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DIETARY INTAKES AND FOOD PATTERNS OF COLLEGIATE FOOTBALL PLAYERS

By

Susan Lynn Gunnink

A THESIS

Submitted to
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in partial fulfillment of the requirements
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ABSTRACT

DIETARY INTAKES AND FOOD PATTERNS OF COLLEGIATE FOOTBALL PLAYERS

By

Susan Lynn Gunnink

The purpose of this study was to assess the dietary intake and food patterns of all 73 collegiate varsity football players. Dietary intakes, food patterns and self-efficacy (SE) for eating fruits and vegetables over three seasons were examined and averaged. Of the 50 players with all three days of food intake recalls, most were on scholarship and half were African American. This was the first study to examine food groups, food patterns and SE of male collegiate athletes. Many athletes, but not all, had diets low in fruits, vegetables and dairy. The SE of players to keep fruit readily available or on hand increased pre-season to in-season post ($p<0.05$). Players ate more fast food pre-season and shopped for groceries the least in-season. Despite high average energy intake of 4000 kcal, a significant portion of players did not meet their Recommended Dietary Allowance (RDA) or Adequate Intake (AI) for some important nutrients. For calcium only 70% attained the AI and for vitamin D, 40%. For vitamin A only 54% attained the RDA, for vitamin E, 32%, for folate, 48%, for magnesium, 34% and for fiber, 2%. Most of the energy (59%) was from fats and total sugars. As a group, collegiate football players need more fruit, vegetables and dairy foods to optimize nutritional intakes for physical performance and recovery.

To my loving husband, Todd, who without his support, none of this would have been possible.

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I. INTRODUCTION

Many male collegiate athletes have high calorie diets inadequate in some micronutrients key for performance (Short et al., 1983; Steen et al., 1986; Hickson et al., 1987). Specific food intakes of male collegiate athletes, however, have not been reported. Food patterns of male college students are typically low in fruit, vegetables and dairy foods and high in fat and sugar (Dinger et al., 1997; Cotugna et al., 1994). Male college athletes probably have similar patterns, but there is no supporting data. This poor diet is of concern, because diets high in fruit, vegetables and dairy, combined with hard training and physical fitness, are essential for optimal athletic performance and recovery (ADA, 2000).

Athletes have to "eat on the run" because of hectic schedules that include practice, strength training, classes, attending tutoring sessions and studying. Therefore a healthy diet is often not a priority nor easily acquired. The little research to date on diets of collegiate male athletes is dated and does not address dietary intake from the perspective of food groups, food patterns or behavioral constructs useful for counseling dietary change. Therefore, this investigation focused on football players' dietary intakes of fruits, vegetables, dairy, fats and sugars, their food patterns, as well as their self-efficacy for eating fruits and vegetables. Coaches and nutrition educators need such information in order to help athletes improve their diets, health and athletic performance.

Participation in collegiate football puts players at increased risk for injuries. Football players must acquire and maintain a high level of fitness and physical performance. Despite rigorous training schedules, failure to consume a healthy diet, and not just one adequate in energy and protein, contributes to the severity and number of injuries sustained as well as to delayed recovery from injuries and even regular workouts. Examination of the diets of collegiate male athletes is necessary to assist nutritionists and coaches to help athletes develop healthful diets to maintain and build their bodies for maximum performance. A benefit to helping collegiate football players eat a healthful diet is the potential for motivating other young men, who view these athletes as role models, to do the same. In today's society much attention is given to televised athletics. By influencing the diets of such role models and using them as spokespeople in the media, nutritionists might be able to help improve diets of other young men who admire the physical ability of athletes. Athletes are being used in commercials in order to promote certain products, so the same could be done with regards to consumption of more healthful foods. For example, in 2003, the U.S. Department of Health and Human Services (HHS) and its principal agency for cancer research and training, National Cancer Institute (NCI), are currently teaming up with the former Houston Rockets basketball star Clyde Drexler to encourage men to consume nine servings of fruits and vegetables each day (NCI, 2003).

The long term intention of this research is have collegiate athletes begin to think about the importance of a healthful diet during their college years and how it will affect them later in life. Improving the diet quality of collegiate athletes would hopefully reduce their risk for chronic disease, and that of their future families. Diets low in fruits, vegetables and dairy and high in excess energy are associated with increased risk for many types of chronic diseases such as cancer, heart disease, hypertension, and diabetes. Weight gain and nutrient deficient diets contribute to such risks, even in the short term. It is not unusual for athletes to continue consuming the high calorie, low nutrient dense diets adopted during training season into off season, when their energy requirements decrease. Thus many athletes may gain weight when not in physical training, increasing their risk for chronic disease.

It is important to understand what influences collegiate male athletes to choose the foods they eat. Considering the importance of a good diet to their athletic performance and recovery (ADA, 2000), it is possible that athletes' diets may not be sufficient to meet their energy and nutrient needs. Their diets may be limited in fruits, vegetables, and dairy, the very foods containing key nutrients for optimal physical performance and recovery. A well balanced diet, in conjunction with an appropriate training schedule, is necessary for collegiate athletes to perform at their highest ability, both on the field and in the classroom. By improving dietary quality of the foods consumed, athletes could reduce the risk of some injuries, both in practice and in competition, a concern of athletes and their coaches. Gaining insight into factors affecting food choices such as food patterns and self-efficacy for eating limited foods, like fruits and vegetables, could assist in nutrition education interventions with this population. Being able to understand these factors could lead to positive eating patterns gained at a younger age which can be continued throughout adulthood – such as eating breakfast on a regular basis or the inclusion of fruits and vegetables into the diet.

According to Brug and colleagues, self-efficacy is the second leading predictor for fruit and vegetable consumption when adjustments are made for behavioral intention (1995). However, it is understood that behavioral intention is typically used as the outcome variable and not a predictor. This means that self-efficacy is a major predictor of fruit and vegetable consumption. Because self-efficacy is a strong predictor for eating fruits and vegetables, educators need to emphasize the benefits of eating fruits and vegetables, such as cost, easy of preparation and convenience. Limited intake of fruit, vegetable and dairy group foods would present a problem for achieving high performance needs of as well as affect dietary habits after college.

The specific aims of this study are:

Aim 1. To examine changes in food group intake, food patterns and self-efficacy scores for fruits and vegetables pre-season, in-season and post-season.

H1: There will be no difference in food group intake, food patterns or self-efficacy scores for fruits and vegetables among pre-season, in-season and post-season time periods.

Aim 2. To identify the nutrient and food group intakes of varsity collegiate football players and compare intakes to dietary recommendations and determine if servings of fruits, vegetables and dairy foods predict MAR scores.

H2a: Fruit, vegetable and dairy intake will be low compared to USDA's Food Guide Pyramid (FGP) recommendations.

H2b: Servings of grain, Lean Meat Equivalents (LME) and grams of fat will be high compared to FGP recommendations.

H2c: Servings of fruit, vegetables and dairy foods will predict Mean Adequacy Ratio (MAR) scores.

Aim 3. To identify food patterns and psychosocial factors which predict intake of fruits, vegetables, and dairy.

H3a: Players' self-efficacy to eat fruits and vegetables will predict their respective intakes.

H3b: Frequency of eating in the cafeteria, eating breakfast, eating fast foods, and grocery shopping will predict intakes of fruit, vegetables and dairy.

The current study is the first to assess food group intake, food patterns and self-efficacy for eating fruit and vegetable in football players. Dietary data are currently very limited, dated and often not sport specific. Therefore, the findings from this study will contribute to our understanding of the more specific dietary intervention needs of college football players, which needs to be addressed.

II. LITERATURE REVIEW

The literature reviewed here relates to the rationale and importance of key foods such as fruits, vegetables and dairy, and their nutrients to physical performance of male college athletes. Studies are reviewed next on food patterns and self-efficacy for eating fruits and vegetables by male college athletes. Because such data are limited and dated for athletes, this section is followed by literature demonstrating the poor intake of these foods and poor food patterns overall by young adult males. Several psychosocial factors, such as self-efficacy for food intake and social norms affecting health behavior, that affect the dietary intake and food patterns of athletes and young men are reported next. These are presented within the context of the Social Learning Theory for behavioral change, which incorporates individual, social and environmental factors into its framework for predicting food intakes.

A. Importance of Fruits, Vegetables, and Dairy Foods to Health and Athletes' Performance

The positions of the American Dietetic Association (ADA), Dietitians of Canada and the American College of Sports Medicine are that optimal nutrition from foods enhances physical activity, athletic performance and recovery from exercise (ADA, 2000). By consuming a healthful diet that includes fruits and vegetables, the risk for chronic diseases such as cancer, heart disease, hypertension, and diabetes may be reduced (Brevard et al., 1996). During times of high physical activity, energy and macronutrient needs – especially those for carbohydrates and protein – must be met in order to maintain body weight, replenish glycogen stores, and provide amino acids for building and repair of tissue (ADA, 2000). In addition, athletes need the antioxidants and phytochemicals from fruits, vegetables, and whole grains for muscle repair, recovery and performance (Rokitzki et al., 1994). The intake of dairy foods, excellent sources of vitamin D, calcium and phosphorous, can benefit athletes in several ways. Some benefits include the mineralization of new bone, enzymatic activities, and other important metabolic processes. Adequate intake of fruits, vegetables and dairy foods can enhance the overall physical performance and recovery of athletes.

Many fruits and vegetables are excellent sources of several micronutrients such as vitamins A, C, E, magnesium and folate, as well as phytochemicals and dietary fiber (Broekmans et al., 2000). It is well known that vitamin A is essential for normal vision, the health of red blood cells, skin, and bones as well as the immune system (Benardot, 2000). It is possible that beta-carotene helps to reduce postexercise muscle soreness and improve postexercise recovery. Although no studies have been conducted to test this hypothesis, the U.S. Olympic Committee has recognized beta-carotene's potential as an antioxidant (Benardot, 2000; Murray et al., 1998). Beta-carotene, a precursor to vitamin A, is found in all red, yellow, orange and green fruits and vegetables and is a powerful antioxidant. The RDA for vitamin A for men age 19-30 is 900 μg RAE/day (Institute of Medicine, 2001). People with low fruit and vegetable consumption, generally have low vitamin A intake compared to those with high fruit and vegetable consumption (Volpe, 2000). With regard to total vitamin A, it is reported that adult athletes are well nourished and that in fact some athletes take too much, which can be potentially toxic (Driskell et al., 1997).

Vitamin C is key to several metabolic processes important to athletes. Ascorbic acid is a cofactor in enzymatic reactions, a radical scavenger in antioxidant processes including hydroxylation reactions in the synthesis of collagen, important for connective tissue stability and wound healing, and an absorption enhancer of iron from non-heme food sources (Rokitzki et al., 1994; Johnston et al., 1998). It is important that athletes have adequate vitamin C status, because their metabolism is accelerated due to high levels of physical exertion (Rokitzki et al., 1994; Johnston et al., 1998). Citrus fruits, tomatoes and tomato juice, and potatoes are the major contributors of vitamin C in the U.S diet. Approximately 90 percent of the vitamin C in a typical U.S. adult diet comes from citrus fruits and vegetables, with citrus fruits, including orange and grapefruit juice, tomatoes and tomato juice, and potatoes contributing the most (Sinha et al., 1993). Other fruit and vegetable sources include brussel sprouts, cauliflower, broccoli, green peppers, strawberries, papaya, cabbage, and spinach. The RDA for vitamin C for men age 19-30 is 90 mg/day (Institute of Medicine, 2000). Studies on male college athletes have shown adequate intake of ascorbic acid (Short et al., 1983; Hickson et al., 1986).

Insufficient intakes of vitamin E, concomitant with increased physical activity, may cause oxidative stress to skeletal muscle and other organs (Meydani et al., 1997). However, studies have shown that vitamin E intake exceeding daily recommendations does not benefit athletic performance (Kanter et al., 1995; Tiidus et al., 1995; Buchman et al., 1999). In the U.S. diet, the main source of vitamin E, an antioxidant, is from vegetable oils. Other food sources include whole grains, nuts, avocados, green leafy vegetables, and the fatty portion of meat. The RDA for vitamin E for men age 19-30 is 15 mg/day (Institute of Medicine, 2000). Very rarely are humans found to be deficient in vitamin E, however, chronic vitamin E deficiency may lead to the degeneration of muscular tissue (Neville et al., 1983), which would obviously concern athletes. An adequate intake of vitamin E has been shown in one study of athletes (Economos et al., 1993).

Magnesium is essential in an athlete's diet, because it plays a vital role in neuromuscular activity, excitation and contraction, and is involved in bone function (Groff et al., 2000; Fragakis, 2003). Vegetables, such as dark leafy vegetables, green peas and baked potatoes with skin, are good sources of magnesium (Anderson, 2000). Other sources of magnesium include whole grains, nuts, meats and milk. The RDA for magnesium for men age 19-30 is 400 mg/day (Institute of Medicine, 1997). It is unlikely that athletes are deficient in magnesium due to its abundance in many foods and athletes high energy intakes.

Folate is important in an athlete's diet because it is required for normal cell division, acting as an acceptor for methyl groups (Institute of Medicine, 1998) and important in energy metabolism and to red blood cell formation (Groff et al., 2000). In addition, a deficiency in folate and B12 can lead to megaloblastic anemia (Volpe, 2000). Given that athletes may have a higher than normal tissue turnover because of the stresses on the body in various sports, and evidence that red blood cell turnover is faster in athletes (Matter et al., 1987; Weight et al., 1988), it is important for athletes to be certain they have adequate folate intake. Foods that are good sources of folate include mushrooms, green vegetables such as spinach, brussels sprouts, broccoli, asparagus, turnip greens, beans, orange juice, and whole grains (Groff et al., 2000). With the fortification of cereals and breads in 1998, these foods have become good sources as well (USDA, 2003). The RDA for folate for men age 19-30 is 400 μg/day (Institute of Medicine, 1998). In a study of elite flatwater paddlers, it was found that average folate values were close to the Dietary Reference Intake (DRIs) requirements (Garcia-Rovés et al., 2000). A study of male distance runners also found intakes of folate adequate (Niekamp et al., 1995). In a 1987 study of collegiate football players, investigators reported a mean intake of 79% of RDA, with seven players' averaging less than 70% of RDA (Hickson et al., 1987); however, in 1987 the RDA for folate was only 200 μg/day (Food and Nutrition Board, 1989). Folate intakes should be monitored for athletes.

Phytochemicals are defined as "substances found in edible fruits and vegetables ingested by humans daily in gram quantities and that exhibit a potential for modulating human metabolism" (Jenkins, 1993). The phytochemicals found in citrus have protective properties including anti-inflammatory and anti-tumor activity, inhibition of blood clots, strong antioxidant activity (Middleton et al., 1994). Phytochemicals activate the body's detoxifying enzyme system (Attaway, 1994). Phytochemicals present in whole grains are protective against cardiovascular disease and cancer (Elson et al., 1994; Yu et al, 1994).

Many fruits, vegetables and whole grains contain flavonoids, a type of phytochemical, which act as antioxidants, preventing blood clotting, and having anti-inflammatory action (Kanner et al., 1994; Cody et al., 1988). Anti-inflammatory properties of foods are very relevant to athletes, because many injuries associated with athletics involve extensive inflammation, causing pain and limiting joint and muscle mobility. These are a few examples of why fruits and vegetables are essential to the diets of athletes.

Sufficient intake of fortified dairy foods provides athletes with an excellent source of calcium, phosphorus and vitamin D. Positive bone health is associated with physical activity and adequate calcium and vitamin D intake (Dook et al., 1997; Drinkwater, 1996; Guezennec et al., 1998). Calcium's main function in health is its role in the mineralization of new bone as well as blood clotting, nerve conduction, muscle contraction, enzyme regulation, and membrane permeability (Groff et al., 2000). It has traditionally been believed that stress fractures in athletes were due to a combination of three possible things: 1) an accumulation of bone microtrauma (Morris et al., 1967); 2) an increase or change in physical activity (Orava et al., 1978); and 3) intrinsic individual biochemical variances (Noakes, 1985). With an increased training load, a bone can weaken due to the resorption of calcium from the bone, because of calcium needs elsewhere in the body are met first (Noakes, 1985). Without adequate daily calcium intake, calcium is not available to replace that lost due to resorption. Research has also shown that shin soreness in athletes has been associated with low dietary calcium intake (Myburgh et al., 1988). The majority of calcium in the U.S. is obtained from dairy foods. Other calcium-rich foods include Chinese cabbage, kale, calcium-fortified orange juice, and broccoli. The Adequate Intake (AI) for calcium for men age 19-30 is 1000 mg/day (Institute of Medicine, 1997). Older studies conducted on male athletes have shown that most male athletes consumed adequate calcium due to their high energy intake (Short et al., 1983; Ellsworth et al., 1985), but with consumption changes since the 1980's in milk, soda, bottled water, fruit drinks and sports drinks, it is not known if this is still true.

Phosphorus is a component of the nucleic acids DNA and RNA, and involved in several mechanisms including creation of high-energy phosphate bonds (ATP), enzymatic activities via phosphorylation or dephosphorylation, the formation of phospholipids for cell membranes, oxygen delivery, and most importantly, bone formation (Groff et al., 2000). Adequate phosphorus intake is essential to athletes due to the increased stress on bones from physical activity, the need of athletes to be able to transport oxygen, and the need to replace the ATP used in the physical activity. Phosphorus is found in a wide variety of foods, including animal meats, dairy products, eggs, and colas that use phosphoric acid. Phosphates are commonly added to food in processing. The RDA for phosphorus for men age 19-30 is 700 mg/day (Institute of Medicine, 1997). Due the adding of phosphates to food in processing, athlete's diets are generally adequate or high in phosphorus.

Vitamin D is essential for the intestinal absorption of calcium and phosphorus and mineralization of bones (Benardot, 2000; Groff et al., 2000). Having adequate amounts of vitamin D and calcium are essential for bone health and repair, nerve conduction and muscle contraction, along with many enzymatic activities (Lewis et al., 1997). With the stress applied to the bones and muscles of athletes, adequate vitamin D intake is important. Dark green vegetables, eggs, and some fish are a few of the natural foods that contain vitamin D. Almost the entire intake of vitamin D in U.S. adults comes from fortified foods such as milk products and breakfast cereals. The AI for vitamin D for men age 19-30 is 5.0 μg/day (Institute of Medicine, 1997). Deficiencies of vitamin D in athletes have not been reported, but have not been investigated either. A deficiency of vitamin D in athletes could contribute to bone fractures, slow healing and problems with muscle control (Lewis, 1997).

For African American athletes, low intakes of milk and reduced vitamin D synthesis due to melanin concentrations could be relevant concerns. Klesges and colleagues found African American men aged 17 to 24 (n=2,736) had the highest percentage of milk-related gastric distress (~28%) compared to men of other ethnicities the same age (1999). Researchers have also found that 65% of African American men (17-24 years) consumed less than the recommended servings for dairy (Klesges et al., 1999). A cholesterol precursor, which is made in the liver and stored in the skin, is converted to previtamin D_3 by ultraviolet rays of the sun. The previtamin D_3 is eventually converted to the active form of vitamin D in the kidney, which carries out the metabolic functions of vitamin D.

Several factors affect skin absorption of sunlight such as use of sunblock, levels of sunlight exposure i.e., time of day, season and latitude, and skin pigmentation. Youth living in the north with less intense year around sunlight are at risk for vitamin D deficiency. Dark skinned ethnic groups whose pigmented skin does not absorb sunlight easily may also be at risk (Holick et al., 1999). Clemens and colleagues found that with the skin of African Americans containing higher melanin concentrations than whites, ultraviolet radiation exposure six times that of white subjects was needed to obtain the same amount of vitamin D synthesis (1982). Therefore African American male athletes may have decreased vitamin D synthesis and low calcium intake, which could lead to problems with bone health, metabolism and repair.

A diet high in fiber is associated with a healthful diet (Cleveland et al., 2000; USDA, 1995). Because improper fiber supplementation can cause gastrointestinal side effects and reduce mineral absorption (Jonnalagadda, 2000), it is recommended that fiber be obtained directly from foods. The amount of fiber in a diet is related to the consumption of whole grains (Adom et al., 2002), fruits and vegetables (Jacob et al., 2003) which are also excellent sources of antioxidants and clearly beneficial to athletes. The AI for fiber for men age 19-30 is 38 g/day (Institute of Medicine, 2002). To date, there is little research related to fiber intake of athletes.

B. Supplement Use

There are important reasons for focusing on foods in the diets of athletes, and not just nutrients or dietary supplements. The American Dietetics

Association, Dietitians of Canada, and the American College of Sports Medicine encourage athletes to obtain nutrients needed through a well-balanced diet of foods without supplements (2000). The rationale is that increased nutritional and energy needs for performance would and should make supplements unnecessary. If an athlete consumes adequate energy (often 3500-5500 kcal/day) from a variety of foods, then adequate vitamins and minerals can be easily consumed. According to the position of the ADA, no single nutrient supplement should be used without a specific medical or nutritional reason (2000). Because foods, especially fruits, vegetables and whole grains, contain a large variety of known and unknown phytonutrients, the first recommended choice for obtaining these nutrients is whole foods (Fragakis, 2003). Even though foods are known to provide a specific nutrient or phytochemical, they can also contain additional nutrients and/or health benefits. Also foods are less expensive and safer than taking the supplement form of a nutrient (Fragakis, 2003).

The safety issues for supplement use arise, not from 100% of the DRI's for key vitamins and minerals, but from special expensive supplements marketed as performance enhancers. Current law does require purity, potency, or efficacy of ingredients for the supplement however this is supposed to be regulated by the Food and Drug Administration (FDA) who does not currently have the resources needed to monitor the supplement manufactures (DSHEA, 1994). Furthermore, nutritional supplements are not strictly regulated and may contain substances banned by the NCAA (NCAA, 2002).

Nevertheless, according to the National Collegiate Athletic Association (NCAA), in 2001, 42% of all college athletes responding to a questionnaire used some form of a supplement within the last year, and about 29% reported continued use of supplements (NCAA, 2001). An earlier study reported that 60 to 90% of elite male athletes reported multivitamin and mineral supplementation (Economos et al., 1993). Additional studies have reported a high prevalence of vitamin supplement (various vitamins and minerals) use by some athletes (Nowak et al., 1988; van Erp-Baart et al., 1989; Williams, 1989; Bazzarre et al., 1993; Ard et al., 2002).

Comparisons of supplement use by athletes to that of non-athletes are inconsistent. A few studies reported higher use of supplements by college students participating in athletics compared to other college students (Fleisher et al., 1982; Barr, 1987; Frusztajer et al., 1990). Other studies have shown little to no difference between use by college students and college athletes (Evers, 1987; Schafer et al., 1989, Ard et al., 2002). One study of university undergraduates reported that approximately 50% had taken a supplement within the last year (Newberry et al., 2001), similar to the percentage found by athletes in the recent NCAA report (2001).

C. Other Nutrients Important to an Athlete's Performance

Other nutrients important to an athlete's performance include protein, zinc and iron. Protein's functions relate to structure, metabolic regulation, muscle contraction, metabolic transport and energy metabolism. Proteins (amino acids) are the building blocks for the synthesis of proteins into skeletal muscle. Hard athletic practice and performance ensures continuous catabolism and synthesis of muscle, thus sufficient protein must be consumed to maintain, repair and build muscle tissue. Protein is necessary for athletes due to the enhanced protein and amino acid breakdown resulting from vigorous exercise.

Not all protein foods are of equal nutritional quality. The ratio of types of amino acids in a particular protein food determines if it is classified as high-quality, intermediate-quality, or low-quality. Protein foods that contain all the "essential" amino acids are term high-quality proteins and are derived from animal sources. Intermediate-quality proteins are lacking or low in one of the essential amino acids; low-quality proteins are lacking in more than one essential amino acid and are from plant sources. Good food sources for protein include: high quality animal sources such as beef, poultry, fish, eggs and milk; intermediate quality sources such as nuts/seeds, legumes, and soybeans; and lower quality sources such as cornmeal, white flour and gelatin (Volek, 2001). The RDA for protein for men age 19-30 is 0.8 $g\text{-}kg^{-1}\text{-}d^{-1}$or approximately 63 g/day (Institute of Medicine, 2002).

Athletes may have an increased need for dietary proteins due to a higher rate of whole body protein turnover (Lemon, 1987). Some research suggests that 1.4 to 1.8 $g\text{-}kg^{-1}\text{-}d^{-1}$ of protein is needed by athletes during intense physical training (Lemon, 1998; Paul et al., 1998). Fortunately, there is little evidence for low dietary intakes of protein for young adult men in the U.S. and many studies showed one and one half to two times the recommended intakes (Hernon et al., 1986; Horwath et al., 1991; Skinner et al., 1991; Glore et al., 1993).

Zinc plays a key role in the function of more than 200 enzymes. Fernandez-Madrid and colleagues found that zinc is a key cofactor for protein and carbohydrate metabolism (1973). Lactate dehydrogenase (LDH) is a zinc-dependent enzyme, important for athletes, because it helps convert pyruvate to lactate in skeletal muscles. During physical performance, the catabolism of glucose produces pyruvate. In muscles, during aerobic conditions, pyruvate is completely oxidized in the mitochondria to produce ATP. During anaerobic conditions this process is blocked and pyruvate is converted to lactate which enters the bloodstream to be cleared by other tissues for aerobic production of ATP. This is important to performance because if lactate builds up and is not cleared from the muscles, the muscles will cramp and not be able to function. In other tissues (liver, cardiac muscle, Type I muscle fibers) LDH converts lactate to pyruvate (Haymes et al., 2001).

Zinc is abundantly found in red meats, certain seafoods, poultry, and whole grains (Institute of Medicine, 2001). The RDA for zinc for men age 19-30 is 11 mg/day (Institute of Medicine, 2001). Athletes must consume an adequate amount of zinc due to high levels of activity, but due to high meat intake, zinc deficiency is unlikely, except perhaps for vegetarian athletes. In studies on male athletes, zinc consumption ranged from 16.3 mg to 21.9 mg per day, far above recommended levels (Lukaski et al., 1983; Lukaski et al., 1990; Fogelholm et al., 1991; Fogelholm et al., 1992).

Iron plays important roles in the human body, but amounts optimal for health and performance exist within a narrow range. Most of the oxygen transported in the blood is attached to the iron in hemoglobin. In addition iron is bound to myoglobin in muscles to transport oxygen through muscles and into the mitochondria for aerobic metabolism. Iron deficiency anemia can cause marked decreases in physical performance and intakes are often low in females and children (Beutler, 1980), but rarely seen in men. It has been controversial if iron deficiency without anemia impairs performance in humans (Beutler, 1980, Clement et al, 1982, Pate et al., 1979). It is safe to say, however, that if an athlete is iron deficient, he is at a higher risk of having iron deficiency anemia, a serious concern for athletes. Sports anemia is typically not an issue for football players, because of their high meat diets, which are high in heme iron. With the high intake of meat at a relatively young age, an athlete should be cautious of a food habit which long term could lead to iron overload. Progressive accumulation of iron in tissues may contribute to ischemic heart disease and cancer (Lukaski; 2002).

Dietary sources of iron are enriched flour products, meat, fish, chicken, legumes, green leafy vegetables, iron fortified cereals, and eggs (Bucci, 1997; Benardot, 2000). The RDA for iron for men age 19-30 is only 8 mg/day (Institute of Medicine, 2001). Given the current available data, only three groups of athletes appear to be at risk for iron deficiency: 1) female athletes; 2) distance runners; and 3) vegetarian athletes. Athletes with high meat intake do not need to be concerned with being deficient in iron but their high iron intakes might be a cause for concern for cardiovascular disease (Konig et al., 1998).

D. Nutrient and Dietary Intake of Collegiate Male Athletes and Collegiate Males in General

Collegiate Male Athletes

The current literature on dietary intakes of male athletes is limited, especially for those in non-endurance sports, i.e., football, wrestling. A literature search was performed for the last 25 years on PubMed, WilsonSelect, Medline and Social Science Abstracts using the key words *athletes, diets, dietary intake, fruit, vegetable, dairy, collegiate* and *young men*. The studies outlined in **Table 2.1**, are all those that sampled male collegiate athletes, assessed dietary intake and did not conduct a dietary intervention. Only four of the seven studies, which met those criteria, reported nutrient intakes, and none reported food group intake.

It is important to recognize that athletes' dietary intake can vary throughout the year, depending on whether they are in-season for training, in athletic competition or out-of-season. A recent, qualitative study demonstrated a change in the type and amount of food hockey players consumed as the players transitioned from season to season (Smart et al., 2001). Therefore, the season in which the dietary intakes were collected is relevant.

Table 2.1 Published reports of collegiate male athletes' dietary intakes.

			Nutrient Intake											
				% of Total Kcal										
Author/Year	Sample	Assessment Method	Kcal	CHO	Pro	Fat	EtOH	Ca (mg)	% RDA[ad]	Vit A (µRE)	% RDA[b]	Vit C (mg)	% RDA[c]
de Wijn et al., 1979	Collegiate rowers (n=8) Netherlands	Food records n=7 d, during training 1968	4140	43	13	43	1	NA	NA	NA	NA	NA	NA
Clement et al., 1982	Collegiate distance runners (n=35) Canada	Weighed intake n=7d, during training	3020	50	16	34	0	NA	NA	NA	NA	NA	NA
Short et al., 1983	Division I lacrosse (n=10) New York	Food records n=3 d, during competitive season, spring 1981	3696	43	17	31	9	1805	180.5	1345	149.4	234	260.0
Short et al., 1983	Division I soccer players (n=8) New York	Food records n=3 d, out of season, spring 1980	2965	43	16	41	0	1041	104.1	1320	146.7	156	173.3
Short et al., 1983	Division I football players (n=56) New York	Food records n=3 d, during competitive season, fall 1981	4838	44	16	40	0	1951	195.1	422	46.9	299	332.2
Hickson et al., 1987	Division I football players (n=16) Texas	Weighed intake n=3 d, out of season, February 1985	3593	39	22	39	0	NA	NA	NA	NA	NA	NA
Niekamp et al., 1995	Collegiate Cross-country runners (n=12) Ohio	Food records n=8 d, during competitive season	3248	61	13	26	0	1463	146	1125	125.0	149	165.6

[a] 1997

[b] 2001

[c] 2000

[d] Measure of AI not RDA. RDAs and AIs may both be used as goals for individual intakes.

In 1979, de Wijn and colleagues studied the intake of eight collegiate rowers during competitive training (1979). The average energy intake was 4100 kcal per day with an equal amount of calories coming from carbohydrate and fat, only 13% from protein and little from alcohol. Protein intake averaged 1.6 $g\text{-}kg^{-1}\text{-}d^{-1}$, within the recommended amount for competitive athletes (Lemon, 1998; Paul et al., 1998). Investigators reported that average intake of vitamins and minerals exceeded recommended levels for this population, but did not report the actual intakes or percentage not meeting recommendations (de Wijn et al., 1979).

Clement and Asmundson studied 35 male collegiate distance runners and reported an average intake of 3020 kcal per day (1982) during training. These athletes consumed half of their calories in the form of carbohydrates, slightly less than the recommendation of 55-70% calories from carbohydrate. Fat and protein intakes were similar to those from other studies of college male athletes. No information was reported for micronutrients except for iron, which was below that recommended.

Two decades ago, Short and Short examined the dietary intake of several men's college athletic teams and found that mean energy intake in male athletes varied from 3000 to 4800 kcal per day depending upon the sport (1983). For the college football team, Short et al. found that during the game season (fall), the average caloric intake was 5270 kcal, with one athlete reporting an average of 11,000 kcal per day. Post-season, collegiate football players' caloric intake dropped to an average of 4687 kcal. For all three team sports, the players' percent of carbohydrate was 43-44% much less than that recommended for athletes participating in strenuous exercise. The protein intake for the 56 football players was between 2.0 and 2.1 $g\text{-}kg^{-1}\text{-}d^{-1}$, above recommendations of 0.8 $g\text{-}kg^{-1}\text{-}d^{-1}$ from the National Research Council and also exceeding the 1.4 to 1.8 $g\text{-}kg^{-1}\text{-}d^{-1}$ recommended by some researchers (Lemon, 1998; Paul et al., 1998). All three teams reported a high percentage of kilocalories from fat, mostly saturated fat. Considering the high caloric intakes, it was not surprising that the average for most micronutrients met or exceeded the RDAs. Of the nutrients reported, only the average intake of vitamin A was low for football players. No information was reported for the number of players not meeting recommended nutrient intakes nor for the foods consumed (Short et al., 1983).

Findings were similar in another study of 16 Division I football players. The average dietary intake was 3593 kcal with a distribution for percent kilocalories from macronutrients similar to that reported by Short (Hickson et al., 1987). For the 16 football players, the overall mean intakes for calcium, iron, phosphorous, zinc, vitamin A, ascorbic acid, thiamin, riboflavin, B12, and niacin all exceeded the RDA's. Mean intakes for magnesium, folacin, and pyridoxine, were below the RDA's, but nutrient databases were incomplete for these nutrients at that time (Hickson et al., 1987).

In the spring of 2001, a pilot study was conducted on 19 collegiate football players at Michigan State University. A single 24 hour recall was obtained from players during training table in a cafeteria used by football players on scholarship. Athletes on scholarship receive their dinner from "training table" Sunday through Thursday at Michigan State University, while players not on scholarship eat in the regular residence hall cafeteria as part of their meal plan. The findings supported the need for this study, because despite earlier studies showing high intakes of calories, low intakes of key nutrients were found (See Appendix III for **Table 2.2**). The average intake for the 19 players was 3792 kcal with 35% from fat and 17% from protein. Of significance was that approximately 54% of the total energy (2035 kcal) came from total grams of sugar and fat. For eight micronutrients, less than 70% of the players consumed the recommended amount: calcium, vitamin D, E, A, folate, magnesium, zinc and fiber. This demonstrated that even with high calorie intake, the players were low in key nutrients. Most of the players (68%) consumed more than twice the recommended amount of iron, which could lead to a higher risk of cardiovascular disease (Lukaski, 2002). The mean number of servings of fruit from the Food Guide Pyramid were 4.2, of vegetables, 2.8, Lean Meat Equivalents, 13.4, dairy, 2.9 and grains, 10.2. The average servings were close to or above the recommended amounts except for vegetables. However, with the large standard deviations there was a high degree of variability between the players.

The study on male collegiate cross-country runners is remarkable for the lower total kilocalories and fat intakes and high percentage of kilocalories from carbohydrate compared to other athletes (Niekamp et al., 1995). The protein intakes for these athletes were between 1.2 and 1.7 $g\text{-}kg^{-1}\text{-}d^{-1}$ (Niekamp et al., 1995). All 12 of these athletes averaged sufficient intake of micronutrients despite the lower average kilocalorie intake than reported in other studies (Niekamp et al., 1995).

From the information that is available, it is evident that male college athletes have a high caloric intake high in carbohydrate and fat. Football players' caloric intake, on average, is 1500 kcal higher than other athletes and therefore it could be possible that their sugar and fat intake is even higher and thus a possible concern. The literature reviewed did not provide information on the consumption of foods and especially fruits, vegetables and dairy foods.

Male College Students

Because we know so little about the diets of male athletes, it is relevant to also review the dietary intake of male college students. This section on dietary intake and nutritional status in male college students focuses on the distribution of the macronutrients and food group intakes according to the Food Guide Pyramid (FGP) and micronutrient intake based on the RDAs. For this section, literature from the past 20 years was searched via PubMed and WilsonSelect using the key words *dietary intake* and *young male*. Studies that reported male college students' dietary intakes were selected for review here and are outlined in **Table 2.3**. The criteria for inclusion of a study in Table 2.3 were that the subjects' data were reported separately as *male* and that they were college students. Many studies reported dietary data on college students, but did not separate findings by gender.

Table 2.3 Published reports of dietary intake of college men.

Author/ Year	Sample	Assessment Method	Dietary Data				
			Kcal/d	% Kcal CHO	% Kcal Pro	% Kcal Fat	% Kcal EtOH
Hernon et al., 1986	College men age 19-22 yr (n=56) Tennessee	Food Record n=3 d all four terms in 1980	2851	43	17	36	4
Horwath et al., 1991	College men age 19-38 yr (n=29) New Zealand	Dietary Record n=(3) 3 d May-Sept 1989	2954	47	15	34	4
Skinner et al., 1991	College men avg age 21.4 yr (n=58) Tennessee	Food Record n=3 d beginning and end of term Date N/A	2608	45	16	35	4
Glore et al., 1993	College male med students 24-26 yr (n=98) Oklahoma	Food Record n=3 d Date conducted N/A	2376	61	20	19	0
			Avg Svg				
			Grain	Veg	Fruit	Dairy	Meat
Song et al., 1996	College men avg age 19.7 yr (n=756), Michigan	Food Record n=1 d Fall 1988-Spring 1991	11.2	6.6	4.8	4.3	3.3
Georgiou et al., 1997	College men avg age 21.1 yr (n=328) AZ, ID, IA, KS, MI, NE, NY, OR, WS	Food Frequency Questionnaire Oct 1993-Jan 1994	6.7	2.2	2	2.2	2.9
			% Meeting recs from FGP				
			Grain	Veg	Fruit	Dairy	Meat
Tavelli et al., 1998	College men (n=161) Washington	Dietary Record n=3 d spring 1996	86	58	63	86	87
McArthur et al., 2002	College men (n=58) Vermont	Food Frequency Questionnaire 2000 school year	57	72	82	82	84

Several studies found similar distributions of macronutrient intake for collegiate males and reported that the distribution did not follow that recommended for all the macronutrients (Hernon et al., 1986; Horwath et al., 1991; Skinner et al., 1991). Male college students consumed less than that recommended for carbohydrates and more than that recommended for fat.

Glore and colleagues studied first year medical students, a slightly older group than average college students (1993). This sample consumed only 19% Kcal from fat on average, about half of that reported in other studies of younger college men (Hernon et al., 1986; Horwath et al., 1991; Skinner et al., 1991).

Four studies examined the food group servings of male college students in comparison to the FGP. Song et al. used subjects enrolled in an introductory nutrition course (1996). Song and colleagues found male students reported an average dietary intake that met the minimal recommendations for all five food groups. Song and colleagues chose the lower limit of the recommended servings to allow for variations in age, gender, and physical activities. Therefore, they did not evaluate the male student with their own specific requirements.

Georgiou et al. reported similar results for male college students who on average consumed the recommended number of servings of all food groups, except vegetables (1997). Data for men and women were analyzed separately in all cases by Georgiou and colleagues, because the number of servings of food eaten tends to depend on energy needs which are higher for young adult men than women (Institute of Medicine, 2002). The other difference was that Georgiou et al. randomly selected their college subjects from nine different states.

Tavelli and colleagues used subjects enrolled in introductory nutrition course (1997). However, Tavelli and colleagues did not consider that gender impacts the number of servings of food eaten, which is dependent on energy needs. Instead they chose the lowest number of recommended servings as the cutoff criterion for meeting the FGP guidelines. It was found that greater than 75% of male college students consumed the recommended servings for grain, meat, and dairy, but less than 75% consumed the recommended servings for fruits and vegetables (Tavelli et al., 1998). Even though Tavelli and colleagues concluded dietary adequacy overall by college men; their information might have over-reported those male college students that actually met the recommended servings for their energy needs due to choosing the lowest number of recommended servings.

McArthur and colleagues found strikingly different intakes by food groups using a Food Frequency Questionnaire (2002). Also, McArthur et al. (2002) recruited a convenience sample at campus sites. Surprisingly, more than 70% of the male college students consumed the recommended servings for vegetables, fruits, dairy, and meat, but that only 57% consumed the recommended servings of grain (McArthur et al., 2002). These differences could be attributed to different dietary assessments used (dietary records versus Food Frequency Questionnaire), geographic location (West coast versus East coast), sample size (n=161 versus n=58) or recruitment of subjects (classroom versus random sample).

E. Factors Affecting Athletes' Dietary Intake & Food Patterns

To study the interaction between individual, social, and environmental factors influencing the health outcomes of interest, models of behavioral theory provide a conceptual framework to inform educators of useful avenues for intervention. For this study, the Social Learning Theory was used to conceptualize the overall dietary intake of collegiate male athletes and specifically why they do or do not eat fruits, vegetables, and dairy foods. The Social Learning Theory is useful because it includes biological (i.e. individual), social and environmental factors as well as the interactions between them in order to predict behavior. The Social Learning Theory framework assumes that three broad domains influence an athlete's behaviors and dietary outcomes (Glanz, 1997). These three domains are shown in **Figure 2.1** and are briefly described here. 1) *Individual factors* include not only physiological needs (i.e. growth, training), but also genetics (lactose intolerance, food allergies) and psychosocial factors like self-efficacy towards eating fruits and vegetables and nutritional knowledge. 2) The *social factors* that can influence food choices include coaches, family, team playing position and peer pressure. 3) *Environmental influences* include financial resources, eating location (training table, cafeteria, home) and daily schedule that changes by season. Environmental factors can also affect dietary intake with regards to factors affecting eating in the cafeteria, eating breakfast, eating at fast food restaurants, and shopping for groceries. If we understand a player's self confidence or self-efficacy for eating adequate fruits and vegetables, then we may begin to understand how to influence their diet to increase intake from these key food groups.

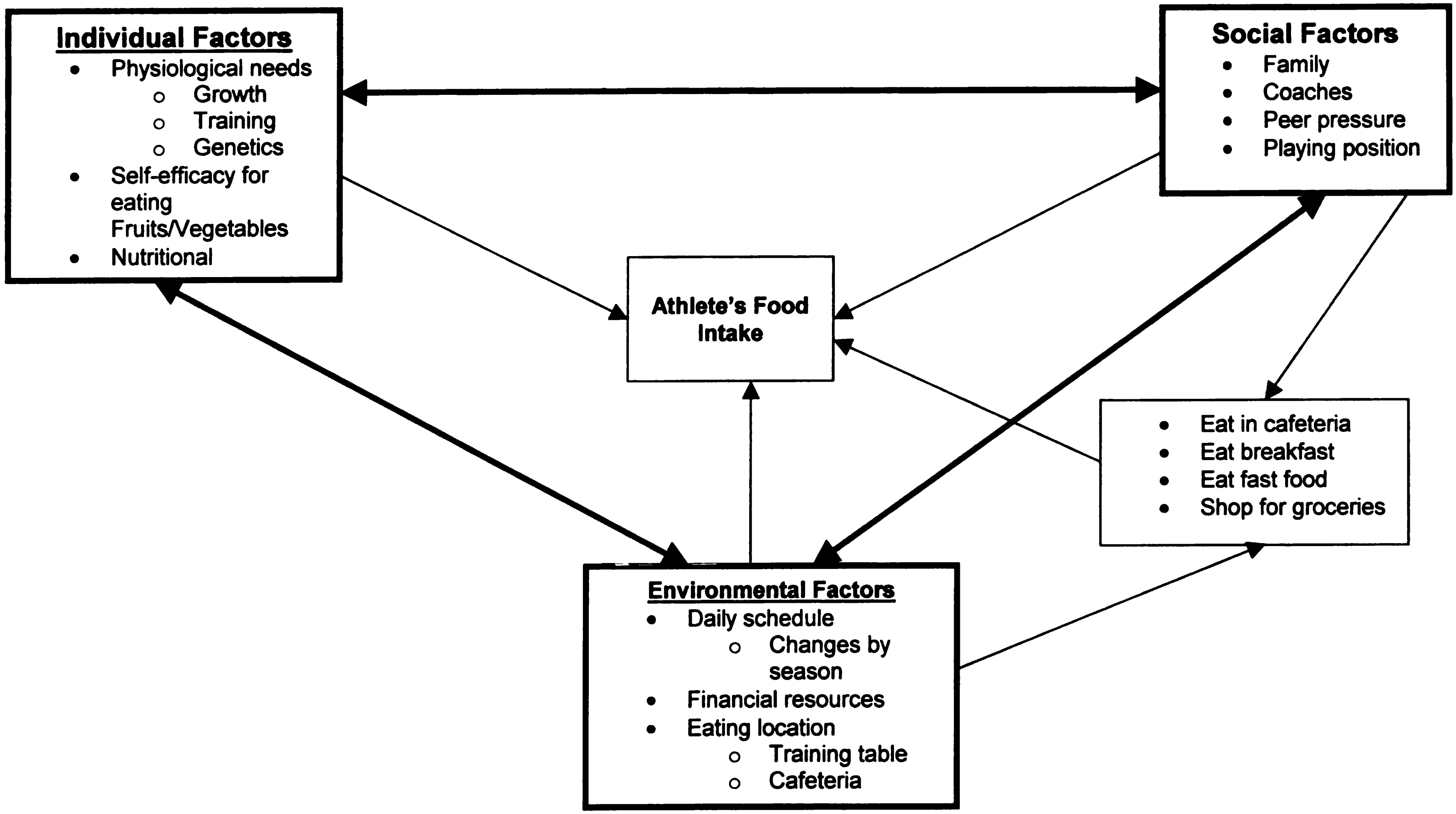

Figure 2.1 Conceptual Model of factors from Social Learning Theory which might affect the food intake of collegiate athletes.

1. *Individual Factors*

The first domain examined is the individual factors that affect an athlete's food intake. In addition to an athlete's self-efficacy for eating fruits and vegetables, the physiological factors also affects food intake. With collegiate athletes, some still experience physical development. Furthermore, the type of training undertaken can influence dietary intake, because during conditioning nutrient needs will be higher than during pre or post season. A qualitative study on collegiate hockey players found differences in the consumption and choices of foods depended upon the particular season the players were in currently (Smart et al., 2001). Finally, a player's genetics strongly affects body size, shape and metabolism and therefore influences nutritional requirements.

Behavioral intention, and eventually behavior itself, is affected by self-efficacy expectations (Lechner et al., 1997). Self-efficacy is defined as "the conviction that one can successfully execute the behavior required to produce the outcome" (Glanz, 1997). The belief a person has about his ability to perform a particular behavior in particular circumstances represents self-efficacy expectation. In particular, this construct has been used to predict various health behaviors such as dietary patterns (Lechner et al., 1997). For example, self-efficacy has been found to predict a large percent of the variance (25%) in the intake of fruits and vegetables for some adults (Baranowski et al., 1999). Brug et al. found that self-efficacy was the strongest correlate with intention to consume boiled vegetables, salads and fruit (1995). Many other studies have found that self-efficacy increased with increased fruit and vegetable intake and advanced stages of change (Brug et al., 1997; Ling et al., 1999; Horacek et al., 2002). In a literature review, authors concluded that self-efficacy was the most consistent determinant of eating behavior and of changes in eating behavior over time (Shannon et al., 1990).

Serious athletes continually search for a competitive edge and seek nutritional information (Perron et al., 1985; Reading et al., 1999). However, many athletes do not have good nutritional knowledge and practice poor nutritional habits (Perron et al., 1985; Reading et al., 1999; Shifflett et al., 2002). A study by Reading et al. demonstrated that athletes' had limited nutritional knowledge, prior to receiving intervention and training, scoring only 20.4 out of a possible 45 on a nutrition knowledge test (1999). In another study of 75 male college track, baseball and football athletes, the athletes scored below 50% on a nutrition knowledge test (Shoaf et al., 1986; Steen et al., 1986). According to some studies on nutritional knowledge of college athletes, it was found that they responded correctly only 55% of the time, even though they reported understanding the nutritional needs of athletes (Shifflett et al., 2002; Shoaf et al., 1986). Athletes' scores were particularly poor for the recommended proportions of energy from protein and fat, as well as hydration and weight gain (Shifflett et al., 2002; Shoaf et al., 1986).

This study specifically examined the construct of self-efficacy towards eating fruits and vegetables, because research has shown that self-efficacy towards eating fruits and vegetables can possibly predict the actual intake of fruits and vegetables. In addition, a validated instrument was previously developed and available for use in evaluating the players self-efficacy (Ma et al., 2000).

2. *Social Factors*

Several social factors such as role models, media and peers can influence the dietary intake of collegiate football players. Athlete's food behaviors are often modeled on those of their parents (Smart et al., 2001). Coaches can also influence dietary intake. From the literature reviewed, it was found that parents, coaches, and magazines appeared to be the most commonly cited sources of information by high school and college athletes. Athletes' have reported their first choice of nutritional information to be parents (Shifflett et al., 2002; Shoaf et al., 1986), followed by coaches (Shifflett et al., 2002). In another study, nutritional information was most often received from the strength and conditioning coaches (21.9%), followed by the athletic trainers (19.0%), and then university classes (12.5%) (Jacobson et al., 2001). Such findings contradicted those from an earlier study, which found magazines to be a primary source (Jacobson et al., 1992). This lack of consistency in sources of nutritional information could be due to sample size, location of study, ratio of males to females and type of sport. For example, Jacobson and colleagues in 2001, found that male athletes were more likely to receive nutrition information from the strength and conditioning coach and athletic trainers, while female athletes were most likely to receive their information form university classes and nutritionists (2001).

The player's position and peer pressure can influence foods eaten. Many college football players often room with and eat with teammates playing the same position (personal communication). When players attend training table together, there is the potential for a player to choose to eat the same things as his roommate or those who play a similar position. There is peer pressure within the team as well as within a specific position that can affect the dietary intake of a football player. Negative remarks about a food offered at training table appeared to discourage other players from selecting the disparaged food (personal communication). Depending on the position, a coach might ask a player to gain or lose weight eating more or less of certain foods.

3. *Environmental Factors*

Athletes not only have all the responsibilities of the average college student, but also the expectation to perform at an elite level in their sport. Although a majority of football players at Big Ten schools do receive scholarships to attend their particular school, some players do not. Those on scholarship receive the benefit of obtaining their dinner from "training table" Sunday through Thursday at Michigan State University, while players not on scholarship eat in the regular residence hall cafeteria as part of their meal plan. The meals at training table differ slightly from those served in the regular cafeteria. For example, both locations serve pasta, a salad bar and cold cereals, however, the main entrée often differs. Crab legs and choice steaks are not available to the general student population in the regular cafeteria, but are served at scholarship players' training table. Additionally, the training table is located in a private dining room on another floor and completely separated from other cafeterias.

Between classes, practices, weight lifting, mandatory study times and competitions – it could be hypothesized that fast food would often be a meal of choice for athletes and breakfast often skipped. No studies were located which reported prevalence of eating in the cafeteria, grocery shopping, breakfast eating or fast food eating by collegiate athletes. In a study conducted by Huang and colleagues, it was reported that 20 percent of male college students (n=607) skipped breakfast (1994). In another study of young adults in nine states, breakfast was eaten an average of 4.1 times per week by male college students (n=328) (Georgiou et al., 1997). In the same study, Georgiou and colleagues reported that male college students ate at a fast food outlet 3.2 times per week on average (1997). In another study on college students, which did not separate findings by gender, it was reported that 55% of students "ate out" one to three times per week and 26% "ate out" four to five times per week (McArthur et al., 2002). Nineteen percent of the restaurants patronized were fast food, 28% family restaurant/diner and 53% a café/deli (McArthur et al., 2002).

In general, studies on young adults have reported varying frequencies of breakfast and fast food consumption. Nicklas and colleagues (1998) conducted a cross-sectional survey for which 504 young adults completed a 24-hour dietary recall and reported that 37% skipped breakfast on a regular basis. Also, the trends of meal patterns and sources of food have changed for young adults. Nielsen et al. reported that the percentage of energy intake from fast food restaurants increased from 14.3% in 1978 to 31.5% by 1996 for young adults, while at the same time the percent of meals at home (prepared at home) decreased from 71.4% to 52.7% from 1978 to 1996 (2002). In a couple of studies, young adults who ate breakfast on a regular basis had better dietary quality compared to those who skipped breakfast (Nicklas et al., 1998; Hammond et al., 1994).

F. Implications of Literature Review

The literature reviewed in this chapter supports the contention that a diet adequate in key nutrients, and possibly phytochemicals, is necessary for optimal physical performance and recovery. The few studies conducted on diets of male college athletes in the last 25 years, support adequate intakes of macronutrients by players, but higher in fat than recommended. Only two studies even reported the average intakes of micronutrients; only the average vitamin A intake was low in one group. No studies to date have reported the percentage of male collegiate players not meeting their RDA's for micronutrients. None have reported food group or food patterns of players or made comparisons of these across seasons of play and training.

If dietary intakes of athletes are important, then it is unclear why there is so little, current information. Studies from the mid-1980's demonstrated that caloric intakes were so high and average nutrient intakes so adequate that dietary deficiencies in this population were considered unlikely. The lack of recent information might also be attributed to the tight schedules of athletes and difficult access to collegiate team players under the close direction of their coaches. Finally, the lack of dietary information on male college athletes is likely due in part, to a change in focus by the nutrition community, itself, from one solely on nutrient intake to one inclusive of foods, food groups and food patterns. The only food pattern data that exist for this age group are on male college students in general. Given the changes in dietary intakes and food patterns over the last 30 years, a current assessment of dietary intakes of college football players is certainly appropriate.

Even less is known about factors influencing food intakes of male collegiate athletes. The few studies conducted have focused primarily on athletes' sources of nutritional information. One recent qualitative study on male athletes from Cornell elicited differences in reasons for food selection by season (Smart et al., 2001). Studies of psychosocial factors influencing intake of fruits and vegetables have demonstrated self-efficacy to be the strongest predictor of up to 25% of the variance in intake. However, it is unknown if and how relevant self-efficacy might be for male collegiate athletes of different sports disciplines or types. In order to best assist athletes to improve their dietary intakes for optimal performance, it is necessary to gain insight into both their food patterns and factors affecting their food choices.

III. METHODS

Design

This was an exploratory study of the diet quality of college football players using cross-sectional data of dietary intakes and food patterns over three seasons – pre-season, in-season and post-season. Players' demographics and self-efficacy for eating fruits and vegetables were also assessed at each interview. The study design and data collection format are shown in **Table 3.1.** **Table 3.2** lists the specific aims, hypotheses, and dependent and independent variables for this study.

Table 3.1 Study design and data collection format.

	Pre-season Aug 2002	In-season Sept/Oct 2002	Post-season Feb 2003
Demographics	X	X	X
24 hr dietary recall	X	X	X
Food patterns	X	X	X
Self-efficacy	X	X	X
Interviews	Multiple trained interviewers (n=19)	4 Trained interviewers	1 Trained interviewer
Site	Classroom in athletic building during pre-season team physicals	Athletic training room - private interview	Athletic training room - private interview

Table 3.2 Specific aims, hypotheses, and variables.

Specific Aims	Hypotheses	Dependent Variables (X±SD)	Independent Variables (X±SD)
1) To examine changes in food group intake, food patterns, self-efficacy scores for fruits and vegetables pre-season, in-season and post-season.	H1: There will be no difference in food group intake, food patterns or self-efficacy scores for fruits and vegetables among pre-season, in-season and post-season time periods.	• Svg Fruit • Svg Vegetables • Svg Dairy • Svg Grain • Svg LME • No. times/wk eating breakfast • No. times/wk eating fast foods • No. times/wk grocery shopping • No. times/wk eating in cafeteria • Self-efficacy scores fruits • Self-efficacy scores vegetables	
2) To identify the nutrient and food group intakes of varsity collegiate football players and compare intakes to dietary recommendations and determine if servings of fruit, vegetable and dairy predict MAR scores.	H2a: Fruit, vegetable and dairy intake will be low compared to Food Guide Pyramid recommendations.	• Svg Fruit • Svg Vegetables • Svg Dairy	
	H2b: Servings of grain, Lean Meat Equivalents and grams of fat will be high compared to Food Guide Pyramid recommendations.	• Svg Grain • Svg LME • Grams Fat	
	H2c: Servings of fruit, vegetables and dairy foods will predict MAR scores.	• MAR Scores	• Svg Fruit • Svg Vegetables • Svg Dairy
3) To identify food patterns and psychosocial factors which predict intake of fruits, vegetables and dairy.	H3a: Players' self-efficacy to eat fruits and vegetables will predict their respective intakes.	• Svg Fruit • Svg Vegetables	• Self-efficacy scores fruits • Self-efficacy scores vegetables
	H3b: Frequency of eating in the cafeteria, eating breakfast, eating fast foods, and grocery shopping will predict intakes of fruit, vegetables and dairy.	• Svg Fruit • Svg Vegetables • Svg Dairy	• No. times/wk eating breakfast • No. times/wk eating fast foods • No. times/wk shopping for groceries • No. times/wk eating in cafeteria

Note: Demographics are covariates

Subjects

The intended sample was all 73 varsity college football at Michigan State University 2002-2003. While the study began with 73 players, a final sample of 50 players was used for season to season comparison analysis. The loss of players was due to graduation, players transferring to another school, choosing to stop playing football or left due to coaching changes. All varsity football players on the Michigan State University football team were recruited by announcements from the MSU football coaching staff during the week prior to the first interview. No freshmen players were included in the sample, because their physical examinations were not completed at the same time as the rest of the football team for the first assessment. No incentive could be provided due to the National Collegiate Athletic Association (NCAA) regulations forbidding such practice.

Procedures

In August of 2002, Human Subjects approval was received to conduct the study. All the participants were informed of the purpose of the research project and consent was obtained prior to each assessment. Each player developed a confidential code using a combination of his birth date and student number to ensure that all responses remained anonymous (See **Consent Form** in Appendix I). Each player's 24-hour dietary recall was assessed three times; once during pre-season in August, once during the game season in September or October and once during post-season in February. At each interview the players also answered a questionnaire pertaining to demographics, food patterns, and self-efficacy for eating fruits and vegetables.

The first assessment on the 73 varsity players was administered mid-week in August within a two-hour time period scheduled during team physicals[1] in the Athletic/Football Building. Due to the short, two-hour window permitted for pre-season data collection, a large number of interviewers were trained (See **Training Materials** in Appendix II). All interviewers' "stations" were situated within one large classroom. Each station had a set of measuring spoons, bowls, cups and photos of serving sizes of various commonly eaten foods. At the time of the assessment, players completed a consent form, a demographic and food pattern questionnaire and a short self-efficacy instrument for eating fruits and vegetables. Each assessment took approximately 20 minutes to complete.

The second assessment on the 68 remaining varsity players was obtained in personal interviews by four trained nutritionists at pre-arranged times in a private location near the athletic training room in the Athletic/Football Building. Interview times were Tuesday through Friday between 7:00 a.m. and 5:00 p.m., thus no dietary recalls were for a weekend day.

The third assessment on the 50 varsity players remaining for post-season was obtained from personal interviews by one trained nutritionist. The assessments were administered at prearranged times in a private location near the athletic training room in the Athletic/Football Building. Interview times were again scheduled Tuesday through Friday at the same times. The 50 players that

[1] These physicals were done the first day that players returned to campus for training camp. Thus, the first recall was most reflective of a pre-training season diet for a weekday.

completed the third recall became the sample group for this study because this group was the same for all three days of food intake. The data obtained were used for each individual recall as well as combining the three days.

Nineteen nutritionists[2] received a one-hour training and review of the Multiple Pass Recall Technique (Moshfegh et al., 1999) prior to the first data collection. (See **Training Materials** in Appendix II). The training session was conducted by a registered dietitian using a PowerPoint presentation followed by mock interviews where trainees practiced their skills. Also, the training permitted the trainer to observe the trainees and make corrections, as needed. Before the subsequent assessments, the interviewers met again with the trainer to refresh the Multiple Pass Recall Technique.

Survey Instrument

Socio-demographic questions items included age, football position, year in school, residence and primary ethnicity. (See **"A Few Questions about You"** in Appendix I.) Players reported height in feet and inches and weight in pounds. The food pattern questions with ordinal response categories were as follows. 1) "Circle the average number of times a week you eat breakfast" 0 1 2 3 4 5 6 7. 2) "Circle the average number of times a week you eat fast food" 0 1 2 3 4 5 6 7 8+. 3) "Circle the average number of times you shop for groceries each week" 0 1 2 3 4+. 4) "Circle how many days a week you eat in a campus cafeteria" 0 1 2 3 4 5 6 7.

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[2] Volunteers from the Department of Food Science and Human Nutrition, specifically faculty, graduate students and undergraduates, assisted in conducting the three 24-hour dietary recalls.

Five items assessed self-efficacy for eating fruits and five for eating vegetables. The item response categories used a Likert scale from 5 = Very Confident to 1 = Not at all Confident. For example, "I can keep vegetables on hand/readily available". These items were developed specifically with and for young collegiate adults (18-24 yr). Five items are summed to comprise a scale score (Ma et al., 2002). The Cronbach's alpha for these constructs was 0.86 for fruits, and, 0.81 for vegetables in a survey with 70 football players administered January 2002. The desired Cronbach's alpha is greater than 0.70 (Mahoney et al., 1995) and will be re-examined with the new data.

Dietary Assessment

The trained interviewers obtained three individual days of dietary recalls for weekdays from subjects over three different time periods (pre-, in- and post-) using the Multiple Pass Technique. The multiple-pass approach was designed by the USDA to maximize the completeness of dietary intake and reduce the underreporting of dietary intake recalled by a respondent (Moshfegh et al., 1999; Casey et al., 1999). Two days of intake is the minimum required to estimate day-to-day variability (Nusser et al., 1996). Interviewers also asked players, "Do you have a problem with digesting fluid milk intake, Yes or No?" Finally, players were asked to list any supplements taken, including the type of supplement and amount taken (**Appendix I**).

Dietary intakes were analyzed using the Nutritionist Pro^{TM} version 1.2 (First Databank, 2001), which contains a database of over 17,000 foods. This software permits analysis by the USDA's FGP servings (First Databank, 2001;

USDA, 1992) and was recently updated for total sugars and dietary fiber. The inclusion of total sugars in Nutritionist Pro was the key advantage for choosing this software instead of the Healthy Eating Index (HEI) by USDA (Haines et al., 1999).

The primary investigator entered all dietary recalls into nutrition analysis software immediately following their collection, and contacted the interviewers for clarification where necessary. All dietary data were entered and reviewed by the key investigator for accuracy. In addition, another dietitian reviewed in detail the entry of every third diet, and mean intakes of the three days of intake were then calculated.

The average food group servings from the FGP were calculated for the five major food groups. According to the FGP, it is recommended that active men should consume an average of 2800 Kcal-day^{-1}. Based on this energy intake, the recommended servings were: 11 servings of grain, 5 servings of vegetables, 4 servings of fruit, 3 servings of dairy and 3 servings of meat (USDA, 1992). For this study, Lean Meat Equivalents (LME) were used to determine the amount of protein in a serving when compared to one ounce of cooked lean meat. Therefore, 1 LME equals 7 g of protein and 2.5 LME are equal to 1 serving from the meat group.

A Food Group Score (FGS) was used to estimate overall diet quality. Subjects who consumed at least one half of a serving from a food group received one-point for that food group. The sum of the five different food groups of the USDA FGP constituted the Food Group Score (FGS 0-5 pt) (Schuette et al., 1996). This scoring system can be used as a quantitative tool for screening nutritional inadequacy with high sensitivity (correctly classifying nutritionally inadequate diets) (Schuette et al., 1996). In addition, the distribution of energy was also reported for carbohydrates, protein, and fat along with total grams of sugar and fat.

Mean nutrient intakes were calculated and reported as the Nutrient Adequacy Ratio (NAR). The NAR, or percentage of the Recommended Dietary Allowances (RDA) consumed, was calculated for each nutrient and the resulting value truncated at 100, so those players who consumed large amounts of food were not unfairly advantaged, over those who ate nutrient-dense diets. The RDAs for vitamins A, C, E, magnesium and folate are 900 μg RAE/day, 90 mg/day, 15 mg/day, 400 mg/day and 400 μg/day, respectively. The AIs set for calcium, vitamin D and fiber are 1000 mg/day, 5.0 μg/day and 38 g/day, respectively. The percentage of players not meeting the DRIs for these eight nutrients are reported.

The average of the NARs is reported as the Mean Adequacy Ratio (MAR), a proxy measure of diet quality. The MAR is an index of the average percent of the recommended intake of several nutrients (Krebs-Smith et al., 1989). The MAR is calculated as follows:

$$\text{MAR} = \frac{\text{sum of NAR's}}{8}$$

MAR was calculated for the following eight nutrients of interest for these players: vitamins A, C, D, E, folate, magnesium, calcium, and dietary fiber. There is no clear consensus between what MAR score is nutritionally adequate. A MAR score of 75 was chosen because it is not as conservative as 100 percent of the RDA but not as liberal as 67 percent of the RDA (Guthrie, 1989; Hoffman, 1989; Krebs-Smith et al., 1989).

These eight nutrients were selected because they were identified as important nutrients for athletes and/or low in their diets (Rokitzki et al., 1994; Johnston et al., 1998; Groff et al., 2000; Fragrakis, 2003; Drinkwater, 1996; Dook et al., 1997; Guezennec et al., 1998). These key nutrients are involved in muscle repair (Rokitzki et al., 1994), are important as antioxidants (Johnston et al., 1998; Murray et al., 1998; Benardot, 2000), play key roles in many different metabolic processes, and/or help ensure proper bone health and repair (Drinkwater, 1996; Dook et al., 1997; Guezennec et al., 1998; Groff et al., 2000; Fragrakis, 2003). In addition, several nutrients are important to reduce inflammation (Cody et al., 1988; Kanner et al., 1994; Middleton et al, 1994).

Analysis

The results were analyzed using the Statistical Package for the Social Sciences (version 10.0.5; SPSS Inc, Chicago, IL, 1999). Descriptive statistics including mean and standard deviation described the sample: time period (pre-season, in-season and post-season), age, race/ethnicity, number on scholarship, height, weight and Body Mass Index (BMI). The statistical analyses for each aim are discussed next (shown earlier in Table 4). Hypotheses were tested using data from the same 50 players for whom data were available pre-season, in-season and post-season.

<u>Aim 1</u>. To examine changes in food group intake, food patterns and self-efficacy scores for fruits and vegetables pre-season, in-season and post-season.

Differences in food group intake were examined by comparing food group scores (FGS) for the average of the same 50 players pre-season, in-season, and post-season. Analysis of Variance (ANOVA) was used to identify differences in FGS between the time periods. Food patterns were examined by the weekly frequency of breakfast consumption, grocery shopping, fast food consumption, and eating in the cafeteria. The sum of self-efficacy scores for fruits and vegetables separately were compared across times using ANOVA, with a post hoc Tukey test to determine which seasons were significantly different.

<u>Aim 2</u>: To identify the nutrient and food group intakes of varsity collegiate football players and compare intakes to dietary recommendations and determine if servings of fruits, vegetables and dairy foods predict MAR scores.

<u>H2a</u>: Means and standard deviations for servings of fruits, vegetables, and dairy were compared across the selected sample and to USDA's FGP recommendations. ANOVA was used to determine significant differences between time periods, with a post hoc Tukey test.

<u>H2b</u>: Means and standard deviations for servings of grains, LME, grams of fat and grams of total sugar were compared across the selected sample and to dietary recommendations. ANOVA was used to determine significant differences between time periods, with a post hoc Tukey test.

<u>H2c</u>: The percentage of players not meeting the DRIs for these eight nutrients was determined. The MAR scores were predicted using forward

stepwise multiple regression analysis for three days of intake, based on servings of fruits, vegetables, and dairy.

Aim 3. To identify food patterns and psychosocial factors which predict intake of fruits, vegetables, and dairy.

H3a: The intake of fruits and vegetables was predicted using forward stepwise multiple regression analysis for three days of intake, based on self-efficacy scores for eating fruits or for eating vegetables.

H3b: The intake of fruits, vegetables and dairy was predicted using forward stepwise multiple regression analysis for three days of food intake, based on food pattern scores (i.e. eating breakfast, grocery shopping, eating fast food and eating in the cafeteria).

IV. RESULTS

Subjects

The subjects' characteristics for each different time period as well as the average for all three recalls completed on the final 50 players are summarized in **Table 4.1.** Of the original sample of 73 male college football players, most were on scholarship and the majority were African American. While the study began with 73 players, a final sample of 50 players was used. Based on the average heights and weights of the players, their average BMI falls into the overweight or obese classification at all three time periods.

The loss of players was due to graduation, transferring to another school, leaving collegiate football or leaving the team due to coaching changes. To examine differences between the players who were dropped (n=23) from the study and the players included (n=50) in the final sample, refer to **Table 4.1b** (See Appendix IV). Of the final 50 players included for this study, most were still on scholarship and the majority were African American, however, it is clear that there was a slightly greater loss of African American players 17 of 41 versus White players 6 of 26. Eighteen of the 23 players who left the team were on scholarship.

Table 4.1 Demographics and anthropometrics of sample at three time periods.

	Pre-season Aug 2002 (n=73)	In-season Sept/ Oct 2002 (n=68)	Post-season Feb 2003 (n=50)
Age (yr) (X ± SD)	20.5 ± 1.4	20.6 ± 1.4	20.6 ± 1.3
Race/Ethnicity			
African American/Black	41	37	24
White	26	25	20
Latino	1	1	1
Other	5	5	5
No. on scholarship	59	55	41
Height† (in) (X ± SD)	74.2 ± 2.5	74.2 ± 2.6	74.6 ± 2.4
Weight (kg) (X ± SD)	108.0 ± 19.7	106.6 ± 19.5	112.3 ± 19.7
BMI (kg/m^2) (X ± SD)	30.1 ± 4.2	29.9 ± 4.2	31.2 ± 4.3

† The variability in height over there time periods is due to the reduction in the sample size

The one day dietary recall data for pre-season were also analyzed for differences between the African American and the Caucasian players (n=73). The results that showed that African American players ate less fruit and dairy, but more total sugar compared to white players (**Table 4.1c** see Appendix III). Caucasian players had average higher intakes of vitamin E, zinc, vitamin D and folate. Such differences might have been related to differences in food patterns observed as well. In addition the data were analyzed for differences between the offensive and defensive players. Results in **Table 4.1d** show that defensive players consumed more vitamin E and zinc (See Appendix IV). Only two players, both African American, reported they had trouble digesting milk. Neither of these players had remained on the team when the post-season data were collected and thus were not included in the final sample.

Macronutrient Intake

The average energy intake, kilocalories per kilogram of body weight, grams of carbohydrate, protein and fat, grams of protein per kilogram of body weight, along with the percentages of total kilocalories consumed is reported in **Table 4.2**. There was no significant difference between time periods in regards to energy intake kilocalories per kilogram of body weight, grams of carbohydrate, grams of protein, grams of fat or grams of protein per kilogram of body weight. The percentage of distribution changed slightly from season to season but not significantly. (See **Table 4.2b** in Appendix IV for values of all participants at each time period)

Table 4.2 Total energy intake, grams of carbohydrate, protein and fat (X ± SD) along with percentage of carbohydrate, protein and fat at three time periods†.

	Pre-season Aug 2002	In-season Sept/ Oct 2002	Post-season Feb 2003	Average for all three recalls
Total Kcal	3865 ± 1839	4201 ± 1581	3869 ± 1725	3978 ± 1308
Kcal/kg BW	37.0 ± 19.5	39.5 ± 17.3	35.8 ± 17.5	37.5 ± 14.7
Carbohydrate (g)	446.2 ± 248.5	495.0 ± 169.2	491.7 ± 231.1	477.6 ± 162.7
Protein (g)	166.7 ± 85.9	164.5 ± 83.2	141.5 ± 59.7	157.6 ± 56.8
Grams Pro/kg BW	1.6 ± 0.9	1.5 ± 0.8	1.3 ± 0.6	1.5 ± 0.6
Fat (g)	159.7 ± 83.9	175.8 ± 86.0	149.8 ± 89.1	161.8 ± 62.9
% Carbohydrate	45	49	50	48
% Protein	18	15	16	16
% Fat	37	36	34	36

† No significant difference between time periods.

Food Patterns (for Aim 1)

Table 4.3 summarizes the food patterns for the 50 male collegiate football players for the pre-season, in-season, and post-season. Food patterns significantly related to time of year included eating more at fast food restaurants pre-season and shopping for groceries the least during football season. (See **Table 4.3b** in Appendix IV for values of all participants at each time period.)

Table 4.3 Food patterns (X ± SD) of sample at three time periods (n=50).

	Pre-season Aug 2002	In-season Sept/ Oct 2002	Post-season Feb 2003	Average for all three recalls
Avg No. days eating in cafeteria/wk	3.9 ± 2.4	4.8 ± 2.1	3.9 ± 2.1	4.2 ± 1.6
Avg No. times eating breakfast/wk	4.7 ± 1.9	4.1 ± 1.6	4.1 ± 1.9	4.3 ± 1.5
Avg No. times eating fast food/wk	4.1 ± 2.0^{x}	3.4 ± 1.4^{xy}	3.1 ± 1.6^{y}	3.6 ± 1.3
Avg No. times grocery shop/wk	4.3 ± 2.0^{x}	2.9 ± 1.3^{y}	3.5 ± 1.9^{xy}	3.6 ± 1.4

^{xy} Different superscripts in the same row (x,y) indicate significant difference (p<0.01) between time periods.

Self-efficacy (for Aim 1)

The average scores from the self-efficacy questionnaire are summarized in **Table 4.4** regarding the self-confidence to select fruits or vegetables. The only item which changed by season was the confidence of the players to keep fruit readily available or on hand (p<0.05) which increased progressively from pre-season to in-season to post-season. (See **Table 4.4b** in Appendix IV for values of all participants at each time period.)

Table 4.4 Self-efficacy† for eating fruits or eating vegetables of sample at three time periods (n=50).

	Pre-season Aug 2002	In-season Sept/ Oct 2002	Post-season Feb 2003	Average for all three recalls
FRUITS	α = 0.8127	α = 0.8591	α = 0.8090	α = 0.8668
I can keep FRUITS on hand/readily available	3.0 ± 1.1^{x}	3.2 ± 1.0^{xy}	3.5 ± 1.0^{y}	3.2 ± 0.8
I can eat the recommended number of servings of FRUITS when I eat on my own	3.2 ± 1.1	3.2 ± 1.1	3.3 ± 1.0	3.3 ± 0.9
I can shop for a variety of FRUITS	3.4 ± 1.2	3.2 ± 1.2	3.7 ± 1.0	3.4 ± 0.9
I can make time to eat FRUITS	3.7 ± 1.0	3.4 ± 1.2	3.6 ± 1.0	3.6 ± 0.7
When I eat at home, I can eat more FRUITS	3.6 ± 1.3	3.3 ± 1.3	3.6 ± 1.2	3.5 ± 0.8
Sum score for FRUITS	16.8 ± 4.2	16.3 ± 4.6	17.6 ± 4.0	16.9 ± 3.4
VEGETABLES	α = 0.8224	α = 0.8621	α = 0.8622	α = 0.8935
I can keep VEGETABLES on hand/readily available	2.8 ± 1.1	3.0 ± 1.0	3.1 ± 1.1	3.0 ± 0.9
I can eat the recommended number of servings of VEGETABLES when I eat on my own	2.8 ± 1.0	2.8 ± 1.1	3.2 ± 1.2	2.8 ± 0.9
I can shop for a variety of VEGETABLES	3.0 ± 1.2	3.1 ± 1.2	2.8 ± 1.1	3.1 ± 1.1
I can make time to eat VEGETABLES	3.2 ± 1.1	3.0 ± 1.1	3.0 ± 1.3	3.1 ± 0.8
When I eat at home, I can eat more VEGETABLES	3.1 ± 1.4	2.9 ± 1.3	3.0 ± 1.4	3.0 ± 1.0
Sum score for VEGETABLES	14.9 ± 4.5	14.9 ± 4.6	15.1 ± 4.9	14.9 ± 4.0

† Scored on a 5 point Likert scale; 1 = "Not at all confident", 5 = "Very confident"

xy Different superscripts in the same row (x,y) indicate significant difference ($p<0.05$) between time periods.

When the questions were analyzed for reliability, a Cronbach's alpha of greater than 0.80 was obtained for the five questions regarding fruits and the five questions regarding vegetables for all three seasons as well as when the three days were averaged together. A Cronbach's alpha greater than 0.70 shows good reliability (Howell, 2002) and thus, this study shows that the self-efficacy questions had internal consistency and the results obtained from these questions is reliable and reproducible.

Food Group Scores and FGP Servings (for Aims 1 & 2)

In **Table 4.5** is reported the FGS and the servings of fruit, vegetables and dairy for the male collegiate football players. The pre-season FGS were significantly less than in-season compared to post-season ($p<0.01$). This difference was driven primarily by low fruit intake pre-season. Compared to the FGP recommendations for active men, the average servings of fruits and vegetables were below recommendations for all three seasons. Average servings of dairy were below the recommended only for the pre-season. (See **Table 4.5b** in Appendix IV for values of all participants at each time period.)

Table 4.5 Food Group Scores, servings of fruit, vegetables and dairy(X ± SD) of sample at three time periods (n=50).

	Pre-season Aug 2002	In-season Sept/ Oct 2002	Post-season Feb 2003	Average for all three recalls
Food Group Scores (0-5)†	4.0 ± 0.7^x	4.4 ± 0.7^y	4.5 ± 0.7^y	4.3 ± 0.4
Fruit svg (4 rec)	1.2 ± 2.6^x	3.2 ± 3.7^y	3.1 ± 3.5^y	2.5 ± 2.3
Vegetable svg (5 rec)	3.8 ± 3.8	3.6 ± 3.0	3.8 ± 4.4	3.7 ± 3.1
Dairy svg (3 rec)	2.7 ± 2.6	4.1 ± 5.0	3.2 ± 2.9	3.3 ± 2.9

†One point awarded for each food group if at least one half of a serving was eaten from that food group

^{xy} Different superscripts in the same row (x,y) indicate significant difference ($p<0.01$) between time periods.

The increase in fruit intake from pre-season to in-season and post-season might be attributed to players being on campus on regular basis and eating more in the cafeteria with ready availability of fruit and juices. In relation to the FGP recommendations for active men, the average number of servings for the three days combined was below the recommended nine servings for fruits and vegetables. The athletes' consumption was 1.5 servings below the recommended servings for fruits and 1.3 servings for vegetables. So while consumption did increase during the school year, these players were still considerably below the daily recommended number of servings.

Table 4.6 shows the reported information for servings of grain and LME, along with the total grams of sugar and grams of fat for the three different time periods. Interestingly, the pre-season servings of LME were significantly higher than the servings post-season ($p<0.01$). This was the only change over the seasons, but the variances were quite large. The average intakes of total sugar were quite high approaching 240 grams in-season (nearly 1000 Kcal per day).

Average fat grams in-season of 176 would be about 1500 Kcal per day. Thus, total grams of sugar and fat comprised the majority of energy for players in-season. (See **Table 4.6b** in Appendix IV for values of all participants at each time period.)

Table 4.6 Servings of grains and LME, total grams of sugar and fat and energy (X ± SD) of sample at three time periods (n=50).

	Pre-season Aug 2002	In-season Sept/ Oct 2002	Post-season Feb 2003	Average for all three recalls
Grain svg (11 rec)	11.8 ± 8.8	10.3 ± 4.9	10.0 ± 5.6	10.7 ± 5.1
LME svg (7.5 rec)	16.8 ± 10.9^{x}	14.1 ± 8.7^{xy}	11.8 ± 5.5^{y}	14.2 ± 5.4
Total Sugar (g)	185.8 ± 151.6	238.5 ± 105.6	234.3 ± 137.6	219.5 ± 93.1
Fat (g)	160.0 ± 83.9	175.8 ± 86.0	149.8 ± 89.1	161.8 ± 62.9
Total Kcal	3865 ± 1839	4201 ± 1581	3869 ± 1725	3978 ± 1308

^{xy} Different superscripts in the same row (x,y) indicate significant difference ($p<0.01$) between time periods.

The decrease in LME was continual from pre-season to in-season to post-season. This could be due to the increased consumption of food from the cafeteria resulting in a greater variety of choices, the decrease in eating of fast food, as well as changes in training needs for post-season. While there was a decline in consumption of LME, it needs to be kept in mind that they were still consuming 4.3 servings above the recommended.

The percent of players meeting the DRI for vitamins A, C, D and E, folate, calcium, magnesium and fiber is shown in **Table 4.7**. There was no significant difference between the seasons for the eight nutrients used to calculate the MAR scores. Even though there was no significant difference between seasons, there were several nutrients for which a large percentage of players did not consume the recommended intake according to the DRIs. Of special concern were low numbers of players meeting DRI's for vitamins D, E, folate, calcium, magnesium and fiber.

Table 4.7 Percent of players (n=50) meeting the DRI for selected nutrients at three different time periods.

Nutrient	DRI	Pre-season Aug 2002	In-season Sept/ Oct 2002	Post-season Feb 2003	Average for all three recalls
Vitamin A (µg)	900	48	54	50	54
Vitamin C (mg)	90	54	70	76	86
Vitamin D (µg)	5	38	32	36	40
Vitamin E (mg)	15	16	34	32	32
Folate (µg)	400	42	44	40	48
Calcium (mg)	1000	58	64	64	70
Magnesium (mg)	400	30	36	32	34
Fiber (g)	38	12	6	4	2
Protein (g)	63	94	94	94	100
Iron (mg)	8	88	96	90	100
Zinc (mg)	11	62	80	70	72

MAR Scores of Final Sample (for Aim 2)

The NAR and MAR scores for the 50 players that completed all three recalls are reported in **Tables 4.8** and **4.9**. In Table 4.8 are the scores without including supplements in the calculations.

Table 4.8 Average NAR[a] and MAR[b] scores without supplements (X ± SD) for the final sample (n=50) at three time periods.

	Pre-season August 2002	In-season September/ October 2002	Post-season February 2003	Average three days of dietary recalls
NAR score (cut at 100)				
Vitamin A	67.9 ± 34.5	81.3 ± 26.6	78.6 ± 27.7	75.8 ± 30.2
Vitamin C	73.7 ± 32.7	84.2 ± 27.3	86.5 ± 26.6	81.5 ± 29.3
Vitamin D	48.1 ± 42.9	52.8 ± 41.8	51.3 ± 43.1	50.7 ± 42.4
Vitamin E	49.7 ± 32.0^{x}	62.5 ± 34.8^{xy}	65.8 ± 32.6^{y}	59.3 ± 33.7
Folate	65.3 ± 33.0^{x}	80.5 ± 26.9^{y}	69.5 ± 31.5^{xy}	71.8 ± 31.1
Calcium	82.1 ± 28.5	88.0 ± 22.5	84.6 ± 23.8	84.9 ± 25.0
Magnesium	65.3 ± 32.0	75.0 ± 28.0	73.7 ± 26.6	71.3 ± 29.1
Fiber	39.1 ± 15.4	33.1 ± 14.9	36.8 ± 16.6	36.3 ± 15.7
MAR Score	61.3 ± 20.2	69.7 ± 17.4	68.4 ± 16.0	66.4 ± 18.1

[a]NAR = (Intake of Nutrient/DRI for that nutrient)*100 If the value was greater than 100 then truncated.

[b]MAR = (Sum of NARs / 8)*100

[xy] Different superscripts in the same row (x,y) indicate significant difference ($p<0.05$) between time periods.

There was a significant increase in vitamin E intake from pre-season to in-season, which may have been due to establishing a more regular eating pattern during the academic school year. For this same possible reason, there was a significant increase in the intake of folate from pre-season to post-season. The MAR scores were all less than 70 without supplements, indicating nutritionally poor diets.

Table 4.9 NAR[a]/MAR[b] scores with supplements† ($\bar{X} \pm SD$) for final sample (n=50) at three time periods‡.

	Pre-season August 2002	In-season September/ October 2002	Post-season February 2003	Average three days of dietary recalls
NAR score (cut at 100)				
Vitamin A	69.0 ± 34.8	81.3 ± 26.6	78.7 ± 27.8	76.4 ± 21.3
Vitamin C	77.3 ± 31.9	85.1 ± 27.0	86.8 ± 26.7	83.1 ± 18.2
Vitamin D	51.9 ± 43.1	52.8 ± 41.8	53.2 ± 43.0	52.7 ± 32.9
Vitamin E	55.0 ± 34.2	63.8 ± 35.0	66.9 ± 32.9	61.9 ± 22.9
Folate	68.0 ± 33.9	81.5 ± 26.7	69.5 ± 31.5	73.0 ± 23.2
Calcium	82.1 ± 28.5	88.0 ± 22.5	84.6 ± 23.8	84.9 ± 17.5
Magnesium	65.8 ± 32.3	75.5 ± 28.2	73.7 ± 26.6	71.6 ± 21.5
Fiber	39.1 ± 15.4	33.1 ± 14.9	36.8 ± 16.6	36.3 ± 10.4
MAR Score	63.5 ± 24.9	70.1 ± 20.0	68.8 ± 19.2	67.5 ± 16.2

[a]NAR = (Intake of Nutrient/DRI for that nutrient)*100 If the value was greater than 100 then truncated.

[b]MAR = (Sum of NARs / 8)*100

† Twinlab Daily One multivitamin (n=1), One-A-Day multivitamin (n=3), Shaklee Vita-lea multivitamin (n=1), Centrum Silver multivitamin (n=1), Schiff vitamin B12 (n=1), Schiff vitamin C (n=2), Shaklee Echinacea (n=1), Myoplex shake (n=1), Flinestones multivitamin (n=1), and EAS precision protein (n=1)

‡ No significant difference between time periods.

Only eight of the 50 players reported taking supplements. A few of these eight took more than one supplement, which accounts for the discrepancy in the number of subjects shown in **Table 4.9**. When the supplemental nutrients were added to the MAR scores, there was no significant difference in any of the time periods or for the three days combined.

Correlation Matrix

In preparation for running the multiple regressions, a correlation matrix was run for key variables of interest (**Table 4.10**). MAR scores moderately correlated with the Food Group Score and eating breakfast ($r = 0.53$ & 0.59 respectively, $p<0.01$) as well as with servings of fruit, vegetable, grain, dairy, and meat, and grams of fat. Fruit was weakly correlated with MAR score, grams of sugar, grams of fat, and self-efficacy for eating fruit. Vegetable intake correlated with fat grams ($r = 0.61$, $p<0.01$) and weakly with self-efficacy for eating vegetables. Interestingly, self-efficacy for eating vegetables negatively correlated with eating fast foods ($r = -0.46$, $p<0.01$) and self-efficacy for eating fruits weakly correlated with eating in the cafeteria ($r = 0.28$, $p<0.05$) – both findings supporting the importance of environmental influences with this population.

Table 4.10 Correlation matrix for multiple variables (n=50; three days of recall).

	FGS	Svg Fruit	Svg Vegetable	Svg Grain	Svg Dairy	Svg LME	MAR score	Sugar (g)	Fat (g)	Eat Breakfast	Grocery Shop	Eat Fast Food	Eat in Cafeteria	Sum SE Fruit	Sum SE Vegetable
FGS	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Svg Fruit	0.577**	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-
Svg Vegetable	0.352*	0.461**	1.000	-	-	-	-	-	-	-	-	-	-	-	-
Svg Grain	0.263	0.127	0.234	1.000	-	-	-	-	-	-	-	-	-	-	-
Svg Dairy	0.093	0.038	0.152	0.296*	1.000	-	-	-	-	-	-	-	-	-	-
Svg LME	0.069	0.104	0.235	0.556**	0.447**	1.000	-	-	-	-	-	-	-	-	-
MAR score	0.533**	0.326*	0.323*	0.544**	0.517**	0.432**	1.000	-	-	-	-	-	-	-	-
Sugar (g)	0.187	0.308*	0.332*	0.298*	0.317*	0.236	0.151	1.000	-	-	-	-	-	-	-
Fat (g)	0.363**	0.308*	0.606**	0.563**	0.553**	0.668**	0.521**	0.470	1.000	-	-	-	-	-	-
Eat Breakfast	0.332*	0.071	0.083	0.419**	0.344*	0.149	0.593**	-0.016	0.258	1.000	-	-	-	-	-
Grocery Shop	-0.202	-0.183	-0.079	0.045	0.275	0.038	-0.126	0.054	0.029	-0.024	1.000	-	-	-	-
Eat Fast-food	0.001	-0.155	-0.002	0.206	0.029	0.111	-0.117	0.198	0.225	-0.164	-0.056	1.000	-	-	-
Eat in Cafeteria	0.188	0.082	0.029	0.163	0.153	0.239	0.382**	-0.010	0.222	0.120	-0.128	-0.195	1.000	-	-
Sum SE Fruit	0.142	0.288*	0.244	-0.055	0.003	-0.042	0.134	0.182	0.090	-0.118	0.124	-0.043	0.281*	1.000	-
Sum SE Vegetable	0.128	0.350*	0.311*	-0.154	-0.165	-0.059	0.115	-0.014	0.008	0.023	0.144	-0.459**	0.223	0.703**	1.000

* $p<0.05$, ** $p<0.01$

Prediction of MAR Scores from Servings of Fruit, Vegetables and Dairy (for Aim 2)

Servings of dairy and servings of fruit predicted the average MAR scores for three days of intake (**Table 4.11**). Dairy servings alone accounted for approximately 24% of the variability in MAR scores for the 50 football players. When servings of fruit were added to the model, the R squared increased to 33%. The addition of servings of vegetables did not cause a large enough change in R square to warrant adding it to the model.

Table 4.11 Stepwise multiple regression models for the prediction of MAR scores using servings of fruit, vegetables and dairy (n=50; 3 days of recalls).

	Model 1		Model 2	
	b	β	*b*	β
Dairy Svg	2.886***	0.486	2.816***	0.474
Fruit Svg	-	-	2.277*	0.31
Intercept	65.004		59.497	
F	14.856***		11.683***	
R2	0.236		0.332	

*p<0.05, **p< 0.01, ***p < 0.001

While not one of the aims, it was tested to see if total grams of sugar and total grams of fat, sum of self-efficacy scores and food patterns would predict MAR scores. Eating breakfast accounted for 35% variance in MAR scores, eating fat and eating in the cafeteria increased the prediction to 56% variance of MAR scores (See Appendix IV for **Table 4.11b** for the results). Environmental factors predicted MAR scores better than psychosocial factors for players.

Prediction of Fruit or Vegetable Intakes from Self-efficacy Questions (for Aim 3)

Only 8% of the variance in fruit intake was predicted by the self-efficacy scale for fruits (**Table 4.10**), but the item "I can eat the recommended number of servings of FRUITS when I eat on my own" predicted the servings of fruit for three days of intake (**Table 4.12**). The one self-efficacy item was responsible for 15% of the variability in fruit servings for the football players.

Table 4.12 Stepwise multiple regression models for the prediction of fruit servings using self-efficacy questions (n=50; 3 days of recalls).

	Model 1	
	b	β
SEfrt2[a]	1.023**	0.39
Intercept	-0.826	
F	8.612**	
R2	0.152	

** $p < 0.01$

[a]SEfrt2 = I can eat the recommended number of servings of FRUITS when I eat on my own

Ten percent of the variance in vegetable intake was predicted by the self-efficacy score for vegetables (**Table 4.10**). Again one item, "I can shop for a variety of VEGETABLES" predicted 11% of the variance of the servings of vegetables (**Table 4.13**).

Table 4.13 Stepwise multiple regression models for the prediction of vegetable servings using self-efficacy questions (n=50; 3 days of recalls).

	Model 1	
	b	β
SEveg3[a]	0.944*	0.326
Intercept	0.815	
F	5.701*	
R2	0.106	

*p < 0.05

[a]SEveg3 = "I can shop for a variety of VEGETABLES"

Prediction of Fruit, Vegetable and Dairy Intake from Food Patterns (for Aim 3)

Multiple stepwise regression analysis showed that none of the food pattern questions predicted the intake of fruits or vegetables for three days of intake. However, eating breakfast and grocery shopping did predict the intake of dairy (**Table 4.14**). It showed that the number of times they ate breakfast each week accounted for 12% of the variability in servings of dairy for the 50 football players. When the number of times they went grocery shopping each week was added to the model, R square increased to 20%.

Table 4.14 Stepwise multiple regression models for the prediction of dairy servings using food patterns (n=50; 3 days of recalls).

	Model 1		Model 2	
	b	β	*b*	β
Eating breakfast	0.653*	0.344	0.666*	0.35
Grocery shopping	-	-	0.583*	0.283
Intercept	0.543		-1.585	
F	6.425*		5.806**	
R2	0.118		0.198	

*p<0.05, **p< 0.01, ***p < 0.001

V. DISCUSSION

This study clearly demonstrated that an athlete consuming a large number of kilocalories each day does not necessarily obtain the correct amount and/or type of nutrients needed for optimum performance and recovery. This study was the first to examine food intakes by food groups and food group scores, specifically fruits, vegetables and dairy foods for collegiate football players, as well as, their food patterns and self-efficacy to eat fruits and vegetables. Surprisingly, high percentages of athletes consumed less than the DRI for key nutrients: vitamins A, D, E, folate, magnesium and fiber. Although caloric intakes, and intakes of meat and grain group foods were high, average intakes were lower than the recommended amounts for fruits and vegetables. A few athletes had very good diets characterized by eating more than nine servings of fruits and vegetables and more than four servings of dairy. Food patterns of frequent breakfast skipping and fast food eating were similar to those by other college students (Georgiou et al., 1997).

This study reported slightly higher energy intakes (3973 Kcal) than most previous studies on male collegiate athletes, which have ranged from 2965 to 3696 Kcal (Clement et al., 1982; Short et al., 1983; Hickson et al., 1987; Niekamp et al., 1995). Findings reinforced that these male collegiate athletes consumed one and one-half times as many calories as the average male student. This is to be expected with higher energy needs due to increased physical demands placed on athletes in general and especially in football players.

One might believe, that with such a high level of energy intake, these athletes would have adequate intakes of the nutrients necessary for optimum performance and recovery. The results of this study showed that less than 55% of the players met the DRI for six out of eight nutrients: vitamins A, D, E, folate, magnesium and fiber; 86% of the players met the DRI for vitamin C and 70% for calcium. These findings are in contrast to the few studies earlier that reported only high average mean intakes (Short et al., 1983; Hickson et al., 1987; Niekamp et al., 1995).

Nutritional supplements might correct for nutritional deficiencies. Only eight players (16%) reported taking some form of nutritional supplement, a surprisingly low percentage compared to nearly 50% reported in the NCAA study and others (NCAA, 2001; Newberry et al., 2001). This addition of supplements did not alter the mean MAR scores for the players. Although male college football players consumed diets high in kilocalories, many were still low in several key micronutrients necessary to optimal performance and recovery. The average Mean Adequacy Ratio for three seasons was only 67.5.

Compared to other male college students on the same campus six years earlier, these football players consumed more servings of LME, similar servings of grain and fewer servings of fruits, vegetables and dairy (Song et al., 1996). It its not surprising that the players consumed more meat, because of the widespread belief that eating more protein is necessary for muscle building (Lemon, 1998; Paul et al., 1998). However, the marked differences in fruit, vegetable and dairy intake were surprising. These findings support that most of these college football players did not achieve the dietary variety necessary for nutrients needed for optimal performance. The low dairy intakes might have been due in part to lactose intolerance. Although all players except two responded negatively to, "Do you have trouble digesting fluid milk?" Some players later said that they didn't drink milk even though they had no trouble digesting it.

In addition to low intakes of fruits and vegetables, and marginal intakes of dairy foods, total grams of sugar and fat were very high for these athletes. Over half of the daily kilocalories were from to sugar and fat, and the athletes omitted one entire food group on average.

The low intake of fruits and vegetables reported was anticipated and athletes were neutral in their confidence towards eating fruits and vegetables, which remained unchanged over the three time periods. This may indicate that the players may not value or are not conscious of their dietary food choices. A study by Horacek et al. reported that, for young adults, self-efficacy towards eating fruits and vegetables was the best predictor in determining the stage of readiness to eat these foods (2002). The lack of predictors for fruit and vegetable intake is in direct contrast to other studies where self-efficacy predicted up to 25% variance of intake (Baranowski et al., 1999). This could be secondary to the players not valuing or being concerned with fruit and vegetable consumption. No change in self-efficacy scores over the three time periods, suggests that players were not concerned about consumption of fruits and vegetables. The significant increase in fruit servings from pre-season to post-season was encouraging, but likely just due to easy availability of juices in the residence hall cafeteria. Research by Smart and Bisogni demonstrated that college hockey players changed the reasons for their food choices according to the season of play or training (2001). Many things interact to influence food choices of college athletes. Nutritionists and food service staff must be aware of how access to food and types of food available affect the food choices of athletes (Smart et al., 2001). Health professionals and coaches need to find ways to help athletes perceive the benefits of eating fruits and vegetables to their performance and finds ways to make them easily available.

Frequency of breakfast consumption and grocery shopping occasions both positively predicted dairy intake. The more often a player ate breakfast and shopped for groceries, the greater was his intake of dairy foods. Players who ate breakfast likely ate more cereal with milk; a finding often found with breakfast eating (Nicklas et al., 1998).

Athletes in this study ate fast food 3.6 times a week similar to that reported by male college students in general (4.1 times/wk) by Georgiou et al. (1997). McArthur and colleagues reported 55% of college students (both male and female) ate out anywhere from one to three times per week (2002). In our study there was a decline in frequency of eating fast foods from pre-season to in-season, coinciding with the increase in consumption of meals from the cafeteria.

Even though fast food consumption decreased in-season, frequency of breakfast consumption tended to decline from pre-season to in-season, although not significantly. The average number of days breakfast was consumed for the three recalls combined was 4.3 times, similar to the 4.1 times per week Georgiou and colleagues reported for male college students (1997). An earlier study of male college students in an introductory nutrition course (n=607) on the same campus found 20% of male students skipping breakfast (Huang et al., 1994).

Examinations of the overall dietary intake and food patterns, there was an improvement from pre-season to the two seasons during the academic school year. The improvement may be due to players going from a non-structured routine into a more structured one. A tight schedule of practices along with classes may have lead to more regular eating behaviors, possibly resulting in the improving dietary quality. The only eating pattern that did not show improvement was the number of times the players ate breakfast during the week. The decline from pre-season to in- and post-season might have been a result of the players' early morning weight lifting schedules, classes, and/or a desire to attain more sleep.

Strengths and Limitations

This was the first to study a large sample of collegiate football players since 1983. It is also the first quantitative study to focus on food group intake and food pattern differences across training seasons. Furthermore, this was the first study to investigate football players' intake of specific nutrients key to performance and recovery. Additionally, an entire varsity football team was recruited, and not just players from a certain position. Because the coaching staff insisted that all players participate, no players were lost due to refusal to complete the assessments. To date, no other study has reported dietary patterns of athletes or self-efficacy to eat fruits or to eat vegetables.

There were several limitations to this study. First, it was not possible to include the freshmen players, because they arrived later in August than the varsity players. Because freshmen had more tests to complete during their physicals, there was no opportunity to examine their pre-season diets prior to the fall semester. Although originally planned, it was not feasible to capture the weekend days of food intake as recommended due to the tight schedule of players. Due to the coaching staff's strong encouragement for all players to participate in the study, all players might not have been highly motivated. The players' BMI classified them into the overweight or obese category, but we were not able to use or obtain measurements of body fatness such as skinfolds, bioelectrical impedance, or underwater weighing to determine if they were actually obese, or if the higher BMI was due to lean mass. There was also a decline in the sample size between the first and second and the second and third assessments. This was due to seniors graduating, players transferring, players choosing to stop playing football and some players leaving to due changes in coaching staff. Finally, it would have been desirable to have three days of food intake from each season, but this was not possible due to training and playing schedules.

VI. CONCLUSIONS AND IMPLICATIONS

A. Conclusions

Dietary intakes and food patterns of these collegiate football players provides evidence that athletes' food intake and dietary patterns do change slightly from pre-season to in-season and post-season. The greatest changes were from pre-season to the two seasons during the academic year with diets and food patterns improving except for the consumption of breakfast.

As hypothesized, fruit and vegetable servings were substantially less than the FGP recommendations for active men. However, average intakes of grain and dairy met the minimum servings recommended while LME greatly exceeded the recommended number of servings. Total grams of sugar and fat were high and accounted for 59% of total energy intake. Many athletes were below the DRI for the eight selected nutrients resulting in low nutrient adequacy scores. The variance in the MAR scores was predicted by intake of fruits and dairy, but not vegetables.

Self-efficacy scores for eating fruits or for eating vegetables predicted only 8% and 10% of the variance in fruit and vegetable consumption, respectively. This was because only two items for fruit and one item for vegetables were significant predictors. In regards to food patterns predicting fruit, vegetable, and dairy intake, the results did not fully support the hypotheses. None of the food patterns predicted fruit or vegetable intake, but eating breakfast and grocery shopping were the two food patterns that predicted dairy intake. Players who ate in the cafeteria and eat breakfast did have better diet quality scores.

Implications

Findings from this study have the following implications for future studies.

1) Because there is little research on collegiate football players' food patterns and their self-efficacy towards fruit and vegetable consumption, the findings need to be confirmed by other studies. Perhaps attention should be directed towards the social and physical environments for healthy food choices.

2) Nutrition education and counseling for collegiate football players should focus on diets based on the Food Guide Pyramid recommendations for active men, especially fruits, vegetables, dairy and whole grains.

3) For players concerned with losing weight, these findings show that they could reduce fat and sugar consumption without sacrificing nutrients.

4) It could be speculated that with increased knowledge about the benefits of fruits, vegetables and dairy foods, those athletes concerned with optimum performance and recovery might increase their consumption.

APPENDICES

APPENDIX I

We would like to ask about everything you ate and drank, including water, within a 24-hour period. We will ask you to include all ingredients for each food, so that the diet can be analyzed with few errors. You may stop the 24-hour recall at any time without penalty or refuse to answer particular questions. All answers are completely coded for anonymity. We can only use the group's answers, not individual ones. Participation in this study is voluntary and by completing this survey, you indicate your consent to include your anonymous responses in this study.

Please answer honestly and completely. The 24-hour recall takes 15-20 minutes to complete.

Thank you again for your assistance.

You can request information regarding the project at any time from Sharon L. Hoerr RD, PhD at 355.8474 (ext 110) or hoerrs@msu.edu and Susan Gunnink, RD at 355.8474 (ext 156) or gunninks@msu.edu , Department of Food Science and Human Nutrition. If you have any questions about being a human subjects of research you may contact the University Committee on Research Involving Human Subjects, Chair, Ashir Kumar, MD at 355.2180 or UCRIHS@msu.edu .

You need a secret code so we can match your responses with other assessments, but still not know your name. To design your code, please fill in the six boxes below.

The first four boxes should contain the month and date you were born (i.e. January 7th would be 0 1 0 7). The last two boxes are the last two digits of your student identification number. By filling in these boxes you are giving your informed consent to this study.

Birth date

☐ ☐ ☐ ☐ ☐ ☐

Month date last 2 digits of your student I.D.

A Few Questions About You...

1. How old are you? ___________

2. Circle your position OL LB DL RB DB QB WR K P
   Other (please specify)_____________

3. Height ___ft. _____in. Weight _______lb.

4. Circle where you live: Residence Hall Apartment House

5. Circle how many days a week you eat in a campus cafeteria
   0 1 2 3 4 5 6 7

6. What year in school are you? (circle the number)
   1. Freshman
   2. Sophomore
   3. Junior
   4. Senior
   5. Grad

7. Are you on scholarship? Yes No (circle one)

8. Circle the average number of times a week you eat breakfast
   0 1 2 3 4 5 6 7

9. Circle the number of times a week you eat at a fast food place
   0 1 2 3 4 5 6 7 8+

10. Circle how many times per month do you go grocery shopping
    0 1 2 3 4 5 6 7 8+

11. What is your race/ethnicity?

_____ African American or Black
_____ White
_____ Latino
_____ Other (please specify)______________________

Thank You for Your Time!

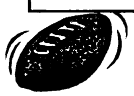
Please circle the number on a scale of 1-5 that most reflects **how confident** you feel about **being able to consume the recommended number of servings** for Fruits and Vegetables. The recommended number of servings is : 2 servings of Fruits a day and 3 servings of Vegetables a day.

Circle the best response from:

1=not at all confident 2 = not too confident 3=somewhat confident

4= confident 5=very confident

I feel:		Confidence Not at all				Very
Ex: *I can eat ______ to benefit my health.*	Fruits **Vegetables**	1 1	2 2	3 3	4 4	5 5
1. I can keep ______ on hand/readily available.	Fruits **Vegetables**	1 1	2 2	3 3	4 4	5 5
2. I can eat the recommended number of servings of _____ when I eat on my own.	Fruits Vegetables	1 1	2 2	3 3	4 4	5 5
3. I can shop for a variety of _____.	Fruits **Vegetables**	1 1	2 2	3 3	4 4	5 5
4. I can make time to eat _____.	Fruits **Vegetables**	1 1	2 2	3 3	4 4	5 5
5. When I eat at home, I can eat more _____.	Fruits **Vegetables**	1 1	2 2	3 3	4 4	5 5



Instructions on Dietary Assessment: As you wait to see the nutritionist, please start thinking and writing down the foods you ate yesterday. Write this information in the form provided.

ID# ______________ Position____________________ DATE____________

Interviewer's Name _______________________ Normal Day? Y N

Time of Day	Food & Drink Description	Amount	Food and Drink Additions

Do you have a problem with digesting fluid milk intake? YES NO

Supplements taken (please list what and amount):

____

____

____

APPENDIX II

24 Hour Recall: USDA Multiple Pass Method

First Pass: Uninterrupted, participant chronological listing of all foods

- "What was the 1st thing you ate after you got up yesterday?"
- Allow extra space for later additions on the recall form.
- Record only foods now; don't worry about portion sizes or other details yet, but record what ever they mention.
- Don't interrupt.

Second Pass: Food Details Probed

- Probe with open ended questions.
- Obtain four kinds of information about each food or beverage.
  - KIND OF FOOD OR BEVERAGE (fresh, frozen, or canned vegetable; skim, 2%, or whole milk).
  - PREPARATION OF FOOD (fried or baked; any added ingredients, such as butter or salt).
  - PORTION SIZE OF FOOD (may underestimate). Use nutrition food models to help with portion size (For Example, ask to see the glass used). Be sure EVERY item has some unit of measure.
  - HOW SERVED (was butter, sugar, gravy, or salt added at the table?).

Last Pass: Final Day's Review

- Ask for additions or corrections.
- Add nutritional supplements or vitamins.
- Finally, thank the participant for their time.

A Quick Reminder...

- Your approach to asking the questions is important. The questions that you are asking may seem somewhat invasive of the privacy and the participant may be sensitive to the questions being asked.

- Do NOT be judgmental.

- Be aware of either verbal or non-verbal signals that could show approval or disapproval of any information the participant is sharing with you.

- Keep the questions in simple terms so you do not confuse or intimidate the participant.

- Keep questions open ended so the participant will feel comfortable to say more.

- Ask about activities that occur during food consumption or vice versa. For example, What were you doing when you ate the piece of pizza?

- You only need to know what food they ate, NOT what food was served.

- Make sure to write down the correct amounts and type of food.

- Anticipate interruptions and try to resume the recall as soon as possible.

APPENDIX III

Table 2.2 Information obtained from a preliminary study on collegiate football players (n=19)

Player	Position*	BMI	Kcal	Kg BW	(Kcal/Kg BW)	Fruit	Vegetables	LME	Dairy	Grains	Sugar (g)	Fat (g)
1	C	38.0	4234	141.8	30	0.0	13.0	4.4	4.0	13.5	261	198
2	DT	37.7	4027	133.2	30	7.0	0.0	13.5	2.0	14.0	184	180
3	OG	37.1	4169	141.8	29	4.5	0.8	15.7	1.0	17.5	298	130
4	OG	36.3	1611	139.1	12	2.0	1.5	1.5	0.5	9.5	118	27
5	OT	36.1	2918	141.8	21	0.0	0.0	30.5	0.5	3.5	75	165
6	DT	35.1	2974	127.3	23	1.5	0.8	15.7	1.0	11.0	174	72
7	OG	34.9	2545	140.5	18	0.0	0.0	29.2	0.5	4.5	59	133
8	OL	34.7	2026	136.4	15	5.0	0.0	6.0	2.0	8.0	114	81
9	DT	34.7	3123	129.5	24	4.0	4.5	7.1	0.0	7.5	232	115
10	FB	34.5	5726	109.1	52	8.0	8.0	17.8	3.0	12.0	183	231
11	LB	34.5	5075	118.6	43	6.5	5.5	10.8	2.0	8.3	227	239
12	DL	32.6	2882	128.2	22	2.0	2.5	4.5	1.3	3.3	171	99
13	LB	30.7	3298	111.4	30	6.5	0.0	17.2	2.5	5.5	157	158
14	FB	28.3	6276	100.0	63	14.5	4.0	24.5	5.5	13.0	128	241
15	DL	27.9	4026	106.8	38	0.0	8.0	9.0	4.0	9.0	209	116
16	QB	26.8	5288	92.3	57	6.3	2.3	9.9	6.5	13.0	216	243
17	TB	25.4	3030	75.9	40	5.0	2.0	5.3	6.5	9.0	107	103
18	WR	24.6	2314	82.3	28	1.5	0.0	17.8	1.5	12.0	60	100
19	N/A	21.0	6504	76.4	85	4.8	0.0	13.9	10.5	19.5	229	306
Mean		32.2	3792	117.5	35	4.2	2.8	13.4	2.9	10.2	169	155
SD		5.0	1429	23.0	19	3.6	3.6	8.3	2.7	4.4	69	73
Rec						**4**	**5**	**7**	**3+**	**11**	**-**	**< 30% of Total Kcal**

*Position: C= Center; DT= Defensive Tackle; OG= Offensive Guard; OT= Offensive Tackle; OL= Offensive Line; FB= Full Back; LB= Line Backer; DL= Defensive Line; QB= Quarterback; TB= Tailback; WR= Wide Receiver

Gunnink S., Hoerr S. MSU 2002, unpublished data from presentation to MSU football coaching staff.

Table 2.2 (cont.) Information obtained from a preliminary study on collegiate football players (n=19)

Player	CHO (g)	Pro (g)	% Kcal CHO	% Kcal Pro	% Kcal Fat	Chol (mg)	Na (mg)	K (mg)	Vit A (RE)	Vit C (mg)
1	573	90	53	8	39	225	10161	2489	954	283
2	445	160	44	16	40	1345	6397	4966	1437	562
3	597	157	57	15	28	969	6332	3522	581	304
4	310	39	76	10	15	40	2708	1683	902	214
5	158	201	22	28	51	973	3746	956	333	15
6	400	191	53	25	22	502	5600	4253	1452	264
7	146	192	23	30	47	926	6423	1192	977	14
8	277	68	53	13	35	39	2218	2636	313	44
9	459	77	58	10	33	241	5152	2919	140	92
10	710	233	49	16	36	1684	7735	5552	4134	720
11	601	136	47	11	42	430	7352	6615	812	600
12	447	61	61	8	31	238	3947	562	578	92
13	305	166	37	20	43	1925	4653	4636	2425	356
14	698	349	44	22	34	871	6959	8067	6885	383
15	569	186	56	18	26	301	9856	5319	1962	187
16	609	193	45	14	41	1123	9603	3936	2219	438
17	399	132	52	17	30	957	5068	3614	1898	406
18	243	108	42	19	39	313	6056	1639	608	181
19	665	300	40	18	42	655	9648	7005	2976	273
Mean	453	160	48	17	35	724	6296	3766	1662	286
SD	178	80	13	6	9	542	2369	2141	1631	200
Rec		**100**	**≥ 55**	**15**	**≤ 30**	**300**	**2400**	**2000-3500**	**900**	**100**

Gunnink S., Hoerr, S. MSU 2002, unpublished data from presentation to MSU football coaching staff.

Table 2.2 (cont.) Information obtained from a preliminary study on collegiate football players (n=19)

Player	Ca (mg)	Fe (mg)	Vit D (ug)	Vit E (mg)	Folate (ug)	Mg (mg)	Zn (mg)	Fiber (g)
1	1179	45.8	5.8	22.1	551	192	18.5	19.7
2	1313	16.7	1.9	15.8	604	405	11.8	19.3
3	903	26.6	3.5	3.6	99	217	8.2	21.3
4	289	19.4	0.0	2.4	437	182	12.2	11.7
5	291	12.6	0.0	8.4	163	80	6.1	3.0
6	1598	19.0	5.9	15.3	375	443	20.8	30.0
7	350	13.8	0.0	2.8	73	102	6.3	3.8
8	999	11.5	4.9	15.0	218	8	0.9	31.4
9	293	10.7	0.0	1.5	81	78	5.3	14.5
10	1345	30.3	5.6	12.7	551	461	17.8	43.2
11	1756	24.6	3.7	2.1	492	325	3.9	12.3
12	330	10.6	1.2	3.0	23	49	1.4	21.7
13	1208	22.1	7.9	13.8	609	433	22.0	20.0
14	4066	54.9	11.4	32.0	1241	852	71.7	49.9
15	2144	18.6	7.0	20.5	542	543	27.2	30.2
16	3654	24.9	9.0	25.1	400	625	28.8	24.1
17	1992	14.4	7.5	11.5	767	393	16.4	16.1
18	639	21.2	2.4	6.6	348	154	11.4	4.8
19	5077	42.0	20.2	53.0	1172	115	50.9	51.4
Mean	1549	23.1	5.2	14.1	460	298	18.0	22.5
SD	1361.7	12.4	5.0	12.8	339	227	17.7	14.2
Rec	**1000**	**8**	**5**	**15**	**400**	**400**	**11**	**25-35**

Gunnink S., Hoerr S. MSU 2002, unpublished data from presentation to MSU football coaching staff.

APPENDIX IV

Table 4.1b Demographics and anthropometrics from pre-season data of the players dropped (n=23) and the players in the final sample (n=50).

	Players dropped from study (n=23)	Players included in the final sample (n=50)
Age (yr) (X ± SD)	21.4 ± 1.2	20.1 ± 1.3
Race/Ethnicity		
African American/Black	16	24
White	6	20
Latino	0	1
Other	1	5
No. on scholarship	18	41
Height (in) (X ± SD)	73.5 ± 2.7	74.5 ± 2.4
Weight (kg) (X ± SD)	101.0 ± 19.3	111.2 ± 19.2
BMI (kg/m^2) (X ± SD)	28.5 ± 4.0	30.8 ± 4.1

Table 4.1c The differences (X ± SD) between African American and Caucasian players for pre-season data from one day dietary recall (n=73).

Variables	African American (n=41)	Caucasian (n=26)
Height (in)	74.3 ± 2.7	73.9 ± 2.2
Weight (kg)	106.5 ± 20.1	108.8 ± 18.1
Kcal	3371 ± 1783	3929 ± 1683
Kcal/kg BW	34.6 ± 19.7	37.3 ± 17.0
BMI	29.5 ± 4.1	30.7 ± 4.1
No. of days eating in the cafeteria	3.0 ± 2.2^{x}	3.5 ± 2.5^{y}
No. of times/wk eating breakfast	4.0 ± 1.6	6.0 ± 1.5
No. of times/wk eating fast food	4.7 ± 2.3	3.5 ± 1.6
No. of times/wk grocery shop	4.2 ± 1.9	4.6 ± 1.9
Self-efficacy for Fruit	16.8 ± 3.7	16.4 ± 4.2
Self-efficacy for Vegetables	15.2 ± 4.1	15.2 ± 4.9
Fruit svg	0.7 ± 2.0^{x}	1.6 ± 2.9^{y}
Vegetable svg	3.5 ± 3.4	4.5 ± 4.1
LME svg	13.5 ± 9.5	18.7 ± 11.2
Dairy svg	1.8 ± 1.8^{x}	3.6 ± 3.0^{y}
Grain svg	10.4 ± 6.5	12.2 ± 9.6
Total Sugar (g)	178.3 ± 150.8	153.5 ± 122.4
CHO (g)	402.6 ± 227.8	440.7 ± 256.6
Protein (g)	134.0 ± 77.8	189.0 ± 77.7
Grams of protein/kg BW	1.3 ± 0.9	1.8 ± 0.8
Fat (g)	139.7 ± 84.8	159.0 ± 70.5

^{xy} Different superscripts in the same row (x,y) indicate significant difference ($p<0.05$) between time periods.

Table 4.1c (cont.) The differences (X ± SD) between African American and Caucasian players for pre-season data from one day dietary recall (n=73).

Variables	African American (n=41)	Caucasian (n=26)
% of Kcal from CHO	48	44
% of Kcal from protein	16	20
% of Kcal from fat	36	36
Vitamin A (RE)	818 ± 829	1639 ± 1015
Vitamin C (mg)	178 ± 280	258 ± 333
Calcium (mg)	1091 ± 710	1797 ± 1301
Vitamin D (µg)	2.4 ± 2.9^{x}	9.3 ± 7.8^{y}
Vitamin E (mg)	8.5 ± 9.5^{x}	24.2 ± 53.8^{y}
Folic Acid (µg)	289 ± 258^{x}	674 ± 435^{y}
Magnesium (mg)	267 ± 225	444 ± 239
Zinc (mg)	13.4 ± 11.6^{x}	23.2 ± 14.3^{y}
Total Fiber (g)	19.8 ± 13.2	23.7 ± 13.7

^{xy} Different superscripts in the same row (x,y) indicate significant difference ($p<0.05$) between time periods.

Table 4.1d The differences ($X \pm SD$) between offensive and defensive players for preseason data from one day dietary recall (n=73).

Variables	Offensive (n=41)	Defensive (n=31)
Height (in)	74.4 ± 2.8	74.0 ± 2.1
Weight (kg)	111.0 ± 21.0	104.2 ± 17.3
Kcal	3301 ± 1707	3999 ± 1677
Kcal/kg BW	32.8 ± 18.5	39.3 ± 17.3
BMI	30.8 ± 4.4	29.2 ± 3.7
No. of days eating in the cafeteria	3.6 ± 2.4	3.0 ± 2.3
No. of times/wk eating breakfast	4.5 ± 1.8	5.0 ± 1.8
No. of times/wk eating fast food	4.1 ± 2.1	4.5 ± 2.3
No. of times/wk grocery shop	4.5 ± 2.1^{x}	4.0 ± 1.4^{y}
Self-efficacy for Fruit	16.8 ± 4.3	16.6 ± 3.7
Self-efficacy for Vegetables	15.3 ± 4.3	14.9 ± 4.5
Fruit svg	1.1 ± 2.3	1.0 ± 2.4
Vegetable svg	3.1 ± 3.8	4.6 ± 3.4
LME svg	12.8 ± 7.6^{x}	19.1 ± 13.2^{y}
Dairy svg	2.5 ± 2.6	2.5 ± 2.2
Grain svg	10.5 ± 8.8	12.6 ± 7.0
Total Sugar (g)	162.9 ± 140.8	170.1 ± 130.3
CHO (g)	405.1 ± 245.0	441.8 ± 212.9
Protein (g)	140.6 ± 72.6	177.9 ± 90.6
Grams of protein/kg BW	1.3 ± 0.8	1.7 ± 0.9
Fat (g)	127.2 ± 67.4	171.3 ± 84.7

^{xy} Different superscripts in the same row (x,y) indicate significant difference ($p<0.05$) between time periods.

Table 4.1d (cont.) The differences (X ± SD) between offensive and defensive players for pre-season data from one day dietary recall (n=73).

Variables	Offensive (n=41)	Defensive (n=31)
% of Kcal from CHO	47	44
% of Kcal from protein	18	18
% of Kcal from fat	35	38
Vitamin A (RE)	935 ± 869	1299 ± 1060
Vitamin C (mg)	218 ± 344	172 ± 210
Calcium (mg)	1218 ± 1211	1476 ± 743
Vitamin D (μg)	4.5 ± 6.5	5.2 ± 5.7
Vitamin E (mg)	8.3 ± 8.7^{x}	21.4 ± 49.0^{y}
Folic Acid (μg)	390 ± 339	466 ± 427
Magnesium (mg)	294 ± 236	379 ± 255
Zinc (mg)	13.3 ± 9.5^{x}	21.4 ± 16.3^{y}
Total Fiber (g)	20.2 ± 14.0	22.6 ± 13.1

^{xy} Different superscripts in the same row (x,y) indicate significant difference (p<0.05) between time periods.

Table 4.2b Total energy intake, grams of carbohydrate, protein and fat (X ± SD) along with percentage of carbohydrate, protein and fat at three time periods[†].

	Pre-season Aug 2002 (n=73)	In-season Sept/ Oct 2002 (n=68)	Post-season Feb 2003 (n=50)
Total Kcal	3607 ± 1718	4199 ± 1495	3869 ± 1725
Kcal/kg BW	35.6 ± 18.2	41.1 ± 17.1	35.8 ± 17.5
Carbohydrate (g)	421.2 ± 230.7	498.3 ± 171.4	491.7 ± 231.1
Protein (g)	157.0 ± 82.5	162.2 ± 76.0	141.5 ± 59.7
Grams Pro/kg BW	1.5 ± 0.9	1.6 ± 0.8	1.3 ± 0.6
Fat (g)	146.5 ± 78.1	175.2 ± 79.7	149.8 ± 89.1
% Carbohydrate	46	48	50
% Protein	18	15	16
% Fat	36	36	34

[†] No significant difference between time periods.

Table 4.3b Food patterns of all participants at three time periods.

	Pre-season Aug 2002 (n=73)	In-season Sept/ Oct 2002 (n=68)	Post-season Feb 2003 (n=50)
Avg No. days eating in cafeteria/wk	3.3 ± 2.3	4.3 ± 2.3	3.9 ± 2.1
Avg No. times eating breakfast/wk	4.7 ± 1.8	4.3 ± 1.8	4.1 ± 1.9
Avg No. times eating fast food/wk	4.3 ± 2.1	3.6 ± 1.5	3.1 ± 1.6
Avg No. times grocery shop/wk	4.3 ± 1.9	3.0 ± 1.3	3.5 ± 1.9

Table 4.4b Self-efficacy[†] for eating fruits or eating vegetables of sample at three time periods.

	Pre-season Aug 2002 (n=73)	In-season Sept/ Oct 2002 (n=68)	Post-season Feb 2003 (n=50)
FRUITS	α = 0.7916	α = 0.8506	α = 0.8090
I can keep FRUITS on hand/readily available	3.0 ± 1.0	3.2 ± 1.1	3.5 ± 1.0
I can shop for a variety of FRUITS	3.4 ± 1.1	3.3 ± 1.1	3.7 ± 1.0
I can eat the recommended number of servings of FRUITS when I eat on my own	3.2 ± 1.1	3.2 ± 1.1	3.3 ± 1.0
I can make time to eat FRUITS	3.6 ± 1.0	3.4 ± 1.1	3.6 ± 1.0
When I eat at home, I can eat more FRUITS	3.5 ± 1.2	3.3 ± 1.2	3.6 ± 1.2
Sum score for FRUITS	16.7 ± 4.0	16.3 ± 4.4	17.6 ± 4.0
VEGETABLES	α = 0.8310	α = 0.8531	α = 0.8622
I can keep VEGETABLES on hand/readily available	2.9 ± 1.1	3.0 ± 1.0	3.1 ± 1.1
I can shop for a variety of VEGETABLES	3.1 ± 1.2	3.1 ± 1.1	3.2 ± 1.2
I can eat the recommended number of servings of VEGETABLES when I eat on my own	2.9 ± 1.1	2.8 ± 1.1	2.8 ± 1.1
I can make time to eat VEGETABLES	3.2 ± 1.0	3.0 ± 1.1	3.0 ± 1.3
When I eat at home, I can eat more VEGETABLES	3.2 ± 1.3	2.9 ± 1.3	3.0 ± 1.4
Sum score for VEGETABLES	15.1 ± 4.4	14.8 ± 4.4	15.1 ± 4.9

[†] Scored on a 5 point Likert scale; 1 = "Not at all confident", 5 = "Very confident"

Table 4.5b Food Group Scores, servings of fruit, vegetables and dairy of sample at three time periods.

	Pre-season Aug 2002 (n=73)	In-season Sept/ Oct 2002 (n=68)	Post-season Feb 2003 (n=50)
Food Group Scores (1-5)†	3.8 ± 0.8	4.2 ± 0.8	4.1 ± 0.8
Fruit svg (4 rec)	1.0 ± 2.3	3.0 ± 3.8	3.1 ± 3.5
Vegetable svg (5 rec)	3.8 ± 3.7	3.6 ± 2.8	3.8 ± 4.4
Dairy svg	2.5 ± 2.4	3.9 ± 4.5	3.2 ± 2.9

† One point awarded for each food group if at least one half of a serving was eaten from that food group

Table 4.6b Servings of grains and LME, total grams of sugar and fat and energy (X ± SD) of sample at three time periods.

	Pre-season Aug 2002 (n=73)	In-season Sept/ Oct 2002 (n=68)	Post-season Feb 2003 (n=50)
Grain svg (11 rec)	11.4 ± 8.1	10.0 ± 4.8	10.0 ± 5.6
LME svg (7.5 rec)	15.6 ± 10.8	14.1 ± 8.1	11.8 ± 5.5
Sugar (g)	166.1 ± 135.4	237.8 ± 109.2	234.3 ± 137.6
Fat (g)	146.5 ± 78.1	175.2 ± 80.0	149.8 ± 89.1
Total Kcal	3607 ± 1718	4199 ± 1495	3869 ± 1725

Table 4.11b Prediction of MAR scores from total grams of sugar and total grams of fat, sum of self-efficacy scores and food patterns (n=50, 3 days of recall)

	Model 1		Model 2		Model 3	
	b	β	*b*	β	*b*	β
Eating Breakfast	6.405***	0.593	5.306***	0.491	5.126***	0.475
Fat (g)	-	-	0.102**	0.395	0.088*	0.344
Eating in Cafeteria	-	-	-	-	2.573*	0.249
Intercept	40.119		28.321		20.438	
F	26.047***		23.253***		19.2***	
R2	0.352		0.497		0.556	

*p<0.05, **p< 0.01, ***p < 0.001

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