DIETARY CALCIUM INTAKE AND OVERWEIGHT IN ADOLESCENCE

A Thesis

by

AMIRA SAMI GERGES

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

December 2004

Major Subject: Nutrition

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ABSTRACT

Dietary Calcium Intake and Overweight in Adolescence. (December 2004)
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Recent research has shown an association between low dietary calcium intake and obesity in adults as well as overweight in young children; however, this relationship has not been investigated in adolescents. The purpose of this study was to examine the relationship between inadequate calcium intake and overweight in adolescents. The hypothesis of this study was that there is a negative correlation between dietary calcium intake and overweight in adolescents. The study population consisted of middle school and high school students (n = 102) in a local school district. The gender and ethnic distributions of the sample were as follows: 74% female, 26% male, 63% Caucasian, 16% African-American, 12% Hispanic, and 8% other. Dietary calcium and energy intakes were assessed using a previously validated calcium-focused food frequency questionnaire (FFQ) for youths. Calcium intake was also assessed using a single question on daily milk consumption. The FFQ was administered by trained interviewers to groups of three to five students. Body fat was assessed using body mass index for age (BMI-for-age) and sum of triceps and subscapular skinfolds (STS). The mean reported calcium intake was 1,972 ± 912 mg/day, and mean reported energy intake was 3,421 ± 1,710 kcals/day. Reported calcium intake from the FFQ was inflated since approximately 75% reported drinking less than three glasses of milk a day. According to BMI-for-age, 29% were classified as at risk of overweight or overweight. Using STS, 39% were classified as overweight. Chi-square analysis using either method of dietary calcium intake and either method of overweight assessment did not show dependence between categories of calcium intake and level of weight or body fat. This study failed to show a relationship between dietary calcium intake and risk of overweight or overweight in adolescents.

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INTRODUCTION AND REVIEW OF LITERATURE

Child and Adolescent Overweight

Definition and Prevalence

Risk of overweight or overweight, in children and adolescents, are defined by the body mass index for age (BMI-for-age) (1). BMI is weight in kilograms divided by squared height in meters squared [weight (kg)/height^2 (m^2)] (1). BMI-for-age charts are available for boys and girls, ages two to 20 years old (1). A BMI-for-age equal to or greater than the 95th percentile is considered overweight (parallel to the term obese for adults) (1). A BMI-for-age equal to or greater than the 85th percentile and less than the 95th percentile is considered at risk of becoming overweight (parallel to the term overweight in adults) (1). The 1999 National Health and Nutrition Examination Survey (NHANES) showed that 14% of adolescents 12- to 19-years-old are seriously overweight (have a BMI-for-age ≥ 95th percentile) (2). This percentage has almost tripled since the 1960's when it was 5% (2).

Health and Financial Costs

The increase in the prevalence of overweight among adolescents has health and financial costs. Type II diabetes, previously known as adult onset diabetes and related to overweight, is now seen in children and adolescents because of the overweight epidemic (3). It is also important to note that child and adolescent overweight is a risk factor for obesity in adulthood (4, 5). Other complications of overweight include hypertension, heart disease, some types of cancers, joint problems, and psychological problems such as low self-esteem, and depression (6). During 1979-1981, annual hospital costs for overweight related diseases in children 6 to 17 years old were $35 million. These costs more than tripled during 1997-1999 to $127 million (7).

This thesis follows the style of the American Journal of Clinical Nutrition.

Dietary Calcium Intake in Adolescence

Recommended calcium intake for 9-18 year olds is 1,300 mg/day (8). Only 13.5 % of girls and 36.3 % of boys age 12- to 19-years-old in the U.S. are meeting the recommended intake (9). Soft drink consumption has been on the rise, and milk consumption has decreased (10). In 1945, Americans drank more than four times as much milk as soft drinks (11). In 1997, they drank nearly 2.5 times more soft drinks than milk (11). This is of concern because 75% of the calcium in the U.S. food supply comes from milk and dairy products (12).

Additionally, even though data show a decline between 1987 and 1995 in percent calories from fat in children's dietary intake, actual total fat intake has not decreased. Rather, total energy intake was increased (13). The source of this increase in energy intake can be primarily attributed to increased soft-drink consumption (13).

Increased soft drink consumption and increased overall energy intake are certainly contributing to the increase in overweight. However, the decrease in milk consumption, and the resulting decrease of calcium intake may also be a contributing factor to the overweight epidemic currently seen in youth.

Significance of Low Dietary Calcium Intake

Role of Calcium and Calcium Homeostasis

Calcium is a very important nutrient. It is involved in many processes in the body including skeletal muscle contraction, heart muscle contraction, and neurotransmitter release (passing of information from nerve cells) (14). For these reasons, the concentration of plasma calcium (Ca^{2+}) is maintained within a tight range (14-16). Hypocalcemia (low blood Ca^{2+}) and hypercalcemia (high blood Ca^{2+}) are life threatening (14). Bone, besides its role of providing structure, is important for calcium storage in the body (14). Approximately 99% of calcium in the body is within the skeleton and teeth (14). The free Ca^{2+} in the blood, whose levels are maintained within a tight range, is less than one-thousandth of the total Ca^{2+} in the body (14). Bone is a dynamic tissue that is constantly remodeled (14). Concentration of calcium in the plasma is maintained by hormonal regulation that causes bone to either take up or release calcium in response to diet (14, 15). For example, parathyroid hormone (PTH) in response to a drop of plasma calcium levels mobilizes some calcium from bone by increasing activity of bone-resorbing osteoclasts. PTH also acts on the kidneys to increase calcium reabsorption and to enhance activation of vitamin D by the kidneys. This vitamin D activation, in turn, increases intestinal absorption of calcium. Thus PTH keeps the plasma calcium from dropping (14).

Consequences of Inadequate Calcium Intake

Long term inadequate calcium intake along with inadequate weight-bearing exercise are risk factors for developing osteoporosis (17). In osteoporosis, bone is less dense and therefore more susceptible to fracture (14). The adolescent years are critical for bone density formation. It is estimated that 90% of adult bone mineral is deposited by the end of adolescence (17).

In addition to the importance of adequate calcium intake to reduce the risk of osteoporosis, inadequate calcium intake has been linked to hypertension, insulin resistance, and certain cancers (18-21). In addition, recent research has shown an association between inadequate calcium intake and overweight in young children (22) as well as obesity in adults (23-25).

Research Linking Inadequate Calcium Intake and Obesity

In a study by Zemel et al. (24), two cups of yogurt (dairy source of calcium) were added to the daily dietary intake of hypertensive African-American males with inadequate calcium intake (~400 mg/day) for one year. This addition brought their intake to recommended levels (~1000 mg/day) for this age group. Zemel et al. found a 4.9 kg (~10.8 pounds) reduction in body fat in those subjects after the one year intervention (24). The mechanism Zemel et al. (24) suggest is that, in response to low dietary calcium intake, calciotropic hormones stimulate calcium influx into fat cells (adipocytes) and as a result lipid (i.e. fat) storage is increased. Increasing calcium intake in the diet could suppress calciotropic hormones and consequently reduce adipocytes' intracellular calcium and lipid storage (24). The reason for this is not well understood. For example, Davies et al. (23) propose that this might go back to the primitive diet which was rich in calcium and in which a high PTH level might have been indicative of inadequate energy intake and thus promoted energy conservation (lipid storage). However, Lind et al. (26) did not find that PTH was significantly related to BMI or to waist to hip ratio.

Carruth and Skinner (22) conducted a longitudinal study of preschool children to assess the role of dietary calcium and other nutrients in moderating body fat. They assessed nutrient intake by diet records kept by mothers. They collected data from six interviews of three-day dietary records for a total of 18 days of dietary intake data per child. They averaged the three day dietary records which resulted in six representative days. They used these days to calculate group means at 27, 34, 42, 48, 54, and 60 months of age. They also calculated total number of servings from the milk/dairy products based on the calcium equivalent of 8 ounces of milk. They assessed the children's body composition at 70 (± 2) months of age using dual-energy x-ray absorptiometry (DEXA). The study sample was 53 children (29 males and 24 females).

For the statistical analysis, Carruth and Skinner (22) developed general linear models using percent body fat or total body fat grams as the dependent variable and children's gender, body mass index (BMI), parent's BMI, dietary calcium and other nutrients as the independent variables. They found that children with the highest percent body fat were not significantly different in height from those with the lowest percent body fat, but they had significantly higher BMI. They also found that the children's percent and grams of body fat adjusted for BMI were negatively related to calcium intake and positively related to fat intake. The variability in percent body fat, after adjusting for BMI, was negatively related to mean servings/day of dairy products. They concluded that their findings supported a relationship between higher intakes of calcium or dairy products to lower body fat in preschool children (22).

In an analysis of the Coronary Artery Risk Development in Young Adults (CARDIA) study, Pereira et al. (19) found that dairy consumption was inversely associated with the incidence of all insulin resistance syndrome (IRS) also known as syndrome X. IRS is the combination of obesity, insulin resistance, and hyperinsulinemia believed to cause glucose intolerance, dyslipidemia, hypertension, and impaired fibrinolytic capacity (19).

Their sample size was 3,157 adults 18 to 30 years old who were followed for 10 years. They queried usual dietary practices and used a quantitative food frequency questionnaire of the past 28 days. The list of foods included approximately 700 items. They measured intake at baseline and at the seventh year. Foods containing dairy were identified by matching CARDIA food codes to the entire University of Minnesota Nutrition Coordinating Center (NCC) nutrient database listings for dairy products. They averaged baseline and seventh year dietary intake. To assess body weight they measured height, weight, and waist and hip circumferences (19).

They used linear regression models to compare the incidence of components of IRS across categories of dairy intake. They also used multiple logistic regression to evaluate associations between dairy consumption and the odds of developing IRS during the 10-year study (excluding subjects who had IRS at baseline) (19).

They found that overweight subjects consumed less dairy products than normal weight individuals, and that there was a positive association between consumption of dairy products and consumption of whole grains, fruit, vegetable, and saturated fat. They also found an inverse association between dairy consumption and intake of sugar-sweetened soft drinks. Their results showed a 50% decrease in the incidence of IRS in overweight individuals from lowest to highest categories of dairy consumption. They did not find an association between dairy intake and IRS incidence in subjects who were not overweight at baseline. Pereira et al. concluded, based on their study results, that increased consumption of dairy products may have a protective effect in overweight individuals against developing obesity and the IRS (19).

Lin et al. (25) conducted a two-year exercise intervention study in young women 18 to 31 years old. Their sample consisted of 54 normal weight, sedentary Caucasian females. They were randomized into either an exercise program which consisted of three sessions of resistance exercise and 60 minutes of jumping rope per week or a control group for 24 months.

They assessed dietary intake using three-day diet records (including intake of vitamin and mineral supplements) at baseline and every six months for two years. They found no differences in nutrient intakes between baseline and the 6, 12, 18, and 24 months intakes so they averaged them for a mean intake for each nutrient for each subject. They determined dairy calcium from the calcium content of dairy foods only. They calculated non-dairy calcium by subtracting dairy calcium from total calcium (25).

They measured weight and height. They used a dual energy absorptiometer (DPXL) to assess body composition (fat mass, percent fat and lean mass) at baseline and at two years and expressed their results as change from baseline to 24 months (25). They used regression methods to investigate the relationship between body composition measures and dietary variables (25).

The mean calcium intake was 781 ± 212 mg/day (which is below the recommended intake of 1,000 mg for this age group). Dairy calcium constituted 69% of total calcium intake. Using calcium (total, dairy, and non-dairy) divided by calories, the authors found that the effect of calcium/kcal on weight did not differ between the exercise and control group. A significant interaction between calcium or dairy calcium and energy intake was found. There was no difference in calcium intakes between the subjects with low energy intake (with intakes below average 1,876 kcal/day) and subjects with higher energy intake (with intakes greater than or equal to the average 1,876 kcal/day). In the low energy group, only total calcium or dairy calcium intake (not energy intake) predicted changes in weight and fat mass. In the higher energy group, energy intake (not calcium intake) predicted changes in body weight. The authors concluded that subjects with lower energy intakes had less weight gain or lost body weight and body fat at higher total calcium and dairy calcium intakes. They also concluded that this percent weight change was likely a change in percent body fat and not a change in lean body mass (25).

Davies et al. (23) used five studies (that were not originally intended to investigate a relationship between calcium and obesity) to relate calcium intake and body weight. Four out of these five studies were published. YWS was a cohort of 184 healthy young women (in their early 20's) followed for 4 years (27). TCD was an unpublished cohort study of 198 young women that was a randomized controlled study of calcium supplementation. "Nuns" was a cohort study of 191 nuns as they moved from premenopause to postmenopause (28). It examined calcium metabolism and bone health at five-year intervals. "MBx" was a cohort of 75 perimenopausal women studied at six-month intervals for over five years (29). "Van" was a randomized controlled study of calcium supplementation in 216 elderly women (30).

The five studies were all conducted in women with ages ranging from 18 to 89 years (23). The outcome variable was BMI in two of the studies (YWS and TCD) and change in weight for the remaining three studies ("Nuns", "MBx", "Van"). They used a 7-day diet diary to assess calcium intake, and they calculated calcium to protein ratio (mg/g). In both of the studies that used BMI (YWS and TCD), they found a significantly negative slope for the regression of baseline BMI on dietary calcium to protein ratio (mg/g). They found that the ages, BMI values, and calcium intakes for the two studies were similar so they combined the subject pool and also found a negative slope -0.186 kg/m^2/mg/g (p =

0.001). They did not find a correlation between reported energy intake with entry weight or BMI. Davies et al. also combined the two datasets from the “Nuns” and “MBx” studies and found a negative slope –0. 0383 ($p = 0.008$) regressing weight change (kg/year) against calcium to protein ratio (mg/g). The “Van” study, which was a randomized controlled trial, reported that both the calcium-supplemented group and the placebo-control group lost weight over the four year observation period; however, the calcium supplemented group lost an additional 0.346 kg/year ($p < 0.025$) (23).

Davies et al. (23) also reported that in the studies they reviewed, calcium explained only about 3% of the variability in weight which emphasizes that body weight is multifactorial. They suggested conducting at least one controlled trial in which calcium intake is controlled by the investigators and weight change is the primary outcome variable.

In a review article, Parikh and Yanovski (31) comment on the article by Davies et al. (23). They point to the fact that none of the studies reviewed by Davies et al. assessed body composition, and therefore it is unknown whether the observed changes in body weight are due to a fat or lean body mass loss (31). However, they do comment that even though the observed difference of 0.346 kg/year between the calcium-supplemented and the placebo-control groups in the analysis by Davies et al. (23) seems small, the cumulative effect could become substantial (31).

In summary, several studies examined the relationship between dietary calcium, calcium supplementation, or more specifically dairy calcium intake and body weight or body fat in various age groups including young children, young adults, and older adults; however, a possible relationship has not been examined in adolescents. This study attempted to investigate this relationship in adolescence, a critical time for bone development. Can inadequate calcium intake in adolescence be a risk factor for more than just osteoporosis?

Assessment of Dietary Intake: the FFQ Method versus Other Methods of Dietary Intake Assessment

Selecting and administering dietary assessment instruments is a challenge. Many things need to be taken into consideration: the population studied in terms of its age, size, literacy, ethnic make-up, and cooperation; the skills of the interviewers/staff; the purpose of the data collected; and the degree of accuracy needed to fulfill the purpose of the study (32).

There are several methods of assessing dietary intake. These include diet records, 24-hour diet recalls, duplicate plate collections, and food frequency questionnaires (FFQs); however, they are all subjective because they rely on what the subjects reported eating (33). The different methods have their advantages and disadvantages. For example, the interviewer-administered 24-hour dietary recall is useful in assessing intake of a population rather than assessing individual intake because it only provides a “snapshot” or small sample of individual intake. Multiple days of 24-hour recalls can provide more representative data on intake in a smaller sample size, but can be difficult to collect if the sample size is large (32). Other advantages of a 24-hour diet recall are the fact that it asks open-ended questions, and requires less time to complete than a diet record and is less burdensome for subjects. One of the disadvantages of one-to-one interviewer-administered dietary recalls is under-reporting especially among individuals who are overweight. Also, recalls are expensive to collect (34, 35).

FFQs assess dietary intake over a longer period of time than recalls, from a week to a month or more, and therefore better account for day to day variability in intake (32). They are also relatively inexpensive. However, they tend to overestimate intake, and the greater the number of foods in an FFQ, the greater the overestimation (36). On the other hand, if FFQs are not comprehensive/long enough, they may not adequately measure intake (37). It is also important that the foods listed are tailored to the group studied and that they are consistently interpreted by a diverse population (i.e., a food name means the same to different cultural/ethnic groups) (32). Another limitation of FFQs and also of 24-hour diet recalls is the challenge of estimating serving sizes and accounting for foods in mixed dishes (32).

Some of the advantages of diet records/food diaries are that they do not depend on memory, and they allow for detailed and quantitative estimates of dietary intake over several days (38). However, they require highly motivated individuals and the ability to write down foods and portions of foods consumed (i.e., literacy) (39). They are subjective and may also influence the way participants eat because their intake is monitored.

Observation is considered the “gold standard” on dietary assessment (33). Observation of subjects (who are unaware that they are being observed while eating) for a week can result in accurate information; however, this is practical only in “captive populations” such as schools, worksites, military, nursing homes, or prisons (33). Ideal methods of dietary intake assessment use biochemical markers; however, these methods are costly and not widely available (33, 40).

The validity and reliability of dietary assessment tools vary among diverse populations (32). In validation studies, it is important to correlate FFQs with diet records or recalls, which provide more detailed information, and to improve methods of measuring portion sizes (32). Research is also needed to determine the best method to collect the data (face-to-face interviews, self-administered or assisted methods, computer surveys, or telephone surveys) for use in various settings and with various populations (32).

FFQs are appealing because the data are simple to collect and process, and in theory represent intake over an extended period, which is the usual time frame of interest for chronic disease (38). According to Jensen et al. (41), FFQs are useful in ranking individuals within a group on the basis of their dietary intakes. They are limited in estimating individual intakes of certain nutrients due to their tendency to over-estimate intakes.

FFQs have been successfully used with young people. However, it has been shown that youths are limited in their ability to estimate portion sizes (42). The two following studies by Rockett et al. (39) and Jensen et al. (41) used semi-quantitative FFQs. Semi-quantitative questionnaires use commonly eaten portion sizes rather than reported portions.

Rockett et al. (39) validated a self-administered youth/adolescent FFQ (YAQ). They administered it twice at a year interval. They also collected three 24-hour diet recalls in that same time period. Their sample consisted of 261 youths 9 to 18 years old. They compared the average of the three 24-hour recalls to the average of the two YAQs. Besides their intake, participants also self-reported their height and weight.

The YAQ consisted of 131 foods. Each food item had its own question and response, and the response categories for frequency of consumption differed depending on the food. It also included a snack section at the end. Foods were grouped as a serving unit (i.e., spaghetti included the pasta and sauce). The YAQ was mailed to youth in 20 states who had agreed to participate. The 24-hour diet recalls were conducted over the telephone. They tried to capture seasonal variability by scheduling them approximately five months apart, and two were taken on weekdays and one on a weekend. The subjects were unaware of the exact schedule of the recalls (39).

Since their data were not normally distributed, they log transformed the data to improve normality. They also applied selection criteria removing outliers with reported energy intake less than 500 kcal/day or greater than 5,000 kcal/day. Then they calculated Pearson correlations between energy-adjusted nutrients. The nutrients compared included energy, protein, carbohydrates, fat, fiber, several vitamins and minerals including calcium. The authors also de-attenuated the correlations by accounting for within person variance (accounting for day to day variation in diet) measured in the 24-hour recalls (39).

Their sample was 47% boys, 53% girls, and was mostly Caucasian (96%) with African American, Asian American, Hispanic, and other representing only 1% each of the study population. Based on the self-reported heights and weights, 19% of boys and 13% of girls had BMI-for-age ≥ 85th percentile. They reported a mean energy intake of 2,169 ± 657 kcal/day on the diet recalls versus 2,196 ± 583 on the YAQ. Mean calcium intake was 1,093 ± 454 mg/day on the diet recalls versus 1,159 ± 417 mg/day on the YAQ. Pearson's correlation coefficient for energy was 0.35. Pearson's correlations for calcium were 0.46, 0.55, and 0.64 for unadjusted, energy-adjusted (using a regression model with total energy intake as an independent variable and absolute nutrient intake as the dependent variable), and de-attenuated respectively. The authors concluded that their study documents validity of the YAQ; however, they suggest testing among a more ethnically diverse group (39).

More recently, Jensen et al. (41) developed a semi-quantitative, self-administered FFQ to estimate calcium intake of Asian, Hispanic, and White youth 10 to 18 years old. The FFQ consisted of a list of 80 foods. The FFQ asked how often on average the food was consumed last month. The questionnaire also included open-ended questions about dietary supplements use and eating patterns. The study population included six western states: California, Washington, Arizona, Nevada, Hawaii, and Idaho. Participants were recruited from schools, churches, and youth clubs. The subjects' participation in the study spanned four consecutive weeks. They completed the FFQ on week one (FFQ1), two face-to-face 24-hour diet recalls on the next consecutive weeks, and the FFQ a second time (FFQ2) on the fourth week. FFQs were self-administered, but a moderator was present to answer questions (41).

They compared mean calcium intake from the two FFQ administrations with a paired sample t test. They cube root transformed the data to normalize the distribution of calcium values. They calculated Spearman correlations on the raw data and Pearson's correlations on the raw and transformed data. The mean calcium intake of the two 24-hour recalls was compared to FFQ2 using a paired sample t test. They calculated Spearman correlations on the raw data, and Pearson correlations on raw, de-attenuated, and transformed data. They also adjusted for within person variation in calcium intake from the two 24-hour diet recalls (41).

Their final sample size was 162 subjects with n = 69 Asian, n = 29 Hispanic, and n = 64 Caucasian. The mean calcium intake for FFQ1 was 1,328 ± 769 mg, 1,154 ± 610 mg for FFQ2, and 1,088 ± 575 mg for the average of the two 24-hour diet recalls. They found Pearson's correlation of 0.69 and 0.68 (raw data and cube root transformed) for calcium intake between the two FFQs. The Spearman correlation was 0.63. Correlation coefficients for calcium intake between FFQ2 and the average of the two 24-hour recalls were as follows: Pearson's correlation of 0.42, 0.50, and 0.54 ($p \leq 0.001$) for raw, de-attenuated, and de-attenuated and transformed data, respectively, for the total sample. When broken down by ethnic groups, the correlation coefficients were significant for

Asian and White but not for Hispanic (0.16, 0.19, and 0.18 were the Pearson's correlations for raw, de-attenuated, and de-attenuated and transformed data for the Hispanic subgroup, respectively) (41).

Percent agreement, indicating reliability, between identical quartiles of calcium intake measured by the two administrations of the FFQ was 49%. This agreement was 85% for within plus or minus one quartile. Percent agreement between FFQ2 and the average of the two 24-hour recalls was 42% within identical quartiles, and 76% within plus or minus one quartile (41).

Jensen et al., concluded that the FFQ they developed may be useful in measuring calcium intake in epidemiological studies, public healthy interventions, and in clinical practice for an ethnically diverse adolescent population; however, it needs to be further evaluated in the Hispanic adolescent population (41).

In summary, a FFQ was chosen in this study exploring dietary calcium intake and overweight in adolescents because of the many advantages of FFQs: their low cost, ease of administration, and reliability and validity regarding eating practices of adolescents.

Assessment of Overweight

Indicators of weight/body fat such as body mass index (BMI), that take into account only the weight and height of the individual, are not as useful as body composition methods for indicating risk for the development of chronic diseases (43). BMI can falsely indicate obesity in heavily muscled individuals (43). However, BMI is a simple measure and requires less skill than other measures of body fat and is generally a suitable measure of adiposity (44), especially when working with large populations.

Assessing body composition is important in children not only to monitor their growth but also to predict risk of chronic disease due to over- or under-fatness (43). Boys with more than 25% relative body fat and girls with more than 30% relative body fat have an increased relative risk for developing cardiovascular disease (43). Overweight also increases the risk of developing type II diabetes in youths, previously an adult onset disease (3).

Hydrodensitometry and dual-energy x-ray absorptiometry (DEXA) are considered to be the best methods of estimating body fatness by some experts; however, these methods are rather expensive and less accessible. On the other hand, skinfold measurement to measure body fat levels is suitable for field and clinical settings (43). Skinfolds are relatively reliable instruments to assess body fat levels. Acceptable ranges of standard errors of estimates (SEE) are from 2.5% to 4.0% (45).

Choosing the right skinfold equation can be a complex process. Age, gender, level of fatness, physical activity levels, and ethnicity can affect body density (43). There are more than 100 population-specific equations to predict body density from various combinations of circumferences, bone diameters, and skinfolds (43). There are generalized equations and population-specific equations. Population-specific equations tend to underestimate percent body fat in individuals that are highly obese and overestimate body fat in leaner subjects (43).

Slaughter et al. (46) developed skinfold equations for children and adolescents ages 8-18 using either the sum of triceps and subscapular or the sum of triceps and calf; however, they do require identifying the maturation stage of boys (prepubescent, pubescent, or postpubescent) and their ethnicity as either African American or Caucasian.

Lohman et al (47) developed percent body fat charts that can be used to estimate percent body fat in children and adolescents. They include tables for boys and girls using either the sum of triceps and subscapular or the sum of triceps and calf skinfolds. Using triceps and subscapular skinfolds gives a more accurate estimation of percent body fat than using skinfolds measurements at the triceps and calf, because the calf measurement site is more difficult to identify (i.e., no skeletal landmark is used in its definition) (45). On the other hand, measurement at the subscapular site may not be appropriate with modest, self-conscious adolescent girls. In the later case, the calf measurement is an acceptable alternative (43).

In this study, the maturation stage of the boys was not determined and therefore it was not possible to use the Slaughter equations. In addition, the only ethnicities accounted for in these equations are African American and Caucasian. Thus, it was decided to use the percent body fat charts for boys and girls developed by Lohman (47) using sum of triceps and subscapular skinfolds.

METHODS

Study Approvals and Subjects

Approvals from the Texas A&M University Institutional Review Board and from the College Station Independent School District (CSISD) were obtained to conduct the study using active consent forms. Then, CSISD school principals were contacted for permission to contact their teachers. Health teachers in middle school and family and consumer science teachers in high school received a letter inviting their classes to participate in the research project. Students in middle school and high school typically have a combined age range of 12 to 19 years. One middle school teacher and two high school teachers allowed their students to participate in the study. Overall, 67 high school and 35 middle school students completed the study.

This study was conducted in conjunction with another study that examined the effectiveness of a calcium website, designed for teens, in improving knowledge, attitude, and intake of calcium-rich foods. The research team collected data for both projects simultaneously.

Measurements

The objective of the study was to relate dietary calcium intake to weight/body fat levels. The hypothesis of this study was that low dietary calcium intake is associated with increased overweight/excess body fat in adolescence.

Dietary Intake Assessment

To assess calcium and energy intake, a calcium-focused semi-quantitative FFQ (Appendix A) that had previously been tested in a one-to-one setting with youth was used (48). This FFQ was modified from an individual to a group administration as described under Phase II.

Subjects were classified into two calcium categories: inadequate (low) intake if they were below the 75th percentile, and adequate (high) intake if they were at or above the 75th percentile. In addition to classifying individuals into calcium intake categories based on the FFQ, individuals were also classified into calcium intake categories based on the number of glasses of milk they reported drinking daily on the Calcium Osteoporosis Physical Activity Questionnaire (COPA) (Appendix A). According to Johnson (11), milk and dairy products account for 75% of the calcium in the US food supply. Subjects were classified as having low calcium intake if they reported typically consuming less than three glasses of milk per day. They were classified as receiving adequate/high calcium intake if they reported that they typically consumed three or more glasses of milk per day. Three cups of milk a day are considered adequate for ages 12 to 19 according to the Dietary Guidelines for Americans (49). The two methods were compared, and they were each used to examine the relationship between dietary calcium intake and body weight/fat levels.

Assessment of Weight/Body Fat

This study used sum of triceps and subscapular skinfold sites to determine percent body fat from charts for boys and girls (43) found in appendix B. In addition, BMI was calculated for each subject in order to classify participants according to the Centers for Disease Control and Prevention (CDCP) charts on BMI-for-age (1) for levels of overweight.

Training to Measure Anthropometrics and to Conduct Food Frequency Questionnaire Interviews

A consultant, who is an expert in skinfold measurements, trained two nutrition graduate students, including the principal investigator, to measure triceps and subscapular skinfold thicknesses in children. Measurements were taken on the right side of the body, and following the guidelines described by Heyward and Stolarczyk (43). First, the site was marked with a permanent marker. For the triceps measurement, the subject was asked to bend her/his elbow at a 90-degree angle. Using a tape measure, the midpoint of the distance between bony projections on the shoulder (lateral projection of acromial process of the scapula) and the elbow (inferior margin of olecranon process of ulna) was marked on the lateral aspect of the arm. A vertical skinfold was lifted one centimeter above the marked line on the posterior aspect of the arm. For the subscapular, the site was marked one centimeter below the inferior angle of the scapula. A Lange caliper was used to measure skinfold thickness. The Lange caliper is considered a high quality caliper (43).

Before beginning the main study, the graduate students practiced taking skinfold measurements on a total of 37 individuals ranging in age from 7 to 24 years of age. Of these, 21 youths were of similar age (11 to 18 year olds) to those anticipated to participate in the actual study. Active parental and participant consent was obtained for individuals less than 18 years of age. “Active consent” consists of reading and signing the consent to participate in the study as opposed to “passive consent” in which parents/children sign forms if they do not wish to participate. The participant sample was obtained by first contacting ministers, coaches, and community centers in the Bryan/College Station areas to ask permission to contact parents of youths with whom they worked. After the participants were measured, they were given their sum of triceps and subscapular skinfolds. These measurements were also analyzed for inter-measurer correlation (see Phase I on following page for details).

Ten graduate and upper level undergraduate nutrition students, enrolled in a research course assisted the principal investigators in collecting data for both phases of the study. They were trained by the principal investigators to measure and record height and weight, and to record skinfold measurements. A portable stadiometer (Perspective Enterprises, Inc., Kalamazoo, MI) was used to measure standing height. Weight in clothes without shoes was measured using an electronic scale (Tanita Corporation, Japan).

The nutrition students were also trained to administer FFQ’s in a one-to-one setting as well as in a group setting of three to four subjects per interviewer. To gain an appreciation of the challenge of determining nutrient intake, the students were given an overview of the different methods of dietary intake assessments in terms of the benefits and the limitations of each method. These methods included the 24-hour recall, the diet record, and different types of FFQ’s. The students then learned more specifically about the calcium-focused FFQ for youth to be used in the study. They were given a list of food categories from the FFQ and the foods assigned to these categories. They were also provided with copies of the FFQ, a teaching tool on cardstock giving an example of how to complete the FFQ, two different interview protocols (one for the one-to-one interview and one for the group-administered interview), and a reminder sheet of the main points in the protocol. The reminder sheet was used as a review before each interview. The interview process was demonstrated to the interviewers, and then they were assigned to groups where they practiced both the individual and the group-administered interviews. The principal investigators went around the classroom observing the interviewers and providing feedback as they interviewed each other. The interviewers were asked to familiarize themselves with the food list and the foods that were under each category. They were tested on the items on the food list. They were encouraged to ask questions about any foods that were not familiar. The training described above was completed in approximately 10 hours in the classroom. The nutrition students were also asked to go through the whole FFQ with a friend and record the amount of time required.

Phase I: Inter-measurer Reliability for Skinfold Thickness Measurements and Validation of the Food Frequency Questionnaire Group Method

Ideally one person measures skinfold thicknesses on all subjects; however, due to limited time in the schools, two graduate students (including the principal investigator) were trained to take skinfold measurements at the triceps and subscapular sites. To compare inter-measurer variability, each of the two graduate students took two to three measurements per site on the same subjects (n = 13). An average of the measurements was determined. The sums of average triceps and average subscapular were compared using a paired sample t-test, Pearson and Spearman correlations, and linear regression analysis.

Due to limited time allowed the investigators in the classrooms, and due to limited research staff, the FFQ was tested for validity using a group administration instead of the traditional one-to-one administration. Permission was obtained from a local church to contact parents of children involved in the youth group. Active parental and participant consent was obtained. Despite heavy recruiting for a target sample of 30, only 14 students volunteered for the validation study. Each student participated in a one-to-one FFQ interview and in a group interview. The students were divided into two groups of three and two groups of four for the group interview. The students who initially completed the questionnaire in a group setting completed it a second time in an individual setting (i.e., each student was individually interviewed). The students who were initially interviewed one-to-one completed the FFQ a second time in a group setting. One-half of the group interviews and one-half of the individual interviews were randomly selected to be conducted first. This format was used to reduce potential bias that if individual administration was first, the students would do better on the group-administered interview due to the extra exposure and vice versa. Paired t-tests were calculated to compare scores for estimating calcium and energy intakes resulting from group- versus one-to-one- interviews. Linear regression analysis, Pearson correlations, and Spearman correlations were also determined.

Phase II: Collection of Anthropometrics and Calcium Intake Assessment

The study was designed to take no more than 2 ½ class periods of each subject's time. On the first day, half a class period was needed to introduce the project and the type of data to be collected. Measurement of skinfolds was explained and demonstrated, and the consent forms (parental and student consent forms) were distributed.

On the second day, anthropometrics were taken. This included standing height and weight with clothes and without shoes. The measurements were taken in a private setting in the presence of a witness of the same gender who also recorded the measurements. There were two measuring stations to speed up the process. While waiting for their turn to have their anthropometric measurements taken, students completed a questionnaire to determine age, gender, ethnicity, and other demographics. Another purpose of this questionnaire was to assess knowledge and attitudes about calcium as part of a concurrent study that was conducted with the same subjects. The questionnaire had previously been used with youth demographically similar to those in this study (50). The students also completed a Calcium Osteoporosis and Physical Activity (COPA) questionnaire containing 85-questions that assessed knowledge, attitudes, and behavior about calcium and physical activity. The COPA has also been previously used with youth similar in age to those in this study (48). For this study, only the COPA questions related to milk intake were used.

On the third day, the participants were divided into groups of up to five students per interviewer and completed the group-administered FFQ. Each interviewer began by giving the students an explanation of how to complete the questionnaire with the assurance that there were no right or wrong answers, that confidentiality was maintained, and that the participants would be more likely to receive an accurate assessment of their calcium intake if their answers were truthful. Then each interviewer led her students through the 112-food categories in the FFQ, one category at a time, periodically asking the students if they had questions, and answering any questions.

Data Analysis

The FFQ and COPA questionnaires were sent to an independent survey development company who scanned them. The questionnaires were then sent to the University of Texas School of Public Health (UTSPH) for determination of daily nutrient estimates which were sent back to the principal investigator in MS Office Excel spreadsheets. One investigator was responsible for data entry and analysis. All data were entered into Excel spreadsheets and then transferred to SPSS statistical program version 11.0 for analysis. In this study, a p-value < 0.05 was considered significant.

Selection criteria for estimated calcium intake using the FFQ were those used by Hoelscher (who designed and validated the original FFQ modified for use in this study). These criteria included subjects who reported energy intakes greater than or equal to 500 kilocalories and calcium intakes that are less than or equal to 3,900 mg, which is three times the recommended calcium intake for the age group in this study (48).

Descriptive statistics were determined for all variables. From the height and weight collected, BMI was calculated. BMI is weight in kilograms divided by height in meters squared. The Centers for Disease Control and Prevention (CDCP) has two charts for individuals two to 20 years of age, one for boys and one for girls (1). The CDCP's BMI-for-age charts classify children as underweight (BMI-for-age less than 5th percentile), desirable weight (BMI-for-age greater than or equal to the 5th percentile and less than the 85th percentile), at risk of overweight (BMI-for-age greater than or equal to the 85th percentile and less than the 95th percentile), and overweight (BMI-for-age greater than or equal to the 95th percentile) (1). For this study, which is focused on the relationship between calcium and obesity, participants were classified as normal (N) if their BMI-for-age was less than the 85th percentile or overweight (O) if their BMI-for-age was equal to or greater than the 85th percentile.

Participants' levels of body fat were also evaluated using the sum of triceps and subscapular skinfolds. They were classified as lean/normal (N) or as having a high percent of body fat, i.e., overweight (O), based on the assumption that a percent body fat greater than 25% for boys and greater than 30% for girls increases their risk for the development of chronic disease (43). The percent body fat was determined from charts that estimate percent body fat from the sum of skinfolds (47). The degree of agreement between the two methods of assessing body fatness used in this study, BMI and skinfolds, was tested using linear regression and chi-square.

Chi-square tests were performed to evaluate the relationship between dietary calcium intake as assessed by the FFQ, and by the milk intake from the COPA questionnaire, and weight status/fatness using both BMI classification and skinfold classification. The subjects were classified into the four categories (low and high calcium, and normal weight and overweight). Overall four Chi square tests were performed: 1) calcium intake estimated by FFQ versus overweight based on BMI-for-age classifications; 2) calcium intake by FFQ versus overweight based on STS; 3) calcium intake estimated by milk intake versus overweight based on BMI-for-age classifications; and 4) calcium intake estimated by milk intake versus overweight based on STS.

RESULTS

Phase I: Validation Studies of the Food Frequency Questionnaire Group Method and of the Inter-measurer Reliability for Skinfold Thickness Measurements

A group-administered FFQ was compared to the one-to-one FFQ to determine if the group method could be substituted for the one-to-one method in order to minimize classroom time required of the subjects. Despite heavy recruitment for a minimum sample of 30, the initial sample was 14. One outlier was deleted because, after careful examination of his scantron answer sheets, it was apparent that he over-reported quantities in the first interview which was a one-to-one interview. For example, on the first interview, he reported drinking two percent milk or buttermilk five times a day. On his second interview, he reported not drinking any two percent milk or buttermilk. He reported an intake of 4,607 mg calcium on the first interview (one-to-one) versus 1,763 mg on the second interview (group-administered). His reported energy intake was 3,937 kilocalories on his first interview versus 2,888 on his second interview. After this participant was deleted, the final sample was 13.

Descriptive statistics for calcium and energy were determined with and without the outlier described above (Tables 1 and 2). Results of paired sample t-tests are shown in Table 3. Pearson’s correlations and non-parametric tests (Spearman’s correlations, Wilcoxon rank tests, and Sign rank tests) analyses were performed to compare values derived for dietary calcium intake as well as energy intake using the group method versus the individual FFQ interviews. The results of the non-parametric tests were found to be similar to the Pearson’s correlations and therefore are not presented to simplify the results. Linear regression results with reported calcium intake in the group-administered FFQ as the independent variable and reported calcium intake in the one-to-one interview as the dependent variable are shown in Table 4.

TABLE 1
FFQ validation study: descriptive data (means and standard deviations) and frequencies

		Calcium one-to-one interview (mg) (n = 14)	Calcium group interview (mg) (n = 14)	Energy one-to-one interview (kcal) (n = 14)	Energy group interview (kcal) (n = 14)
Mean ± SD		1,730.33 ± 1,106.95	1,652.79 ± 812.46	2,205.83 ± 774.17	2,492.45 ± 756.46
Minimum		494.04	281.39	957.93	724.16
Maximum		4,606.80	3,067.57	3,936.81	3,665.31
Percentiles	25th	888.14	1,051.79	1,724.94	2,010.74
	50th	1,449.14	1,764.39	2,104.33	2,610.30
	75th	2,145.51	2,440.02	2,537.58	2,981.43

TABLE 2
FFQ validation study: descriptive data and frequencies after selecting for those who reported at least 500 kilocalories and no more than 3,900 mg of calcium

		Calcium one-to-one interview (mg) (n = 13)	Calcium group interview (mg) (n = 13)	Energy one-to-one interview (kcal) (n = 13)	Energy group interview (kcal) (n = 13)
Mean ± SD		1,509.06 ± 764.79	1,644.33 ± 844.99	2,072.68 ± 616.75	2,462.08 ±778.41
Minimum		494.04	281.39	957.93	724.16
Maximum		3,094.11	3,067.57	3,345.94	3,665.31
Percentiles	25th	887.20	968.67	1,616.54	1,999.29
	50th	1,317.75	1,765.99	2,047.87	2,535.07
	75th	1,987.21	2,443.73	2,504.73	3,035.47

Comparison of Reported Calcium Intake in Milligrams (mg) of the Group-Administered Interview versus the One-to-One Interview

The mean reported calcium intake using the one-to-one interview method was 1,509 ± 765 mg, and the mean reported calcium intake using the group-administered interview method was 1,644 ± 845 mg (Table 2). The p-value of the paired sample t-test was 0.45 (Table 3). The Pearson's correlation of 0.703 was significant (p-value = 0.007). Thus, reported calcium intakes using the two different methods of individual versus group interview were significantly correlated and there appears to be no significant difference in calcium intake as determined by the two interview methods.

TABLE 3
FFQ validation study: paired samples t-tests for calcium and energy in the one-to-one interview vs. the group-administration interview (n = 13)

	Paired Differences						
	Mean ± SD	Std. Error Mean	95% Confidence Interval of the Difference		t	df	p-value
			Lower	Upper			
Calcium one-to-one – calcium group	-135.27 ± 624.84	173.30	-512.86	242.32	-0.781	12	0.450
Energy one-to-one - energy group	-389.40 ± 611.32	169.55	-758.82	-19.98	-2.297	12	0.040

A linear regression with the one-to-one interview as the dependent variable was performed (Table 4). The adjusted R^2 for the linear regression analysis was 0.448 (Table 4). Thus, there was moderately strong correlation between reported calcium intake using the one-to-one interview and using the group-administered method. Based on these statistical results, the group-administered method was used to assess dietary calcium intake for the larger study.

TABLE 4
FFQ validation study: linear regression for calcium in the one-to-one interview vs. the group-administered interview (n = 13)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.703	0.494	0.448	568.17

a Predictors (constant): Calcium group-administered
b Dependent variable: Calcium one-to-one interview

ANOVA

Model		Sum of squares	df	Mean square	F	Significance
1	Regression	3,467,768.42	1	3,467,768.42	10.74	0.007
	Residual	3,551,035.07	11	322,821.37		
	Total	7,018,803.49	12			

a Predictors (Constant): Calcium group-administered
b Dependent variable: Calcium one-to-one interview

Coefficients

		Unstandardized Coefficients		Standardized Coefficients	t	Significance
Model		B	Std. Error	Beta		
1	(Constant)	462.96	355.96		1.301	0.220
	Calcium group-administered	0.636	0.194	0.703	3.278	0.007

a Dependent variable: Calcium one-to-one interview

Comparison of Reported Energy Intake in Kilocalories (Kcals) of the Group-Administered Interview versus One-to-One Interview

The results for agreement between the two methods used to determine energy intake were ambiguous. The mean reported energy intake in kilocalories (kcals) using the one-to-one interview was 2,073 ± 617 kcals, and the mean reported energy intake using the group-administered interview was 2,462 ± 778 kcals (Table 2). The Pearson's correlation of 0.638 was significant (p-value = 0.019). However, the p-value of the paired sample t-test was 0.040 (Table 3). Thus, group-administered interviews resulted in significantly greater reported caloric intake than did interviews in the one-to-one setting.

Inter-Measurer Skinfold Reliability Study

The mean sum of triceps and subscapular for the first technician was 27.16 ± 15.42 mm, and the mean sum of triceps and subscapular for the second technician was 27.79 ± 16.19 (Table 5). These means were not statistically different (p = 0.638) (Table 6). The Pearson correlation was 0.957 (p-value < 0.0001). The linear regression analysis showed an adjusted R^2 of 0.908 which shows good agreement between the measurements of the two technicians (Table 7). Since, these results showed no significant difference in the skinfold measurements between the two technicians, it was decided that both technicians would take measurements in the main study.

TABLE 5
Descriptive statistics (mean and standard deviation) of subject’s sum of skinfolds* measured by two technicians (n = 13)

	Mean ± SD	Std. Error Mean
Sum of skinfolds (1st tech)	27.16 ± 15.42	4.28
Sum of skinfolds (2nd tech)	27.79 ± 16.19	4.49

*Sum of skinfolds = Triceps + Subscapular (mm)

TABLE 6
Paired samples t-test comparing the difference between subject’s sum of skinfolds* measured by two technicians (n = 13)

	Paired Differences				t	df	p-value
	Mean ± SD	Standard error mean	95% Confidence interval of the difference				
			Lower	Upper			
Sum of Skinfolds (1st tech) - Sum of Skinfolds (2nd tech)	-0.628 ± 4.691	1.301	-3.463	2.207	-0.483	12	0.638

*Sum of skinfolds = Triceps + Subscapular (mm)

TABLE 7

Linear regression for the subjects' sum of skinfolds* measured by two technicians (n = 13)

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.957	0.916	0.908	4.90

a Predictors: (Constant), Sum of skinfolds (triceps + subscapular) in (mm) taken by first technician.

b Dependent variable: Sum of skinfolds (triceps + subscapular) in (mm) taken by second technician.

ANOVA

	Sum of Squares	df	Mean Square	F	Significance
Regression	2,881.92	1	2,881.92	120.089	0.000
Residual	263.98	11	24		
Total	3,145.90	12			

a Predictors: (Constant), Sum of skinfolds (triceps + subscapular) in (mm) taken by first technician.

b Dependent variable: Sum of skinfolds (triceps + subscapular) in (mm) taken by second technician.

Coefficients

	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	B	Std. Error	Beta		
(Constant)	0.493	2.837		0.174	0.865
Sum of Skinfolds (1st tech)	1.005	0.092	0.957	10.959	0.000

a Dependent Variable: Sum of skinfolds (triceps + subscapular) in (mm) taken by second technician.

*Sum of skinfolds = Triceps + Subscapular (mm)

Phase II: Relationship between Dietary Calcium Intake and Weight

Description of Subjects

A teacher in a CSISD middle school and two teachers in the CSISD high school allowed their students to participate. A total of 102 individuals completed the FFQ and had their anthropometrics (height, weight, and skinfolds) measured. Two subjects did not report their age and gender. The mean age for the remaining 100 subjects was 14.8 ± 1.9 years. Ages ranged from 11 to 19 years. The gender distribution was 74% females and 26% males. Ten subjects chose not to indicate their ethnic background. The ethnic background distribution of the 92 who chose to answer was 63% Caucasian, 16% African American, 12% Hispanic, and 8% other.

Recommended calcium intake for the age group of this study is 1,300 mg per day (8). Research shows that a large percentage of boys and girls in this age group are not meeting this recommendation (11). Reported intake in this study ranged from 110 to more than 21,000 mg of calcium per day with a mean of 3,163 ± 3,138 mg (Table 8). After examination of the scantron sheets, it was apparent that some individuals filled in unrealistic data (i.e., 20 milkshakes per day). Due to the high values of reported calcium and the possibility of overestimation of the measurement instrument, the selection criteria described under the Data Analysis section of the Methods section were followed. Following these criteria, twenty-three individuals were dropped from the analysis using reported calcium from the FFQ, resulting in a sample of 79. The mean reported calcium intake for these 79 subjects was 1,972 ± 912 mg ranging from 425 to 3,856 mg (Table 8).

TABLE 8
Descriptives (means, standard deviations, and percentiles) for reported calcium and energy intake using the group-administered FFQ

Mean ± SD (mg) (n = 102)		3,163.04 ± 3,138.48
Minimum		110.53
Maximum		21,719.28
Percentiles	25th	1,381.13
	50th	2,253.49
	75th	3,477.44

Reported calcium intake in milligrams (mg) with all subjects (n = 102)

Mean ± SD (mg) (n = 79)		1,971.65 ± 911.99
Minimum		425.18
Maximum		3,856.04
Percentiles	25th	1,289.02
	50th	1,817.44
	75th	2,815.92

Calcium (mg) after excluding individuals reporting less than 500 kilocalories and more than 3,900 mg calcium (n = 79)

Mean ± SD (kcal) (n = 79)		3,420.86 ± 1,710.44
Minimum		1,131.98
Maximum		11,054.65
Percentiles	25th	2,286.84
	50th	2,910.38
	75th	4,287.54

Reported energy intake in kilocalories (kcal) after using the selection criteria of removing individuals reporting less than 500 kilocalories and more than 3,900 mg of calcium (n = 79)

Since the mean reported calcium intake was very high, the problem remained of how to classify subjects into categories of low calcium intake and high calcium intake (classification categories are described in Methods under Measurements in the Dietary Intake Assessment section). This classification was compared to the milk intake question on the Calcium Osteoporosis and Physical Activity (COPA) questionnaire. Three or more servings of milk are the recommended intake for this age group (49). According to the milk intake question, 74.5% were consuming less than three glasses of milk, and 25.5% had an adequate intake (Table 9). Therefore, using this method, 75% of subjects were classified as having low calcium intake, and 25% were classified as having high calcium intake. The two methods of assessing calcium intake were compared using chi-square tests (Table 10). The Pearson chi-square was low (0.088) and not significant (p-value > 0.05). Measurements of association, Phi and Cramer's V, were also not significant. Thus, subjects' answers were not consistent across the two methods.

TABLE 9
Descriptives (mean and standard deviation) and frequencies for reported number of glasses of milk consumed daily (COPA) (n = 98)

Mean ± SD (n = 98)		1.8 ± 1.5
Minimum		0
Maximum		5
Percentiles	25th	1
	50th	1
	75th	3

0 = none
5 = 5 or more glasses of milk a day

Reported number of glasses of milk consumed per Day	Frequency	Percent (%)
0	17	17.3
1	33	33.7
2	23	23.5
3	10	10.2
4	6	6.1
5	9	9.2
Total	98	100.0

TABLE 10
Chi-square test for the relationship between calcium intake classification using the FFQ and the milk intake question using COPA (n = 76)

		Classification of calcium FFQ		Total
		Low	High	
Reported milk intake (COPA)	Low (< 3 glasses of milk)	43	16	59
	High (≥ 3 glasses of milk)	13	4	17
Total		56	20	76

	Value	df	Significance
Pearson Chi-Square	0.088	1	0.767

a Computed only for a 2x2 table
b 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.47

Measures of Association

		Value	Significance
Nominal by nominal	Phi	-0.034	0.767
	Cramer's V	0.034	0.767

a Not assuming the null hypothesis.
b Using the asymptotic standard error assuming the null hypothesis.

Body weight was evaluated using two different methods: the body mass index (BMI) which only takes into account height and weight, and the sum of skinfolds (triceps and subscapular) which takes into account subcutaneous body fat levels. Table 11 provides descriptive statistics for BMI and sum of skinfolds. The relationship between BMI and skinfolds prior to classifying subjects into normal (N) or overweight (O) categories was examined. The Pearson’s correlation was 0.846 with a p-value < 0.001. From the regression of BMI on the sum of skinfolds, the adjusted $R^2 = 0.713$ (p-value < 0.0001) (Table 12). Thus, BMI and sum of skinfolds were significantly correlated.

TABLE 11
Descriptive statistics (means, standard deviations, and percentiles) for body mass index (BMI) and sum of skinfolds

		BMI (n = 102)	Sum of skinfolds (mm) (n = 102)
Mean ± SD		22.62 ± 4.58	35.56 ± 19.80
Minimum		15.00	10.00
Maximum		38.00	115.70
Percentiles	25th	19.00	22.10
	50th	21.00	31.00
	75th	24.25	45.25

TABLE 12
Linear regression BMI and sum of skinfolds (n = 102)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.846	0.716	0.713	2.45352

a Predictors: (Constant), Sum of skinfolds

ANOVA

Model		Sum of Squares	df	Mean Square	F	Significance
1	Regression	1,514.11	1	1,514.11	251.52	0.000
	Residual	601.98	100	6.020		
	Total	2,116.09	101			

a Predictors: (Constant), Sum of skinfolds
b Dependent Variable: BMI

Coefficients

		Unstandardized coefficients		Standardized coefficients	t	Significance
Model		B	Std. Error	Beta		
1	(Constant)	15.67	0.501		31.258	0.000
	Sum of skinfolds	0.196	0.012	0.846	15.859	0.000

a Dependent Variable: BMI

Based on the BMI classifications of normal (BMI-for-age < 85th percentile) and at risk for overweight or overweight (BMI-for-age ≥ 85th percentile), 71% of subjects were normal weight and 29% were at risk of overweight/overweight (Table 13). According to the sum of skinfolds classifications based on percent body fat, 61% were lean/normal and 39% were overweight/had excessive fat (Table 13). The two methods of assessing body weight/levels of body fat were compared using chi-square tests (Table 14). The Pearson's chi-square was high (29.657) and significant (p-value < 0.0001). Thus, the two methods yielded significantly similar results. Measurements of association, Phi and Cramer's V, were also significant.

TABLE 13

Frequencies for BMI and sum of triceps and subscapular skinfolds by normal weight (N) or overweight (O) categories (n = 102)

BMI Classification		
	Frequency	Percent
Normal (N)	72	70.6%
Overweight (O)	30	29.4%
Total	102	100.0%

Skinfold Classification		
	Frequency	Percent
Lean/Normal (N)	62	60.8%
Boys: %BF ≤ 25% Girls: %BF ≤ 30%		
High %BF/Overweight (O)	40	39.2%
Boys: %BF > 25% Girls: %BF > 30%		
Total	102	100.0%

% BF = percent body fat

TABLE 14
Chi-square analysis for the relationship between BMI and sum of skinfolds classifications (n = 102)

		Classification by BMI		Total
		Normal (N)	Overweight (O)	
Classification by sum of skinfolds	Normal/Lean (N)	56 (54.9%)	6 (5.9%)	62 (60.8%)
	Overweight (O)	16 (15.7%)	24 (23.5%)	40 (39.2%)
Total		72 72.0 70.6%	30 30.0 29.4%	102 102.0 100.0%

	Value	df	Significance
Pearson Chi-Square (n = 102)	29.657	1	0.000

a Computed only for a 2x2 table
b 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.76.

Measurements of Association

		Value	Significance
Nominal by Nominal	Phi	0.539	0.000
	Cramer's V	0.539	0.000

a Not assuming the null hypothesis.
b Using the asymptotic standard error assuming the null hypothesis

Four different Chi-Square tests were performed to examine the relationship between dietary calcium intake and overweight: (1) calcium as measured by the COPA questionnaire (reported glasses of milk consumed) and overweight as measured with BMI (Table 15); (2) calcium as measured by COPA (reported glasses of milk consumed) and overweight as measured with the sum of skinfolds (Table 16); (3) calcium as measured by the FFQ (total reported calcium intake) and overweight as measured by BMI (Table 17); and (4) calcium as measured by the FFQ (total reported calcium intake) and overweight as measured by the sum of skinfolds (Table 18). All four Chi-square tests showed no dependence. Tests of association Phi and Cramer's (bottom of Table 17 and Table 18) failed to show significant association. Thus, these data do not support a significant relationship between low dietary calcium intake and overweight.

This study examined the relationship between inadequate calcium intake and risk of being overweight or overweight (i.e. a BMI-for-age ≥ 85th percentile) rather than overweight only (i.e. BMI-for-age ≥ 95th percentile), because the sample size of overweight individuals was not large enough to detect a possible relationship. Specifically, only 15% of the sample (n = 15) were overweight compared to 29% (n = 29) who were at risk of overweight or overweight. In addition, the BMI-for-age ≥ 85th percentile method was more in agreement with the sum of skinfolds method, which defined 39% of the sample as having high percent body fat.

TABLE 15
Chi-square test for the relationship between calcium intake using milk intake and body weight using the body mass index for age (BMI-for-age) (n = 98)

		BMI Classification		Total
		Normal (N)	Overweight (O)	
Reported milk intake (COPA)	Low (0 to 2 glasses of milk) per day	49 (50.0%)	24 (24.5%)	73 (74.5%)
	High (3 or more glasses of milk) per day	20 (20.4%)	5 (5.1%)	25 (25.5%)
Total		69 (70.4%)	29 (29.6%)	98 (100.0%)

	Value	df	Significance
Pearson Chi-Square (n = 98)	1.482	1	0.223

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.40.

TABLE 16

Chi-square test for calcium intake using milk intake and body weight using the sum of skinfolds (STS) (n = 98)

		Classification by Sum of Skinfolds (mm)		Total
		Normal/Lean (N) Boys:%Body Fat =< 25% Girls:%Body Fat =< 30%	High %Body Fat/Overweight (O) Boys: %Body Fat > 25% Girls: %Body Fat > 30%	
Reported milk intake (COPA)	Low milk intake	43 (43.9%)	30 (30.6%)	73 (74.5%)
	High milk intake	16 (16.3%)	9 (9.2%)	25 (25.5%)
Total		59 (60.2%)	39 (39.8%)	98 (100.0%)

	Value	df	Significance
Pearson Chi-Square (n = 98)	0.202	1	0.653

a Computed only for a 2x2 table

b 0 cells (0%) have expected count less than 5. The minimum expected count is 9.95.

TABLE 17
Chi-square test for calcium intake using the FFQ and body weight using the Body Mass Index (BMI) for age (n = 79)

		BMI Classification		Total
		Normal (N)	Overweight (O)	
FFQ classification	Low calcium intake (below 75th percentile)	41 51.9%	18 22.8%	59 74.7%
	High calcium intake (above 75th percentile)	12 (15.2%)	8 (10.1%)	20 (25.3%)
Total		53 (67.1%)	26 (32.9%)	79 (100.0%)

	Value	df	Significance
Pearson Chi-Square (n = 79)	0.609	1	0.435

a Computed only for a 2x2 table
b 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.58.

Tests of Association

		Value	Significance
Nominal by Nominal	Phi	0.088	0.435
	Cramer's V	0.088	0.435

a Not assuming the null hypothesis.
b Using the asymptotic standard error assuming the null hypothesis.

TABLE 18
Chi-square test for calcium intake using the FFQ and body weight using STS (n = 79)

		Skinfold classification		Total
		Lean	High %BF	
FFQ classification	Low calcium	36 (45.6%)	23 (29.1%)	59 (74.7%)
	High calcium	12 (15.2%)	8 (10.1%)	20 (25.3%)
Total		48 (60.8%)	31 (39.2%)	79 (100.0%)

	Value	df	Significance
Pearson Chi-Square (n = 79)	0.006	1	0.936

a Computed only for a 2x2 table
b 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.85.

Tests of Association

		Value	Significance
Nominal by Nominal	Phi	0.009	0.936
	Cramer's V	0.009	0.936

a Not assuming the null hypothesis.
b Using the asymptotic standard error assuming the null hypothesis.

DISCUSSION

Food Frequency Questionnaire Validation

The initial sample size (n = 14) was small. Removal of an outlier resulted in a smaller final sample size (n = 13). The mean reported calcium intake in the one-to-one interview was 1,509 ± 765 mg, and the mean reported calcium intake in the group-administered interview was 1,644 ± 845 mg. These means are relatively high given that the recommended calcium intake for the age group of this study (11 to 19 years) is 1,300 mg (8) and that typically a large percentage of children in this age group do not meet the recommended intake, according to a national survey (11). Hoelscher (48), who designed and validated the one-to-one FFQ used in this study, reported a mean calcium intake of 1,334 ± 772 mg in their study. Their sample consisted of mostly white (70%) 11- to 12-year-old girls who lived in the suburbs of Austin, from relatively well-educated households (48). In a validation of a self-administered, semiquantitative youth/adolescent food frequency questionnaire, Rockett et al. (39) reported a mean calcium intake of 1,159 ± 417 mg in a sample of youth that were 9 to 18 years of age. Thus, the mean reported calcium intake in this study is higher than what was reported in other studies using food frequency questionnaires in youth.

Despite the limitations of this validation study and its small sample size, the Pearson's correlations for reported calcium and energy intakes in the group-administered versus the one-to-one interview were significant and showed moderate correlations between the two methods. Hoelscher found much weaker correlations between results for calcium and energy intake from the FFQ and the mean of two 24-hour diet recalls (48). Their validation study was conducted in 54 6th graders. They compared the FFQ to the mean of two 24-hour recalls and found a Pearson correlation of 0.305 for calcium and of 0.285 for energy. They also examined calcium/1000 kcals and found a higher Pearson correlation of 0.559 ($p < 0.05$) between the food recalls and the FFQ (48). These results show low to moderate validity for this FFQ. Unfortunately, this was not available to the principal investigators prior to using the FFQ. Had these results been analyzed/known before initiating the study, an alternative dietary intake assessment tool would have been chosen with a focus on obtaining more accurate dietary intake information even if that meant a sample size < 100 due to staffing limitations. Also, using correlations may not be the most appropriate method for determining validity of the FFQ as explained by the inconsistencies of the results explained below.

The validation of the group-administered method showed inconsistencies. Reported energy intake using the one-to-one interview was 2,073 ± 617 kilocalories, and reported energy using the group-administration method was 2,462 ± 778 kilocalories. The paired sample t-test for reported energy using the two methods (one-to-one versus group-administered) had a p-value = 0.04. Thus, the group and one-to-one interviews produce different results for energy intake. It is of interest to note that the mean reported energy intake was higher in the group method. Is social desirability at work in the one-to-one interview? In other words, do subjects under-report energy intake in the one-to-one setting? On the other hand, the individual interview method may provide more opportunities for accountability and clarifications of responses. Subjects might be less likely to report drinking twenty milk shakes a day, for example, as was seen in the actual study, which used the group-administered method. It is of interest to note that in a validation study of a group 24-hour recall in a population of low-income women, Scott (2002) found that reported energy intake was greater in the group instruction setting (51). Her subjects reported a mean energy intake of 2,333 ± 1626 kilocalories in the group instruction setting versus 1,975 ± 648 kilocalories in the individual instruction setting (51).

Inter-Measurer Skinfold Reliability Study

Results from the inter-measurer skinfold reliability study were very good, showing strong correlations between the two technicians. The means for the sum of skinfolds for the two technicians were 27.16 ± 15.43 and 27.79 ± 16.19, respectively (Table 5). However, the sample size (n = 13) was very small. It is known that technician skill is a major source of error when measuring skinfolds. It accounts for 3% to 9% of the variability in measurements (43). It is recommended to practice on 50 to 100 clients to develop a high level of skill and proficiency (43). Unfortunately, in this study the technicians only practiced on 37 clients. It is also possible that the results of the reliability study were biased because the technicians were able to see each other's measurements.

Relationship between Calcium Intake and Obesity

This study did not demonstrate a relationship between dietary calcium intake and body fat levels. However, a possible relationship could have been obscured by the dietary assessment instrument (FFQ) overestimating calcium and energy intakes, when administered in the group setting. After applying the selection criteria described under the Data Analysis section of Methods, the mean reported calcium intake was 1,972 ± 912 mg with values ranging from 425 to 3,856 mg, and the mean reported energy intake was 3,421 ± 1,710 kilocalories with values ranging from 1,132 to 11,055 kilocalories. These means are higher than national mean intakes of 938 mg of calcium (1,081 mg for boys and 793 mg for girls) (52), and 2,342 kcals (2,686 kcals for boys and 1,993 kcals for girls) (53) in the NHANES for youth similar in age (12 to 19 year olds) to subjects in this study. The milk intake question from the COPA further confirmed that the results of the FFQ were over inflated since almost 75% reported drinking fewer than three glasses of milk a day, which is considered an adequate amount for the age group of this study (49). While it is possible to have adequate calcium intake without drinking milk, it is unlikely since milk and dairy products are major sources of calcium (49). Thus, it appears likely that the FFQ overestimated calcium and energy intake when compared to another measure (milk intake) in the same subjects and when compared to national data. The possible effects of over-estimation of the FFQ were minimized by placing subjects in low and high categories rather than using absolute numbers. Regardless, the estimates of dietary calcium intake using the FFQ or milk intake yielded similar results when compared to fatness levels (i.e. there appeared to be no relationship).

It does not appear that errors associated with body weight assessment were as significant as errors assessing calcium intake, since results from the body mass index (BMI) compared well with national statistics. For example, according to the 1999 National Health and Nutrition Examination Survey, 14% of 12 to 19 year olds had BMI-for-age greater than or equal to the 95th percentile (i.e., were overweight) (2). The values for Texas are higher than the national data (54). According to Hoelscher et al. (54), who collected data from a representative sample of Texas school children in grades 4th, 8th, and 11th, 21% of 8th graders and 19% of 11th graders in Texas were overweight (have BMI-for-age ≥ 95th percentile). In this study, 15% percent were overweight using the BMI-for-age classification and 29% with a BMI-for-age ≥ 85th percentile (were at risk of overweight or overweight). The Texas data for 8th and 11th graders showed 37% and 29%, respectively, having BMI-for-age ≥ 85th percentile (54). Thus, the prevalence of at risk of overweight or overweight in this study was comparable to national and Texas data.

One possible explanation as to why dietary results from this study did not agree with previously published results may be partly due to the use of different methods of dietary intake and overweight assessments. For example, Lin et al. (25) conducted a two-year exercise intervention study with women 18 to 31 years of age. They used three-day diet records, including intake of mineral and vitamin supplements. They collected diet records at baseline and every six months for up to 30 months. Since they found no significant differences in any nutrient intakes over time, they averaged the multiple diet records. The mean calcium intake they reported was 781 ± 212 mg (range: 356-1,352 mg). They found that calcium from dairy products accounted for 69% of total calcium intake (25). They assessed fat mass, percent body fat, and lean mass with a dual-energy x-ray absorptiometer (DEXA) at baseline and at 24 months. The body composition variable measured the change from baseline to 24 months. They categorized their subjects into high and low energy intake groups based on the mean energy intake. They found no difference in calcium intake between the high and low energy intake groups. In the low energy intake group, they found that only total calcium or dairy calcium intake, but not energy intake, predicted changes in weight and fat mass. In the higher energy intake group, they found that energy intake, but not calcium intake, predicted changes in body weight (25). In their study they used energy-adjusted calcium intake (mg/kcals). They found negative correlations of –0.34 and -0.35 ($p < 0.05$) between total calcium per energy (mg/kcals) and change in body fat and change in body weight respectively. They also found negative correlations of –0.32 and -0.35 ($p < 0.05$) between dairy calcium/energy (mg/kcals) and change in body fat and change in body weight respectively (25). The agreement found by Lin et al. between weight change and change in body fat as assessed by DEXA (a more expensive method) supports less expensive methods of weight assessment such as BMI. Of interest in their study, is that in the higher energy intake group, energy intake but not calcium intake, predicted changes in body weight. This was not examined in this study and could have been overlooked by combining the two groups. Also Lin et al. used diet records, which would likely be difficult in the age group of this study as it would have required motivated adolescents to keep records of their food intake.

Carruth and Skinner examined the relationship between calcium intake and body fat in 24- to 60-month-old preschool children (22). They also used methods of dietary intake assessment and body composition assessment that were different from those used in this study. In-home interviews with the mothers by two registered dietitians were used to collect three days of dietary intake. The mothers completed six interviews. Body composition was assessed using DEXA. They also calculated body mass index (BMI). They found that the children’s percent body fat and grams of body fat adjusted for BMI were negatively related to calcium intake, suggesting that higher mean intakes of calcium were associated with lower body fat at 70 months (22). They also found that adjusting for BMI, the variability in percent body fat was significantly and negatively related to mean servings of dairy products per day (22). Thus, other studies have shown a negative relationship between dietary calcium intake and obesity in different age groups and using different methods from this study; however, no studies have been conducted with adolescents. Thus, direct comparison with another study is not possible.

Limitations of This Study

A limitation of the FFQ is that it requires subjects to remember their food intake over the past week which may be difficult for those who pay little attention to foods eaten. The respondent burden to complete the multiple questionnaires, which included a 85-question survey on knowledge, attitudes, and behaviors questionnaire (COPA), a demographic questionnaire, and a 112-item FFQ, was probably too burdensome for these ages and in a school setting. Thus, results from self-reported dietary intake may not have been accurate.

In addition to the subjects that were not included in the final analysis because they did not complete the study, an additional 23 subjects were dropped from the analyses examining calcium intake from the FFQ (approximately 22% of the initial sample size of 102 subjects that completed the study) due to unrealistically high reported calcium intakes on the FFQ.

The standard used to classify subjects into high and low milk intake based on the number of milk servings they reported drinking on a daily basis might have been too high and therefore might have excluded subjects who have a sufficient/high calcium intake from other dairy sources (e.g., yogurt and cheese) and other food sources.

Other limitations of this study were: vitamin/mineral supplement use was not included, and classifications of individuals into high and low calcium intake based on the FFQ and the COPA questionnaire did not agree well (Table 10). This was in part due to the FFQ overestimation of calcium intake and the use of the 75th percentile cut off as the criterion to include subjects in low versus high calcium intake. This percentage agreed with the percentages obtained by the COPA questionnaire, with only 25.5% reporting consuming three or more glasses of milk daily; however, the classifications based on the two methods did not match well as tested by Chi-Square methodology.

In addition to challenges with assessment of dietary calcium intake, other challenges of this study included access to subjects, recruiting and training interviewers, working around the interviewers' schedules, working around the teachers' schedules, concerns about use of classroom time, and keeping some subjects interested and motivated. To obtain approval from the University Institutional Review Board, active consent was required. Thus subjects had to return the two signed consent forms (theirs and their parents) to participate in the study. Passive consent, where only those who do not wish to participate in the study return consent forms, could have facilitated the process and resulted in a larger sample size. Many students who might have participated in the study were not able to due to failure to return their signed consent forms on the day of data collection. One disadvantage of passive consent, however, is not having documentation to show consent.

In addition, the study was not funded, and thus the subjects were not given monetary compensation for their participation. Instead those who completed the study qualified for prizes from businesses that cater to their age group. These prizes included gift certificates, photo frames, calendars, and jewelry among other things.

The limited funds, staff, and access to subjects were among the factors that contributed to the small sample sizes for the two phases of the study. Furthermore, the limited number of staff and their busy schedules (i.e., all were full-time college students) led to bigger group interviews than desired with groups of up to five students per interviewer in a few groups. Maintaining order and cooperation was challenging in some group interviews.

CONCLUSIONS AND FUTURE STUDIES

This study did not demonstrate a relationship between dietary calcium intake and obesity in adolescents despite this relationship having been shown in previous studies with other age groups. There are many factors associated with obesity including a sedentary lifestyle, increased intake of high energy and low nutrient foods and snacks (55), television advertisement to children of such foods (56), increased consumption of soft drinks (11), and genetic factors. A recent review examining the relationship between dietary calcium intake and obesity in women of various ages concluded that calcium intake explained only about three percent of the variability in weight (23). In addition to inaccuracies in measuring dietary intake, many factors affect body weight/fatness.

Due to the problems associated with the collection of dietary intake data, a future study may be more effective if it analyzes National Health and Nutrition Examination Survey (NHANES) data or other national survey data to test the relationship between calcium intake and obesity in adolescence as Zemel et al. did with young and middle age men and women (24).

If analysis of NHANES data shows a relationship between dietary calcium intake and overweight in adolescence, then further testing in a setting that is more controlled and more flexible than in the school setting could be done. For example, Cullen et al. have found Girl/Boy Scouts and other youth groups to have good participation and compliance in research projects (57).

In summary, future research may consider using multiple 24-hour diet recalls or observation of subjects who are unaware of being observed over a week to investigate dietary intake and BMI and DEXA to evaluate body weight/fat. An interventional study investigating long term effects of calcium supplementation can also be appropriate. For example, Zemel (24) supplemented the diet of subjects with dairy products and assessed the effect on their body weight. It would also be helpful to investigate the difference between using calcium supplements versus supplementing the diet with dairy products, because other components of dairy products such as protein may also play a role in weight management by increasing satiety and preserving muscle mass (the later would also be important in a weight loss study). An example would be a multi-center study in which researchers would first assess calcium intake and measure body weight, height, and body composition of a sample of individuals. After doing so the researchers would randomly assign these subjects into either a calcium supplemented group or a dairy supplemented group and reassess their body composition after a year. Such a study would be especially helpful to conduct with adolescents who in a critical time for bone formation are not receiving adequate calcium and are also already suffering from the consequences of the increasing prevalence of overweight among this age group.

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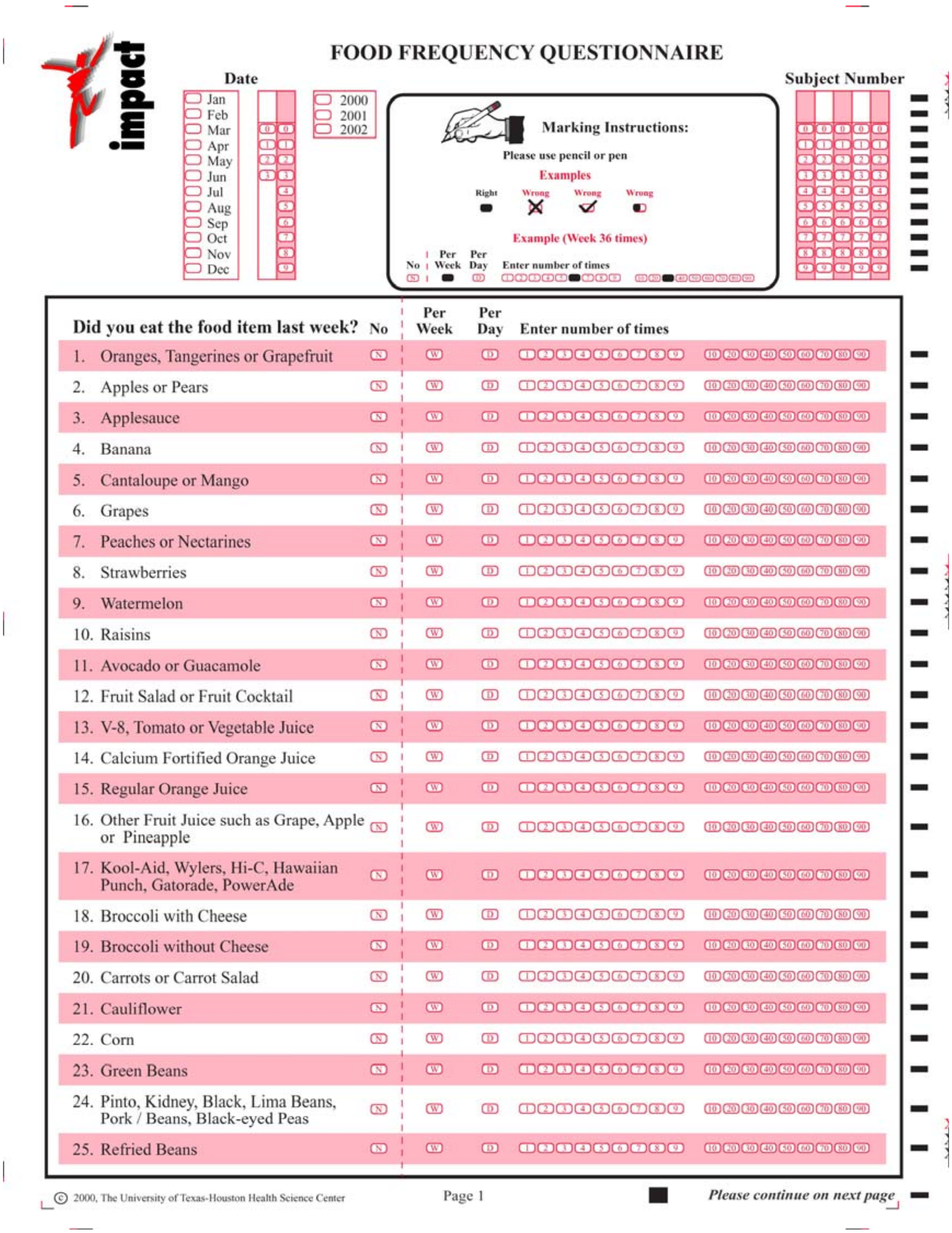
APPENDIX A

Food Frequency Questionnaire (FFQ)[†]



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FOOD FREQUENCY QUESTIONNAIRE

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☐ 2001
☐ 2002

Marking Instructions:

Please use pencil or pen

Examples

Right ● Wrong ☒ Wrong ✓ Wrong ◐

Example (Week 36 times)

No | Per Week | Per Day | Enter number of times

Subject Number

0 1 2 3 4 5 6 7 8 9 | 0 1 2 3 4 5 6 7 8 9 | 0 1 2 3 4 5 6 7 8 9 | 0 1 2 3 4 5 6 7 8 9 | 0 1 2 3 4 5 6 7 8 9

Did you eat the food item last week?	No	Per Week	Per Day	Enter number of times	
1. Oranges, Tangerines or Grapefruit	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
2. Apples or Pears	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
3. Applesauce	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
4. Banana	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
5. Cantaloupe or Mango	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
6. Grapes	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
7. Peaches or Nectarines	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
8. Strawberries	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
9. Watermelon	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
10. Raisins	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
11. Avocado or Guacamole	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
12. Fruit Salad or Fruit Cocktail	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
13. V-8, Tomato or Vegetable Juice	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
14. Calcium Fortified Orange Juice	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
15. Regular Orange Juice	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
16. Other Fruit Juice such as Grape, Apple or Pineapple	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
17. Kool-Aid, Wylers, Hi-C, Hawaiian Punch, Gatorade, PowerAde	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
18. Broccoli with Cheese	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
19. Broccoli without Cheese	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
20. Carrots or Carrot Salad	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
21. Cauliflower	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
22. Corn	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
23. Green Beans	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
24. Pinto, Kidney, Black, Lima Beans, Pork / Beans, Black-eyed Peas	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
25. Refried Beans	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90

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Did you eat the food item last week?	No	Per Week	Per Day	Enter number of times	
26. Raw Tomatoes Other Than In Salads	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
27. Kale, Mustard or Chard Greens	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
28. Spinach, Collards or Turnip Greens	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
29. Acorn, Butternut, Zucchini, Crooked Neck Squash or Eggplant	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
30. Mixed Vegetables Such as Stir Fry	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
31. Chef Salad or Lettuce Salad with Cheese	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
32. Chef Salad or Lettuce Salad without Cheese	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
33. Regular Salad Dressing	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
34. Reduced Calorie or Light Salad Dressing	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
35. Spanish Rice	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
36. Fried Rice	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
37. Brown, White or Mixed Rice	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
38. Macaroni or other Pasta with Cheese	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
39. Pasta with Tomato or Meat Sauce such as Spaghetti	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
40. Potato Salad	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
41. Hash Browns, Tater Tots or French Fries	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
42. Stuffed Baked Potato with Cheese or Au Gratin Potatoes	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
43. Boiled, Mashed or Baked Potato w/o Cheese Topping	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
44. Lasagna, Cannelloni or Ziti	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
45. Beef or Pork Casseroles, Chinese Dishes, BBQ or Goulash	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
46. Chicken, Turkey, Seafood Casseroles, Chinese Dishes or Barbecue	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
47. Egg Roll	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
48. Bean Soup	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
49. Vegetable, Tomato, Noodle or Broth Soup	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
50. Cream Soup	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
51. Cheese Nachos with any Topping	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
52. Cheese Enchiladas or Quesadillas	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
53. Meat or Bean Enchiladas, Burritos, Tacos, Flautas or Chalupas	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
54. Taco Salad	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
55. Chili Con Carne	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
56. Cheeseburger	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90

Please continue on next page

Did you eat the food item last week?		No	Per Week	Per Day	Enter number of times	
57. Hamburger		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
58. Tuna, Chicken or Egg Salad Sandwich		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
59. Hot Dog or Corn Dog		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
60. Cheese Sandwich		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
61. Meat Sandwiches with Cheese		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
62. Meat Sandwiches without Cheese		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
63. Pizza or Calzone		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
64. Peanut Butter or Peanut Butter Sandwich		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
65. Beef or Pork as a Main Dish such as Fajitas		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
66. Fried Chicken		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
67. Baked or Broiled Chicken or Turkey		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
68. Shrimp		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
69. Canned Salmon, Sardines or Mackeral		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
70. Fried Fish or Shellfish		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
71. Baked or Broiled Fish or Shellfish		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
72. Sausage, Bacon or Chorizo		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
73. Eggs Prepared Any way with Cheese		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
74. Eggs Prepared Any way without Cheese		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
75. Fortified Cereals, Basic 4, Total, Raisin Bran or Corn Flake Total		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
With Milk	83 84 85 86	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
76. Other Dry Cereals		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
With Milk	83 84 85 86	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
77. Cooked Cereal or Grits		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
78. Pancakes, Waffles or French Toast		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
79. Doughnuts, Sweet Rolls, Croissants, Muffins or Coffee Cake		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
80. Breakfast Bar or Granola Bar		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
81. Tortillas		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
82. Bread, Rolls, Pita, Bagels, Biscuits, English Muffins or Cornbread		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
83. Skim or 1/2% Milk		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
84. 1% Milk		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
85. 2% Milk or Buttermilk		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
86. Whole Milk, Chocolate Milk or Milkshakes		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
87. Liquid Meals such as Instant Breakfast, Slim Fast, Sego, Dynatrim		N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90

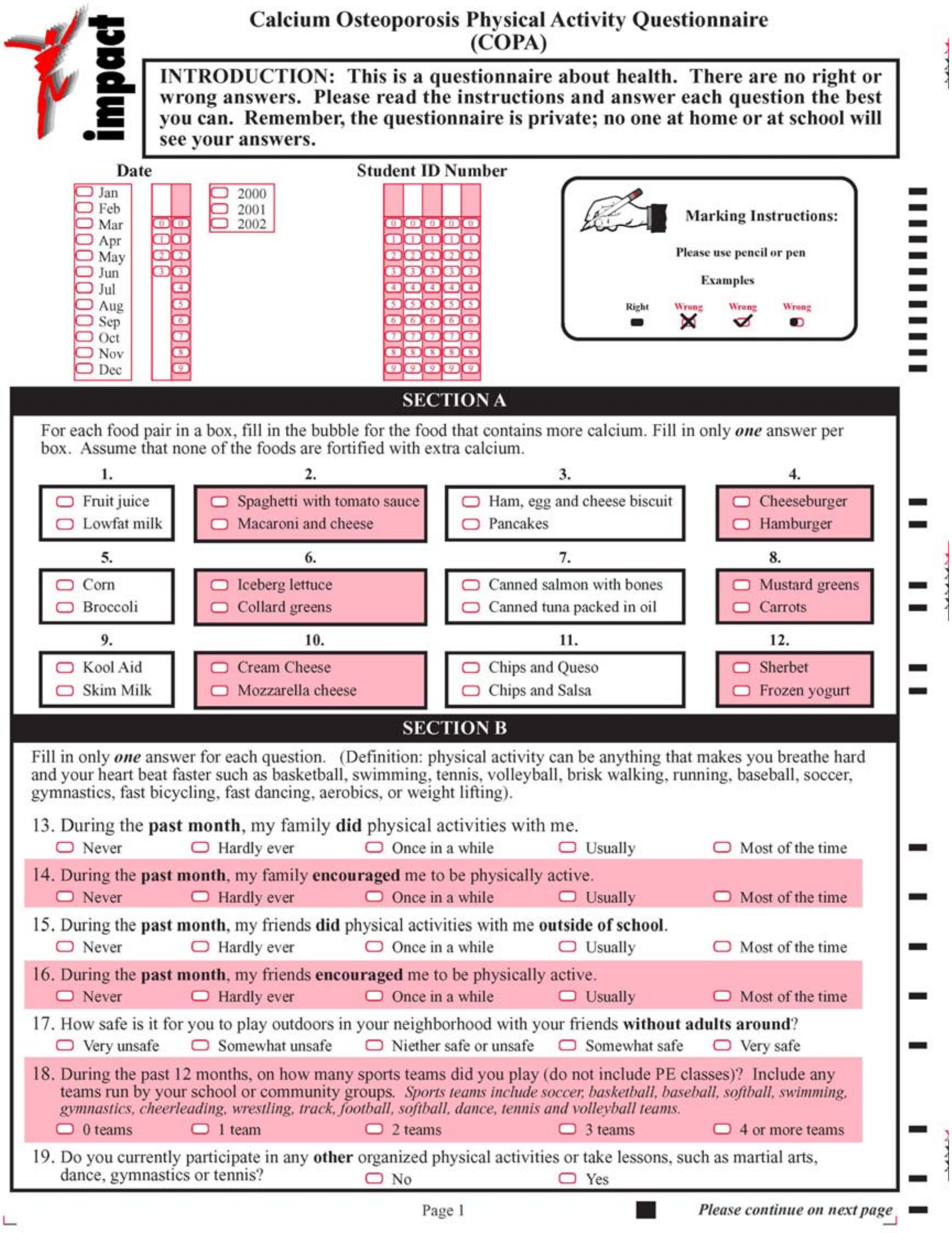
Please continue on next page

Did you eat the food item last week?	**No**	**Per Week**	**Per Day**	**Enter number of times**	
88. Yogurt Made with Whole Milk	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
89. Lowfat or No-Fat Yogurt	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
90. Frozen Yogurt, Ice Milk or Lowfat Ice Cream	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
91. Sherbet	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
92. Ice Cream or Ice Cream Bar	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
93. Pudding, Flan or Custard	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
94. Sour Cream or Sour Cream Dip	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
95. Cottage Cheese	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
96. Mozzarella or String Cheese	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
97. Cheddar, Swiss, American or Other Cheese	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
98. Nuts	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
99. Pretzels	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
100. Salty Snacks, Corn Chips, Tortilla Chips or Potato Chips	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
101. Taco Sauce, Picante Sauce or Salsa	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
102. Popcorn	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
103. Chile Con Queso or Cheese Sauce	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
104. Cream Cheese or Cheese Spread	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
105. Cookies or Brownies	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
106. Cake, Pie or Cobbler	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
107. Chocolate Candy	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
108. Other Candy	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
109. Diet Soft Drink	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
110. Regular Soft Drink	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
111. Iced or Hot Tea	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
112. Coffee	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90

Please tell me of any other foods that you ate last week that were not mentioned.

	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90
	N	W	D	1 2 3 4 5 6 7 8 9	10 20 30 40 50 60 70 80 90

Calcium Osteoporosis Physical Activity Questionnaire (COPA)[‡]



Calcium Osteoporosis Physical Activity Questionnaire (COPA)

INTRODUCTION: This is a questionnaire about health. There are no right or wrong answers. Please read the instructions and answer each question the best you can. Remember, the questionnaire is private; no one at home or at school will see your answers.

Date

☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☐ Dec

0 1 2 3

0 1 2 3 4 5 6 7 8 9

☐ 2000 ☐ 2001 ☐ 2002

Student ID Number

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

Marking Instructions:

Please use pencil or pen

Examples

Right ▬ Wrong ✗ Wrong ✓ Wrong ◐

SECTION A

For each food pair in a box, fill in the bubble for the food that contains more calcium. Fill in only ***one*** answer per box. Assume that none of the foods are fortified with extra calcium.

1.
☐ Fruit juice
☐ Lowfat milk

2.
☐ Spaghetti with tomato sauce
☐ Macaroni and cheese

3.
☐ Ham, egg and cheese biscuit
☐ Pancakes

4.
☐ Cheeseburger
☐ Hamburger

5.
☐ Corn
☐ Broccoli

6.
☐ Iceberg lettuce
☐ Collard greens

7.
☐ Canned salmon with bones
☐ Canned tuna packed in oil

8.
☐ Mustard greens
☐ Carrots

9.
☐ Kool Aid
☐ Skim Milk

10.
☐ Cream Cheese
☐ Mozzarella cheese

11.
☐ Chips and Queso
☐ Chips and Salsa

12.
☐ Sherbet
☐ Frozen yogurt

SECTION B

Fill in only ***one*** answer for each question. (Definition: physical activity can be anything that makes you breathe hard and your heart beat faster such as basketball, swimming, tennis, volleyball, brisk walking, running, baseball, soccer, gymnastics, fast bicycling, fast dancing, aerobics, or weight lifting).

13. During the **past month**, my family **did** physical activities with me.
☐ Never ☐ Hardly ever ☐ Once in a while ☐ Usually ☐ Most of the time

14. During the **past month**, my family **encouraged** me to be physically active.
☐ Never ☐ Hardly ever ☐ Once in a while ☐ Usually ☐ Most of the time

15. During the **past month**, my friends **did** physical activities with me **outside of school**.
☐ Never ☐ Hardly ever ☐ Once in a while ☐ Usually ☐ Most of the time

16. During the **past month**, my friends **encouraged** me to be physically active.
☐ Never ☐ Hardly ever ☐ Once in a while ☐ Usually ☐ Most of the time

17. How safe is it for you to play outdoors in your neighborhood with your friends **without adults around**?
☐ Very unsafe ☐ Somewhat unsafe ☐ Niether safe or unsafe ☐ Somewhat safe ☐ Very safe

18. During the past 12 months, on how many sports teams did you play (do not include PE classes)? Include any teams run by your school or community groups. *Sports teams include soccer, basketball, baseball, softball, swimming, gymnastics, cheerleading, wrestling, track, football, softball, dance, tennis and volleyball teams.*
☐ 0 teams ☐ 1 team ☐ 2 teams ☐ 3 teams ☐ 4 or more teams

19. Do you currently participate in any **other** organized physical activities or take lessons, such as martial arts, dance, gymnastics or tennis?
☐ No ☐ Yes

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Please continue on next page

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SECTION C

For each question below fill in only ***one*** answer.

20. What is the minimum number of servings of calcium-rich food adolescent girls need to consume each day to meet their daily requirement of calcium?
☐ At least 2 servings ☐ At least 4 servings ☐ At least 6 servings
☐ At least 3 servings ☐ At least 5 servings ☐ Don't know/unsure

21. At about what age do bones reach their peak bone density?
☐ 10-19 years old ☐ 20-29 years old ☐ 30-39 years old ☐ 40 years or older ☐ Don't know/unsure

22. At what age are females increasing their bone density the fastest?
☐ 10-19 years old ☐ 20-29 years old ☐ 30-39 years old ☐ 40 years or older ☐ Don't know/unsure

23. Which of the following factors does **NOT** influence peak bone mass?
☐ Genetics/Family History ☐ Calcium intake ☐ Vitamin C
☐ Weight-bearing exercise ☐ Age ☐ Don't know/unsure

24. Which of the following is **NOT** a weight-bearing activity?
☐ Football ☐ Swimming ☐ Walking
☐ Soccer ☐ Gymnastics ☐ Don't know/unsure

25. Milk is available at my house:
☐ Never ☐ Hardly ever ☐ Once in a while ☐ Usually ☐ All of the time

26. Which activity is best for building strong healthy bones?
☐ Bicycling ☐ Softball ☐ Climbing stairs ☐ Jumping rope ☐ Don't know/unsure

27. A glass of skim milk has more fat than a glass of soda.
☐ True ☐ False ☐ Don't know/unsure

SECTION D

For each question below fill in only ***one*** answer.

28. How many glasses of milk do you usually drink in a day?
☐ None ☐ 1 glass ☐ 2 glasses ☐ 3 glasses ☐ 4 glasses ☐ 5 or more glases

29. Have you been drinking this amount for more than 6 months?
☐ No ☐ Yes

30. In the future, do you intend to increase this amount, decrease this amount or stay the same?
☐ Increase ☐ Decrease ☐ Stay the same

31. If you intend to increase or decrease this amount, do you intend to make this change in the next 6 months?
☐ No ☐ Yes ☐ I do not intend to increase or decrease this amount

32. How many days a week do you do activities that involve jumping (for example, jumping rope, gymnastics, basketball, volleyball, cheerleading, aerobics)?
☐ None ☐ 2 days a week ☐ 4 days a week ☐ 6 days a week
☐ 1 day a week ☐ 3 days a week ☐ 5 days a week ☐ 7 days a week

33. Have you been doing this amount of jumping each day for more than 6 months?
☐ No ☐ Yes

34. In the future, do you intend to increase this amount, decrease this amount or stay the same?
☐ Increase ☐ Decrease ☐ Stay the same

35. If you intend to increase or decrease this amount, do you intend to make this change in the next 6 months?
☐ No ☐ Yes ☐ I do not intend to increase or decrease this amount

Please continue on next page

SECTION E

For each statement below, fill in the number that most represents how much ***you*** agree or disagree with the statement. These numbers range from 1 (for *strongly disagree*) to 5 (for *strongly agree*).

How much do you agree or disagree with the following statements?	(1) Strongly Disagree	(2) Disagree	(3) Neither Agree nor Disagree	(4) Agree	(5) Strongly Agree
36. I do well at all kinds of sports or physical activities.	①	②	③	④	⑤
37. When I'm physically active, it bothers me if my hair gets messed up.	①	②	③	④	⑤
38. Preventing osteoporosis later in life is important to me now.	①	②	③	④	⑤
39. I could do well at sports or physical activities I have never tried.	①	②	③	④	⑤
40. Eating calcium-rich foods will make me feel better physically.	①	②	③	④	⑤
41. It is important for me to feel better physically.	①	②	③	④	⑤
42. I get enough milk and dairy foods in my diet.	①	②	③	④	⑤
43. It is important to me to have time to myself during the day.	①	②	③	④	⑤
44. I am better than others my age at sports or physical activities.	①	②	③	④	⑤
45. I like to drink milk.	①	②	③	④	⑤
46. I am willing to try calcium-rich foods that I have not tried before.	①	②	③	④	⑤
47. It is important for me to be physically active.	①	②	③	④	⑤
48. Eating calcium-rich foods will prevent osteoporosis when I am older.	①	②	③	④	⑤
49. It is important for me to be healthy.	①	②	③	④	⑤
50. Being physically active each day will make me healthier.	①	②	③	④	⑤
51. Being physically active each day will mess up my hair.	①	②	③	④	⑤
52. My friends drink milk.	①	②	③	④	⑤
53. Being physically active will make me more attractive.	①	②	③	④	⑤
54. Being attractive is important to me.	①	②	③	④	⑤
55. Being physically active takes up too much time in my day.	①	②	③	④	⑤
56. Eating calcium-rich foods will make me healthier.	①	②	③	④	⑤
57. Having my hair fixed is important to me.	①	②	③	④	⑤
58. Being physically active will help me to make new friends.	①	②	③	④	⑤
59. Milk makes my stomach hurt.	①	②	③	④	⑤
60. Making new friends is important to me.	①	②	③	④	⑤
61. Eating calcium-rich foods will help me to make new friends.	①	②	③	④	⑤
62. Being physically active each day will help me to lose weight.	①	②	③	④	⑤
63. Eating calcium-rich foods will make me gain weight.	①	②	③	④	⑤
64. Maintaining a good weight is important to me.	①	②	③	④	⑤

Please continue on next page

SECTION F

For each statement below, fill in the number that most represents how confident ***you*** feel about the statement. These numbers range from 1 (for *not at all confident*) to 5 (for *very confident*).

How confident are you that you could usually:	(1) Not at all Confident		(3) Fairly Confident		(5) Very Confident
65. Drink milk instead of sodas at dinner?	①	②	③	④	⑤
66. Eat yogurt for a snack?	①	②	③	④	⑤
67. Eat cereal and milk instead of a donut for breakfast?	①	②	③	④	⑤
68. Eat a cheeseburger instead of a hamburger for lunch?	①	②	③	④	⑤
69. Be physically active no matter how busy your day is?	①	②	③	④	⑤
70. Eat string cheese for a snack?	①	②	③	④	⑤
71. Ask your parent(s) to take you to sports or physical activity practice?	①	②	③	④	⑤
72. Eat pudding for a snack?	①	②	③	④	⑤
73. Be physically active no matter how tired you feel?	①	②	③	④	⑤
74. Eat broccoli with dinner?	①	②	③	④	⑤
75. Be physically active at home after school?	①	②	③	④	⑤
76. Be physically active with friends instead of watching TV or playing video games?	①	②	③	④	⑤
77. Participate in sports at school?	①	②	③	④	⑤
78. Ask your parent(s) to sign you up for a sport, dance or physical activity?	①	②	③	④	⑤
79. Be physically active even though it is hot outside?	①	②	③	④	⑤
80. Participate in sports outside of school (such as martial arts, gymnastics, summer league)?	①	②	③	④	⑤
81. Do activities that involve jumping?	①	②	③	④	⑤
82. Lift weights (free weights, machines)?	①	②	③	④	⑤
83. Be physically active even though you have a lot of homework?	①	②	③	④	⑤
84. Drink milk at school?	①	②	③	④	⑤
85. Ask your parents to buy foods that are high in calcium such as milk?	①	②	③	④	⑤

Thank you for your participation

APPENDIX B

Triceps plus subscapular skinfolds

	Boys		Girls	
	Skinfolds (mm)	**% Fat**	**Skinfolds (mm)**	**% Fat**
Very low	≤8	≤6	≤11	≤11
Low	8 to13	6 to 10	11 to 15	11 to 15
Optimal	13 to 23	10 to 20	15 to 27	15 to 25
Mod high	23 to 26	20 to 25	27 to 35	25 to 30
High	26 to 38	25 to 31	35 to 45	30 to 35.5
Very high	38 and up	31 and up	45 and up	35.5 and up

Percent body fat table for boys and girls.
Adapted from Measuring body fat using skinfolds [videotape] by T. G. Lohman, 1987, Champaign, IL: Human Kinetics. Copyright 1987 by Human Kinetics Publisher.

VITA

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Education

Texas A&M University
Major: Nutrition
Degree: Combined Master of Science/Dietetic Internship Program (December 2004)

Texas A&M University
Major: Nutritional Sciences
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Work Experience

University of Texas M. D. Anderson Cancer Center
Clinical Dietitian (since September 2003)
Perform nutritional assessment and counseling of hospitalized cancer patients
Supervisor: Ms. Nicki Lowenstein

Texas A&M University
Student Technician, Expanded Nutrition Program (August 2001 – December 2002)
Assisted with various nutrition education projects and clerical functions
Supervisor: Dr. Debra Reed

Teaching Assistant (January 2001 – July 2001)
Community Nutrition and Scientific Principles of Nutrition
Supervisor: Ms. Joanne Kuchta

Research Assistant (August 2000 – December 2000)
Assisted with study on fish oil and colon cancer
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Areas of interest

The role of nutrition in the prevention and management of chronic diseases such as cancer, diabetes, and heart disease