Impact of a School-Based Nutrition Curriculum on Intake of Dietary Calcium among Adolescents

By

Claire Stephanson, BS

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CERTIFICATE OF APPROVAL

This is to certify that the MS thesis of

Claire Yvonne Stephanson

has been approved

[redacted]
Victoria Warren-Mears, PhD, RD

[redacted]
Diane Stadler, PhD, RD

[redacted]
Robert Klein, MD

Table of Contents

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Abstract

Calcium intake by adolescents in the United States is consistently lower than recommended. Peak rates of calcium accumulation, retention, and growth occur during adolescence, making adolescence a critical time to consume adequate amounts of calcium. Previous research indicates that tailored nutrition education lessons are an effective way to educate adolescents about the importance of dietary calcium. To test the impact of a school-based nutrition curriculum, 11 Oregon schools were randomized into intervention and control groups. Students enrolled in thirty-eight middle school and high school Health and Family Consumer Science classes in Oregon completed Child and Adolescent Block Food Frequency Questionnaires for 8 to 17 year olds at baseline and approximately six-weeks later. The intervention classes received a thirty-minute nutrition curriculum on calcium that included 1) food sources and serving sizes 2) daily requirement and, 3) information on osteoporosis. Control classes did not receive the nutrition curriculum. Results showed that calorie adjusted calcium intake and dairy servings per day were not significantly affected by the nutrition curriculum. Less than 20% of students in the current study consumed the Adequate Intake level for calcium (1300 mg/day). A multi-unit, gender-tailored, and parent-involved nutrition intervention may be a more effective way to increase dietary calcium intake among adolescents.

Chapter 1: Background

The primary aim of this study is to determine if an increase in dietary calcium intake occurs in adolescent students, following a tailored nutrition curriculum on calcium. It is hypothesized that the calcium curriculum will have a significant impact on dietary calcium intake, with an increase in intake from baseline to 6 weeks following the nutrition curriculum. A secondary aim is to identify if students categorized as lowest consumers of calcium increase their dietary intake of calcium. It is hypothesized that students receiving the nutrition curriculum who are the lowest consumers of calcium will significantly increase their dietary intake of calcium.

Introduction

Osteoporosis is a significant public health problem, manifested by the presence of low bone mass, decreased skeletal integrity, and an increased risk of fractures. In the United States today, 10 million people have osteoporosis and 18 million additional individuals have low bone mass, placing them at increased risk for osteoporosis [1]. Over 1.5 million osteoporotic fractures occur each year, mostly involving lumbar vertebrae, hip, and wrist and this number is estimated to rise to 6 million by 2050 [2]. Health care expenditures attributable to osteoporotic fractures in 2001 were estimated at $17 billion [2]. About 50% of women and 25% of men are expected to develop osteoporosis in their lifetime [2].

There are proven ways to help prevent or slow the progression towards osteopenia and osteoporosis. Adequate and appropriate nutrition plays an important role in optimizing bone health. The chief mineral responsible for development and maintenance of bone tissue is calcium.

Despite numerous studies and public health efforts stressing the role and importance of consuming adequate amounts of calcium, Americans of all ages continue to consume less than the Adequate Intake (AI) for calcium [3, 4]. Specifically, calcium intakes among adolescents and females of all ages are below recommendations [5]. As the majority (~90%) of bone growth is completed by the age of 18, it is essential that adolescents consume a diet optimal for bone health with adequate amounts of daily calcium.

Consumption of adequate amounts of calcium is not only required for optimal bone accrual but is also required to slow the decline in bone mineral density and progression towards osteoporosis, that occur with aging. However, studies indicate that calcium intake remains inadequate over the lifespan of the average American female [5]. Women have approximately 10% lower peak bone mass by maturity than men and experience a faster rate of bone loss following menopause, further placing them at increased their risk for osteoporosis [6]. Because of higher peak bone mineral density at maturity and a more gradual decline in circulating sex hormone concentrations, men are at significantly lower risk of developing osteoporosis. Although males tend to have a lower risk of developing osteoporosis, they are not exempt from the disease. It is estimated that men have about a 13% lifetime risk of fractures of the hip, spine, or distal forearm and tend to develop osteoporosis 10 years later than females [6, 7]. Estimated lifetime risk of fracture in females is about 40% for any of the above fractures [7].

Other factors that influence bone mineral accrual during growth are vitamin D status and physical activity. Adequate vitamin D intake levels are required to facilitate intestinal absorption of calcium. Although daily exposure to the sun is sufficient to achieve adequate vitamin D levels in healthy adolescents [8], seasonal changes in sunlight exposure and health status may affect vitamin D status [9]. Also, weight-bearing exercise is important to strengthen bone and increase muscle mass [10].

The prevalence of osteoporosis, fractures, and the associated costs is cause for concern. Not only is continued research on osteoporosis essential, it is crucial that efforts continue to increase awareness and to educate the public on osteoporosis prevention strategies. Through development and implementation of effective education tools, progress in the prevention of osteoporosis and reduced consequences associated with the disease will be made.

Calcium and adolescents

Roles of Calcium in the Body

Calcium is the most abundant mineral in the body, and essentially all body processes require calcium [11]. Calcium acts as a "second messenger" to signal many physiological responses, including muscle contraction, hormone release, glycogen metabolism and, cell differentiation, proliferation, and motility [12]. A unique characteristic of calcium is it's extracellular to intracellular concentration ratio. The extracellular calcium concentration is about four orders of magnitude higher (1×10^{-4})

than intracellular calcium concentration for maintenance of membrane potentials, muscle contraction, exo-cytosis, blood clotting, and modulation of plasma enzyme activity.

Adequate calcium within the bones is directly related to higher bone mineral density and prevention of osteoporosis. Beyond the skeletal level, calcium is an important nutrient to maintain optimal health. Calcium intake studies have recently shown improvements in hypertension among African American adolescents [13] and pregnant women [14], reduced risk of colon cancer [15], decreased incidence of kidney stones [16], reduced symptoms of premenstrual syndrome [17], and a possible protective role in weight management [18]. Approximately 1200 grams of calcium are present in an adult human with more than 99% of that amount found in the mineralized components of bones and teeth, contributing significantly to skeletal structure and total exchangeable bone calcium [19, 20]. It is clear that calcium is one of the most important minerals in our body and is tightly regulated to maintain body processes and health.

Calcium Accretion

Calcium is a threshold nutrient, meaning that bone mass increases with calcium intake up to a certain level, after which no further accumulation occurs [21]. Peak calcium accretion occurs at approximately 12.5 years of age in girls, concomitant with the time of greatest calcium absorption and the pubertal growth spurt. In boys, peak accumulation of calcium is reached about 1.5 years later at the age of 14 [22]. Twenty-six percent of adult bone is gained during the two adolescent years of peak skeletal growth. This period of rapid growth requires high accretion rates of calcium, achieved in part by increased rates of intestinal absorption of dietary calcium and renal reabsorption [22].

Fractional absorption of calcium is inversely related to calcium intake [23]. In 2000, O'Brien et al studied the effect of low versus high dietary calcium intakes on calcium absorption in adolescent girls [23]. Girls who were instructed to eat at least five servings of calcium-rich foods over the course of ten days were found to have a lower fractional intestinal absorption ($p<0.001$) of calcium and higher urinary calcium excretion ($p<0.004$) than girls who were instructed to avoid calcium-rich foods. After ten days of eating low or high calcium diets, fractional calcium absorption was determined by using oral and IV isotopes of calcium following consumption of fluid milk. Urinary excretion of N-telopeptide, a marker of bone resorption, was higher during the low calcium diet than the high calcium diet ($p<0.02$). This study concluded that when female adolescents consume low amounts of calcium, their bodies compensate by increasing the efficiency of calcium absorption and decreasing the rate of calcium excretion to minimize bone loss. Although the body compensates by increasing fractional calcium absorption and decreasing calcium excretion, this compensation is still inadequate for females with low dietary calcium intake to conserve bone mass [23].

Calcium Balance

The maintenance of extra-cellular fluid (ECF) calcium concentration within a tight range (4.65-5.25 mg/dL) is essential for the proper functioning of calcium dependent cellular processes [24]. ECF calcium concentration is regulated by specific hormones targeting bone, gut, and kidney cells [25]. As a result of these hormonal signals, ECF calcium concentration is increased or decreased to maintain calcium balance.

Three main hormones are involved in calcium balance: parathyroid hormone (PTH), vitamin D, and calcitonin [25]. Parathyroid hormone is the most important of the three hormones in regulation of calcium balance. A description of the physiological effects of PTH, vitamin D and calcitonin when calcium levels are above and below normal ranges follows. When extracellular calcium concentrations are low, calcium-sensing receptors in cells of the parathyroid gland elicit an intracellular message to stimulate the secretion of PTH. Increased PTH has three main effects when calcium levels are low. 1) In bone, PTH-stimulated resorption mobilizes calcium and phosphate in the ECF, 2) in the kidney, PTH increases reabsorption of calcium while decreasing the reabsorption of phosphate and, 3) catalyzes the reaction producing the active form of vitamin D (1,25- OH_2 vitamin D_3) [26]. When ECF calcium concentrations are low, PTH indirectly enhances intestinal absorption of calcium from the small intestine by stimulating production of 1,25 D_3. Production of vitamin D_3 occurs in the kidney where 25-hydroxycholecalciferol serves as a substrate for 1-α-hydroxylase, yielding 1,25-dihydroxycholecalciferol, the active form of vitamin D [26]. 1,25 D_3 enhances calcium absorption by two mechanisms. Active vitamin D stimulates the synthesis of calcium-binding protein and the expression of a number of other proteins involved in the transport of calcium across the epithelial wall of the intestine and into the blood. In the event of very low vitamin D, dietary calcium is absorbed less efficiently and the structural integrity of bone may be impaired [26]. Muscle weakness and cardiac dysfunction may also result from a deficiency of vitamin D in animals. In the presence of vitamin D, the gene directing the synthesis of PTH is inhibited, minimizing resorption of calcium from the bone.

When ECF calcium concentration is above normal, reverse processes occur resulting in lower serum PTH and a decrease in active vitamin D formation. When PTH is decreased, less calcium and phosphate are reabsorbed in the proximal tubule of the kidney, and urinary calcium and phosphate excretion is increased. Both excessive PTH secretion (hyperparathyroidism) and excessive intake of Vitamin D can result in hypercalcemia. Hyperparathyroidism results in above normal reabsorption of calcium in the proximal tubule of the kidney while excessive vitamin D intake can lead to above normal absorption of calcium in the GI tract. There is little support that calcium intakes above 2500 mg/day, by healthy individuals has any harmful effects. The Food and Nutrition Board developed the Tolerable Upper Intake Levels for calcium and reported that 2500 mg/day of calcium is safe for all healthy population groups [27] other than infants where no safe Upper Intake Level has been established. Symptoms of hypercalcemia include constipation, nausea, increased urine volume, lax muscle tone, confusion, coma, and death [27]. In the case of hypercalcemia pharmacological intervention is typically necessary to bring ECF calcium concentrations back within normal the normal range.

The third hormone involved in calcium balance is calcitonin. Calcitonin synthesis occurs primarily in the C cells of the thyroid gland, however, a large amount is also synthesized in many other tissues, including the lung and intestinal tract [26]. When serum calcium concentrations are low, PTH secretion is enhanced to restore ECF calcium concentrations whereas calcitonin secretions are reduced to remove hypocalcemic stimulus. Calcitonin decreases blood calcium concentration by inhibiting bone resorption and reabsorption of calcium and phosphorous in the renal tubules [26]. This renal effect lasts only as long as calcitonin concentrations are elevated. Unlike PTH and Vitamin D, calcitonin has a very minor role in regulation of calcium concentrations and homeostatic adjustment. Humans with chronically increased blood calcitonin levels (medullary thyroid cancer) or decreased levels (surgical removal of thyroid gland) do not show alterations from normal in serum calcium [26].

Unless consumed in great excess, calcium levels are maintained at homeostatic levels with the help of PTH and 1-25-dihydroxyvitamin D3, and minimally by calcitonin. Although ECF calcium balance is maintained with great efficiency, it is often at the expense of bone mineral density. Continued low intakes of dietary calcium can lead to increased PTH and resorption of calcium from the bones, resulting in weaker, more porous bones, increasing the risk of fracture and osteoporosis later in life.

Intake of calcium by adolescents

Calcium intake by adolescents in the United States is consistently lower than the Adequate Intake (AI) of 1300 mg per day [28]. With peak calcium accumulation, retention, and growth occurring during adolescence, it is critical that teens consume adequate amounts of calcium; adequate amounts may be higher or lower than recommended. At least 90% of peak bone mass is acquired by age 18 for males and females [29]. Knowing that total peak bone mass occurs around the age of thirty, adequate intake of calcium in the younger years positively impacts bone strength later in life.

Reasons for low calcium consumption rates

Dietary calcium can greatly reduce the risk of osteoporosis, however, adolescents consume less calcium than recommended. This leads to the question of why adolescents are not consuming enough calcium.

According to data from the 1994-1996 Continuing Surveys of Food Intakes by Individuals (CSFII), consumption of soft drinks among adolescents has increased by 74% for boys and 65% for girls since the 1970's [30] while consumption of milk by adolescents has declined over the same period [30]. For example, the proportion of adolescent girls drinking fluid milk as decreased from 72% in 1977-1999 to 57% in 1994 [31]. With the trend of soft drink consumption among adolescents on the rise, there is more concern for the nutritional deficits resulting from inadequate consumption of calcium containing beverages. Looking at food and nutrient intakes of children aged 2 to 18 years in the United States, Harnack et al studied the relationship between soft drink and milk consumption [30]. For all age groups, subjects in the high soft drink consumption category were more likely to consume less than 8 oz of milk per day and consume less dietary calcium than non-consumers of soft drinks.

It is evident that soft drinks affect dietary calcium intake, and it has been argued that the components of soft drinks also negatively impact bone mineral density. Some researchers have tested this questioned belief and have come to the same conclusion that the soft drinks contribute to decreases in bone mineral content (BMC) simply by displacing more calcium rich beverages in the diet [32, 33]. The constituents in soft drinks have, if any, very minimal impact on overall calcium balance in the body [32, 34]. Caffeine, phosphorus, and high dietary sugar have been hypothesized to have a negative impact on bone. Both caffeine and high dietary sugar elevate urinary calcium excretion but are followed by reduced calcium clearance by the kidneys, making up for the previous losses [33, 34]. Fitzpatrick and Heaney's editorial titled "Got Soda" reviewed research on the effect of low nutrient dense beverages, concluding that healthy bones can coexist with soft drinks as long as milk intake is not displaced by the soft drinks [35].

Soft drink consumption influences intake of calcium for both male and female adolescents but does not adequately explain the lower intake of calcium among females. Population-based studies have historically shown that females have poor calcium intake. Calcium intake trends among females decline in the adolescent years and low calcium intakes persist throughout life [20]. Consumption rates for female adolescents are often influenced by the misconception that all dairy foods are fattening [36]. With increased preoccupation with being thin, adolescent females commonly consume less dairy products [35]. Females are often associated with skipping meals to maintain or lose weight, ultimately decreasing their intake of essential nutrients. Many adolescents do not know that all fluid milk has the same amounts of calcium, no matter what the fat content [36]. For males, calcium intake tends to be closer to recommended intakes. Frequency of meals and snacks contributes to nutrient intakes in adolescent males. As males tend to have higher overall energy intake, their intake of several nutrients, including calcium, is also higher than females. In a study of adolescent males, it was found that the majority of their dietary calcium and iron came from breakfast and dinner meals [37]. With less concern about body weight and more overall food intake than females, male adolescents typically consume higher amounts of dietary calcium.

Gender is not the only predictor of calcium intake in adolescents. Calcium intake also differs among cultural groups. In a study comparing the calcium intakes of Asians, Hispanics, and Caucasian youths, it was found that Caucasians had the highest calcium intakes followed by Hispanics and Asians. Milk intake was the primary factor positively influencing calcium intake, while Asian ethnicity and female gender negatively influenced calcium intake. Study results also suggest that the diets of youth change over time, and negative trends are more common in females than in males and in African-American and Hispanic youth compared to Caucasian youth.

Lactose intolerance is another possible reason for low calcium intake among individuals in the US. Affecting about 25% of adults in the US, lactose intolerance results from deficient amounts of the lactase enzyme, which is responsible for the digestion of lactose in dairy products. In adults, the presence of lactose intolerance is highest in Asians (about 85%), intermediate in African Americans (about 50%), and lowest in Caucasians (about 10%). Although lactose intolerance may influence intake of foods high in calcium, the recommended intake for calcium is not different for lactose intolerants [38].

Besides gender and race differences, adolescents are often influenced by their peers to follow a trend. When it comes to their nutrition, adolescents are often influenced to drink trendy or "cool" drinks like soft drinks, energy drinks, and coffee instead of milk [39]. Similar to soft drink availability in schools, energy drinks and coffee have begun to appear in middle and high schools. Whether or not adolescents prefer to drink milk to coffee or energy drinks, preference is often overridden by peer pressure [40]. Matching of beverages with meals such as a hamburger with a soft drink or a pastry with coffee instead of milk can also play a role. Both the desire to be "cool" and the act of matching beverages to meals can result in displacement of milk or other calcium-rich beverages in the diet. This displacement can decrease the total calcium intake of adolescents, negatively affecting their bone mineral accrual.

Daily Calcium Requirement

With insufficient evidence to make a Dietary Reference Intake (DRI), an Adequate Intake (AI) level was established, based on dietary intake required for maximal calcium retention for different age groups [41]. Compared to all other groups, including pregnant and lactating mothers, calcium needs during adolescence are the highest. The AI for adolescents is 1300 mg/day compared to children, adults, pregnant and lactating mothers, and elderly who require 800 mg/day, 1000 mg/day, 1000 mg/day, and 1200 mg/day respectively [42]. Due to inadequate data, it is unknown whether males and females require different amounts of calcium. The AI's for males and females are currently the same for both genders, despite the possibility of different requirements for body size and stage of physical development [43].

Sources of Calcium

There are many sources of dietary calcium. The primary source, contributing to about 70% of dietary calcium, is dairy products, including milk, cheese, and yogurt [44]. Other important calcium-rich sources that are non-dairy include beans, nuts, fish, soy, fortified or enriched foods, and calcium supplements [45]. However, because of the relatively low calcium content, considerable amounts of non-dairy foods (6–15 servings, depending on the food) are required to meet the calcium content of one dairy serving. By selectively increasing non-dairy calcium containing foods, it is unlikely that calcium requirements will be met [46]. Due to the decreased bioavailability of calcium from plant foods containing oxalic or phytic acid, it is even more difficult to meet calcium needs through non-dairy foods. For example calcium absorption from dried beans and spinach is about 50% and 10%, respectively, of the absorption of calcium from milk [47]. Regarding the significant role of dairy products in providing adequate calcium, Healthy People 2010 stated, "With current food selection practices, use of dairy products may constitute the difference between getting enough calcium in one's diet or not" [48].

Dietary Education Interventions

Calcium Interventions

Considering the importance of calcium for bone health and the current intakes of adolescents in the United States, efforts have been made to improve dietary intakes using nutrition education. A few education interventions, that focus on increasing dietary calcium intake, have shown a positive impact on calcium intake [49, 50]. In 2000, Peterson et al studied the effect of an educational intervention on calcium intake and bone mineral content (BMC) in young women (ages 18-30) with low calcium intake [51]. Women in the intervention group received 3 weekly calcium intervention sessions, which included information on osteoporosis, dietary counseling on calcium-rich foods, and supplemental intake of calcium. Women who received the education intervention demonstrated greater increases in total dietary and supplemental calcium intake than women who did not receive the education ($p<0.001$). Sueta and Fukudu found that a calcium education intervention was associated with increased calcium intakes of female college students after one week and one year of the intervention [49]. Additionally, Peterson et al found that the women in the education intervention group who had decreasing BMC stopped further decline of BMC [51], whereas the control group continued to lose BMC.

Data on gender differences in response to calcium interventions are limited and have not shown significant variation [52-54]. Few interventions testing the effects of calcium supplementation in adolescents have been done but studies conducted on children and adolescents indicate that calcium supplementation has a positive impact on bone mineral density for males and females [53-55]. Other interventions have tested the effects of increasing dietary calcium among adolescent females but not adolescent males. Supplementation with calcium-rich foods has resulted in improvements of bone mineral density in adolescent females [56]. No studies looking at the effects of a nutrition education intervention on calcium intake have been done thus far, indicating a significant need for studies of this type.

Nutrition education and non-calcium research

Adult studies testing dietary impact of nutrition education interventions have shown an improvement in biological indicators of health [51, 57]. The National Cholesterol Education Program's Step I and Step II dietary interventions demonstrated a positive impact of nutrition education on lipid values of free living subjects since 1981 [57]. In 2004, Cheng saw more improvements in cholesterol, weight, and dietary risk for coronary heart disease in study subjects receiving nutrition education. In an iron deficiency study reported by Khoshnevisan in 2004 [58], children randomized into nutrition education groups had elevated ferritin concentrations while control groups, not receiving education, had reduced ferritin concentrations, increasing their risk for consequences associated with iron deficiency. As indicated by the studies described above, nutrition education has shown to be an effective method that can result in favorable biological outcomes.

Tailored Interventions

The effectiveness of interventions can depend on how tailored an intervention is to a particular group. In a study comparing the effectiveness of a website aimed towards heavy drinking college students and a standard alcohol education web site, researchers found that participants who used the intervention website had significantly reduced alcohol consumptions than those who used the control website [59]. Interventions designed for gender [60, 61], disease state [62], and race [63] have all had positive impacts on either behavior change, knowledge, or beliefs among intervention groups. It therefore seems likely that the more customized an intervention is to a particular group, the more effective an intervention is in encouraging positive behavior change. No studies have been done using a tailored calcium intervention for any population or age group, indicating a need for further research.

Measures of Change

To determine effectiveness of dietary calcium interventions in meeting objectives, different tools have been used. Food frequencies and diet recalls are commonly used to determine change in dietary and supplemental calcium intake.

There are strengths and weaknesses of each of these measurement tools. Food frequency questionnaires (FFQ) and diet recalls allow an investigator to obtain an indication of usual dietary intake, both in food and nutrients. These tools can be self-administered, with minimal instruction. FFQ's, unlike diet recalls, can be optically scanned and analyzed for nutritional content, to reduce analysis time and data entry costs. FFQ's are particularly useful when they are developed specifically for certain age groups and cultures. However, there are many potential weaknesses of FFQ's. Memory of food patterns in the past is required, and may be imprecise. Quantification of food intake may be imprecise because of poor estimation or recall of portions or use of standard sizes. Suitability of FFQ's is questionable for certain cultural groups consuming foods not on the list. Questionnaires with a long list of food items tend to overestimate and those with a short list underestimate intake [27].

Block Food Frequency Questionnaires

Many Food Frequency Questionnaires have been created to decrease the error associated with the weaknesses listed above. Since 1982, Block Dietary Data Systems, now known as Nutrition Quest (founded in 1993 by Gladys Block), has developed and provided researchers with user-friendly assessment tools [64]. Nutrition Quest is the source of the Block Food Frequency Questionnaire as well as physical activity questionnaires. Nutrition Quest has used large representative national dietary surveys including the Nutrition Examination Survey (NHANES) to create their FFQ's. Based on the national dietary surveys, Nutrition Quest is able to identify key foods, portion sizes and contributors of each nutrient that are appropriate to include in their questionnaires. This in turn allows FFQ's to be as short as possible, while capturing nutrients effectively. Ethnic food intakes are taken into consideration by using national dietary surveys to determine appropriate foods and portions for Whites, African Americans, and Hispanics. Block FFQ's have also been designed specifically for children and adolescents of different ages [64].

The Child and Adolescent Block Food Frequency Questionnaires for 8 to 17 year olds was developed from the NHANES 1999-2002 dietary recall data and includes 77 food items [64]. There are no published validation studies for the Block Kids FFQ, however, an unpublished validation study conducted on an earlier version of the Kids questionnaire was done in 2002 [65]. At two separate time points a single 24 hour recall and FFQ were administered to 74 children aged 8-10; 98% were African American. The FFQ that was administered was a modified version of the Block 1998 FFQ, comprised of foods identified by NHANES III as important in the target age and demographic group. In the first administration, most FFQ nutrient means were not significantly different from recall means. In regards to the survey's ability to capture calcium intake, the FFQ showed a correlation of 0.64 when compared to 24 hour recalls. The first FFQ produced reasonable nutrient estimates in the African American children. The second administration produced poorer results. Compared to full length dietary questionnaires, shorter FFQ's created by Block have shown to capture nutrient intakes similarly [66].

Summary & Aims

The incidence and costs of osteoporosis in the United States are too great to ignore. Proven time and time again, calcium intake is one of the greatest influences of bone density. Intake of dietary calcium, however, is consistently inadequate for adolescents. It is essential that school-based nutrition programs be developed, tested, and implemented among adolescents to increase calcium intake and to promote optimal bone health.

The primary aim of this study was to determine if an increase in dietary calcium intake occurs in students who receive a tailored nutrition curriculum on calcium. It was hypothesized that the calcium curriculum would significantly impact on dietary calcium intake, with an increase in intake from baseline to 6 weeks following the nutrition curriculum. A secondary aim was to identify if students categorized as the lowest consumers of calcium would increase their dietary calcium intake. As a result of this nutrition education curriculum, it was hypothesized that students receiving the nutrition curriculum who were the lowest consumers of calcium would significantly increase their dietary calcium intake.

Chapter 2: Methods

Design

The purpose of this study was to determine if participation in a classroom-based nutrition curriculum on calcium resulted in increased calcium intake by adolescents. This study used a randomized prospective classroom-based design, to test the hypothesis that participation in a nutrition curriculum resulted in higher dietary calcium intakes. The Block Kids Food Frequency Questionnaire (FFQ) [64] for ages 8 through 17 was administered to students before the nutrition curriculum and again 6 weeks later to determine change in calcium intake. Control classes did not receive the nutrition curriculum but completed the same Block Kids FFQ's, two times, 6 weeks apart. This Block FFQ consists of 77 items, including questions on food and beverage intake and 1 question on vitamin use. The FFQ was administered in the classroom, and took approximately 30-45 minutes for students to complete.

Recruitment

Recruitment of teachers occurred using an email list of teachers/schools that used Oregon Dairy Council (ODC) education materials in the past but had not yet received and/or used the intervention packet titled "Calcium: Got it? Get it!" during the current school year. Each teacher from the email list was sent a recruitment letter inviting his or her classes to participate in the research study (Appendix A, Recruitment Letter). To attempt to standardize other classroom content, only teachers of middle school and high school Health and Family Consumer Science classes were enrolled in the study.

Randomization

Only public middle and high schools in Oregon were invited to participate in the research study. One or more classes per school were invited to participate. Randomization was initiated by flipping a coin and assigning the first school, whose teacher responded to the invitation to participate as a control school. The next teacher who replied to the recruiting email from a different school was assigned as an intervention school. Each consecutive teacher that replied to the recruiting email had his/her school assigned to either intervention or control groups based on the order of their response. If a school was assigned to the intervention group and did not have 90 minutes of class time available, they were not included in the study. In this case, the next school that was randomized into the intervention group, who had 90 minutes of class time available, was included in the study. For schools with more than one class wishing to participate, randomization to intervention or control group was done with the school being the unit of randomization. To prevent interactions between the control and intervention classrooms, no schools had both intervention and control groups. Students at intervention and control schools were blinded to which study group they were allocated.

Students

Middle school and high school students in health and family consumer science classes were the research subjects in this study. The only criteria for participation in this study were that students were in middle school or high school and attended either a health or family consumer science class. Race/ethnicity, health status, and previous exposures to calcium education were not considered as inclusion/exclusion criteria.

Consent

Once a date was scheduled for the investigator to visit a school, a copy of the student assent and parental consent forms were sent to participating teachers (Appendix B). Teachers were asked to make copies of the consent forms and to distribute them to students to take home for their parent/guardian to sign before the scheduled survey and/or nutrition curriculum. Students who did not return consent forms were allowed to participate in the class and fill in surveys but were asked to return signed consent forms by the six-week follow-up. Due to perceived difficulties with return of parental consent, a change in protocol was submitted and approved by the IRB to allow analysis of anonymized data that was previously collected. All student names were removed from the data sets and only ID numbers remained. Class activities for both intervention and control classes were explained to students before distributing Food Frequency Questionnaires. If a student did not want to participate in the study, the student was instructed by their teacher to perform a different activity.

Intervention Tool: "Calcium: Got it? Get it!"

The Oregon Dairy Council (ODC) developed the classroom-based educational intervention tool titled "Calcium: Got it? Get it!" In response to requests for educational workshops on how to teach calcium and bone health to adolescents, ODC chose to develop "Calcium: Got it? Get it!" for teacher use in schools [67]. This tool was intended for use by health, physical education, consumer science, and science teachers of high school students. A pilot project called "Calcium: What's up with That?" was completed in 2002 [67]. Five nutrition educators were hired to teach fifteen, 7th through 10th grade nutrition classes using the intervention tool. Four hundred and eighty-eight students participated. Informal evaluations by the nutrition educators and the teachers were attained to improve the educational packet, which was re-titled "Calcium: Got it? Get it!"

The primary component developed for the educational packet was a Power Point presentation on calcium. This presentation was designed with the help of a graphic designer to be bright, bold, and catchy for adolescents.

Study

On the day of each initial classroom session, the research investigator reviewed classroom activities with students before administering the Block Kids Food Frequency Questionnaire for ages 8 through 17 and standardized serving size handouts, developed by Nutrition Quest. Once surveys were distributed, students were instructed to fill in their name, the date, and instructed on how to fill in their unique ID number. ID numbers were determined based on class number (given chronologically from first scheduled class to last scheduled class), initial FFQ number (4 digit number on bottom corner of FFQ), and class session (initial or follow-up). For example, an individual in the fifth scheduled class with a FFQ numbered as '4522' that filled out a survey at the initial time point had the following ID number: 05452201. For the follow-up survey, that same student had the ID number: 054522**02**. The only number that changed in the ID number was the last digit, which indicated that the survey was the follow-up survey. Students were instructed to fill in their gender, height, weight, ethnicity, and "For Office Use Only" box on the last page of the FFQ, which included today's date, and their age, weight in pounds, and height. Two sample questions on the front page of the survey as well as the portion sizes handout were reviewed with students before completing the surveys. Students were encouraged to ask questions at any time. Students took approximately 30-45 minutes to complete their FFQ's.

When all surveys were completed, they were collected by the investigator and/or assisting dietetic interns from the OHSU dietetic internship program. The research investigator then presented the Power Point curriculum on calcium titled "Calcium: Got it? Get it!" (See Appendix C). For classrooms lacking Power Point access, the instruction was given using color overhead transparencies. The presentation took approximately 30-40 minutes to complete and consisted of 21 slides, 9 of which were pictures and/or graphs. The topics discussed included: where calcium is in the body, roles of calcium in the body, calcium and body weight, peak bone density, lifetime calcium intake by males and females, beverage intake by adolescents, osteoporosis, effect of exercise on bone mass, nutrients in dairy foods, adequate intakes of calcium for age groups, barriers to getting enough calcium, calcium on food labels, portions and serving sizes, and a group discussion if students had questions or comments.

Six-week follow-up

Student names and ID numbers were recorded and sent to teachers via email for the purpose of a second round of FFQ administration 6 weeks later. For all classes, the initial classroom session was followed by a six-week follow-up FFQ administration. Teachers of intervention and control classes were provided with a second set of Food Frequency Questionnaires after the initial classroom session. Teachers were instructed to administer one questionnaire per student, six weeks after the initial Food Frequency Questionnaire was administered. Student ID numbers, ending in '02', were filled in by teachers before the follow-up or by students as they filled out their surveys. Any nutrition education given to students by their teacher during the study period, was not controlled for by the investigator. However, participating teachers were asked not to teach their students about calcium or to use the "Calcium: Got it? Get it!" packet until the 6-week follow-up surveys were returned.

Completed surveys were returned to the primary investigator, using pre-addressed envelopes provided during the initial encounter. Postage costs were reimbursed to the teachers.

Students in the control schools

For the control groups, Food Frequency Questionnaires were administered at baseline and 6-week follow-up. However, these students did not receive the intervention curriculum.

Data entry and Quality Control

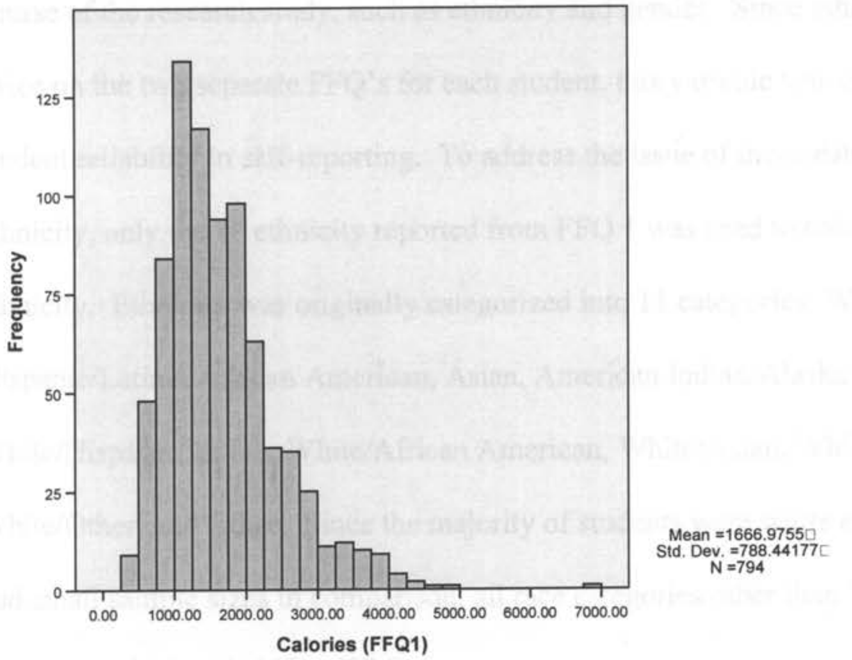
Student data including student ID numbers, gender, age, height, weight, ethnicity, and soft drink consumption were recorded in an Excel spread sheet by the research investigator and trained dietetic interns after the first and second classroom sessions. All student information was self reported and accuracy of information was not confirmed. The primary aim of this study was to measure the effect of a school-based nutrition curriculum on intake of dietary calcium. Nutrition Quest, Berkeley CA, estimated nutrient intakes from the Block Kids FFQ. Data provided from Nutrition Quest included a data file with student ID numbers listing estimated dietary and supplement intakes for 85 variables. Intakes were reported as percent of total calories for macronutrients, dietary intake of micro and macronutrients, supplement intakes of micronutrients, and food group serving sizes. For the purpose of this study, analysis was done on dietary intake of nutrients with a focus on intake of dietary calcium. For a list of variables analyzed, refer to Appendix D.

Upon completion of all survey administration, FFQ's were sent to Nutrition Quest for electronic scanning and data tabulation of food and nutrient intake. To analyze all data together, it was necessary for both the Nutrition Quest and investigator-entered data file to be merged into one common document. Prior to merging, student ID numbers from both files were matched. If any ID number was not recorded in the investigator-entered file, the investigator referred back to the hard copies of the FFQ to identify missing surveys. If surveys were found, data was entered into the investigator-entered data file. If missing surveys were not found, data was not included in the analysis. If ID numbers were indistinguishable in the Nutrition Quest data file due to missing digits this information was not included in analysis. In summary, all data that was not able to be matched between both data files were excluded from analysis.

Frequencies and descriptive statistics were run on the complete merged data file to identify abnormalities and/or questionable data. For example, an unrealistic BMI value, weight, height, or age was identified and revised by referring back to the investigator-entered data file or hard-copy of the surveys. If a questionable value could not be repaired, the value was changed to a missing variable. All missing data was marked by '99999999' and was excluded from analysis.

FFQ's were flagged for "serious errors" by Nutrition Quest (Berkeley, CA) based on too many food items skipped and/or excessive amount of food eaten in any given day. Any FFQ's flagged as containing "serious errors" were excluded from analysis. The complete set of included FFQ's was analyzed for the overall distribution of energy intake to identify any distinct gap in reported energy intake among students (see Figure 1). Based on an obvious gap after 5000 calories, only FFQ's with total energy intake below 6000 calories were analyzed, regardless of reported energy intake. Since individuals on the lower end of the histogram followed a normal distribution, they were not excluded from analysis. A total of 793 students at FFQ1 remained in the analysis after FFQ's with serious errors and energy intake < 6000 calories were removed. Out of the 793 students, 519 students completed both FFQ1 and FFQ2.

Figure 1:
Distribution of energy intake at FFQ1 after excluding FFQ's with errors



Failure to designate a serving size in the FFQ was not considered a serious error. For students who did not fill in serving sizes on their FFQ, median portion sizes for all food items missed, was assumed. Consequently all nutrient intake values for reported foods without a serving size designated were based on median portion sizes for these students. The FFQ's for these students were not excluded from analysis.

To determine if any difference in exclusion due to serious error for the intervention and control groups existed, a Chi-square analysis was used. The likelihood of excluding a student from the study due to seious error was not significantly different between the intervention and control group (p=0.108).

Crosstabulations were examined for variables that could not realistically change over the course of the research study, such as ethnicity and gender. Since ethnicity was reported twice on the two separate FFQ's for each student, this variable was chosen to test for student reliability in self-reporting. To address the issue of inconsistent reporting of ethnicity, only the 1st ethnicity reported from FFQ 1 was used to categorize student ethnicity. Ethnicity was originally categorized into 11 categories: White, Hispanic/Latino, African American, Asian, American Indian/Alaska Native, White/Hispanic/Latino, White/African American, White/Asian, White/American Indian, White/Other, and Other. Since the majority of students were white and all other groups had small sample sizes in comparison, all race categories other than White were grouped into one variable titled Non-Whites.

Selection Bias

Younger students were more likely to be in control schools because of shorter class duration availability (<90 minutes). Since the time required to conduct the intervention curriculum was 90 minutes, many of the control schools were considered ineligible if they were randomized into the intervention group. Therefore, a larger portion of the intervention classes were conducted at high schools. High schools were more likely to have class periods that could accommodate the 90 minute curriculum than middle schools, therefore the majority of intervention classes were delivered to high school students and the majority of the control classes were delivered to middle school students. Because of this selection bias, there was a two-year difference in mean age between intervention and control group students.

Another source of bias resulted if a teacher chose to give follow-up surveys to students as homework. Students who took FFQ's home were more likely to not return surveys. Despite instruction to administer surveys in class, some teachers opted to give FFQ's to students as homework. This could create additional selection bias in that some students did not return the survey. This could also create recall bias in that students completing the FFQ's at home, may have access to prompts that would facilitate more complete recall of their recent food intake.

Power Calculation

Based on data reported by Preisser, et al [68] a sample size of approximately 1280 students was estimated to provide adequate power to detect changes in dietary calcium intake of about 150 mg of calcium. Using age-matched CSFII data for dairy consumption, fruit and vegetable consumption, and a desired change of 0.5 servings of dairy foods per day (equivalent to about 150 mg of calcium), power was determined to be 0.8, using a two-sided t-test with alpha = 0.05. A change of one serving of food was assumed to be appropriate post-intervention with a variation of 1, for standard deviation.

Statistical Analysis

All statistical tests were done using SPSS, version 14, Chicago, IL [69]. A p-value <0.05 was considered statistically significant.

Differences in the means between control and intervention group for FFQ1 and FFQ2 were tested using independent t-tests. Mean differences of study variables from FFQ1 to

FFQ2, for students within the control and intervention group were tested using paired t-tests. All t-tests were run to test for differences between males and females, whites and non-whites, and study groups.

To address the secondary hypothesis of whether or not the lowest consumers of calcium increased their dietary intake of calcium, calcium intake adjusted for energy intake was further tested for differences in tertiles. Differences in dietary intake from FFQ1 to FFQ2 were determined using paired t-tests. Mean differences for all students, followed by differences among intervention and control groups were tested.

A new variable was computed for change in energy-adjusted calcium intake to compare mean change from FFQ1 to FFQ2 for each tertile. Between-group comparisons for all groups, whites, non-whites, females, and males were tested using independent t-tests.

One-Way ANOVA was used to test for mean difference in energy-adjusted calcium intake for the intervention and control group across age groups. Bonferonni post-hoc analysis was chosen to test for significance of differences between age groups.

Proportions tests were used to compare the proportions of students who did or did not consume the Adequate Intake (AI) for calcium, across age groups. Frequencies were calculated to determine the percentage of students in the study meeting the AI for calcium

(1300 mg). Percentages were determined for all students, females, and males, aged 11-12, 13-14, 15-16, and 17-18. Logistic Regression was used to determine the odds ratio for achieving the AI for calcium.

Chapter 3: Results

Data was available from 891 students at FFQ1 and 649 students at FFQ2 (Appendix D, Table 1). Before the addition of filters for serious errors and energy intake greater than 6000 calories, there were 627 students who completed both FFQ1 and FFQ2 (70% follow-up with both surveys). After exclusion of 98 students at FFQ1 and 80 students at FFQ2 due to serious errors and/or energy intake greater than 6000 calories (Appendix D, Table 2), there were 519 students remaining who completed both surveys (65% follow-up with both surveys after filters). Percent follow-up of students who completed both surveys was greatest among white females. Intervention and control groups had similar follow-up rates.

Frequencies and descriptive statistics were run for students who submitted FFQ's that were flagged as having a serious error(s) or who reported energy intake >6000 calories per day. Students excluded due to error had higher mean values for all nutrients except for dietary vitamin D and dairy servings.

Test for Normality

To test for normality, mean intakes of percent of energy from protein, carbohydrate, and total fat from the National Health and Nutrition Examination Survey 1999-2000 (NHANES) were compared to mean macronutrient distribution of students in the current study for FFQ1 (see Table 1 below). NHANES means were listed by age group categories and gender. The category for adolescents aged 12-19 were compared to data from this study (age range of 11-18). A one sample t-test was used to test for differences in means. Mean percent of energy from protein was significantly different (p=0.042) between the reference data and the study derived data. Overall means for percent of energy from carbohydrate (p=0.057) and fat (p=0.077) were not statistically different. Means were not statistically different for any macronutrient component among females. Mean differences in percent of energy from carbohydrates (p=0.016) and protein (p=0.049) but not fat (p=0.59) were significant in males. P-values were likely affected by difference in sample size. Dietary intakes of 2207, 12-19 year olds, were analyzed by NHANES, compared to 519 students in the current study. Also, NHANES estimated dietary intakes using one 24-hour dietary recall, compared to one food frequency questionnaire in the current study, which could explain some of the differences in reported intakes. Overall, the means of the macronutrient composition of the diet at FFQ1 from the current study are similar to dietary intakes reported by NHANES 1999-2000.

Table 1:
Mean Comparison between study sample and NHANES 1999-2000 data for % Energy from Protein, % Energy from Carbohydrate, % Energy from Total Fat for a) all students, b) females, and c) males

a) Nutrient Comparison of Study Sample to NHANES Data 1999-2000

	Mean	SD	N	NHANES Means	P-Value
% Energy from Protein	13.9	2.9	793	13.7	0.042
% Energy from Carbohydrate	55.3	8	793	54.8	0.057
% Energy from Total Fat	32.3	5.8	793	32	0.077

b) Nutrient Comparison of Female Subjects to NHANES Data 1999-2000

	Mean	SD	N	NHANES Means	P-Value
% Energy from Protein	13.6	3	392	13.4	0.118
% Energy from Carbohydrate	55.5	7.9	392	55.5	0.828
% Energy from Total Fat	32.4	5.6	392	32.1	0.181

c) Nutrient Comparison of Male Subjects to NHANES Data 1999-2000

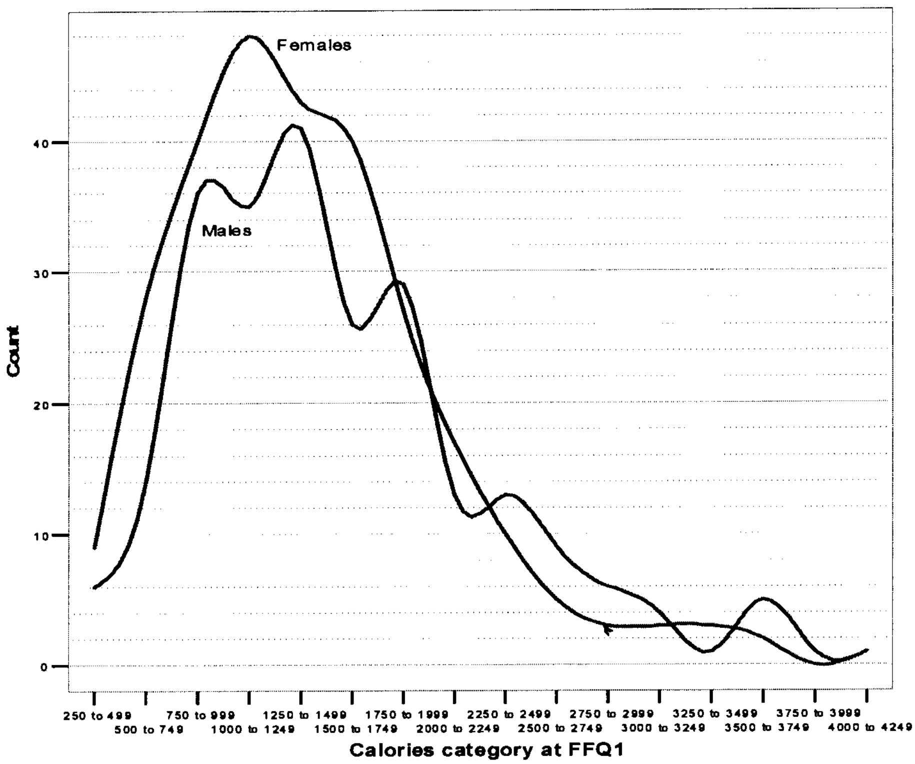
	Mean	SD	N	NHANES Means	P-Value
% Energy from Protein	14.1	2.8	393	13.9	0.049
% Energy from Carbohydrate	55.1	8	393	54.2	0.016
% Energy from Total Fat	32.1	5.8	393	32	0.59

*students with <6000kcals, no errors, FFQ1

Differences between groups at FFQ1

Energy intakes by males and females at FFQ1 indicate that females students consume significantly less energy than male students ($p<.001$) (Figure 2).

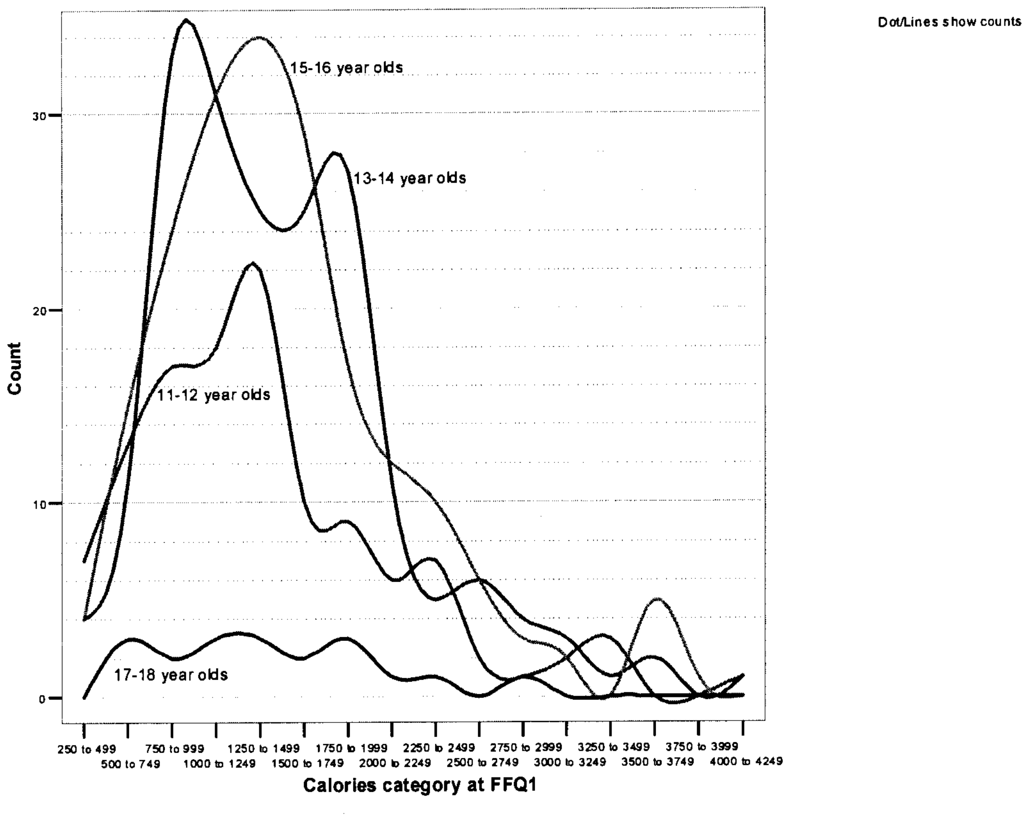
Figure 2: Energy intakes by male and female students at FFQ1



To test for differences in energy intake at FFQ1 across ages, four categories, in two-year age increments, were created: 11-12, 13-14,15-16, and 17-18. A One-Way ANOVA test revealed no overall significant difference in energy intake across age categories ($p=0.515$). Bonferonni Post-Hoc analysis further showed that despite age differences, the amount of reported energy consumed was not significantly different between age group ($p \geq 0.629$).

As seen in Figure 3, energy intake is not progressive as age increases and range of energy intake around the peak energy value is small.

Figure 3: Energy intakes at FFQ1 across age groups



Based on independent t-tests, comparing students who completed both surveys, had no errors on their FFQ, and consumed less than 6000 calories (n=519), between group differences were identified for intervention vs. control groups (Appendix D, Table 3), whites vs. nonwhites, and males vs. females. As explained earlier because of misrandomization of control and intervention groups, there was a significant difference in age, with intervention students being nearly 2 years older than controls ($p<.001$). As expected, older students in the intervention group were significantly taller and heavier than students in the control group. Absolute intakes of energy, fat, and carbohydrate were not significantly different between groups. However, absolute protein intake was higher for the intervention group, males consumed more than females for all *macronutrients, and non-whites consumed more carbohydrates, and grain servings than* whites. In examination of percent of energy from protein, carbohydrate, and fat, non-whites consumed a lower percent of energy from fat than whites and males consumed a higher percent of their energy from protein than females. Males also consumed more saturated fat, cholesterol, meat products, and non-diet soda than females. Students in the control group consumed a higher percent of their total energy from sweets than the students in the intervention group.

Because of the age difference between the intervention and control groups, significant differences of many of the variables can be explained for by age. Independent t-tests were run for 13-15 year olds to account for difference in age. Differences in means between intervention and control groups were tested. This age group was selected because it encompasses the mean age of students in the study (mean of 13 for control and 15 for intervention). Variables with significant mean differences for all students that were no longer different among 13 to 15 year olds were servings of grains, dietary iron and zinc. Dietary calcium intake and dairy servings were not different for intervention and control groups.

Additionally, since males consume more food overall than females, many of the differences are explained by gender. To compensate for age and gender bias, as well as to focus on energy density of nutrients, new variables were made to index nutrient intake to energy intake based on per 1000 calories of food consumed. The new variables were created for dietary calcium, vitamin D, phosphorus, iron, zinc, and daily soda consumption. After adjusting for energy content, calcium consumption was lower for non-whites than whites, and phosphorus and vitamin D were higher for whites and males than non-white females. Iron and zinc were higher for the intervention group than controls, and daily soda consumption remained statistically higher among males compared to females ($p<.001$).

Impact of Intervention

The primary variable hypothesized to increase post-intervention was calcium. To assess the impact of the intervention on calcium intake, calcium will be the primary focus for further analysis.

To test for differences in means from FFQ1 to FFQ2 for the study sample (n=519), paired t-tests were run for intervention and control groups. No change was anticipated for the control group, while change was anticipated for the intervention group. Table 1 provides the means at FFQ1 and FFQ2, the numbers of students compared, and the p-values for all variables of interest. All highlighted p-values indicate statistically significant differences in means between FFQ1 and FFQ 2.

Table 1:
Paired t-tests for differences in means between FFQ1 and FFQ2 for overall study sample, intervention group and control group

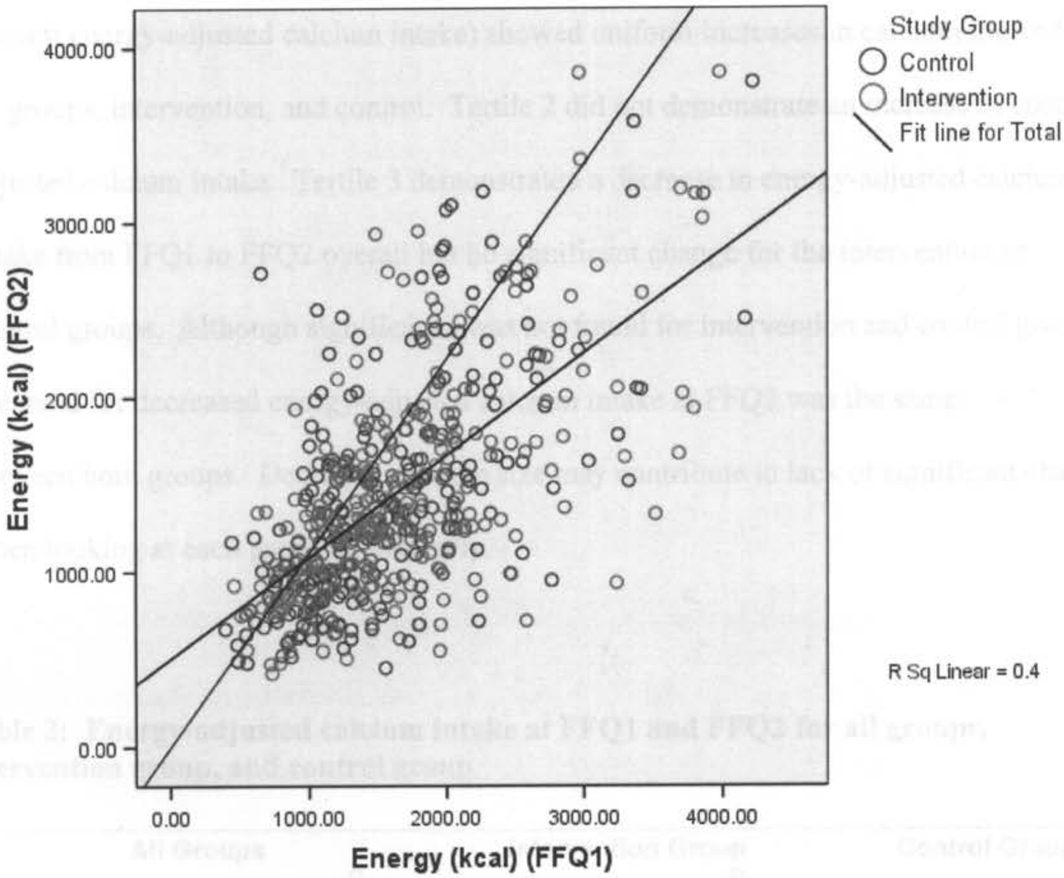
	Overall				Intervention				Control			
Item	FFQ1	FFQ2	Number	P-value	FFQ1	FFQ2	Number	P-value	FFQ1	FFQ2	Number	P-value
Age (years)	14	14.1	519	<.001	15	15.1	265	<.001	12.9	13	254	<.001
Height (inches)	64.5	65	459	<.001	65.8	65.9	240	0.033	63.2	64	219	<.001
Weight (pounds)	129.9	131.4	424	<.001	138.2	139.5	221	0.007	120.8	122.5	203	0.004
BMI [(lbs/(ht^2)x703]	21.8	21.6	405	0.163	22.3	22.3	211	0.806	21.2	20.9	194	0.062
Energy (calories)	1616	1444	519	<.001	1672	1451	265	<.001	1558	1438	254	0.001
Protein (g)	55.5	50.5	519	<.001	58.1	51.7	265	<.001	53.1	49.3	254	0.009
Total Fat (g)	58.5	52.8	519	<.001	60.5	53.8	265	<.001	56.5	51.7	254	0.004
Carbohydrate (g)	223.3	197.4	519	<.001	230.5	195.4	265	<.001	215.8	199.4	254	0.001
% Kcals from Protein	13.9	14.1	519	0.061	14	14.4	265	0.033	13.7	13.8	254	0.638
% Kcals from Fat	32.5	32.7	519	0.52	32.5	33.1	265	0.115	32.5	32.3	254	0.436
% Kcals from Carbohydrates	55.1	54.6	519	0.161	55	53.9	265	0.033	55.3	55.4	254	0.807
% Kcals from Sweets	15.4	16.2	519	0.058	14.1	15.2	265	0.054	16.7	17.3	254	0.415
Saturated Fat (g)	20	18.3	519	<.001	20.5	18.5	265	<.001	19.4	18.1	254	0.017
Dietary Cholesterol (mg)	166.7	155	519	0.004	168.1	155.2	265	0.015	165.2	154.7	254	0.096
Servings of vegetables	1.4	1.2	519	<.001	1.6	1.2	265	<.001	1.3	1.2	254	0.226
Frequency of fruits, fruit juices	1.4	1.2	519	<.001	1.3	1.1	265	<.001	1.5	1.2	254	<.001
Servings of bread,cereal,rice,pasta	4	3.7	519	<.001	4.3	3.8	265	<.001	3.8	3.6	254	0.262
Servings of meat,fish,poultry,beans,eggs	1.6	1.4	519	<.001	1.6	1.4	265	<.001	1.5	1.3	254	0.001
Servings of milk,yogurt,cheese	1.4	1.4	519	0.832	1.4	1.4	265	0.588	1.4	1.4	254	0.407
Frequency of fats,oils,sweets	3.2	2.9	519	<.001	3.1	2.8	265	<.001	3.2	3	254	0.009
Dietary Calcium (mg)	769.1	729.8	519	0.005	783.5	738	265	0.019	754	721.2	254	0.1
Calcium (mg) / 1000 kcals	487.4	493.4	519	0.543	478.5	482.3	265	0.775	496.7	505.1	254	0.576
Dietary Phosphorus (mg) / 1000 kcals	638.7	625.7	519	0.259	637.8	618.9	265	0.196	639.6	632.9	254	0.706
Vitamin D (IU) / 1000 kcals	99.5	110.5	519	<.001	95.4	110.9	265	<.001	103.8	110.2	254	0.06
Dietary Iron (mg) / 1000 kcals	6.9	6.5	519	0.002	7	6.4	265	<.001	6.8	6.6	254	0.427
Dietary Zinc (mg) / 1000 kcals	5.6	5.3	519	0.003	5.7	5.3	265	0.002	5.5	5.3	254	0.295
Daily soda consumption (oz) / 1000 kcals	4.4	3.6	449	0.004	4.8	3.7	229	0.007	4	3.5	220	0.199

As shown in Table 1, mean intake of energy, absolute protein, fat, and carbohydrates was significantly lower in FFQ2 than FFQ1 for both groups ($p \leq 0.033$). For the intervention group, percent of energy from protein was higher ($p=0.033$), percent of energy from fat did not change ($p=0.115$), and percent of energy from carbohydrates was lower ($p=0.033$). Grams of saturated fat and milligrams of dietary cholesterol were both lower ($p \leq 0.015$). For the control group, percent of energy from protein, fat, or carbohydrates was not different at the two time points ($p>0.4$) but grams of saturated fat was lower ($p=0.017$). Servings of vegetables, fruits, grains, meats, and frequency of fats, oils, and sweets were lower at FFQ2 than FFQ1 in the intervention group ($p<0.001$). Servings of fruits, meats, fats, oils, and sweets were lower in the control group ($p\leq0.009$). Energy-adjusted intake of iron, zinc and soda consumption were all significantly lower in FFQ2 than FFQ1 for the intervention group ($p\leq0.007$), whereas, the control group demonstrated no difference for these variables ($p\geq0.199$). For servings of dairy and energy-adjusted dietary calcium intake, there was no difference between FFQ1 and FFQ2 for either the intervention or the control groups, for whites and non-whites, or for females and males ($p\geq0.407$). Energy-adjusted dietary intake of vitamin D was higher in the intervention group ($p<0.001$) but not the control group at FFQ2 than FFQ1. Energy-adjusted vitamin D per 1000 calories was not different for whites, non-whites, or females in the intervention and control groups but was higher in males in the intervention group compared to the control group at FFQ2 than FFQ1. It is assumed that changes in nutrient intake that occurred in both intervention and control groups were not due to the intervention. Likewise, changes in the intervention group that were not seen in the control group may be due, at least in part, to the intervention effect.

Accounting for mean differences due to age, paired t-tests were run for 13-15 year olds in the control and intervention group to test for differences in means from FFQ1 to FFQ2 (Appendix D, Table 4). Variables that were significantly different for the entire study sample that were not significantly different among 13 to 15 year olds were servings of grains and energy-adjusted soda consumption. For students in the intervention group, protein, fat, percent of energy from carbohydrates, percent of energy from sweets, saturated fat, cholesterol, servings of grains, servings of meats, energy-adjusted zinc, and energy-adjusted soda were no longer found to be significantly different between FFQ1 and FFQ2. For the control group, servings of vegetables, and energy-adjusted vitamin D were no longer significantly different between FFQ1 and FFQ2. Energy-adjusted calcium intake and dairy servings remained unchanged from FFQ1 to FFQ2 for both the intervention and control group.

As described by the paired t-test for energy intake from FFQ1 to FFQ2, overall energy intake reported by students was significantly lower. Figure 4 provides a visual perspective of reported energy consumption for students at the first and second FFQ in the intervention and control groups. There are many students who had drastic changes in energy intakes, demonstrated by consumption of higher energy intake at FFQ1 to low energy at FFQ2 or low energy at FFQ1 to high energy at FFQ2. As the line of best fit indicates, there was a greater incidence of students reporting lower energy intake at FFQ2 than at FFQ1.

Figure 3: Overall comparison of reported energy intake at FFQ1 and FFQ2 for intervention and control groups: Reference line vs. fitted regression line



To further investigate the impact of the nutrition curriculum on calcium intake, students were divided evenly into 3 separate ranked groups (tertiles) for energy-adjusted calcium intake at FFQ1. Mean energy-adjusted calcium intake for all groups, intervention and control groups in the three tertiles at FFQ1 and FFQ2 are shown in Table 2. Highlighted p-values indicate a significant difference between FFQ1 and FFQ2 energy-adjusted calcium intake. One-Way ANOVA tests found that there was a difference in mean for all groups, intervention and control groups (all p<0.001). Bonferonni Post Hoc analysis further showed all paired comparisons of means for tertiles in both intervention and control groups to be statistically different (all p<0.001). Paired t-tests were used to test for differences in mean energy-adjusted calcium intake from FFQ1 to FFQ2. Tertile 1 (lowest energy-adjusted calcium intake) showed uniform increases in calcium intake for all groups, intervention, and control. Tertile 2 did not demonstrate an increase in energy-adjusted calcium intake. Tertile 3 demonstrated a decrease in energy-adjusted calcium intake from FFQ1 to FFQ2 overall but no significant change for the intervention or control groups. Although significance was not found for intervention and control groups, the trend for decreased energy-adjusted calcium intake at FFQ2 was the same between both groups. *Decreased sample size may contribute to lack of significant change* when looking at each group individually.

Table 2: Energy-adjusted calcium intake at FFQ1 and FFQ2 for all groups, intervention group, and control group

	All Groups			Intervention Group			Control Group		
Tertile	FFQ1	FFQ2	P-value	FFQ1	FFQ2	P-value	FFQ1	FFQ2	P-value
1st	335.2	401.3	<.001	330.7	390.1	0.003	340.4	414.1	0.004
2nd	463.1	462.9	0.991	460.3	456.7	0.854	466.2	469.8	0.888
3rd	667.7	623.8	0.018	667.7	623.9	0.109	667.7	623.6	0.085

A new variable for calcium intake was created to compare the mean difference in the degree of change between FFQ1 and FFQ2 for calcium intake among tertiles. Mean difference in the degree of change in calcium intake from FFQ1 to FFQ2 were tested using independent t-tests. Mean differences in calcium intake between the intervention and control group for all groups, whites and non-whites, females and males were not significantly different in any of the tertiles. Although there was a significant increase in energy-adjusted calcium intake in tertile 1 and a significant decrease in energy-adjusted calcium intake for tertile 3 (Table 2), the degree of change in calcium intake between intervention and control groups was not significantly different (Appendix D, Table 5).

Percent of Students Meeting the Adequate Intake (AI) for Calcium

Study subjects in the control and intervention group were divided into two categories based on whether or not they consumed the Adequate Intake (AI) of calcium for adolescents (1300 mg). Students were then sub-classified by age group. Proportions tests were used to compare the proportions of students who did or did not consume the AI for calcium, within each age group at each time point (FFQ1 and FFQ2) (Appendix D, Table 5). The proportion of 13-14 year old control students consuming ≥1300 mg of calcium decreased significantly from 10.3% to 4.8% from FFQ1 to FFQ2 (p=0.043). All other age groups in the control group did not demonstrate any significant change. The intervention group had no significant differences in the proportion of students consuming the AI for calcium intake from FFQ1 to FFQ2. Differences in proportion of students consuming the AI for calcium between study groups were not significant at FFQ1. The change in the percent of students meeting the AI for calcium at FFQ1 and FFQ2 between the intervention and control group was significant for 13-14 year olds (p=0.026).

Table 3 shows the percentage of students meeting the AI for calcium at FFQ1 and FFQ2. Supplemental calcium intake was not considered in this analysis. Differences between males and females were statistically significant for 13-14 year olds at FFQ1 (p=<0.001) and 15-16 year olds at FFQ1 (p=0.0128) and FFQ2 (p=0.004). For all significant differences, percent of males consuming the AI for calcium was higher than the percent of females. It is important to state that in all age categories, at both the first and second FFQ, fewer than 20% of students met the recommended AI for calcium intake (1300 mg).

Table 3:
Percent of students meeting the Adequate Intake for calcium (1300 mg) at FFQ1 and FFQ2 based on dietary intake

Percent of students meeting AI for calcium (1300 mg) at FFQ1 and FFQ2 based on dietary intake							
	AGE	Overall % (number of students)		Female % (number of students)		Male % (number of students)	
		FFQ1	FFQ2	FFQ1	FFQ2	FFQ1	FFQ2
	11-12	8.8% (171)	4.9% (123)	9.5% (105)	5.4% (74)	7.6% (66)	4.1% (49)
	13-14	10.5% (276)	6.3% (207)	2.4% (123)*	3% (101)	17% (153)*	9.4% (106)
	15-16	13.4% (292)	10% (201)	8.3% (144)*	4.5% (110)*	18.2% (148)*	16.5% (91)*
	17-18	9.1% (33)	6.1% (33)	0% (16)	6.7% (15)	17.6% (17)	0% (18)
	All students	11.2% (793)	7.1% (575)	6.4% (392)	4.2% (306)	16% (393)	10.4% (268)
Students without serious errors, and energy intake <6000kcals							
*Significant differences between males and females							

Logistic Regression was used to determine the odds ratio of achieving the AI for calcium. For all tests, only females were found to have significantly lower odds of meeting the AI than males (OR: 0.383; 95% CI: 0.201, 0.728, p=0.003). After adjusting for age and ethnicity, females remained less likely than males to consume the AI for calcium (p<.001). Odds were equal for whites and non-whites, as well as for each age category.

In summary, the hypothesis that calcium intake would increase following a nutrition curriculum on calcium was rejected. Although calcium intake increased for the lowest consumers of calcium (tertile 1), the finding that it increased in both intervention and control groups suggests that the intervention was not the cause for this change.

An important finding was discovered following tests to prove or disprove the study hypotheses. A higher percentage of males consumed the AI for calcium and the odds of meeting the AI for dietary calcium were lowest for females. In all age categories, at both the first and second FFQ, less than 20% of students met the Adequate Intake for calcium.

Chapter 4: Discussion

The primary aim of this study was to identify if dietary calcium intake increased following a tailored nutrition curriculum on calcium. It was hypothesized that the calcium curriculum would significantly increase dietary calcium intake from pre to post-intervention. The secondary aim of this study was to determine if students categorized as lowest consumers of dietary calcium increased their dietary intake of calcium from pre to post-intervention. It was hypothesized that lowest consumers of dietary calcium, who received the nutrition curriculum, would significantly increase their dietary intake of calcium. For each aim, the hypothesis was rejected.

Observed in the current study, a decrease in macronutrients, saturated fat, dietary cholesterol, and servings of all food groups, besides dairy servings occurred in the intervention group. Similar decreases in dietary intake for control group students were also found. An overall decrease in energy, macronutrients, and food group servings (besides servings of grains for the control group) for both groups suggests that changes were not due to the nutrition curriculum but some other factor.

One possible explanation for the reported decrease in dietary intakes is sample repetition of the survey, resulting in survey fatigue. Since students completed FFQ1 and FFQ2 only 6 weeks apart, it is possible that students experienced some fatigue the second time they filled out the survey and dietary intakes may not have been accurate. The test-retest reliability of this particular FFQ appears to be poor. In a previously mentioned unpublished validation study by Block et al., reasonable nutrient estimates in a first FFQ administration with children were followed by poorer results in the second FFQ administration, as compared to 24 hour recalls [65]. The particular FFQ used in the validation study was a modified version of the Block 1998 FFQ for Children.

Another possible reason for decreased dietary intakes is the effect of participating in a study. Described by the Hawthorne effect, individuals have a tendency to change their behavior when they are the target of special interest and attention in a study. Regardless of the type of intervention, individuals may report inaccurate information in an effort to please the investigator. Also, individuals who volunteer to participate in studies may adjust their responses because of a desire to contribute to the perceived positive study results [70].

As both control and intervention groups showed no difference for dairy servings and energy-adjusted calcium, it is possible that students more accurately reported dairy intake than intake of other foods. It is also possible that although the calcium curriculum was not given to the control group, students may have been more conscious of their dairy intake due to consent form information and the administration of two additional surveys relating to calcium and dairy consumption. Not previously mentioned, 2 additional surveys were given to students to assess knowledge of calcium and readiness to change related to calcium intake. The results of these surveys are to be analyzed in future study. Since the current study was described in the consent forms, and calcium and dairy servings were the focus of additional surveys filled out by all students, students may have been more focused on reporting their intakes of dairy servings, knowing that one intent of the study was to determine calcium and dairy intake. Despite overall decrease in food groups besides dairy servings for the intervention and control group (besides servings of grains for the control group), students did not change their reported daily dairy servings or energy-adjusted calcium.

As stated in the results section, there were dietary differences between males and females. Males were found to consume more energy, protein, saturated fat, cholesterol, meat products, and soda than females. The results of this study are in agreement with NHANES III data, which show adolescent males consume more soda and energy and consequently higher amounts of nutrients than females. Males consume more calcium than females but after adjusting for energy, calcium intake was not different for males and females. Energy-adjusted soda consumption remained significantly higher for males than females.

Female intake of dairy and calcium is of greatest concern. Other studies have found that females are lower consumers of calcium than males and tend to have inadequate intakes throughout life [5]. Adolescent females in this study showed the start of this trend. Dietary intakes of calcium were inadequate, and lower than males. The percent of females meeting the AI of 1300 mg for calcium was below 10% for all age group categories and were significantly lower than males for 13-14 year olds and 15-16 year olds. This is of great concern since peak calcium accretion occurs at approximately 12.5 years of age for females and at least 90% of peak bone density is obtained by18 years of age. Although females are consuming less calcium than males, males and females are both consuming below the Adequate Intake for calcium.

Energy-adjusted calcium intake also differed among ethnic groups. Energy-adjusted calcium was higher in whites than non-whites. In a study comparing calcium intake of Asian, Hispanic and white youth, whites reported higher intakes of calcium than the non-white ethnicities [43].

Differences in age between the intervention and control groups may explain some of the between-group differences. To account for age differences, mean differences were tested for 13-15 year olds. Despite few nutrient differences from FFQ1 to FFQ2, energy-adjusted calcium intake and dairy servings remained unchanged from pre to post-intervention. In order to further account for gender and age differences, nutrient and soda intakes were standardized for a per 1000 calorie energy intake. This allowed for a more equal comparison between groups and decreased the effect of age and gender on nutrient intake. Standardizing dietary intake data is recommended in cases where the use of a FFQ is associated with bias that differs for groups of subjects, for example, if it is different for males and females [71]. Adjusting nutrient intake by a standard of 1000 calories of energy consumed was used to standardize an effect and control for bias due to dietary differences across age, gender, and race [70]. Standardizing enabled estimation of the overall effect of the nutrition curriculum on calcium intake between different groups.

Stratification of energy-adjusted calcium occurred by tertiles within the data set, to compare calcium intakes of lowest to highest consumers of dietary calcium. Unlike the findings of the overall effect of the nutrition curriculum on dietary calcium intake, the analysis of tertiles found that the lowest consumers of dietary calcium increased their dietary intake of calcium in both control and intervention groups. By comparing the difference in change of dietary calcium intake between groups, it was found that the degree of change was not significant between intervention and control groups.

The inadequate dietary calcium intake of the students in this study reinforces the need for additional intervention efforts. Although this particular intervention tool was not successful at increasing calcium intake in adolescents, other methods and tools need to be tested. Because calcium intake is below the Adequate Intake for both genders, interventions need to be implemented earlier on and for both genders. Suggestions for future interventions include implementation of a multi-unit nutrition curriculum on calcium intake, interventions that teach both adolescents and parents about the importance of calcium and methods on how to increase intakes, and implementation of gender-tailored interventions for male and female adolescents.

Future research will analyze the behavior change and knowledge surveys included from pre to post-intervention. Also, change in supplemental intakes and total calcium intake will be analyzed. It will be of interest to further investigate intervention effect and reported intakes for the pre-intervention FFQ's on other dietary components not analyzed in the current study.

Limitations of the Study:

Several limitations must be taken into account when considering this study. First, an unintentional error in randomization, resulting in a 2-year age difference between intervention and control students created unequal comparisons between groups. Because of the age difference between the intervention and control groups, statistically significant differences of many of the variables could be explained for by age. Limiting the current study to high schools, who were more likely to have 90 minutes of class time, or splitting the survey administration and nutrition curriculum into two separate classes likely would have eliminated the error in randomization and can be used in future studies.

Second, intervention and control schools were not matched based on similarities, including mean age of students, geographic region, or socioeconomic status. Matching would have greatly decreased the differences between the intervention and control groups and created a more equal comparison.

Third, including a large range of student age (11-18) was not ideal. Focusing on either high school or middle schools separately would increase validity of study results as sample sizes for age groups would be larger and differences due to age would be limited.

Finally, design issue of not having the investigator do follow-up surveys, likely accounted for decreased survey return rate, and potentially a decreased accuracy in the FFQ reported food intakes. Having the investigator present at both the first and second FFQ would likely improve sample size, and increase survey completion accuracy.

Strengths of the Study:

Apart from the above limitations, the current study also has many strengths. This study provides a large set of data for adolescent dietary and supplement intakes in Oregon, which were not previously available. Based on study results, an area of great concern in adolescent health was identified. Study findings demonstrate the majority of adolescents that are not meeting the Adequate Intake for calcium. The extreme inadequacy of dietary calcium intake among Oregon adolescents is an important reason to find effective ways to increase intakes. Use of the results from this study will strengthen future intervention efforts in Oregon.

Chapter 5: Summary and Conclusions

The aims of this study were to determine if an increase in dietary calcium intake occurs in all students and students categorized as lowest consumers of calcium, following a tailored nutrition curriculum on calcium. Once adjusted for 1000 calories of energy consumed, dietary calcium intake did not show a significant change from pre to post-intervention. Dairy servings also did not change. Students categorized as lowest consumers of calcium did increase their energy-adjusted calcium intake but differences in dietary change between intervention and control groups were not significant.

In the current study, less than 10% of females and less than 20% of males reported dietary intakes that met or exceeded the Adequate Intake level for calcium. The inadequate dietary calcium intake of the students in this study reinforces the need for additional intervention efforts targeting adolescents. Further research would be useful to examine multi-unit, gender-tailored, and parent-involved nutrition interventions to improve the outcome of increased calcium intake among adolescents.

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Appendix A: Recruitment Materials

Recruitment Letter

Dear Teacher Name,

My name is Claire Stephanson and I am currently a graduate student at Oregon Health & Sciences University in Portland. I am in my second year, working towards my Masters of Science in Clinical Nutrition, and plan to work as a dietitian in the Northwest upon graduation.

The reason I am writing to you is to ask if you would be interested in having me teach a nutrition class at your school in the fall. My primary research focus at OHSU is studying the effect of an educational tool developed by the Oregon Dairy Council (ODC) on dietary intake of calcium rich foods.

In order to conduct my study, I need to recruit a total of 64 middle and high schools in Oregon. Thirty-two of these schools will be randomly chosen as my "experimental" group and the remaining 32 schools will be my control group. The experimental groups will be taught 1 nutrition class using the materials developed by ODC and the control will receive normal lessons from their teacher. For those classes I teach, the total time required will be approximately 90 minutes. For control schools, students will be asked to fill out diet surveys twice, which take ~30 minutes.

There are perks to taking part in this study. Joining this study will give you the opportunity to participate in a research study from a well-known research university. If your class is chosen as the experimental group, students will get the benefit of receiving a fun and interactive nutrition lesson developed by ODC. Whether you are in the classroom teaching intervention or not, as a thank-you, you will receive a gift certificate from Starbucks.

I am only going to be teaching classes from middle to high school. To create equality across my study, I request that all classes be health or food science classes. If there are no formal health classes at the middle school level, I will accept any class type. If you teach several classes per day, I would be more than happy to include all of them in the study.

I plan to begin teaching classroom sessions in mid-September, so request that responses be at your earliest convenience. Please let me know whether you would like to participate or not. I greatly appreciate your interest in my study and hope to be in touch with you soon. If you have any questions, please contact me via email at stephans@ohsu.edu or my faculty mentor, Victoria Warren-Mears, PhD, RD, LD at 503-494-0704 or warrenme@ohsu.edu .

Thanks!
Claire Stephanson
OHSU Clinical Nutrition Coordinated Masters Student

Appendix B: Consent Forms

eIRB#: 1419
Protocol Approval Date: 07/27/2005

OREGON HEALTH & SCIENCE UNIVERSITY
Consent to Participate in Research

TITLE: *Impact of Nutrition Education on Dietary Intake*
PRINCIPAL INVESTIGATOR: Victoria A. Warren-Mears, PhD, RD, LD (503) 494-0704
SPONSOR: Oregon Health & Science University and the Oregon Dairy Council

PURPOSE:

"You" means you or your child in this consent form. You have been invited to be in this research study because you are participating in a nutrition education program at school. The purpose of this study is to learn about how children eat before and after receiving nutrition education. If you agree to join and do not withdraw later, you will be in this study for 6 months. About 1280 children will be enrolled into the study at OHSU.

PROCEDURES:

You will be asked to fill out a diet record and three surveys before the class if you are a student. Immediately after the class you will fill out three short surveys if you are a student and one if you are a teacher. Then six weeks after the class you will fill out a diet record and two surveys. The table below shows you when these items will be collected and about how much time it will take you to fill them out.

	Before the class	Right after the class	6 – weeks after the class
Diet Survey	X		X
Change Survey	X	X	X
Confidence Survey	X	X	X
Knowledge Survey	X	X	
Teacher Survey (if applicable)		X	
Total time	1 hour	30 minutes student 30 minutes for teacher	1 hour

This is a randomized study. Neither you nor the investigator can choose whether you get the standard education or specific nutrition education class. This means that you will get either the usual class or specific class by chance. This is like tossing a coin--heads could mean you get the study class and tails would mean you get the usual class. You have a 50 % chance of getting the study nutrition education class.

You will not know which class you get. The study is done this way because sometimes knowing that you are getting the study class can change the results of the study. Please ask the investigator if you have any questions at all about this kind of study.

Questions will be asked about the type of food you eat and how often you eat it, about what was learned about nutrition, about how confident you feel about changing your diet habits and how ready you are to make changes in the next 6 months. The food questionnaire will be assigned as homework and will take about ½ hour to complete. The other forms take less than 10 minutes each.

RISKS AND DISCOMFORTS:
Some of these questions that are asked may seem very personal or embarrassing. They may upset you. You may refuse to answer any of the questions that you do not wish to answer. If the questions make you very upset, we will help you to find a counselor.

BENEFITS:
You will not personally benefit from being in this study. However, by serving as a subject, you may help us learn how to benefit students in the future.

ALTERNATIVES:
You may choose not to be in this study. You may choose to get nutrition information sent to you by Dr. Warren-Mears. To receive this information, call her at (503) 494-0704.

CONFIDENTIALITY:
We will not use your name or your identity for publication or publicity purposes.

Research records may be reviewed and/or copied the OHSU Institutional Review Board.

All questionnaires being used for research purposes, will be identifiable your child and his/her school by a code that will be held in a locked file and accessed only by Dr. Warren-Mears. Questionnaires will be stored for six months following collection. They will be shredded following finishing the study.

COSTS:
There are no costs to you for joining the study, state that explicitly.

LIABILITY:
The Oregon Health & Science University is subject to the Oregon Tort Claims Act (ORS 30.260 through 30.300). If you suffer any injury and damage from this research project through the fault of the University, its officers or employees, you have the right to bring legal action against the University to recover the damage done to you subject to the

limitations and conditions of the Oregon Tort Claims Act. You have not waived your legal rights by signing this form. For clarification on this subject, or if you have further questions, please call the OHSU Research Integrity Office at (503) 494-7887.

PARTICIPATION:
Dr. Warren-Mears (503) 494-0704 has offered to answer any questions you may have about this study. If you have any questions regarding your rights as a research subject, you may contact the OHSU Research Integrity Office at (503) 494-7887.

You do not have to join this or any research study. If you do join, and later change your mind, you may quit at any time. If you refuse to join or withdraw early from the study, there will be no penalty or loss of any benefits to which you are otherwise entitled. You may be removed from the study prior to study conclusion if you do not follow with instructions correctly for completing surveys. If you chose to withdraw, only the forms you have already completed will be taken from you. We will give you a copy of this consent form. Your child will be asked to sign the attached Child Assent Form.

SIGNATURES:

Your signature below indicates that you have read this entire form and that you agree to be in this study.

OREGON HEALTH & SCIENCE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
PHONE NUMBER (503) 494-7887
CONSENT/AUTHORIZATION FORM APPROVAL DATE

Jul. 27, 2005

Do not sign this form after the

Expiration date of: 7/26/2005

Signature of parent:______________________________ Date:________

Signature of Investigator:___________________________ Date:________

eIRB#: 1419

Protocol Approval Date: 07/27/2005

OREGON HEALTH & SCIENCE UNIVERSITY
Child Assent Form
(Use for children ages 7 through 17)

TITLE: *Impact of Nutrition Education on Dietary Intake*
PRINCIPAL INVESTIGATOR: Victoria A. Warren-Mears, PhD, RD, LD (503) 494-0704

Part I

Dr. Warren-Mears has explained this research study to me. I know how it may or may not help me. I also know that this study will help doctors know more about eating patterns in school kids.

1. The investigator will ask me to explain what I will do and what will happen in this study to be sure I understand the study.

2. The investigator will ask me if I have any questions or want to know anything else about this study or eating patterns.

3. The investigator will ask me to explain some of the good and bad things that might happen to me if I enter this study.

Part 2

I have thought about being a part of this study. I have asked and received answers to my questions. I agree to be in this study. I know that I don't have to agree to be in the study. Even though I agree to be in it now, I know I may feel differently later on and can ask to stop being in the study. I know that I may talk with my parents and/or doctor about not being in this study at any time.

OREGON HEALTH & SCIENCE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
PHONE NUMBER (503) 494-7887
CONSENT/AUTHORIZATION FORM APPROVAL DATE

Jul. 27, 2005

Do not sign this form after the

Expiration date of: 07/26/2006

Name/signature:____________________________ Date:__________________

Appendix C: Intervention Materials

Slide 1

CALCIUM:
Got It? Get It!

Nutrition Education Services/
Oregon Dairy Council

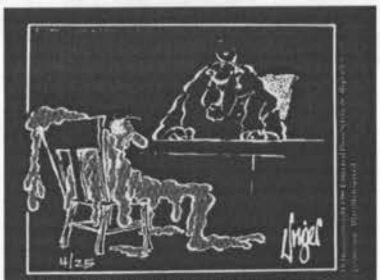
Slide 2

- Where is it?
  - Bones & Teeth 99%
  - Blood & Tissue 1%
- What does it do?
  - Bones to hold you up
  - Strong teeth
  - Strong heart and muscles
  - Healthy weight

Slide 3

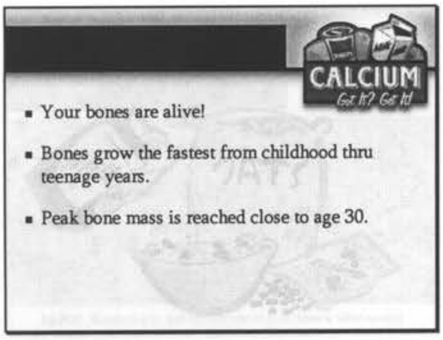
- Enough calcium + the right amount of calories = healthy body weight
- Naturally calcium-rich foods = better nutrition & health

Slide 4



"You're not getting enough calcium."

Slide 5



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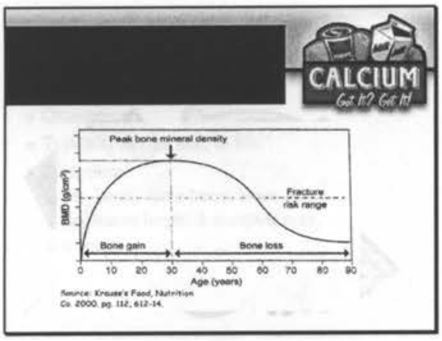

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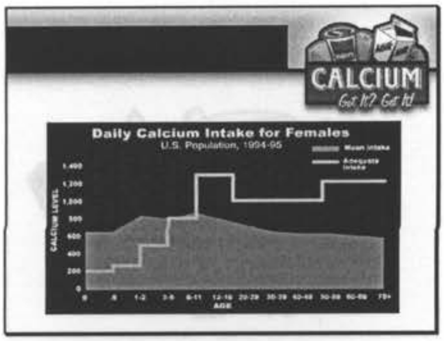

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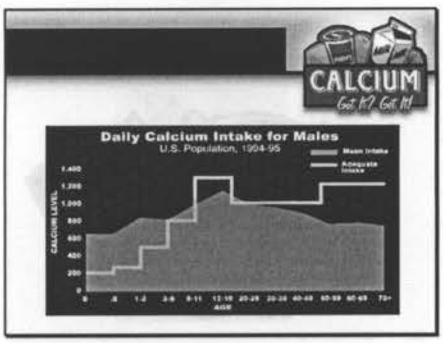

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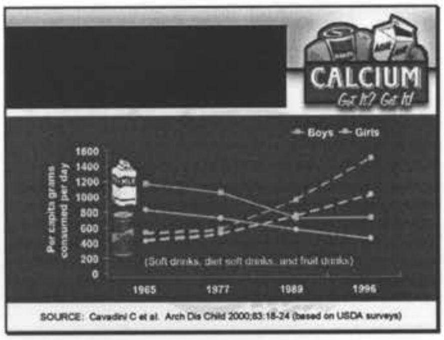

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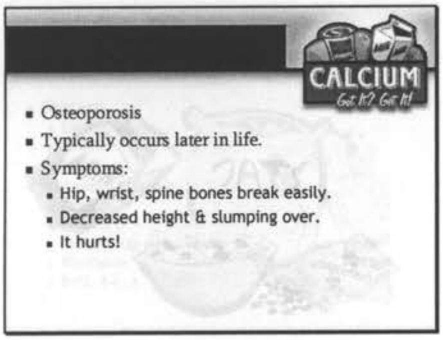

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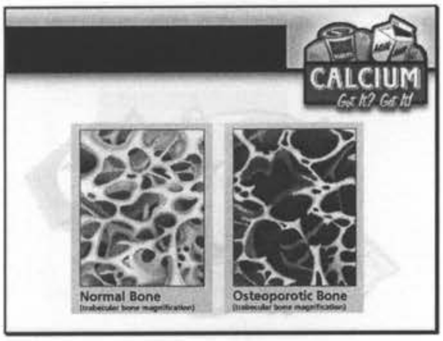

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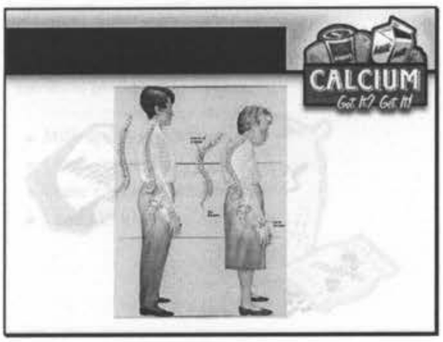

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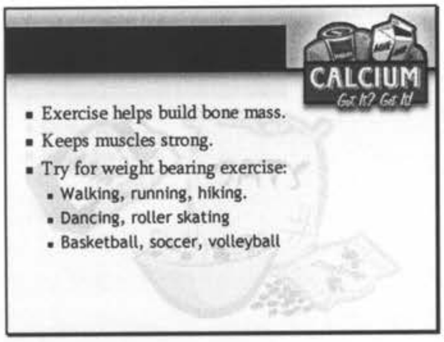

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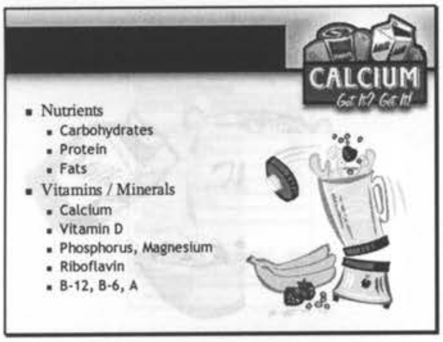

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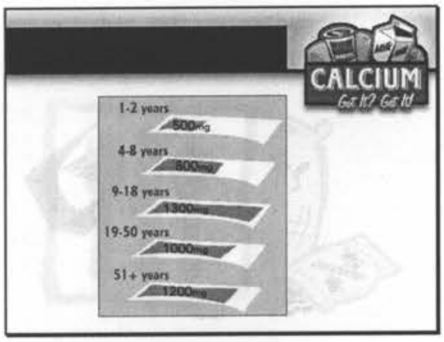

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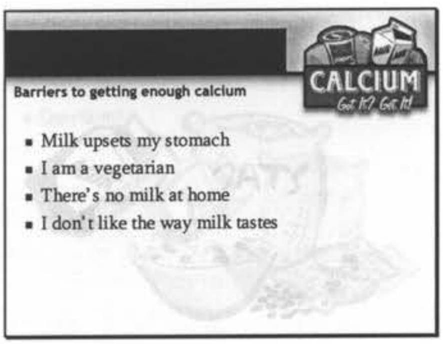

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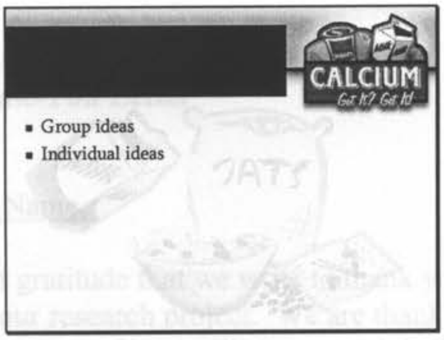

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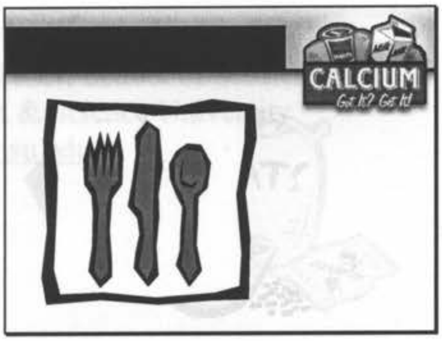

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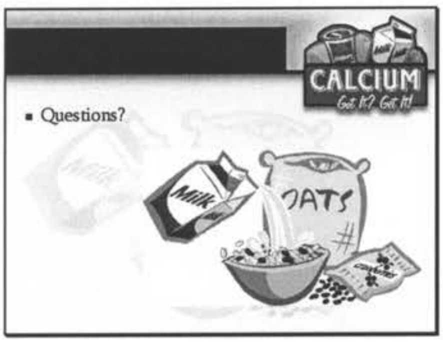

Teacher Thank-You Letter

Dear Teacher Name,

It is with great gratitude that we write to thank you for agreeing to have your class participate in our research project. We are thankful for the effort you put forth to make this project a success. Your willingness and dedication at working on our project will assist us in developing additional nutrition education information and knowing what targets might be appropriate in this age group.

Enclosed please find a gift card as a token of our gratitude for your assistance. If we can answer any questions of be of further assistance, please let us know.

Sincerely,

Victoria A. Warren-Mears, PhD, RD, LD
Assistant Professor, School of Medicine
Oregon Health & Science University
warrenme@ohsu.edu

Claire Y. Stephanson, BS
Project Research Assistant
Oregon Health & Science University
stephans@ohsu.edu

Appendix D: Variables and Tables

Table of Variables Analyzed

Item
Age (years)
Height (inches)
Weight (pounds)
BMI (lbs/(ht)^2 x 703)
Energy (calories)
Protein (g)
Total Fat (g)
Carbohydrate (g)
% Calories from Protein
% Calories from Fat
% Calories from Carbohydrates
% from Sweets
Saturated Fat (g)
Dietary Cholesterol (mg)
Servings of vegetables
Frequency of fruits, fruit juices
Servings of bread, cereal, rice, pasta
Servings of meat, fish, poultry, beans, eggs
Servings of milk, yogurt, cheese
Frequency of fats, oils, sweets
Dietary Calcium (mg)
Calcium (mg)/1000 calories
Dietary Phosphorus (mg)/1000 calories
Dietary Vitamin D (IU)/1000 calories
Vitamin D (IU)/1000 calories
Dietary Iron (mg)/1000 calories
Dietary Zinc (mg)/1000 calories
Daily soda consumption (oz)/1000 calories

Appendix D Table 1:

Frequencies: number of students who completed FFQ1, FFQ2, and both surveys before and after data filters (<6000 calories and no errors)

No Filters		FFQ1	FFQ2	Both Surveys	% Follow-up with Both Surveys	After Filters*	FFQ1	FFQ2	Both Surveys	% Follow-up with Both Surveys
Overall		891	649	627	70	Overall	793	575	519	65
Males		457	316	306	70	Males	393	268	240	61
Females		425	331	321	75	Females	392	306	279	71
Whites		540	406	391	72	Whites	495	368	340	68
Non-Whites		338	240	235	70	Non-Whites	287	206	179	62
Intervention		457	334	317	69	Intervention	400	295	265	66
Control		434	315	310	71	Control	393	280	254	65
*Filters are <6000 calories at FFQ1 or FFQ2 and no errors										

Appendix D Table 2:

Frequencies: number of students excluded for errors and >6000 calories (after errors) for FFQ1 and FFQ2

	# Excluded (FFQ1)			# Excluded (FFQ2)		
	Errors	After Errors	Total (FFQ1)	Errors	After Errors	Total (FFQ2)
Overall	97	1	98	73	7	80
Males	63	7	70	47	5	52
Females	33	1	34	25	2	27
Whites	45	2	47	38	4	42
Non-Whites	50	6	56	34	3	37
Intervention	56	3	59	38	3	41
Control	41	5	46	35	4	39

Appendix D, Table 3:

Independent t-tests comparing intervention and control groups between FFQ1 and FFQ2

Independent T-tests		Intervention	Control	
Item		Mean	Mean	P-value
Age (years) (FFQ1)		15.0 (n=265)	12.9 (n=254)	<.001
Age (years) (FFQ2)		15.1 (n=265)	13.0 (n=254)	<.001
Height (inches) (FFQ1)		65.7 (n=247)	63.1 (n=226)	<.001
Height (inches) (FFQ2)		65.8 (n=250)	63.9 (n=236)	<.001
Weight (pounds) (FFQ1)		139.6 (n=235)	120.7 (n=210)	<.001
Weight (pounds) (FFQ2)		140.0 (n=237)	122.5 (n=223)	<.001
BMI [(lbs/(ht^2)]x703 (FFQ1)		22.5 (n=225)	21.1 (n=202)	0.001
BMI [(lbs/(ht2)]x703 (FFQ2)		22.4 (n=233)	20.9 (n=216)	<.001
Energy (calories) (FFQ1)		1672 (n=265)	1558 (n=254)	0.06
Energy (calories) (FFQ2)		1451 (n=265)	1438 (n=254)	0.819
Protein (g) (FFQ1)		58.1 (n=265)	53.1 (n=254)	0.025
Protein (g) (FFQ2)		51.7 (n=265)	49.3 (n=254)	0.233
Total Fat (g) (FFQ1)		60.5 (n=265)	56.5 (n=254)	0.1
Total Fat (g) (FFQ2)		53.8 (n=265)	51.7 (n=254)	0.375
Carbohydrate (g) (FFQ1)		230.5 (n=265)	215.8 (n=254)	0.095
Carbohydrate (g) (FFQ2)		195.4 (n=265)	199.4 (n=254)	0.628
% Kcals from Protein (FFQ1)		14.0 (n=265)	13.7 (n=254)	0.234
% Kcals from Protein (FFQ2)		14.4 (n=265)	13.8 (n=254)	0.014
% Kcals from Fat (FFQ1)		32.5 (n=265)	32.5 (n=254)	0.911
% Kcals from Fat (FFQ2)		33.1 (n=265)	32.3 (n=254)	0.085
% Kcals from Carbohydrates (FFQ1)		55.0 (n=265)	55.3 (n=254)	0.679
% Kcals from Carbohydrates (FFQ2)		53.9 (n=265)	55.4 (n=254)	0.022
% Kcals from Sweets (FFQ1)		14.1 (n=265)	16.7 (n=254)	0.001
% Kcals from Sweets (FFQ2)		15.2 (n=265)	17.3 (n=254)	0.016
Saturated Fat (g) (FFQ1)		21.4 (n=265)	19.8 (n=254)	0.165
Saturated Fat (g) (FFQ2)		18.6 (n=265)	18.3 (n=254)	0.642
Dietary Cholesterol (mg) (FFQ1)		178 (n=265)	166.5 (n=254)	0.744
Dietary Cholesterol (mg) (FFQ2)		156.8 (n=265)	89.5 (n=254)	0.958
Servings of vegetables (FFQ1)		1.6 (n=265)	1.3 (n=254)	0.005
Servings of vegetables (FFQ2)		1.3 (n=265)	1.2 (n=254)	0.734
Frequency of fruits, fruit juices (FFQ1)		1.3 (n=265)	1.4 (n=254)	0.201
Frequency of fruits, fruit juices (FFQ2)		1.1 (n=265)	1.3 (n=254)	0.158
Servings of bread,cereal,rice,pasta (FFQ1)		4.4 (n=265)	3.9 (n=254)	0.004
Servings of bread,cereal,rice,pasta (FFQ2)		3.9 (n=265)	3.7 (n=254)	0.259
Servings of meat,fish,poultry,beans,eggs (FFQ1)		1.7 (n=265)	1.5 (n=254)	0.109
Servings of meat,fish,poultry,beans,eggs (FFQ2)		1.4 (n=265)	1.3 (n=254)	0.182
Servings of milk,yogurt,cheese (FFQ1)		1.5 (n=265)	1.4 (n=254)	0.887
Servings of milk,yogurt,cheese (FFQ2)		1.4 (n=265)	1.4 (n=254)	0.451
Frequency of fats,oils,sweets (FFQ1)		3.1 (n=265)	3.2 (n=254)	0.299
Frequency of fats,oils,sweets (FFQ2)		2.8 (n=265)	3 (n=254)	0.043
Dietary Calcium (mg) (FFQ1)		783.5 (n=265)	754.0 (n=254)	0.341
Dietary Calcium (mg) (FFQ2)		738.0 (n=265)	721.2 (n=254)	0.576
Dietary Calcium (mg)/1000 calories (FFQ1)		783.5 (n=265)	754.0 (n=254)	0.18
Dietary Calcium (mg)/1000 calories (FFQ2)		738.0 (n=265)	721.2 (n=254)	0.278
Dietary Vitamin D (IU)/1000 calories (FFQ1)		158.9 (n=265)	156.9 (n=254)	0.864
Dietary Vitamin D (IU)/1000 calories (FFQ2)		150.8 (n=265)	149.6 (n=254)	0.548
Dietary Phosphorus (mg)/1000 calories (FFQ1)		1094.7 (n=265)	1002.2 (n=254)	0.096
Dietary Phosphorus (mg)/1000 calories (FFQ2)		963.9 (n=265)	932.2 (n=254)	0.909
Dietary Iron (mg)/1000 calories (FFQ1)		11.8 (n=265)	10.6 (n=254)	0.022
Dietary Iron (mg)/1000 calories (FFQ2)		*10.1 (n=265)*	*9.9 (n=254)*	*0.447*
Dietary Zinc (mg)/1000 calories (FFQ1)		9.7 (n=265)	8.6 (n=254)	0.041
Dietary Zinc (mg)/1000 calories (FFQ2)		8.3 (n=265)	7.9 (n=254)	0.8
Daily soda consumption (oz)/1000 calories (FFQ1)		5.0 (n=242)	4.0 (n=229)	0.095
Daily soda consumption (oz)/1000 calories (FFQ2)		*3.6 (n=250)*	*3.7 (n=241)*	*0.96*

Appendix D, Table 4:

Paired t-tests for differences in means of 13-15 year olds between FFQ1 and FFQ2 for overall study sample, intervention group and control group

Item	Overall				Intervention				Control			
	FFQ1	FFQ2	Number	P-value	FFQ1	FFQ2	Number	P-value	FFQ1	FFQ2	Number	P-value
Age (years)	13.7	13.8	238	<.001	14.5	14.5	72	0.024	13.4	13.5	166	<.001
Height (inches)	64.5	65.1	212	<.001	65.5	65.6	65	0.228	64.1	64.9	147	<.001
Weight (pounds)	127.6	129.8	196	<.001	131.4	134.1	57	0.037	126.1	128	139	0.003
BMI [(lbs/(ht^2)x703]	21.5	21.4	189	0.474	21.5	21.8	55	0.181	21.5	21.2	134	0.176
Energy (calories)	1652	1501	238	<.001	1730	1593	72	0.064	1619	1461	166	0.001
Protein (g)	56.5	52.4	238	0.007	59.6	57.1	72	0.378	55.2	50.3	166	0.008
Total Fat (g)	59.6	54.4	238	0.002	64.5	58.8	72	0.376	58.8	52.5	166	0.002
Carbohydrate (g)	229.1	206.4	238	<.001	241.3	215.1	72	0.016	223.8	202.6	166	<.001
% Kcals from Protein	13.7	14	238	0.064	13.7	14.5	72	0.034	13.6	13.8	166	0.46
% Kcals from Fat	32.5	32.3	238	0.766	32	32.9	72	0.22	32.7	32.1	166	0.195
% Kcals from Carbohydrates	55.4	55.1	238	0.572	55.8	54	72	0.067	55.2	55.6	166	0.518
% Kcals from Sweets	16.1	16.5	238	0.595	13.7	14.6	72	0.435	17.2	17.3	166	0.865
Saturated Fat (g)	20.3	18.8	238	0.006	20.8	20.1	72	0.503	20.1	18.3	166	0.004
Dietary Cholesterol (mg)	173.5	160.6	238	0.044	168	156.7	72	0.21	175.8	162.3	166	0.104
Servings of vegetables	1.4	1.2	238	0.005	1.8	1.5	72	0.037	1.3	1.1	166	0.056
Frequency of fruits, fruit juices	1.4	1.2	238	<.001	1.4	1.2	72	0.022	1.5	1.3	166	0.001
Servings of bread,cereal,rice,pasta	4	3.8	238	0.147	4.1	4	72	0.409	3.9	3.7	166	0.232
Servings of meat,fish,poultry,beans,eggs	1.6	1.4	238	0.004	1.6	1.5	72	0.406	1.6	1.4	166	0.004
Servings of milk,yogurt,cheese	1.5	1.4	238	0.372	1.6	1.7	72	0.32	1.5	1.3	166	0.09
Frequency of fats,oils,sweets	3.3	3	238	<.001	3.3	3	72	0.02	3.3	3	166	0.001
Dietary Calcium (mg)	794.9	753.7	238	0.042	835.1	826	72	0.801	777.4	722.3	166	0.025
Dietary Calcium (mg) / 1000 kcals	489.8	484.9	238	0.693	489.1	506.6	72	0.454	490.1	475.5	166	0.321
Dietary Phosphorus (mg) / 1000 kcals	638.2	619.6	238	0.222	643.2	651.4	72	0.765	636.1	605.7	166	0.215
Dietary Vitamin D (IU) / 1000 kcals	101.5	109.1	238	0.031	98.6	111.4	72	0.037	102.8	108.1	166	0.1
Dietary Iron (mg) / 1000 kcals	6.7	6.4	238	0.067	6.9	6.3	72	0.079	6.7	6.5	166	0.3
Dietary Zinc (mg) / 1000 kcals	5.5	5.2	238	0.07	5.6	5.4	72	0.472	5.4	5.2	166	0.089
Daily soda consumption (oz) / 1000kcals	4.7	4	210	0.123	5.6	4.6	64	0.301	4.4	3.7	146	0.252

Appendix D, Table 5:

Proportions test for difference in proportion of students in intervention and control groups at FFQ1 and FFQ2 who met the Adequate Intake for calcium

	Control								Intervention								Group Difference FFQ1		Group Difference FFQ2	
	FFQ1			FFQ2					FFQ1			FFQ2								
	X	n	%	X	n	%	Z score	P value	X	n	%	X	n	%	Z score	P value	Z score	P value	Z score	P value
Age 11 to 12	10	117	8.5%	5	86	5.8%	0.7356	0.462	5	39	12.8%	1	31	3.2%	1.4244	0.1543	0.784	0.433	0.5601	0.5754
Age 13 to 14	24	233	10.3%	8	168	4.8%	2.0193	0.0435	3	30	10.0%	5	33	15.2%	0.6133	0.5397	0.051	0.9593	2.2185	0.0265
Age 15 to 16	2	29	6.9%	2	20	10.0%	0.39	0.6966	20	180	11.1%	17	174	9.8%	0.4123	0.6801	0.6863	0.4925	0.0328	0.9739
Age 17 to 18	1	7	14.3%	0	1	0.0%	0.4041	0.6862	0	19	0.0%	2	29	6.9%	1.4268	0.1537	1.6801	0.0929	0.2718	0.7858

Appendix D: Table 5

Change in dietary calcium intake per 1000 calories from FFQ1 to FFQ2 for intervention and control groups across tertiles

	Means for All Groups			Means for White			Means for Non-White		
Tertile	Intervention	Control	P-value	Intervention	Control	P-value	Intervention	Control	P-value
1st	59.4	73.7	0.648	73.4	70.8	0.957	42.5	77.9	0.34
2nd	-3.6	3.5	0.821	-13.2	-15	0.958	12.5	34.6	0.727
3rd	-43.8	-44.1	0.993	-48.7	-18.3	0.477	-32.7	-186	0.051

	Means for Female			Means for Male		
Tertile	Intervention	Control	P-value	Intervention	Control	P-value
1st	70.2	36.2	0.303	42.4	112.1	0.229
2nd	-1.9	-10.6	0.783	-5.9	25	0.626
3rd	-68.5	-4.3	0.238	-26.7	-79.7	0.298