NUTRITION KNOWLEDGE AND EATING BEHAVIORS OF NCAA DIVISION IA COLLEGIATE ATHLETES

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CHAPTER I

INTRODUCTION

Each year in the United States the level of athletic competition continually grows. The athletes who compete are often instructed by a combination of coaches, trainers, strength and conditioning specialists, and team physicians in order to reach their genetic potential and enhance athletic performance. They are being trained with advanced techniques and machines to compete at high levels. Collegiate athletics require one of the highest levels of competitive performance.

College athletes are willing to sacrifice their time and bodies to attain self-determined goals. Along with their coaches' expectations, these goals are generally set to achieve success on the playing field or court. Reaching these goals depends not only on how the athletes train, but also on what food nutrients they consume.

Background

Aside from the limits imposed by heredity and training, no single factor plays a greater importance in optimizing performance than diet [1]. An athlete's dietary needs are principally determined by their body mass and training load. Training load consists of intensity, frequency, and duration of daily workouts. Scientific investigations have associated energy requirements, composition of the diet, and intake of proper fluids with optimal athletic performance [2,3].

Many athletes incur extremely high-energy requirements due to their large body size, periods of growth and muscular development, training intensity and frequency, or a combination of these factors [4]. If energy expenditure is not matched by increased energy consumption, the athlete's training capacity will be compromised by a loss in body mass. Energy intakes of greater than 50 calories per kilogram of body weight per day for male athletes who train for greater than 90 minutes per day and 45-50 calories per kilogram of body weight per day for female athletes who train for greater than 90 minutes per day has been recommended [5].

Athletes have many misconceptions about ideal body mass and body composition, and about safe long-term methods of reducing body fat levels [6]. Athletes in endurance sports, weight classification sports, or appearance sports are most often at increased risk for eating disorders based on self-perception of body composition [7]. The consequences of trying to maintain low body fat levels and chronically low energy intakes may include metabolic adaptations, menstrual disturbances, loss of performance, and inadequate nutrient intake [8,9]. A combination of these consequences can result in the female athlete triad syndrome, which is defined as the interrelation of eating disorders, amenorrhea, and osteoporosis. This is most common in distance runners [10].

For most running and jumping sports, excess body fat is a disadvantage in accordance with Newton's second law of motion (force = mass x acceleration), whereas for throwing and strength sports, increased body mass in the form of muscle may be advantageous because of increased power potential. Most athletes attempt to optimize body composition specific to their sport through functional exercise and dietary regimens. However, many factors inhibit the achievement of sound nutrition practices by an athlete. These factors may include: a poor understanding of sports nutrition principles (reliance on myths and misconceptions); a failure to recognize their individual nutrition requirements (based on sport, training, age, sex, and body type); conflict of nutrition goals (achieving increased macro and micro nutrient requirements while trying to lose body fat); lack of nutrition knowledge and skills (food composition, food purchasing, and food preparation); over committed lifestyle (inadequate time and opportunities to obtain or consume foods); inadequate finances; and challenges associated with team travel [8].

With the pressures of obtaining optimal performance and the associated nutrition concerns, many athletes turn to coaches, nutritionists, trainers, strength and conditioning coordinators, physicians, parents, and even friends for advice and direction. Research [11] indicates that coaches are very influential for giving nutrition information and shaping the eating attitudes of athletes, despite the fact that 61% of these coaches have had no formal nutrition training [12]. Several past surveys have recommended focusing on nutrition education for either athletes or coaches [12,13,14,15,16,17]. Research has indicated that people who are educated in basic nutrition concepts and principles are more likely to apply such knowledge [18].

Many coaches now realize the importance of a nutrition specialist that has a background in sports nutrition, eating habits, eating disorders, weight management, and supplementation. A specific example of a strong nutrition program at the collegiate level that has nutritionists integrated into optimizing athletic performance is Penn State University (NCAA Division IA athletics) [19].

Most of the sports nutrition authorities agree that a balanced diet will supply the necessary macro and micronutrients for most athletes to obtain adequate nutrition status. Adequate nutrition status means sufficiency of ingested food products to permit cells, tissues, organs, anatomical systems, of the athlete to perform optimally their intended function. Nutrition status effects work capacity, endurance, VO2 max, and submaximal VO2 [9]. The following paragraphs will introduce the nutritional background of a well balanced diet, which includes macronutrients (carbohydrate, protein, fat); micronutrients (vitamins and minerals); water (fluid replacement); and to many athletes, sports supplementation (ergogenic aids).

Macronutrients

All movement in athletics is dependent upon the contraction of skeletal muscle to provide the pulling force to move bony segments. Skeletal muscles derive energy for muscle contraction from adenosine triphosphate (ATP). A consistent supply of ATP is generated through the metabolism of carbohydrate, fat, and protein that is ingested by the athlete. The most important nutrient that the athlete can consume is carbohydrate [1]. Carbohydrate is the athlete's first fuel source for many anaerobic and aerobic activities.

Dietary carbohydrates are converted to glucose, which circulates in the blood. Blood glucose has several alternative fates depending on specific energy needs of the athlete. Glucose may enter the glycolytic pathways, where it is metabolized to produce ATP energy. If the athlete is performing an activity in which oxygen demand is greater than oxygen supply (ex. 400-meter race), the blood glucose will go through anaerobic glycolysis. If the athlete is performing an activity in which oxygen supply is greater than or equal to oxygen demand (ex. jogging for 20 minutes), the blood glucose will go through aerobic glycolysis to produce energy for this activity. Blood glucose can also be stored in the liver and muscles as glycogen, or it can be converted to fat and stored as adipose tissue.

Consuming foods that contain mainly carbohydrate provides substrate to refuel the athlete's glycogen stores in muscle and liver, and helps to decrease fat intakes. Athletes can then match their energy intakes to their expenditure in order to control their body mass [20]. Factors that influence the rate of muscle glycogen resynthesis include the timing, amount, and type of carbohydrate ingested and the amount of muscle damage [21].

A lack of adequate muscle glycogen has been shown to limit endurance capacity of athletes [22,23,24,25]. Athletes must replenish their muscle glycogen stores daily to prevent progressive glycogen depletion [25]. As mentioned above, glycogen resynthesis depends on a daily high carbohydrate diet of 500-600 grams per day and the timing of carbohydrate consumption post exercise [4,26]. Most exercise scientists agree that carbohydrates should compose 50-60% of an athletes total energy intake per day [1,3,5,20,21,27,28,29,30,31,32,33,34].

Specific recommendations have been made for energy intake of carbohydrate and protein. Some researchers feel that the recommendation of carbohydrate intake per day should be extended to include the quantity of carbohydrate in grams per kilogram of body weight [20,21,35]. For example, several studies have indicated that the daily training diet for athletes should include seven to ten grams of carbohydrate per kilogram of body weight [3,21,36]. With this recommendation, heavy athletes would not consume excessive amounts of carbohydrate per day that would be stored as fat and/or limit intake of other nutrients.

The goals of pre-exercise nutrition are to optimize muscle and liver glycogen stores; avoid gastrointestinal discomfort during exercise; and avoid an increase in plasma insulin concentrations that results in hypoglycemia (low blood sugar). fatigue, and light headedness in susceptible individuals [4,11]. According to several reports, three to four grams of carbohydrate per kilogram of body weight should be consumed three to four hours before exercise to promote carbohydrate utilization and improve performance [37,38,39]. Warnings to avoid carbohydrate intake during the hour before endurance exercise have become part of sports nutrition belief because of the supposed pronounced elevation in plasma glucose and insulin concentrations at the onset of exercise [36,40]. However, a review of the literature reveals that these are the only two studies to find reductions in performance capacity after the ingestion of carbohydrate in the hour before exercise [4].

Recent studies have shown that drinking a carbohydrate-electrolyte solution immediately before and during prolonged moderate intensity exercise can improve endurance capacity with no hypoglycemia or associated onset of fatigue [21,41,42,43,44,45,46,47]. The extent to which foods increase blood glucose is determined by gastric emptying time and the physical properties of the carbohydrate ingested. A glycemic index of glucose responses of numerous carbohydrate foods has been developed [48]. Glycemic index refers to the rate at which the ingested carbohydrate is made available to intestinal enzymes for hydrolysis and intestinal absorption [5].

Several studies have indicated that during the post exercise recovery phase of training, foods with a low glycemic index (complex carbohydrate) may not promote glycogen storage as efficiently as those with a high glycemic index (simple carbohydrate) [49,50,51]. However, two studies in the post exercise recovery phase of training have indicated that both high and low glycemic index foods appear to be equally efficient in providing substrate for muscle glycogen synthesis [52,53].

In a duration comparison study of an 80% carbohydrate diet and a 43% carbohydrate diet for maintaining strenuous swim training [54], the researchers reported no advantage of the 80% diet. These results suggest that the dietary recommendations of carbohydrate intake be expressed as a daily amount of carbohydrate relative to body weight, rather than as a percentage of energy from carbohydrate. A sport specific study on university soccer players [55], demonstrated the need for proper amounts of carbohydrate in the diet. Players ate high (10 grams per kilogram body weight) or normal (five grams per kilogram body weight) carbohydrate diets of equal energy density during a 22 hour recovery period between two 90 minute tests of endurance capacity; involving intermittent running, sprinting, and walking. The high carbohydrate diet soccer players were able to run for approximately three minutes longer than the day before. However, they were unable to match their previous day's performance when they maintained their normal carbohydrate intake.

According to the ACSM, exercise that lasts longer than one hour and/or is performed in high temperature and humidity warrants consumption of a sports drink that is six to eight percent carbohydrate [56]. In a related study [57], it was reported that consuming a seven percent carbohydrate solution at a rate of approximately 50 grams per hour during a 90 minute period of high intensity intermittent running, reduced muscle glycogen utilization. According to two researchers [58], 40-75 grams of carbohydrate per hour should be consumed during competition to improve endurance running capacity and performance. Several studies and researchers have reported the importance of acute supplementation of the normal diets of trained athletes with carbohydrate immediately after exercise to promote restoration of muscle glycogen and improve performance in future exercise bouts [20,59,60,61]. It appears that with the exception of fructose, all other types of carbohydrate (glucose, sucrose, and polymers), on their own or in mixtures that can include fructose, have the potential to reduce muscle glycogen utilization during exercise and improve exercise performance [62,63,64].

Protein consumption in the athlete's diet is important because it provides eight essential amino acids and additional nitrogen for the production of non-protein compounds such as nucleotides and hormones, and for the synthesis of nonessential amino acids. After protein digestion is complete, amino acids are then stored in muscles, liver, and blood. Amino acids can be removed from these sites (catabolized) for ATP energy (endurance activity), stored as fat, utilized for protein synthesis (muscle fiber repair and growth), or contributed to non-protein nitrogen needs of the body [65]. The rate of protein metabolism is influenced by intensity, duration, and type of exercise; the training environment; the carbohydrate content of the diet; and age and gender of the athlete [27,66]. Athletes tend to need more protein than sedentary people because of increased conversion of protein to glucose (gluconeogenesis), increased muscle breakdown from strenuous activity, and increased amino acid oxidation.

The current recommended daily allowance (RDA) for protein is based primarily on data derived from sedentary subjects. Well-designed studies using advanced technology (metabolic tracer technique) indicate that protein needs should be increased for those who exercise regularly [67]. Research supports the recommendation that endurance athletes need protein in excess of the RDA (O.8 grams per kilogram body weight), in order to promote maintenance of lean body mass due to increased protein breakdown and/or a decrease in protein synthesis [66,68,69,70,71,72]. Those who engage in endurance exercise need protein as an auxiliary fuel source and athletes who engage in strength training need protein/amino acids to be used as building blocks for muscle development.

Several researchers agree that the range of protein required for strength, speed, and endurance athletes is between one and two grams per kilogram of body weight [20,28,67,73,74,75], or 12-15% of the total energy intake per day [3,5,20,21,27,28,29,30]. For example, to build one pound of lean tissue, an athlete must consume approximately 98 grams of protein and 2800 calories in addition to normal energy balance intake to synthesize muscle [76]. Most athletes due consume adequate amounts of protein per day; however, some groups could benefit from protein supplementation in their daily diets. These groups include those with low protein diets; low calorie intake; and those with high energy output such as: wrestlers, swimmers, gymnasts, and cross-country runners [67].

It is important to individualize protein recommendations for the athlete based on training demands, calorie intake, and special requirements [65]. Sufficient attention has not been paid to the changes in protein requirements of female athletes and those who are injured or ill. In addition, very little information is available to develop nutritional strategies on the type and timing of protein intake as a means of enhancing the performance of athletes [20].

Previously, amino acid supplements were thought to possibly stimulate human growth hormone and insulin, which could offset the protein degradation that occurs during illness and injury [77,78,79,80]. A recent review of five studies that collectively indicated supplements of several amino acids reported no significant effect on human growth hormone secretion or measures of muscular development for experienced weightlifters in training [81]. A strong comparison between supplementary protein powders and protein from food sources has been made [82]. Joe Weider's Dynamic Protein Shake provides only 16 grams of protein per serving (three tablespoons), while a three ounce serving of light tuna in spring water provides 25 grams of protein.

High doses of protein powders and amino acids have been reported to have harmful side effects, such as nausea, dizziness, stomach pain, dehydration, gout, liver and kidney damage, and calcium loss [83,84,85]. In addition, several researchers agree that no scientific evidence exists to support the notion that increasing protein intake through supplementation with protein powders and amino acids will enhance metabolic efficiency and increase muscle mass [19,85,87].

Fat plays an important role in energy production, membranes of cells, neural tissue, and general health [20]. Dietary fat carries the fat-soluble vitamins A, D, E, and K [11]. Fat is an essential energy source, particularly when exercise continues beyond twenty minutes. Body fat (adipose tissue) is comprised of triglycerides, the storage form of fat, and it is an excellent source of stored energy. One kilogram of body fat (adipose tissue) is sufficient to supply energy for approximately 10-20 hours of low to moderate exercise intensity [88].

The use of fat as an energy fuel for activity depends on the duration and intensity of exercise. Fat becomes a fuel source to provide ATP for energy production when the energy used by the body exceeds the amount consumed in food. As duration increases, and intensity decreases, fat is increasingly used as the preferred fuel source by the human body.

Lipolysis is the breakdown of adipose tissue into free fatty acids and glycerol. Lipolysis can be increased by epinephrine, available albumin carriers, and training levels or decreased by high insulin and lactate levels in the blood [65]. During prolonged exercise, there is an increase in the contribution of fatty acids and triglyceride stores for muscle metabolism, with an associated decrease in glucose contribution [89,90,91]. Several exercise scientists have recommended that fat consumption should be limited to 25-30% of the total energy intake per day of athletes [3,5,20,21,27,28,29,30,34,36,92]. A higher fat content in the diet has been linked to many health problems (heart disease, stroke); as well as reduced endurance [27].

Micronutrients

Vitamins and minerals are important in the well balanced diet of the athlete to promote optimal physical performance. Vitamins and minerals cannot be synthesized within the body and they must be supplied by the diet. Adequate intakes of vitamins and minerals are very important for the chemical reactions of metabolism (ex. glycolysis, lipolysis, enzymatic activity); maintaining vital functions; and body tissue structure [93]. Inadequate intake of various vitamins and minerals has been associated with restricted energy intake, fad diets, vegetarian eating, and intolerance to certain food [8].

Deficiencies of vitamins and minerals have been linked to cardiovascular disease, cancer, anemia, and osteoporosis. Recommended daily allowances (RDAs) for vitamins and minerals have been established by the Food and Nutrition Board-National Research

Council of the National Academy of Sciences. The RDAs are reference points and certain health conditions or training loads can increase or decrease need [28].

The speculations concerning micronutrients and enhanced sports performance have increased athlete's use of vitamin and mineral supplement [9]. Vitamins and minerals play very important roles in energy metabolism and their presence in acceptable levels in the human body is required for optimal physical performance. Deficiency of several vitamins for only four weeks has been shown to impair aerobic capacity and decrease anaerobic threshold [94]. Several studies have shown that indices of the minerals magnesium, zinc, copper, and iron status are related to decreased physical performance [76,93,95]. For example, iron-deficiency anemia has been shown to impair aerobic performance of athletes [96].

Physical activity has shown to increase the rate at which minerals are excreted during exercise from sweat and urine [93]. For example, several researchers have found that magnesium levels in all female athletes is only about 65% of the RDA and only 30-50% in all athletes that participate in weight restricted sports [96,97]. Magnesium is very important in enzymatic reactions, membrane stability, and immune function [93]. In a study of collegiate swimmers [95], biochemical indices of iron status were significant predictors of 100-yard freestyle times and swimming performance. In addition, daily intakes of copper, magnesium, and zinc were significant independent predictors of swim performance.

Previous surveys have found that vitamin supplements were the most common type of dietary manipulation by athletes for the purpose of enhancing performance [2,17,98]. According to several reports [9,29,84,85,99], supplementation with vitamins and minerals in excess of recommended daily allowances appears to have no effect on muscle mass or athletic performance. Two separate authors [5,28], agree that if athletes are not able to meet their vitamin and mineral needs from their diets, supplementation at safe levels (less than or equal to 100% of the RDA), may be required. In related studies [100,101,102], supplementation with magnesium and iron in athletes with depleted mineral status has been reported to improve VO2 max; increase exercise time to exhaustion; improve cellular metabolism; and improve strength and power.

Excessive intake of the fat-soluble vitamins (A, D, E, and K) can be dangerous because these vitamins are stored in the body in potentially toxic amounts. For example, excessive supplementation with Vitamin E can result in weakness, fatigue, headache, nausea, and diarrhea [85]. In double-blind, placebo-controlled studies of vitamin supplementation, indicators of vitamin status in blood were improved, but aerobic fitness was not affected [103,104,105].

Water

Water constitutes 60% of the total body weight and 70% of the muscle mass [106]. Several researchers [11,65], consider water as the most necessary nutrient for the body. Water is important for the metabolism of macronutrients, delivery of fuel sources to cells, muscle contraction, and riding the body of cellular waste products. At the 1991 Consensus Conference on Foods, Nutrition, and Sports Performance, the clear message was that athletes underestimate the importance of fluid replacement and the detrimental influences on performance of even mild dehydration [20]. Practices that promote dehydration (fluid restriction, diuretics, laxatives, and salt tablets), may impair electrolyte balance and have serious consequences on vital functions and athletic performance [56,107].

Sweat losses during intense exercise varies between athletes and environmental condition. The associated fluid losses from exercise can be up to one to two liters per hour. Several factors can contribute to dehydration such as: poor access to fluid during and after training sessions; gastrointestinal discomfort from fluid intake; and a coach or instructor limiting water breaks [8]. Fluid replacement is for the most part a behavioral issue. For example, it has been shown that the practice of some distance runners of not drinking fluids during competition can promote dehydration and nervous system dysfunction [76].

Dehydration is a serious concern in the athlete, since it may result in impaired exercise capacity, muscle cramping, inability to regulate body temperature, hallucinations, or heat stroke [8,108,109,110]. Fluid replacement should occur before, during, and after exercise in order to prevent dehydration [8,65]. Thirst is not a good guide to sweat losses and state of dehydration. A fluid replacement protocol is essential to prevent dehydration and heat injury [5,28,65]. Drinking to thirst will only replace 50-60% of fluid loss [65]. Each successive day of training without adequate hydration can place the athlete into further fluid deficit. The athlete should be weighed before and after each exercise bout. For each pound of body weight lost, one to two cups of fluid should be consumed to maintain fluid balance [5,65]. Fluid should be available during all times of athletic events [56,65,107].

One exercise scientist suggests that athletes drink 120-240 milliliters of non-caffeinated fluid every 15 minutes for the hour prior to exercise and during the exercise event [28]. Another scientist recommends 300-500 milliliters of fluid consumption 30 minutes before exercise and 500-1000 milliliters per hour during competition [5].

Sports Supplementation

As nutrition technology has advanced, scientists have been able to synthesize and manufacture all known nutrients, and many of their metabolic by-products essential to human physiology. These manufactured nutrients and products are called nutritional supplements or ergogenic aids. The nutritional supplements have been theorized to improve athletic performance primarily by enhancing energy efficiency, energy control, or energy production [86,111]. Athletes often resort to the use of nutritional supplements for improving athletic performance when they believe that their training and genetics have been maximized.

Promotions and advertisements of sports supplements have resulted in hundreds of millions of dollars in retail sales by nutritional supplement companies in the United States [98]. Media hype and poorly interpreted research by supplement companies have prompted misinformation and improper nutritional guidance to athletes [112]. Advertisements are designed in word and picture to appeal to the competitive psyche of the athlete. For example, these nutrition products claim to conserve energy, build muscle mass, increase endurance, develop strength, and refuel the body.

Some examples of the various terms and product names used are: anabolic stack, sterols, growth hormone releasers, body lean, anabolic cycle, megamass, super juice, chromium, ultimate orange, carbo fuel, betagen, hmb, creatine, EAS, Champion Nutrition, Sportspharma, Advocare, Twin Lab, and Peak Nutrition. A survey of nutritional supplements in health and body building magazines found 89 brands, 311 products, and 235 unique ingredients [113]. According to one researcher [17], the abundance of nutritional supplement advertisements in magazines associated with athletics share in the responsibility for current nutritional beliefs and supplement use.

Star athletes, coaches, and trainers offer glowing testimonials for big time money. Reference is made to "scientific studies" supporting the claims of ergogenic potential, but details are rarely provided. Only supporting study results are shown. Flaws in the design of the study and follow-up studies are never shown [84]. According to one researcher, studies fail to show that the manipulation of existing nutritional recommendations, such as excessive protein, can enhance physical efficiency [114]. Many of the nutritional supplements are theorized to possess ergogenic potential when taken in quantities or forms normally not found in typical foods or diets [115].

The Food and Drug Administration has not approved the safety of many products sold in health food and nutrition stores, and has not substantiated the claims made on them [83]. Although research is limited in most cases of supplementation, several researchers feel that some reliable scientific data support the ergogenic efficacy of several substances, such as creatine [86,115]. However, they also state that additional research is needed to evaluate supplements and their potential for enhancing performance in specific athletic events. One author goes on to state that such nutrients consumed in the body may function as drugs [115].

The mechanism by which supplementary creatine could have potential ergogenic effects would be an increased muscle creatine and phosphocreatine concentration, leading to a higher rate of ATP resynthesis, a delay in the onset of muscular fatigue, and a facilitated recovery during repeated bouts of high-intensity exercise. Creatine supplementation has been reported to increase body mass by increasing total muscle creatine content, synthesis of contractile proteins [116], or through greater water retention [117]. However, additional research is needed to define the cause of compartmentalization of the weight gain [86,117]. The available research is somewhat supportive of an ergogenic effect for creatine supplementation in events characterized by repeated bouts of high-intensity exercise with an adequate recovery period [117,118]. However, the results of the available research on other types of performance are somewhat inconsistent [119,120].

Caffeine is a stimulant drug found naturally in some foods and beverages that humans consume. The ergogenic effect of caffeine is related to its stimulant properties, either acting directly on cell functions or indirectly by increasing the release of adrenaline from the adrenal medulla [86]. Human research has shown that caffeine may enhance muscle contraction and serve as an effective ergogenic aid to increased aerobic endurance performance [86,121,122,123,124], however, more research is warranted. Several studies have reported enhanced performance in swimming and treadmill runs following consumption of caffeine in moderate dosage (250-350mg) [125]. Also, caffeine has been reported to increase energy expenditure and enhance fat oxidation during exercise [126,127].

Sodium bicarbonate is an alkaline salt found naturally in the body and its concentration in blood is referred to as the alkaline reserve. It is one of the first mechanisms to buffer lactic acid during high intensity anaerobic exercise. Recent scientific reviews [128,129,130], have all concluded that sodium bicarbonate, in doses approximately 300mg per kilogram of body weight, is an effective ergogenic aid in events that may depend primarily on the lactic acid energy system (anaerobic glycolysis).

In summation, several scientific reviews have all found that the existing data are inconsistent, and insufficient to state unequivocally that the following ergogenic aids improve athletic performance: high fat diets, amino acids, carnitine, boron, chromium, omega-3 fatty acids, plant extracts, diuretics, choline, ginsengs, inosine, and aspartates [86,111,131].

Collegiate athletes can become very confused with all differences between macronutrients, micronutrients, and sports supplements. Professionals, such as trainers, strength and conditioning coordinators, sports physicians, nutritionists, and coaches need to be educated in the areas of sports nutrition, current nutrition knowledge, and eating behaviors of the collegiate athletes they work for and with. It has been suggested that coaches be required to take formal nutrition courses [17,132]. Further recommendation was for strength and conditioning coordinators to be required formal nutrition training in college courses and workshops, and that a process be developed to ascertain this knowledge by certification criteria [132]. Also, it was recommended that measures be taken to educate athletes about nutritional supplements [17].

Several researchers suggested methods to improve nutritional development of athletes. A nutrition care plan was recommended for each athlete [65]. The foundation of this plan was a nutrition eating assessment, determination of energy needs based on weight goals and demands of training, and consideration of psychological factors that relate to eating patterns. Promoting educational strategies that focus on practical areas of food choice, preparation, and guidelines that can address a number of key nutrition issues at once have been advised [8,73]. Lists of nutrient content in foods and nutrition checklists were recommended as a strong self-assessment tool for planning or reviewing eating patterns [133]. Lastly, eating a number of smaller meals and snacks over the day was suggested to increase the energy and carbohydrate needs of athletes [4,8].

The American Dietetic Association [107] has suggested that it is not appropriate to restrict or withhold fluids from an athlete as a disciplinary measure because of the potential for dehydration and heat illness. It has also been suggested [11], that coaches have water available at all times during practice and competition. Additionally, guidelines for adequate intake of fluids on a daily and pre-competition basis were recommended to promote peak performance [134].

A multivitamin/mineral supplement with 100% RDA was recommended for athletes with a diet lacking micronutrient intake [99]. To accommodate both the coach and athletic administration, a nutrition supplement policy similar to Penn State University was advised [19]. Student athletes had to follow a three-step protocol when requesting supplements. First, they had to make an appointment with a sports nutritionist for dietary assessment. Second, the student athlete had to follow a planned intervention strategy for two weeks. Third, they had to return for a follow-up evaluation. The sports nutritionist could recommend a supplement if the protocol appeared to be followed and the athlete was still unable to gain weight etc. In addition, it was suggested that athletic governing organizations consider the legality and ethics underlying the use of ergogenic substances in athletics [115].

Problem

Current literature relating to nutrition knowledge and eating behaviors of collegiate athletes has isolated some specific problems related to the improvement of athletic performance from diet. These problems include the following: lack of nutrition education and associated nutrition knowledge; nutritional misconceptions from various nutrition information sources; and confusion between sports supplementation and a balanced diet. The need exists to develop nutrition strategies that effectively communicate correct nutrition knowledge of nutrient function and consumption importance as related to a balanced diet for athletes. In addition, specific sport groups and/or genders need to be identified and educated about sports supplementation.

Purpose

The purpose of this study was to ascertain selected nutrition knowledge and eating behaviors of NCAA Division IA collegiate athletes and compare the results to those of two previous studies of nutrition knowledge and information sources of collegiate athletes [17,132].

Assumptions/Limitations/Delimitations

It was assumed that our sampling is representative of the male and female collegiate Division IA varsity athletes by sport in the United States, and that the survey would be completed accurately and honestly. The limitations to this study were: the athlete's understanding of directions and selected questions on the survey, the sports tested, only highly skilled collegiate athletes, and regional eating styles. The delimitations to this study were: the regional selection of universities, use of a survey with a test-retest factor of 0.83, selected number of questions on the survey, number of surveys sent to each university, number of universities selected, and contact person at each university.

Hypotheses

HYPOTHESIS 1: There will be no significant difference between males and females in their frequency of receiving nutrition information.

HYPOTHESIS 2: There will be no significant difference between males and females in their top three sources of nutrition information.

HYPOTHESIS 3: There will be no significant difference between males and females in their types of nutritional supplements consumed.

HYPOTHESIS 4: There will be no significant difference between males and females in their knowledge relating to the function of vitamin supplementation.

HYPOTHESIS 5: There will be no significant difference between males and females in their knowledge relating to the function of protein supplementation.

CHAPTER II

REVIEW OF RELATED LITERATURE

The following pages will detail literature related to the nutrition knowledge and eating behaviors of collegiate and high school athletes. Information on high school athletes is appropriate in this review because the data establishes foundation of nutrition knowledge and eating behaviors of this population as they move into college athletics.

Nutrition Knowledge

Several previous studies have reported poor nutrition knowledge for both college and high school athletes [12,16,135,136,137]. Nutrition knowledge scores of high school athletes are low because of several possible reasons. First, the questions might be too difficult. Sports nutrition is seldomly covered in high school curricula. Second, many misconceptions and myths prevail in regard to ergogenic supplements and their properties. Third, advertising claims have been successful in raising expectations of certain supplements [125].

Coaches have a significant influence on the dietary habits and nutrition knowledge of athletes. Coaches tend to spend the most time around athletes when nutrition is important and the knowledge they project to their athletes is assumed to be true and correct. However, in a study of high school wrestling coaches [138], 82% considered themselves not informed about sport nutrition, weight loss, and vitamin supplementation. The mean of correct responses, for these coaches, to questions about weight loss, training diets, dehydration, and body composition was below the 65th percentile. In another study of high school coaches [14], 85% of coaches scored below the 70th percentile on a nutrition knowledge questionnaire, although 86% gave out monthly nutrition information to their athletes. Finally, in a study of college coaches in the Big Ten Conference (NCAA Division IA) [139], 69% reported rarely reading nutrition information applied to their profession.

Several studies of high school and college athletes reported higher mean nutrition knowledge scores for females than males [125,135,140]. This difference might be attributed to a greater overall interest in nutrition by females; advertisements are targeted toward females; and most women's magazines have many articles on the subject of dieting [125]. In one of these studies [135], high school cross country and track athletes were significantly more knowledgeable about nutrition than baseball and football athletes. In another study [16], college male athletes scored less than 50% on a nutrition knowledge questionnaire, 64% could not identify the function of fat, 67% could not list carbohydrate as a major source of energy, and fewer than 33% could identify fat-soluble vitamins.

In studies of female runners at high school and college [18,141], nutrition knowledge was directly associated with age, education, dietary pattern, sources of nutrition education, and length of time in a sport. The study conducted in 1992 [11], on 54 female college and high school cross-country runners reported a mean nutrition knowledge score of 71% correct for the college runners. More than 60% of the college runners felt that a diet with little or no fat was the best for an athlete. In addition, 59% of these college females felt it was important for athletes to take nutrient supplements.

Finally, a study of 13 female collegiate track members reported that only 50% of them were in agreement of warning signs for anorexia and bulimia [141].

One of the largest studies of male and female collegiate athletes at the Division 1A level [17], reported that 85% of the 812 athletes surveyed correctly identified the primary function of carbohydrate (provide immediate energy). Only six percent of these athletes identified daily carbohydrate consumption to be 55-65% of total calorie intake per day. Sixty-five percent of these athletes felt that carbohydrate intake per day should be approximately 40% or less of the total calories consumed.

In the same study conducted in early 1990 [17], 60% of the athletes identified the correct function of protein and only one percent responded correctly to the recommended daily protein intake of 12-15%. Seventy-three percent of the athletes surveyed felt that athletes need extra protein and 69% of the athletes believed that ingesting amino acids could increase muscle mass and strength. In addition, 59% of these athletes felt that fat should comprise 10% or less of the daily calories consumed.

According to one study [98], approximately 75% of college athletes believed that they require more vitamins than non-athletes do. In line with the previous study, college males showed a significantly higher probability when compared to females, in the belief that athletes need extra vitamins [17]. Also, only 42% of all the collegiate athletes surveyed could correctly identify the major function of vitamins. In another related study [16], only 54% of college track, football, and baseball athletes could correctly identify the major function of vitamins.

Many athletes misunderstand or interpret the incorrect function of nutritional supplements. A four-year longitudinal study on university athletes' dietary intake indicated that 63% of athletes believed that supplements really worked to increase energy, strength, and vitality [142]. Lastly, in a study of collegiate athletes [143], the most frequent reasons cited for supplement use were nutrition insurance, avoiding illness, and increasing energy.

Nutrition Information Sources

Earlier studies of athletes suggested that parents were the primary source of nutrition information [12,16,135]. Magazines were also listed as a very important source of nutrition information for athletes in these studies and the following studies [12,17,132,137,144]. In a related study [141], female college track members listed the media as the number one source for nutrition education.

The study of 430 varsity college athletes representing eight sports from six randomly selected universities [132], had the following rank order of nutrition information sources for all athletes. Magazines topped the order at 40%, while athletic trainers were reported second at 31%; friends, 28%; college courses, 25%; strength and conditioning coordinators, 23%; sport coaches, 22%; parents, 20%; and high school courses, 15%, finished the rank order. Within this study, football players listed the strength and conditioning coordinator as the primary source of nutrition information.

The study of 812 varsity athletes representing eight sports from 11 randomly selected Division IA universities reported the following rank order for nutrition information sources [17]. Again, magazines topped the list at 40%; athletic trainers, 31%; friends, 28%; and college courses, 25%, finished the rank order.

A survey of coaches, athletic trainers, and athletes [12], revealed that all of these groups believed that the athletic trainer had primary responsibility for the athlete's nutrition. One-third of the coaches in the Big Ten Conference actually recommended vitamin supplements to their athletes [139]. However, one author [19], writes that coaches and trainers do not typically have formal training in nutrition.

Eating Behaviors

The frequency and timing of training sessions may affect access to food, causing some athletes to make poor food choices and lack proper energy intake recommendations of food nutrients [32]. For example, research has shown that most athletes do not consume adequate levels of dietary carbohydrate in order to maximize athletic potential [27,35,134,137,145,146,147]. Athletes who restrict their overall energy intakes in preparation for competition in weight category sports or sports in which a low body mass confers an advantage (wrestling and endurance running), may consume a balanced diet, but the absolute amount of carbohydrate and energy may be insufficient to support their activities. Specifically, soccer players appear to consume adequate energy, but low carbohydrate diets [3].

Positive attitudes toward nutrition are linked with accurate nutrition knowledge [11]. Many female athletes report energy intakes that appear too low to match the energy expenditure of their training. This fact could be attributed to poor self reports on body image, or some type of energy adaptation that results from nutritional attempts to keep body fat levels down [6]. For example, weight loss advice is sought by approximately 80% of all athletes, mostly female, requesting appointments with a nutritionist at Penn State University [19]. In a related study [148], a positive correlation existed between pathogenic weight control and irregular menses in collegiate female lacrosse, track, and cross-country athletes. Additionally, 13 female collegiate track team members did not score a combined mean of 50% correct on a nutrition attitude assessment [141].

In a comparative study of weight loss by energy restriction on collegiate wrestlers for 72 hours without dehydration, 18 calories per kilogram of body weight significantly reduced anaerobic performance in repeated bouts on an arm ergometer, as compared to 21 calories per kilogram of body weight in which performance was improved [3]. In a study of 24 collegiate distance runners during a regular cross-country season [73], males reported adequate energy intake of the RDA for most nutrients, while females fell short of the RDA for energy intake of several nutrients. In the same study, male cross-country runners averaged eight grams of carbohydrate per kilogram of body weight per day, and female cross-country runners averaged six grams of carbohydrate per kilogram of body weight per day during the season. A study of 12 male collegiate cross-country runners reported a mean daily carbohydrate and energy intake that was not significantly different than the RDA [149]. Despite this fact, their mean micronutrient intake was only approximately 70% of the RDA.

Sports Nutritional Supplements (Ergogenic Aids)

The wide spread use among athletes of various nutritional products such as vitamins, minerals, sports drinks, and protein powders has been well-documented [9,73,125,150]. Use of nutritional supplements by high school, college, and professional athletes for performance has been estimated at between 38-67% [2,12,137]. Vitamins are currently the most common type of supplement used to increase athletic performance [2,17,98,151]. In one study of college athletes [17], 73% of the athletes reported that they would use nutritional supplements if they were provided for them.

In a study of 509 high school students [125], the most common types of nutritional supplements used were fluid replacement drinks, multi vitamin and minerals, protein drinks, and carbohydrate loading drinks. In the same study, a higher rate of supplement use by athletes in contact verse non-contact sports was reported. This finding might have been attributed to the emphasis placed on increasing muscle mass to compete in contact sports.

Supplementation of Carbohydrate

In a major study of collegiate athletes [17], 43% of the football players surveyed indicated that they added carbohydrate supplements to their diets. In a related study of collegiate distance runners [149], the most commonly reported carbohydrate supplements ingested were sports drinks and sports bars. In addition, cool dilute carbohydrate and electrolyte solutions have been found to delay fatigue of athletes in extremes of temperature, humidity, or duration of event [152].

Supplementation of Protein and Amino Acids

In a study of collegiate athletes [17], 30% of all athletes supplemented their diets with protein and 13% reported using amino acids. Thirty-nine percent of all males and 19% of all females used protein supplements. Twenty-three percent of all males and three percent of all females reported using amino acids. This was in disagreement with another study that suggested only nine percent of college athletes supplemented their diets with protein [153].

Supplementation of Vitamins and Minerals

Several studies of collegiate athletes from a variety of sports and both genders have reported that approximately 50-80% of collegiate athletes use vitamin and mineral supplements on a regular basis [2,141,154,155]. In a related study [17], 37% of all male collegiate athletes and 35% of all female collegiate athletes reported the use of vitamin supplementation. In the same study, 54% of the male athletes in track and field reported the use of vitamin supplements.

In the largest review of vitamin and mineral supplementation [156], 51 studies provided data on over 10,000 male and female athletes at several levels of athletic participation in over 15 sports. The overall mean prevalence of athletes' vitamin and mineral supplement use was 46%. Elite athletes used supplements more than college or high school athletes did. Women used this type of supplement more often than men did. Varying patterns existed by sport. The mean for all college athletes who used supplements was 43%. In addition, multivitamins taken on a regular basis were the most frequent type of nutritional supplement used by all athletes.

Summary

In summary, several past studies have recommended focusing on nutrition education for athletes and coaches [12,16,137]. Specifically, male collegiate athletes tend to lack nutrition knowledge as compared to female collegiate athletes [125,130]. Special attention concerning nutrition knowledge and education was recommended for female athletes who participate in running sports [11,18]. Recommendation was also made for improvements in knowledge of nutritional supplement use and function, specifically for vitamins [16,17,142].

In the past, magazines have been listed as an important source of nutrition information along with friends, trainers, strength and conditioning coordinators, parents, and college courses [12,16,17,132]. Specifically, strength and conditioning coordinators have been listed as the primary source of nutrition information by collegiate football players [17,132]. However, trainers have been indicated as the one responsible for athlete's nutrition [12].

Several studies have recommended that athletes increase their daily intake of carbohydrate in order to improve athletic performance [27,35,146]. Improvement of total energy intake per day has also been recommended for athletes [19], specifically females [6,73,148]. Further, it has been recommended that athletes increase daily micronutrient intake [149].

Vitamins appear to be the most widely used nutritional supplement by collegiate athletes [9,17,73,151,156]. Carbohydrate supplements have also been identified by collegiate athletes as being consumed [17,149]. Lastly, it has been recommended that carbohydrate solutions be ingested during practice and events [152].

CHAPTER III

METHODS

Subjects

Three-hundred-seventeen varsity athletes from nine regionally selected NCAA Division IA universities completed a survey in the winter of 1997-1998. The athletes were male and female participants in twelve sports: football, basketball, baseball, track and field, softball, tennis, wrestling, volleyball, soccer, swimming, golf, and rowing. Telephone and mail contact was made through each university strength and conditioning coordinator. Self-select volunteer subjects were then chosen from each sport. Subjects were then asked to confidentially and anonymously complete a survey.

Instrument

The instrument for this study was a five-page survey, containing 37 questions (see Appendix A). The survey was modified from similar surveys with a test-retest factor of 0.83 [17,132]. The modifications included adding questions pertaining to water consumption frequency during practice, frequency of various eating behaviors, servings per day or frequency of consuming various foods, and including answer possibilities for the newest nutritional supplements on the market such as creatine. The survey took approximately 10 minutes to complete. Subjects were asked questions pertaining to the following areas: demographics-location of university, gender, and year in school; nutrition information-frequency and sources; eating behaviors-meal frequency, type, time, and weight loss or weight gain diets; food consumption-servings per day of various foods;

nutrition knowledge-macronutrients, micronutrients, and function; nutritional supplements-source, use, and types; and water-consumption during practice.

Design

A total of 50 surveys were mailed to each of 16 regionally selected universities. The regional selection of universities was based on the division of the United States into four quadrants (Northwest, Southwest, Northeast, and Southeast). A total of four universities in each quadrant were mailed surveys based on the researcher having a telephone call and communication with each university strength and conditioning coordinator. The surveys were mailed to each university strength and conditioning coordinator (SCC.). Each SCC was instructed to complete a convenience sample with self-select male and female volunteers from different sports. Also, each SCC was given specific instructions to communicate to the athletes when they were about to take the survey. Athletes were instructed to not write their name and or identification number on the survey and to personally place the survey back into a closed collection envelope. Three-hundred-seventeen surveys were completed and returned from the SCC of nine universities. These responses comprise the basis for this study. The Internal Review Board of Oklahoma State University approved the survey form and method for collection used for this study (see Appendix B).

Statistical Procedure

The collected data were analyzed by the Statistical Packages for Social Sciences (SPSS) version 7.0. The self-select volunteer population who completed the survey were arranged into groups based on: year in school, gender, and sport(s) in which the athletes participated. Chi Square (χ^2) tests with alpha level 0.05 and descriptive statistics (percentages) were used on year in school, sport, gender, nutrition knowledge and eating behaviors data.

CHAPTER IV

RESULTS

From the 50 surveys that were mailed to each of the 16 regionally selected NCAA Division IA universities, 317 completed surveys were returned from a total of nine universities. There was a 56% response rate from all the universities and a 70% response rate from the universities that returned the survey. Of the returned surveys, 40% (n=127) were from female athletes and 60% (n=190) were from male athletes. The athletes who completed a survey reported the following current year in school; first (27.8%), second (22.2%), third (22.7%), fourth (18.8%), and fifth (8.5%). The response rates of athletes participating in the following 12 sport(s) were reported; football (27.2%), men's basketball (1.1%), women's basketball (4.2%), baseball (13.9%), men's track and field (6.5%), women's track and field (11.9%), women's softball (3.7%), men's tennis (2.3%), women's tennis (4.5%), wrestling (4.8%), women's volleyball (5.7%), men's soccer (1.1%), women's soccer (2.3%), men's swimming (2.3%), women's swimming (5.1%), men's golf (0.8%), and women's crew (2.3%).

Almost one-half (46.8%) of the athletes reported a low frequency of receiving nutrition information while in college. The following response rates were reported concerning the frequency of receiving nutrition information while in college; always (14.5%), often (39.5%), seldom (37.7%), and never (9.1%).

Hypothesis 1: There will be no significant difference between males and females in the frequency of receiving nutrition information, was rejected for females with an alpha level of $p<0.05$ for the frequency of never. Concerning the frequency of receiving nutrition information during their college career, the response rates by gender are listed in Appendix C, Table 1.

The strength and conditioning coach was the highest ranked source of nutrition information. The athletes reported the following response rates for their top three sources of nutrition information; strength and conditioning coach (19.3%), university classes (17.4%), athletic trainer (16.7%), individual sport coach (12.9%), nutritionist (10.0%), magazines (8.8%), family member (4.8%), friend (3.4%), television (2.0%), other (1.1%), team physician (0.8%), and camp or clinic (0%).

Hypothesis 2: There will be no significant difference between males and females in their top three sources of nutrition information, was rejected for males and females with an alpha level of $p<0.05$; for males concerning the sources of family member, friend, television, other, and team physician; for females concerning the sources of nutritionist, family member, friend, television, other, and team physician. Concerning the top three sources of nutrition information, the response rates by gender are listed in Appendix C, Table 2.

Approximately 40% of the athletes reported a high frequency of tending to skip breakfast. In addition, 80.3% reported a high frequency of eating three meals per day. The response rates concerning the frequency of various eating behaviors are listed in Appendix C, Table 3.

Very few of the athletes reported a nutritionally substantial intake of vegetables per day, although, most did report not eating many high fat foods. The response rates concerning the frequency or number of servings per day of various foods that the athletes eat are listed in Appendix C, Table 4.

Over one-half of the athletes reported having no discussion with a professional at their school to determine caloric intake to effect body mass. The following response rates were reported concerning discussion of approximate calorie intake per day to maintain, lose, or gain weight with a coach or trainer etc.; yes (40.6%) and no (59.4%).

According to the review of literature, it was assumed that the correct macronutrient intake for athletes, expressed as a percentage of total kilo-calorie intake per day, is; carbohydrate (51-60%), protein (12-15%), and fat (26-30%). The following rates of correct responses were reported concerning the best combination of macronutrients for athletes, expressed as a percentage of total kilo-calorie intake per day; carbohydrates (25.7%), protein (4%), and fat (14.9%). Concerning the best combination of macronutrients for athletes, expressed as a percentage of total kilocalorie intake per day, the response rates are listed in Appendix C, Table 5.

A majority of the athletes reported the necessity and use of nutritional supplements, especially if they are for free. The following response rates were reported concerning the opinion that typical athletes need too use nutritional supplements; yes (61.3%), and no (38.7%). The following response rates were reported concerning the use of nutritional supplements if they were given for free; yes (86.7%), and no (13.3%). The following response rates were reported concerning the use of nutritional supplements during their college career; yes (74.1%), and no (25.9%).

Hypothesis 3: There will be no significant difference between males and females in their types of nutritional supplements consumed, was rejected for males and females with an alpha level of $p<0.05$; for males concerning creatine, vitamin/mineral, carbohydrate drink, electrolyte drink, energy bar, and protein drink; for females concerning vitamin/mineral, carbohydrate drink, electrolyte drink, and energy bar. Concerning the types of nutritional supplements taken or consumed, the response rates by gender are listed in Appendix C, Table 6.

Many of the subjects reported that athletes need vitamin supplements, even though only 37% knew the function of vitamins. The following response rates were reported concerning the opinion that athletes need vitamin supplements; yes (76.7%) and no (23.3%).

Hypothesis 4: There will be no significant difference between males and females in their knowledge relating to the function of vitamin supplementation, was rejected for males and females with an alpha level of $p<0.05$; for males concerning regulates metabolism, provides immediate energy, aids in weight gain, and increases muscle strength; for females concerning regulates metabolism, provides immediate energy, and increases muscle strength. Concerning the importance or function of vitamin supplementation, the response rates by gender are listed in Appendix C, Table 7. It was assumed that the correct answer concerning the importance or function of vitamin supplementation was to regulate metabolism.

A majority of the subjects reported that athletes need extra protein, despite only one-half knowing the function of protein in the body. The following response rates were reported concerning the opinion that athletes need extra protein; yes (79.3%) and no (20.7%).

Hypothesis 5: There will be no significant difference between males and females in their knowledge relating to the function of protein supplementation, was rejected by males and females with an alpha level of $p<0.05$; for males concerning aids in tissue maintenance, provides immediate energy, increases muscle size, increases muscle strength, and used for weight gain; for females concerning aids in tissue maintenance, provides immediate energy, and increases muscle size. Concerning the importance or function of protein supplementation. the response rates by gender are listed in Appendix C, Table 8. It was assumed the correct answer concerning the importance or function of protein supplementation was to aid in tissue maintenance.

Nutritional supplements are very popular in college, and the most common way they are obtained is by the athletes buying them. Concerning how nutritional supplements are obtained, the following response rates were reported; you buy them (62.7%), given out by strength coach (16.6%), given out by the athletic trainer (8.1%), given out by your coach (7.0%), other (3.7%), given out in the cafeteria (1.1%), and given out by the team physicians (0.7%). Lastly, the following response rates were reported concerning the frequency of being given a drink of water when a drink was desired during practice; always (61%), often (26.4%), seldom (8.0%), and never (4.6%).

CHAPTER V

CONCLUSIONS

In order to draw conclusions and make recommendations for this specific population, the results from this study must be compared to the results of two previous studies of nutrition knowledge, eating practices, and information sources of collegiate athletes [17,132]. The following paragraphs will detail the comparison of results and point out important similarities and differences.

The current study had 317 respondents from nine different universities, while the study conducted in early 1990 and published in 1991 [132] had 430 respondents from six universities and the study in 1991 and published in 1992 [17] had 812 respondents from eleven universities. The current study had respondents from 12 different sports, while studies [17,132] had respondents from eight different sports. Even though the current study did not have as large of subject pool as the two previous studies, this study did ascertain data from athletes of four more sports. These sports were soccer, swimming, golf, and crew.

The top three nutrition information sources in the current study were the strength and conditioning coach, university classes, and athletic trainer. In the two previous studies, the top three sources of nutrition information were magazines, athletic trainers, and friends. The current study was similar to study [132], in that the strength and conditioning coach was the primary source of nutrition information specifically for football players. The response rates concerning the sources of nutrition information of the current study and study [132] are compared in Appendix D, Figure 1.

In the previous study [17], 6% of the athletes reported that daily carbohydrate consumption should be 55-65% of the total calorie intake per day. Over 31% of the athletes in the current study reported that daily carbohydrate consumption should be 55-65% of the total calorie intake per day. Additionally, 65% of the athletes in the previous study reported that carbohydrate should comprise 40% or less of total calorie intake per day compared to 40.2% of the athletes in the current study with the same opinion.

In the previous study [17], only 1% of the athletes identified the correct protein intake per day of 12-15%. Similarly, only 3% of the athletes in the current study identified the correct protein consumption of total calorie intake per day. Seventy-eight percent of the athletes in the previous study believed that daily protein intake per day should be 40% or more, compared to 46.4% of the athletes in the current study with the same belief.

Only 28.8% of the athletes in the previous study identified daily fat consumption to be 20-30% of the total calorie intake, compared to 47.1% of the athletes in the current study with the same opinion. In addition, 59% of the athletes in the previous study reported that fat consumption should be 10% or less of the total calorie intake per day. In similarity, 49.4% of the athletes in the current study also reported that fat consumption should be 10% or less of the total calorie intake per day. A direct comparison of the current study and the previous study [17] of responses for recommended percentages of carbohydrate, fat, and protein calorie intake per day are listed in Appendix C, Table 9.

From the previous study [17], it was reported that 72.9% of the athletes would take nutritional supplements if they were given to them. In the current study, 86.7% of the athletes reported the same belief. It was reported that 29.6% of the athletes from the previous study used protein supplements. However, in the current study, only 7.7% of the athletes reported using protein supplements. Despite this difference, both the current and previous group reported that athletes needed additional protein, 79.3% and 73.4% respectively. From the previous study, 39.4% of males and 18.9% of females reported using protein supplements compared to 9.6% of males and 4.3% of females in the current study.

The current group of athletes and the previous group [17], had similar reports for the correct function of protein, 54.4% and 59.8% respectively. However, the studies did very for alternative answers to the correct function of protein. From the previous group of athletes, 51.1% identified that the function of protein was to provide immediate energy and 35.12% felt that protein increased muscular strength. Compared to the current study, only 20.9% of the athletes reported that protein provided immediate energy and 7.3% felt that protein increased muscular strength.

Both the current study and previous study [17], reported similar beliefs that athletes should use vitamin supplements, 76.7% and 72% respectively. However, the groups reported different amounts of vitamin supplement use. From the previous study, 37% of all athletes reported using vitamin supplements, of which 39.8% were males and 34.7% were females. In the current study, 18.9% reported using vitamin supplements, of which 13.2% were males and 29.3% were females. Lastly, the current athletes and previous athletes varied in their responses to the correct function of vitamin supplements. Thirty-seven percent of the athletes in the current study identified the correct function of vitamins, despite the fact that 30.3% felt that vitamins provided energy. In comparison, 42% of the athletes in the previous study identified the correct function of vitamins, although 77% felt that vitamins provided energy. In addition, 12.6% of the athletes reported a low frequency of being given a drink of water when a drink was desired during practice. Special attention should be paid to this reporting to limit dehydration and associated deficits in performance level.

Some conclusions can be drawn from the comparison of this study to the two previous studies of nutrition knowledge, eating behaviors, and information sources. It appears that a smaller percentage of athletes are receiving nutrition information from their college environment that includes strength and conditioning coordinators, trainers, and individual sport coaches. The evidence for this is the smaller reporting of nutrition information sources compared to the two previous studies. Even though the strength and conditioning coordinator was listed as the number one source of nutrition information in this study, a smaller percentage of athletes are reporting that they receive information form this person than previously reported.

The athletes in this study are apparently getting their nutrition information from other sources at the university as compared to the previous studies. Ten percent of the athletes in the current study reported getting their nutrition information from nutritionists. Nutritionists were reported as sources of nutrition information in this study and not in the two previous studies. Sports nutritionists in collegiate athletics are relatively new, and they might be getting nutrition information to athletes in an effective method. Perhaps, athletes of today are more knowledgeable about nutrition as they come out of high school or they are just not interested in seeking out nutrition information or it is not being provided.

We can be certain from this study that athletes have shifted away from magazines as an important source of nutrition information. Magazines ranked very low as compared to the two previous studies [17,132]. In addition, other poor sources of nutrition information have taken a decline in the current study. Athletes don't report as much nutrition information from friends, parents, and individual sport coaches. These sources are often not qualified to give out sound nutrition advice.

Whoever is giving nutrition information in collegiate athletics, improvement still needs to be made in the area of nutrition knowledge education for athletes. Nutritionists, trainers, and strength coordinators need to be educated and tested in the area of sports nutrition. Despite the efforts of certain certifying organizations such as the American College of Sports Medicine and the National Strength and Conditioning Association to improve professional nutrition testing, many inconsistencies exist in the area of nutrition knowledge. This is evidenced by athletes still scoring poorly on nutrition knowledge questions.

If athletes were receiving sound and consistent nutrition information from strength coordinators, trainers, coaches, and nutritionists, the evidence would still not exist of poor nutrition knowledge. For example, over 75% of the athletes in this study are still not educated about the correct percentages of macronutrients as part of their total calorie intake per day. In addition, if over one-half of the athletes in this study are not receiving nutrition education on how to control body mass through caloric intake, we can expect results such as approximately 38% of athletes tending to skip breakfast. Athletes who are trying to perform optimally need effective caloric intakes that match or exceed caloric expenditure.

With poor reports of nutrition knowledge of nutrient functions, such as protein and vitamins, athletes are not going to improve their eating behaviors because they will not justify the importance of eating correctly. For example, the combined correct response to the functions of vitamins and minerals from this study and the two previous studies was only 48%. Again, with this lack of nutrition knowledge, we can expect poor food choices and misconceptions of food nutrients.

From all three studies it is apparent that athletes believe in nutritional supplementation such as vitamins and protein. A combined total of approximately 80% of all the athletes would use nutritional supplements if given to them. One should question giving nutritional supplements because this promotes the use of alternative food products for nutritional development and demonstrates that eating normal foods will not enhance physical performance. One should question the person given the supplements as to what the scientific nutritional basis is and if other food choices have been exhausted to improve performance.

Recommendations

In consideration of the two previous studies [17,132], and the current study, the following recommendations are appropriate for collegiate athletes to promote nutrition knowledge and sound eating behaviors. In time, these recommendations may improve athletic performance.

Each university should designate one or two individuals that will maintain current levels of nutrition knowledge education. These individuals should be required to take nutritional workshops and classes or continuing education credits. These individuals need to develop nutrition education plans for athletes and communicate these to the athletic administration for mandatory team meetings and or individual appointments. With each team or individual athlete, nutrition knowledge development and sound eating behaviors should be encouraged. Collectively, these individuals will be called the nutrition consultant.

Athletes should be required to take a nutrition knowledge and eating behavior survey to access their individual needs. For those athletes who are educated and score highly on the survey, annual or semi-annual meetings with the designated nutrition consultant are recommended. These meetings will keep the athlete up to date on the information concerning the newest nutritional supplements and provide a check system to see if athletes are practicing what they know. For those athletes who score poorly, an immediate nutritional consultation is very important. These athletes may need help in any of the following areas; meal patterns, meal timing, caloric intake, meal planning, eating disorders, and possible supplementation protocol.

University athletic administrators and the nutrition consultant should develop a specific nutritional supplementation protocol. The supplementation protocol should include a series of steps and meetings that take place between the athlete and nutrition consultant. Supplementation with ergogenic aids should only be permitted when specific eating behaviors or patterns are followed and no sign of improvement exists. This protocol will ensure the safety of the athlete and promote traditional food choices to improve athletic performance. Vitamin and mineral supplements, up to 100% of the Recommended Daily Allowance (RDA), should be prescribed to those individuals who lack a proper nutrient intake to meet the demands of training.

Additional recommendations for collegiate settings are to promote optimal food choices in the dining area of young athletes. Nutrition strategies to develop optimal intake of carbohydrate, protein, fat, and water should be promoted. They can be promoted with lectures, newsletters, bulletins, and flyers. Lastly, no athlete should be able to participate in a collegiate athletic setting without measures being taken to ensure adequate nutrition knowledge and eating behaviors to develop and improve athletic performance. Sound nutrition practices will move on with the athlete as they move on with life outside collegiate athletics.

Recommendations for Further Research

From the data and results of this study, some recommendations for further research are warranted. Research is needed in the following areas: why athletes at the NCAA Division IA collegiate level are reporting a low frequency of receiving nutritional information; why sources of nutrition information have declined; why athletes report poor eating behaviors such as skipping breakfast; why athletes report low frequency of vegetable intake per day; why nutritional education and knowledge is not and has not improved in the areas of macronutrient intake per day and the function of protein and vitamin supplementation; are there benefits of nutritional supplementation verse consuming typical food products; and how nutritional information, education, and knowledge can improve in the collegiate setting. Research is also needed for lower levels of collegiate athletics that might not have the sources and athletic support staff that is in place at the Division IA level. Lastly, research is needed on methods and or systems that can and do effectively educate all collegiate support staff and athletes in the areas of correct nutrition information, nutrition knowledge, and eating behaviors to improve athletic performance on the playing field and or court.

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APPENDIX A

Nutritional Knowledge and Eating Behaviors Survey

For

Collegiate Athletes

Nutritional Knowledge and Eating Behaviors Survey For Collegiate Athletes

Purpose

This survey is an attempt to gather the knowledge and eating behavior athletes have for common foods and nutritional supplements. The data collected will be presented to collegiate coaches, trainers, strength and conditioning coordinators, team physicians, nutritionists, etc. This feedback will provide valuable information as to the areas that athletes need nutritional education and/or help to improve athletic performance.

Confidentiality

The researchers who designed this survey understand your concern about personal information. All of your information will be handled in a strictly confidential manner in accordance with medical and research ethics.

Directions

Read each statement or question and fill in the blank, check, or circle the number(s) of the choices that are correct according to your nutritional knowledge and eating behaviors. When you are finished, place your survey in the envelope provided. Do not write your name or any identification number on your survey.

1. Name of your university ______________________________

2. Your current year in school

    1. 1^{st}
    2. 2^{nd}
    3. 3^{rd}
    4. 4^{th}
    5. 5^{th}

3. Sex

    1. Female
    2. Male

4. Sport(s) in which you participate at the collegiate level

    1. Football
    2. Men's Basketball
    3. Women's Basketball
    4. Baseball
    5. Women's Track and Field
    6. Men's Track and Field
    7. Softball
    8. Men's Tennis
    9. Women's Tennis
    10. Wrestling
    11. Volleyball
    12. Men's Soccer
    13. Women's Soccer
    14. Men's Swimming
    15. Women's Swimming
    16. Men's Golf
    17. Women's golf
    18. Men's Rowing
    19. Women's Rowing

5. At any time in your college career have you received nutritional information?

    1. Always
    2. Often
    3. Seldom
    4. Never

6. If your answer to #5 was yes, what source(s) have you received nutritional information from? * Please rate your top 3 sources, 1=most and 3=least

    A. Athletic Trainer
    B. Strength and Conditioning coach
    C. Your individual sport coach
    D. Nutritionist
    E. Team Physician
    F. Magazines
    G. Television
    H. Friend
    I. Family member
    J. University classes
    K. Clinic or camp
    L. Other

Please put the number that applies for each statement. 1=Always, 2=Often, 3=Seldom, 4=Never

7. Eat three meals a day	____
8. Tend to skip breakfast	____
9. Eat snacks between meals	____
10. Eat fast food five or more times per week	____
11. Eat a snack or meal 1-2 hours prior to training	____
12. Eat a snack or meal 1-2 hours after a practice or game	____
13. Follow a weight loss diet	____
14. Follow a weight gain diet	____

Please put the number that corresponds with the number of servings <u>per day</u> that you eat in the provided blank for each question.

1. Don't eat
2. Seldom eat
3. One
4. Two
5. Three or more

15. Vegetables (carrots, peas, green beans, corn, broccoli, etc.) ____
16. Fruit or fruit juices ____
17. Rice, macaroni, pastas, potatoes ____
18. Bread, rolls, cereal ____
19. French fries, potato chips ____
20. Pie, cake, doughnuts ____
21. Skim milk, 1% or 2% milks ____
22. Whole milk ____
23. Red meat, chicken, fish, etc. ____
24. Soft Drinks (regular or diet) ____
25. Caffeinated coffee, tea ____

Please circle the number(s) of the correct choices.

26. At any time in your college career, has any coach/trainer etc. ever discussed your approximate calorie intake per day that you should be consuming to maintain, lose, or gain body weight?

    1. Yes
    2. No

27. In a well balanced meal for athletes, what percent (%) of each of the following do you feel is the best combination?

    ____ Protein

    ____ Carbohydrates

    ____ Fat

    100% Total

28. Do you feel that typical athletes need to use nutritional supplements?

    1. Yes
    2. No

29. Would you use nutritional supplements if they were given to you for free?

    1. Yes
    2. No

30. Have you at any time in your college career used a nutritional supplement?

    1. Yes
    2. No

31. If your answer to #30 was yes, what type of nutritional supplement(s) have you taken or consumed? * Please rank your top 3, 1=most and 3=least

    1. Carbohydrate powder or drink
    2. Electrolyte replacement powder or drink
    3. Protein powder or drink
    4. Weight gain powder or drink
    5. Amino acids
    6. Vitamins/Minerals
    7. Creatine
    8. Energy bar
    9. Diet or weight loss pills
    10. Don't know what it was

32. Do you feel that athletes need vitamin supplements?

 1. Yes
 2. No

33. What is the importance/function of vitamin supplementation? (Circle any that apply)

 1. Aids in weight gain
 2. Provides immediate energy
 3. Increases muscle size
 4. Increases muscle strength
 5. Regulates metabolism

34. Do you feel athletes need extra protein?

 1. Yes
 2. No

35. What is the importance/function of protein supplementation? (Circle any that apply)

 1. Provides immediate energy
 2. Aids in tissue maintenance
 3. Increases muscle size
 4. Increases muscle strength
 5. Used for weight gain

36. If you use nutritional supplements, how are they obtained? * Please rank any that apply. 1=most

 1. You buy them
 2. Given out by your coach
 3. Given out by athletic trainer
 4. Given out by strength coach
 5. Given out by team physicians
 6. Given out in the cafeteria
 7. Other

37. During practice, is water given to you at any time you desire a drink?

 1. Always
 2. Often
 3. Seldom
 4. Never

APPENDIX B

Oklahoma State University

Internal Review Board Approval

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 11-17-97 **IRB#:** ED-98-037

Proposal Title: NUTRITION KNOWLEDGE AND BEHAVIOR OF COLLEGE ATHLETES

Principal Investigator(s): Bert H. Jacobson, Chris Sobonya

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

ALL APPROVALS MAY BE SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING, AS WELL AS ARE SUBJECT TO MONITORING AT ANY TIME DURING THE APPROVAL PERIOD.
APPROVAL STATUS PERIOD VALID FOR DATA COLLECTION FOR A ONE CALENDAR YEAR PERIOD AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Disapproval are as follows:

Signature: [signature]
Chair of Institutional Review Board

Date: November 18, 1997

cc: Chris Sobonya

APPENDIX C

Table 1
Frequency of Receiving Nutrition Information

	Males(%) n=190	Females(%) n=127	Total(%) N=317
Always	13.8	15.5	14.5
Often	35.7	45.1	39.5
Seldom	38.6	34.1	37.7
Never	11.9	*4.9	8.3

*p<0.05

Table 2
Top Three Sources of Nutrition Information

	Males(%) n=190	Females(%) N=127	Total(%) N=317
Strength Coach	27.8	13.6	19.3
University classes	8.8	17.4	17.4
Athletic Trainer	22.8	13.6	16.7
Sport Coach	10.6	15.2	12.9
Nutritionist	5.6	*15.9	10.0
Magazines	11.1	8.3	8.8
Family member	*5.6	*5.3	4.8
Friend	*2.2	*6.1	3.4
Television	*3.3	*0.8	2.0
Other	*1.7	*0.8	1.1
Team Physician	*0.6	*2.3	0.8

*p<0.05

Table 3
Frequency of Various Eating Behaviors

Eating Behaviors	Always	Often	Seldom	Never
Eat three meals a day	44%	36.3%	16.6%	3.1%
Tend to skip breakfast	7.45%	31.1%	29.7%	31.7%
Eat snacks between meals	20.3%	40%	29.7%	31.7%
Eat fast food five of more times per week	6%	14.9%	31.2%	47.9%
Follow a weight gain diet	5.5%	13.4%	17.4%	64.7%

Table 4
Frequency of Various Foods (Servings per day)

Various Foods	Don't eat	Seldom eat	One	Two	Three or more
Vegetables	6%	22.8%	32.3%	24.8%	12.1%
French fries or potato chips	13%	47.6%	25.1%	9.8%	4.3%
Skim, 1%, or 2% milks	7.2%	13.3%	27.7%	27.4%	24.2%
Whole milk	70.4%	12.1%	7.4%	3.5%	2.1%

Table 5
Combination of Macronutrients for Athletes

Percent of Kcal/day	Responses for Carbohydrate (%)	Responses for Protein(%)	Responses for Fat(%)
0-2			2.6
3-5			8.8
6-8			0.9
9-11	0.3	3.2	37.1
*Protein 12-15		3.0	0.3
16-20	0.6	11.6	32.2
21-25	2.0	5.1	3.1
*Fat 26-30	10.5	24.9	11.7
31-35	4.3	5.1	1.5
36-40	22.5	21.6	.09
41-45	7.4	4.7	
46-50	16.5	11.3	
*CHO 51-60	29.5	4.6	0.3
61-65	2.0	1.5	
66-70	4.4	1.8	
71-76	1.5	0.3	
77-80	1.2	0.6	0.3
81-85			
86-90	0.3		

*- Indicates correct percentage of carbohydrate, protein, and fat

Table 6
Types of Nutritional Supplements Consumed

Type of supplement	Males(%) n=190	Females(%) n=127	Total(%) N=317
Creatine	*38.9	9.8	28.6
Vitamin/Mineral	*13.2	*29.3	18.9
Carbohydrate drink	*16.8	*15.2	16.0
Electrolyte drink	*7.8	*19.6	11.9
Energy bar	*6.6	*16.3	10.0
Protein drink	*9.6	4.3	7.7
Weight gain powder or drink	4.2	0	2.7
Amino acids	2.4	2.2	2.3
Diet or weight loss pills	0.6	2.1	1.2
Do not know what it was	0	1.2	0.4

*p<0.05

Table 7
Function of Vitamin Supplementation

Choices	Males(%) n=190	Females(%) n=127	Total(%) N=317
#Regulates metabolism	*31.1	*40.2	37
Provides immediate energy	*29.8	*31.3	30.3
Aids in weight gain	*18.1	8.9	14.7
Increases muscle strength	*14.4	*15.2	14.7
Increases muscle size	2.7	4.5	3.3

#- Indicates correct function of vitamin supplementation
*p<0.05

Table 8
Function of Protein Supplementation

Choices	Males(%) n=190	Females(%) n=127	Total(%) N=317
#Aids in tissue maintenance	*52.0	*58.4	54.4
Provides immediate energy	*21.1	*20.8	20.9
Increases muscle size	*13.7	*12.0	13.1
Increases muscle strength	*7.8	6.4	7.3
Used for weight gain	*2.1	2.4	2.1

#- Indicates correct function of protein supplementation
*p<0.05

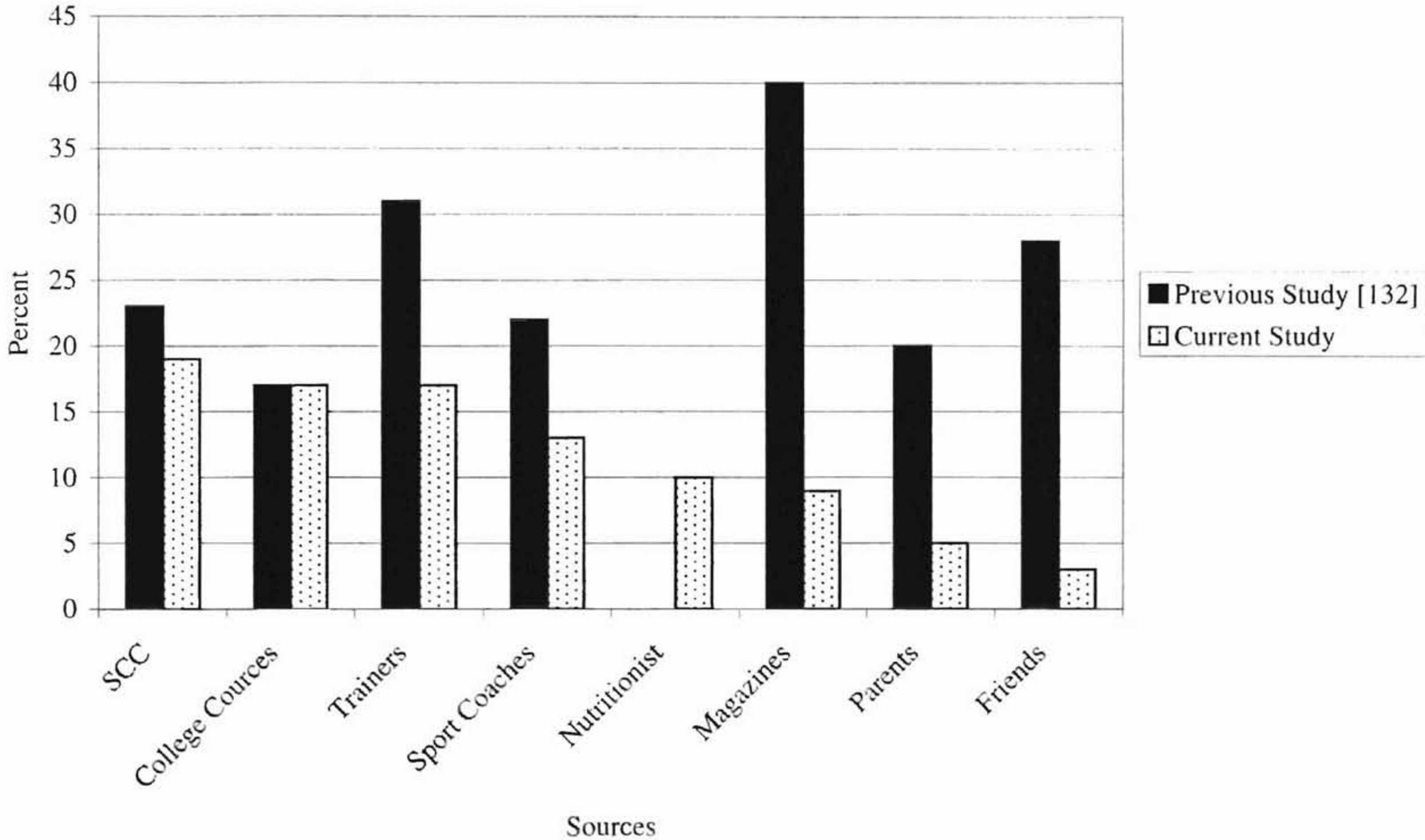
Table 9
Comparison of Responses to
Recommended Macronutrient Intakes per day

Percent of Kcal/day	Current Study CHO(%)	Previous Study [17] CHO(%)	Current Study Protein (%)	Previous Study [17] Protein (%)	Current Study Fat (%)	Previous Study [17] Fat(%)
0-2					2.6	4.8
3-5					8.8	17.5
6-8					0.9	0.6
9-11	0.3	4.0	3.2		37.1	36.5
*Protein 12-15		2.3	3.0	1.1	0.3	9.4
16-20	0.6	12.6	11.6	4.0	32.2	21.8
21-25	2.0	6.3	5.1	3.4	3.1	4.1
*Fat 26-30	10.5	15.0	24.9	9.8	11.7	2.9
31-35	4.3	5.7	5.1	2.9	1.5	1.2
36-40	22.5	19.0	21.6	17.8	.09	0.6
41-45	7.4	5.8	4.7	6.3		
46-50	16.5	19.0	11.3	13.2		1.2
*CHO 51-60	29.5	5.1	4.6	21.9	0.3	
61-65	2.0	0.6	1.5	3.4		
66-70	4.4	0.6	1.8	5.2		
71-76	1.5	2.3	0.3	5.7		
77-80	1.2	0.6	0.6	2.3	0.3	
81-85				1.1		
86-90	0.3			1.1		

*- Indicates correct percentage of carbohydrate, protein, and fat

APPENDIX D

Figure 1
Comparison of Nutrition Information Sources



VITA

Chris Sobonya

Candidate for the Degree of

Master of Science

Thesis: NUTRITION KNOWLEDGE AND EATING BEHAVIORS OF NCAA DIVISION IA COLLEGIATE ATHLETES

Major Field: Health, Physical Education, and Leisure

Biographical:

Education: Graduated from Helena High School, Helena, Montana in May, 1992; received Bachelor of Science degree in Exercise Science from Montana State University, Bozeman, Montana in June, 1996.
Completed the requirements for the Master of Science degree with a major in Health, Physical Education, and Leisure at Oklahoma State University in May, 1999.

Experience: Played inside linebacker at Montana State University from 1992-1995; worked as student intern strength and conditioning coach at Montana State University from 1995-1996; worked as graduate assistant strength and conditioning coach at Oklahoma State University from 1996-1998; employed by the Tampa Bay Devil Rays as a strength and conditioning coach for the Durham Bulls 1998 to present.

Professional Memberships: National Strength and Conditioning Association