it, how much you usually had.**
- **If you mark "Never" for a question, follow the "Go to" instruction.**
- **Choose the best answer for each question. Mark only one response for each question.**

1. Over the last month, how many times per month, week, or day did you drink **100% juice** such as orange, apple, grape, or grapefruit juice? **Do not count** fruit drinks like Kool-Aid, lemonade, Hi-C, cranberry juice drink, Tang, and Twister. Include juice you drank at all mealtimes and between meals.

○	○	○	○	○	○	○	○	○	○
Never (Go to Question 2)	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 times per day	5 or more times per day

1a. Each time you drank **100% juice**, how much did you usually drink?

○	○	○	○
Less than ¾ cup (less than 6 ounces)	¾ to 1¼ cup (6 to 10 ounces)	1¼ to 2 cups (10 to 16 ounces)	More than 2 cups (more than 16 ounces)

2. Over the last month, how many times per month, week, or day did you eat **fruit**? Count any kind of fruit—fresh, canned, and frozen. **Do not count** juices. Include fruit you ate at all mealtimes and for snacks.

○	○	○	○	○	○	○	○	○	○
Never (Go to Question 3)	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 times per day	5 or more times per day

2a. Each time you ate **fruit**, how much did you usually eat?

○	○	○	○
Less than 1 medium fruit	1 medium fruit	2 medium fruits	More than 2 medium fruits

OR

○	○	○	○
Less than ½ cup	About ½ cup	About 1 cup	More than 1 cup

3. Over the last month, how often did you eat **lettuce salad (with or without other vegetables)**?

◯ Never (Go to Question 4)	◯ 1-3 times last month	◯ 1-2 times per week	◯ 3-4 times per week	◯ 5-6 times per week	◯ 1 time per day	◯ 2 times per day	◯ 3 times per day	◯ 4 times per day	◯ 5 or more times per day

3a. Each time you ate **lettuce salad**, how much did you usually eat?

◯ About ½ cup	◯ About 1 cup	◯ About 2 cups	◯ More than 2 cups

4. Over the last month, how often did you eat **French fries** or **fried potatoes**?

◯ Never (Go to Question 5)	◯ 1-3 times last month	◯ 1-2 times per week	◯ 3-4 times per week	◯ 5-6 times per week	◯ 1 time per day	◯ 2 times per day	◯ 3 times per day	◯ 4 times per day	◯ 5 or more times per day

4a. Each time you ate **French fries** or **fried potatoes**, how much did you usually eat?

◯ Small order or less (About 1 cup or less)	◯ Medium order (About 1½ cups)	◯ Large order (About 2 cups)	◯ Super Size order or more (About 3 cups or more)

5. Over the last month, how often did you eat **other white potatoes**? Count **baked, boiled**, and **mashed potatoes, potato salad,** and **white potatoes that were not fried.**

◯ Never (Go to Question 6)	◯ 1-3 times last month	◯ 1-2 times per week	◯ 3-4 times per week	◯ 5-6 times per week	◯ 1 time per day	◯ 2 times per day	◯ 3 times per day	◯ 4 times per day	◯ 5 or more times per day

5a. Each time you ate **these potatoes**, how much did you usually eat?

◯ 1 small potato or less (½ cup or less)	◯ 1 medium potato (½ to 1 cup)	◯ 1 large potato (1 to 1½ cups)	◯ 2 medium potatoes or more (1½ cups or more)

6. Over the last month, how often did you eat **cooked dried beans**? Count **baked beans, bean soup, refried beans, pork and beans** and **other bean dishes.**

◯ Never (Go to Question 7)	◯ 1-3 times last month	◯ 1-2 times per week	◯ 3-4 times per week	◯ 5-6 times per week	◯ 1 time per day	◯ 2 times per day	◯ 3 times per day	◯ 4 times per day	◯ 5 or more times per day

6a. Each time you ate **these beans**, how much did you usually eat?

◯ Less than ½ cup	◯ ½ to 1 cup	◯ 1 to 1½ cups	◯ More than 1½ cups

7. Over the last month, how often did you eat **other vegetables**?

DO NOT COUNT:
- Lettuce salads
- White potatoes
- Cooked dried beans
- Vegetables in mixtures, such as in sandwiches, omelets, casseroles, Mexican dishes, stews, stir-fry, soups, etc.
- Rice

COUNT:
- All other vegetables—raw, cooked, canned, and frozen

○ Never (Go to Question 8) ○ 1-3 times last month ○ 1-2 times per week ○ 3-4 times per week ○ 5-6 times per week ○ 1 time per day ○ 2 times per day ○ 3 times per day ○ 4 times per day ○ 5 or more times per day

7a. Each of these times that you ate **other vegetables**, how much did you usually eat?

○ Less than ½ cup ○ ½ to 1 cup ○ 1 to 2 cups ○ More than 2 cups

8. Over the last month, how often did you eat **tomato sauce**? Include tomato sauce on pasta or macaroni, rice, pizza and other dishes.

○ Never (Go to Question 9) ○ 1-3 times last month ○ 1-2 times per week ○ 3-4 times per week ○ 5-6 times per week ○ 1 time per day ○ 2 times per day ○ 3 times per day ○ 4 times per day ○ 5 or more times per day

8a. Each time you ate **tomato sauce**, how much did you usually eat?

○ About ¼ cup ○ About ½ cup ○ About 1 cup ○ More than 1 cup

9. Over the last month, how often did you eat **vegetable soups**? Include tomato soup, gazpacho, beef with vegetable soup, minestrone soup, and other soups made with vegetables.

○ Never (Go to Question 10) ○ 1-3 times last month ○ 1-2 times per week ○ 3-4 times per week ○ 5-6 times per week ○ 1 time per day ○ 2 times per day ○ 3 times per day ○ 4 times per day ○ 5 or more times per day

9a. Each time you ate **vegetable soup**, how much did you usually eat?

○ Less than 1 cup ○ 1 to 2 cups ○ 2 to 3 cups ○ More than 3 cups

10. Over the last month, how often did you eat **mixtures that included vegetables**? Count such foods as sandwiches, casseroles, stews, stir-fry, omelets, and tacos.

○ Never ○ 1-3 times last month ○ 1-2 times per week ○ 3-4 times per week ○ 5-6 times per week ○ 1 time per day ○ 2 times per day ○ 3 times per day ○ 4 times per day ○ 5 or more times per day

Thank you for taking the survey!!!

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