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The Role of Dairy Products in the Calcium Intake of Suburban Adolescents

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THE ROLE OF DAIRY PRODUCTS IN THE CALCIUM INTAKE OF SUBURBAN ADOLESCENTS

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ABSTRACT

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The purpose of this study was to examine consumption of dairy products by suburban adolescents. This was a secondary analysis of data from a questionnaire administered in late fall of 2003. There were 255 adolescents who completed the questionnaire. Data were examined to estimate calcium intake from dairy products.

There was a significant difference in the amount of calcium adolescents consume from cheese, compared to that supplied by milk ($t = -8.502, p = .000$). Further analyzing by gender, there was a significant difference between boys and girls intake of milk and cheese. No significant difference was found between boys and girls regarding their weekly milk consumption ($t = 1.825, p = 0.070$). Finally, there was no significant difference between boys' and girls' relative percentages of total calcium contributed by milk ($t = -1.630, p = 0.105$).

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CHAPTER ONE

INTRODUCTION

Osteoporosis is a silent disease that is currently incurable, yet largely preventable. Osteoporosis or "porous bone" is a disease characterized by low bone mass, the structural loss of bone tissue that leads to bone fragility and a consequent increase in fracture risk (Centers of Disease Control and Prevention [CDC], 2002). Osteoporosis and osteopenia are serious and costly diseases. They affect 44 million Americans, or 55 % of people 50 years of age or older (National Institute of Health Osteoporosis and Related Bone Diseases [NIH ORBD], 2004). The national health care cost for osteoporotic fractures and sequelae was over $17 billion in 2001 ($47 million each day) and is predicted to exceed $62 billion by the year 2020. (Lyson & Walker, 1997; NIH ORBD, 2004).

Several factors affect the development of osteoporosis: building peak bone mass (bone mineralization & bone structure) in the adolescent years, genetics, and the rate at which bone mineralization is lost later in life (National Institute Child Health and Human Development [NICHD], 2003). In addition, getting appropriate exercise and eating nutritiously helps bones grow stronger. According to research, approximately 75%-80% of peak bone mass cannot be controlled since it is related to genetic disposition (Kulak & Bilezikian, 1998). However, exercise and nutrition can be controlled to help boost the accretion of bone mineral during the developing years of adolescence. A diet rich in calcium-containing foods can account for a 5-10 % higher peak bone mass in adolescents (NIH ORIB, 2002).

Calcium is an essential nutrient for bone health. Bones are living structures that need the mineral calcium to develop and stay strong. Calcium is the most abundant mineral in the body. Ninety-nine percent of the body's calcium is found in the bones and teeth (NICHD, 2003). Bones store calcium and release it into the bloodstream to maintain a serum concentration necessary to perform regulatory functions, which include muscle contraction, bone building and clotting of the blood (Gallo, 1996). Through diet, calcium is acquired to help maintain the delicate calcium balance. However, when the calcium intake is inadequate, calcium is reabsorbed from the bones to be used for those processes, making the bones fragile and at risk for developing osteoporosis (Kulak & Bilezikian, 1998). Therefore, a diet full of calcium rich foods is essential to help prevent osteoporosis.

A significant amount of osteoporosis research has focused on the management and treatment of bone loss in later life, rather than on how to prevent osteoporosis from developing. However, today osteoporosis is referred to as a classic pediatric disease with geriatric consequences (Anderson, 1997). A diet deficient in calcium in the younger years leads to fragile bones. That is why calcium has been identified as a nutrient of concern for adolescents by the American Academy of Pediatrics and the National Institute of Child Health and Human Development (Hampton, 2004; NICHD, 2003). Therefore, in order to reduce the risk of osteoporosis and skeletal fractures in later life, current research has focused on the role of calcium consumption in childhood and adolescence.

Bone mass is accumulated in the early part of life with bone stores developing and bone mineral density increasing until approximately age 30 when peak bone mass is attained (Drugay, 1997). According to the National Osteoporosis Foundation (2004), by

age 20 around 98% of an adolescent's skeletal mass are formed. Therefore, adolescence marks a crucial time for calcium consumption.

Low calcium intake is also of particular concern because of the growing scientific evidence that supports calcium's health benefits (McBean, 2004). A diet low in calcium can lead to a number of serious health issues. An adequate diet rich in calcium has been demonstrated to reduce the risk of osteoporosis, hypertension, and obesity, certain cancers such as colon and breast, and stroke (Appel, Moore, Obarzanek, & Vollmer, 1997; Heaney, 2000; McBean, 2002; Power, Heaney, Kalkward, Pitkin, Repke, Reginald et al., 1999). Calcium also is potentially beneficial to premenstrual syndrome, polycystic ovarian syndrome, asthma and periodontal diseases (Nishida, Grossi, Dunford, Ho, Trevisan & Genco, 2000; Thys-Jacod, Starkey, Bernstein & Tian, 1998; Wijga, Smit, Kerkhof, deJongste, Gerritsen, Neijens et al., 2003; Zemel & Gottieb, 2003). Calcium prevents a number of chronic conditions making a calcium-rich diet vital during the adolescent period.

Adolescence is the ideal time for calcium to be absorbed into the bones, but most adolescents do not consume the optimal amount of calcium. The current Recommended Daily Allowance (RDA) or Dietary Reference Intake (DRI) for calcium in adolescents 9 to 18 years old is 1,300 mg/day (CDC, 2002). Many surveys of calcium intake in adolescent boys and girls have shown that they consume far less than the recommended amounts of calcium. According to the *Third National Health and Nutrition Examination Survey of 1989-1994* (NHANES III), a national population based survey, many American females of all races, over the age of 11, do not consume the recommended intake of calcium (Got Calcium Organization, 2001). In addition, data from the *Continuing Survey of Food*

Intakes by Individuals (CFSII) 1994-1995 revealed that 70% of adolescent males consume less calcium than the RDA, while 92% of females consume less calcium than recommended (Got Calcium Organization, 2001). Furthermore, according to Healthy People 2010, only 19% of adolescent females and 52% of males aged 9 to 19 years met the calcium recommendation goal for Healthy People 2000. This justifies the Healthy People 2010 objective of increasing the proportion of persons age 2 or older who meet the dietary recommendation for calcium (United States Department of Health and Human Services Office of Disease Prevention and Health Promotion, 2001).

With adolescents not meeting their dietary intake of calcium it is not a surprise that adolescent fracture rates are on the rise. Over the past 30 years forearm fracture rates have jumped by 42 % among adolescent boys and girls (Khosla, Melton, Dekutoski, Achenbach, Oberg & Riggs, 2003). Young people who exclude dairy in their diets are at increased risk for fractures not only in adulthood, but childhood also. A study by Black, Williams, Jones and Goulding (2002) observed that a group of 50 white children with a history of avoiding cow's milk had low dietary calcium intake, short stature, poor skeletons, and a high prevalence of adiposity. Goulding and his partners (2004), using the same children, did a two-year follow-up interview to access 46 of those children's fracture histories. Twenty-two fractures were confirmed in the study (12 radius/ulna, 3 fingers, 2 tibia/fibula, 1 clavicle, 1 femur, 1 ankle, 1 nose, 1 metatarsal). All of the fractures occurred during puberty and were associated with only mild trauma. However, factors such as high activity levels, not wearing protective gear, or involvement in accident prone activities could also have influenced the children's number of fractures.

To meet calcium needs, milk and other dairy products are considered to be the preferred and leading dietary source (Heaney, 2000). That is why the dairy industry, along with the National Medical Association, American Academy of Family Physicians, and the American Academy of Pediatrics launched a campaign for stronger bones called "3 A Day." The campaign focuses on getting children and adolescents to eat three servings of milk, cheese and/or yogurt a day and teaches adolescents correct serving sizes, because most do not know how to measure a dairy serving size (American Dairy Association, 2003).

Milk consumption decreases during adolescence and continues to decrease into adulthood, whereas soda consumption rises (Bowman, 2002). Previous research has shown that adolescents are typically not concerned about how their diet affects their health. They choose to eat whatever they like over what is healthy (Neumark-Sztainer, Story, Perry, Cassey, 1999). Consequently, adolescents snack often. Snacking accounts for 30% of an adolescent's diet and makes up a major source of their nutrition (Bateson & Finch, 2002). Information regarding the types of calcium rich foods adolescents most often eat is lacking, making it difficult for both healthcare practitioners and the milk industry to make the most desired calcium rich snacks available for adolescents. Without adequate calcium in their diets adolescents are at an increased risk for early fractures, osteoporosis, and many other chronic diseases, which will cost $264 billion in direct healthcare costs over the next 5 years (McCarron & Heaney, 2004).

Purpose

The purpose of this study was to examine the consumption of dairy products by suburban adolescents. Adolescence marks a time when eating patterns change and dairy

intake decreases. Information from this study will aid healthcare professionals and the milk industry in determining ways they can market calcium rich foods to adolescents.

CHAPTER TWO

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

Theoretical Framework

To date, few have applied the Health Promotion Model (HPM) as a theoretical framework to assess health behaviors of adolescents (Pender, 1982; Pender, Murdaugh, & Parsons, 2002). In the past, researchers have used the Health Belief Model (HBM) (National Cancer Institute, 2004) and social cognitive theory (Bandura, 1977 as cited in Pender et al., 2002; Bandura, 1986) to assess the health benefits and barriers adolescents perceive are indicative of the likelihood they will take a health promoting action. Pender, in building on the work of the two models listed above, proposed the HPM.

The Health Promotion Model provides the framework for this study. The HPM describes concepts proposed to predict health-promoting behaviors. The model consists of three broad categories: individual characteristics and experiences, behavior-specific cognitions and affect, and behavior outcomes. In the HPM the three broad categories are broken down into ten determinants of behavior. They include: prior related behavior and personal factors, perceived benefits and barriers of action, perceived self-efficacy, activity-related affect, interpersonal influences, situational influences, commitment to a plan of action, immediate competing demands and preferences, and finally, the health promoting behavior (Pender, Murdaugh, & Parsons, 2002).

The HPM can be used to analyze why adolescents are not consuming an adequate amount of dairy. The model proposes several reasons including, (a) adolescents are more likely to eat a healthy diet when their parents and peers eat a healthy diet, (b) prior behaviors impact the dietary intake of adolescents, (c) the external environment (schools, magazines, celebrities, and television) influences a teenager's commitment to consume a healthy daily diet, and (d) personal factors such as biological, psychological, and sociocultural influences will shape the eating habits of adolescents (Pender et al., 2002).

According to many researchers, as stated above, adolescents are more likely to consume a diet that includes the recommended daily intake of calcium when their parents and peers are consuming dairy products. Family mealtimes increase the likelihood that adolescents will eat breakfast and meet their daily dairy intake requirement (Videon, 2003).

Behavioral factors are often the best predictor of the likelihood that an adolescent will engage in health promoting behaviors (Pender, et al., 2002). Once an adolescent has developed his or her dietary habits, they become a repetitive practice of behavior. For example, an adolescent who enjoys the taste of dairy foods is likely to consume those foods more often and consequently have higher calcium intake (McBean, 2003).

Adolescents are highly influenced by the media. The media can positively impact food choices by promoting health education and awareness through "healthier" food choices. However, a concern is that the numerous, diverse messages about diet and health through the media, promotions, and advertising may lead to "nutrition backlash" or disregard for all health-related messages (McBean, 2003). Schools impact the type of foods that adolescents will choose to consume during the day. They can promote intake of

dairy products by having flavored milk machines, displaying healthy foods in an appealing manner, and making the healthy food lines shorter (Neumark-Sztainer, et al., 1999).

Finally, in using the HPM as a guide to explore adolescents' dairy consumption, it is important to analyze their personal factors. Biological factors such as age, body mass index, or gender are influential. Males are more likely to meet their RDI for calcium than females (NDC, 2003). In addition, an adolescent's self image, perceived health and social-economic class is associated with dietary intake (Neumark-Szainer, Story, Resnick, & Blum, 1998).

Literature Review

In the past osteoporosis research has focused primarily on postmenopausal women, with few studies focusing on prevention for adolescents, especially for males. Adolescence is a period where peak bone mass is developed. It is a time when most adolescents' diets lack milk or cheese, resulting ultimately in calcium deficiency. According to the United States Dairy Association, nearly 9 out of 10 teenage girls and 7 out of 10 teenage boys do not get enough calcium (NDC, 2003). To meet the RDA for calcium an adolescent only needs to consume 4 to 5 servings (1200-1400 mg/day of calcium) of milk, cheese, or yogurt a day. The literature review for this study is divided into 3 major categories: (a) osteoporosis risk factors, (b) dietary calcium intake, and (c) adolescents' perceived barriers, and knowledge.

Osteoporosis Risk Factors

Osteoporosis is easier to prevent than to treat. Once peak bone mass is achieved during adolescence it is for the most part impossible to restore it if it is lost as a person ages. Both genetic and lifestyle factors affect the development and maintenance of bone mass, which in turn affects the likelihood of an adult developing osteoporosis (Ali & Siktberg, 2001). Genetic factors are non-modifiable and include gender, family history, race/ethnic background, age, hormonal status, and personal history. Lifestyle factors are modifiable and include calcium intake, physical activity, alcohol and caffeine consumption, smoking, medications, and eating disorders (McBean, 2004; Wardlaw, 1993). According to Lysen and Walker (1997), non-modifiable factors account for as much as 80% of total bone mass, while the rest can be controlled by lifestyle. Adolescents can reduce their chances of developing osteoporosis in late life through a healthy lifestyle.

Adolescents are in a developmental period when lifestyle factors become engrained as well as routine. If healthy habits are not emphasized or taught to adolescents the chances of them having low bone mass rises dramatically. According to the NIH Consensus Statement on Osteoporosis, "bone mass attained early in life is perhaps the most important determinant of lifelong skeletal health" (NDC, 2003). For that reason, adolescents must eat a diet rich in calcium to develop well-mineralized bones and reduce their chances of developing osteoporosis.

Bone Density

Strong evidence indicates that calcium helps adolescents develop well-mineralized bones (NDC, 2003). Adolescence is a critical period of human growth and development.

Between the ages of 11-20, adolescents gain 50% of their adult weight, approximately 90% of their skeletal mass and 20 % of their adult height (Wahl, 1999).

As children near the adolescent growth spurts the skeletal accumulation of calcium increases considerably. "'Between 140 mg and 165 mg calcium/day is deposited into the skeleton during preadolescence and as much as 350 mg calcium/day during adolescence'" (Bonjour, Carrie, Ferrari, Clavien, Slosman, Theintz et al., 1997 as cited in NDC, 2003). The early teenage years are critical for bone development. By the age of 18, most of an adolescent's bone mass is deposited, making osteoporosis seem like a pediatric disease (Albertson, Tobelmann & Marquart, 1997; Weaver, 1997). In addition, research by Abrams and Stuff (1997) indicates that the peak calcium accretion rate occurs at age 12.5 year old for girls and 14 years for boys. For that reason, exercise and nutritional education should be emphasized in middle schools.

This last point is illustrated through results that were found in a recent longitudinal study, The Saskatchewan Bone Mineral Accrual Study (BMAS). Students aged 8 to 14 years old, were followed for 6 years. Bone mineral densities and 24-hour diet recalls were recorded quarterly. Results suggest the age of maximal peak bone mineral content velocity occurred at age 14.0 ±1.0 years in boys and 12.5 ± 0.9 years in girls. Boys gained on average, 407 grams of bone mineral during each of the two years surrounding this age, while girls gained 322 grams (Whiting, Vatanparast, Baxter-Jones, Faulkner, Mirwald, & Bailey, 2004).

Bonjour, Theintz, Buchs, Slosman, and Rizzoli (1991) concluded in a cross sectional study of 207 healthy Caucasian boys and girls aged 9-18 years that during the adolescent years major differences are observed in increases in bone mass according to sex

and skeletal site. At age 10 the mean bone mineral density (BMD) is similar between both sexes, and between 12-13 and 14-15 years females tend to have a higher mean value than males. However, at 15-18 years, growth in skeletal mass appears to dramatically slow down for females at both the lumbar and femoral neck area, but continues to increase in males.

Benefits of Calcium to Bone Density

Calcium plays a critical role in accruing well-mineralized and healthy bones and has long been associated with reducing the risk of developing osteoporosis (Weaver, 1997). A calcium deficient diet leads to increased fracture rates in adolescents. A New Zealand study assessed a group of 100 girls aged 3 to 15 with forearm fractures, and 100 girls without fractures, and found that girls age 3 to 7 and 11 to 15 years with fractures had lower dietary calcium intakes from milk than their controls (372 vs. 509 mg/day and 354 vs. 499 mg/day) (Goulding, et al., 1998, as cited in MacDonald, 1998).

Numerous studies show that when adolescents increase their intake of calcium rich foods, especially dairy products, they generate increases in bone mineral. Girls in Utah aged 9-13 years old, increased their calcium intake from 728 mg/day to 1400 mg/day or higher for one year by consuming more milk and milk products. Their total spinal bone density increased. In addition they were able to meet their calcium needs via foods from the milk group without increasing their fat intake or body weight (Lloyd, Andon, Rollings, Martel, Landis, Demers, et al., 1993 as cited in NDC, 2003). In another study performed on 45 identical pre-pubertal twins over a 3-year time, one twin received 700 mg of calcium daily and the other twin did not receive calcium supplementation. The supplemented twin gained between 1% to 5% more BMD than the twin who received no supplementation

(Johnston, Miller, Slemenda, Reister, Hui, Christian, et al., 1992 as cited in Kerstetter, 1995).

Another study performed by Llyod, Andon, and Rollings (1993) found that when adolescent girls were supplemented with 350 mg of calcium per day for over 18 months their BMD increased between 1% to 3% when compared to non supplemented girls. (As cited in Kerstetter, 1995). In a similar study, reported by Kerstetter, researchers divided a group of adolescent girls into 3 groups, who for 6 months received either 1000 mg supplemental calcium per day, 500 mg per day, or no supplemental calcium. The 1000 mg, 500 mg, and placebo groups gained 154, 138, 125 grams of total body mineral content, respectively. In a third investigation, 28 boys were randomly assigned to consume an additional three servings of 1% milk, or non calcium fortified juice while engaging in a 12-week resistance training program. Compared with those who drank the juice, the milk-ingesting group had a two fold greater increase in BMD. Since a "non training group" was not implemented into the study the effect of the resistance training is uncertain (Volek, Gomez, Scheett, Sharman, Duncan, French et al., 2003). Finally, 80 adolescent girls were supplemented with an additional pint of milk a day over 18 months. The supplemented girls had a 9.6% increase in bone density compared to a 8.5% increase among the non-supplemented girls (Cadogan, 1997).

Dietary Calcium Intake

Adolescence marks a period of critical growth that requires sufficient nutrition. Yet, despite the need for adequate nutrition, adolescence is a time when many nutritional deficiencies occur, especially that of calcium (Bateson & Finch, 2002; Cavadini, Siega-Riz, & Popkin, 2000; Durst, 2000). In 1997, for the first time since 1989, the National

Academy of Sciences (NAS) Food and Nutrition Board (FNB) of the Institute of Medicine (IOM) issued updated dietary recommendations for calcium and related nutrients. The calcium recommendations were expressed as *Adequate Intakes* (AIs)-based on the amount of calcium needed to support maximal retention of body calcium. A calcium intake of 800 mg/day is recommended for children aged 4-8 years, for the teenage years (9-18 years old), a calcium intake of 1,300 mg/day, and finally, for young adults age 19-30 years a minimal intake of at least 1000 mg/day to maximize calcium retention (NDC, 2003). Based on current research the NIH does suggest an optimal calcium intake of 1500 mg/day for all adolescents age 9–18 years old (NDC, 2003). However, evidence is lacking as to whether the extra 300 mg/day of calcium is really optimally absorbed into the bone (NOF, 2003).

Research shows that a high percentage of adolescents are calcium deficient. Bateson and Finch (2002) examined the level of calcium intake in 430 eighth grade pupils. Data were collected from questionnaires, which included a 24-hour diet recall, food frequency and knowledge questionnaire. The results showed that while girls had a greater knowledge regarding calcium rich foods than boys the knowledge did not influence their diet. In the study only 1.4% of girls and 12% of boys met the RDA recommendations of 1300 mg/day. Similarly, Story and Alton (1996), based on data from NHANES III study, found that girls age 12 to 19 had a low calcium intake of 809 mg/day.

Cavadini, Siega-Riz and Popkin (2000) analyzed adolescents' dietary intake from four nationally representative US Department of Agriculture surveys. From 1965 to 1996 milk consumption decreased by 36 %. In 1965 the average calcium intake was 1100 mg/day, whereas in 1994-1996 it was 960 mg/day. Only 20% of adolescent girls and 33% of boys were meeting the recommended dietary intake for calcium in 1996.

A study in Rhode Island found 89% of 1,117 ninth grade adolescents consumed considerably less than the RDA for calcium, with boys consuming 681 ± 28 mg/day, and girls consuming 536 ± 19 mg/day. About a third of the adolescents took daily calcium supplements. However, the supplements included only 100-200 mg of elemental calcium and failed to significantly increase calcium intake (Harel, Riggs, Vaz, White, & Menzies, 1998). Finally, the National Dairy Council (2001) stated in their *Digest* newsletter, that the United States Agricultural Association had discovered that only 28% of males and 11% of females aged 12 to 19 years old had consumed 4 servings/day of dairy foods.

Dairy

Adolescent eating patterns have changed over the last 20 to 30 years. According to a United States Dairy Association (USDA) report (1999), between 1977 and 1995, away-from-home meals have increased by more than two-thirds, from 16% to 27%. The calcium content of home prepared foods (429 mg per 1000 calories) was close to the recommended calcium density, but away-from-home meals have a calcium density of only 343 mg per 1000 calories, more than 20% below adequate intake (McBean, 2003). As a result of not eating meals at home, dairy consumption has dropped, causing adolescents to lose many important nutrients from their diets.

Dairy products contain several important nutrients in sizable quantities, including calcium (72%), phosphorus, riboflavin, magnesium, potassium, zinc, protein and vitamin A, D, and B_{12} (Gerrior, Putnam, & Benete, 1998). Accumulating scientific data supports the valuable role that dairy foods play in health promotion and disease prevention (Miller, Jarvis, & McBean, 2000). McCarron and Heaney (2004) noted that their analysis of research conducted over the past decade finds that 3-4 servings of dairy foods per day as

part of a healthful diet could lead to significant decreases in various medical disorders and estimated healthcare savings of $200 billion over a 5 year time period. Dairy foods appear to be more effective than calcium alone in reducing the risk of chronic diseases including obesity, cancer, heart disease, and dental caries (Miller, Jarvis, & McBean, 2000; Teegarden & Zemel, 2003).

Milk. Milk is the main source of calcium in the typical American diet, according to the American Academy of Pediatrics (AAP) (Hampton, 2004). Milk contributes approximately two-thirds of the total calcium intake for infants and toddlers, and more than half of total calcium intake for adolescent girls (Albertson, Tobelmann, & Marquart, 1997). The daily percent value for milk is considered "good" for 9 essential nutrients according to the AAP (2004). But, unfortunately milk consumption – and therefore calcium intake, has decreased as the eating patterns of adolescents have changed. Soft drink, sports drink and fruit juice consumption has increased replacing that of milk.

Milk consumption has decreased by 36% since the 1970s because of fruit juices and soda (Bowman, 2002). Soft drink consumption has increased by 300% in 20 years, and serving sizes have increased from 6.5 oz. in the 1950s to 20 oz. in the 1990s. Between 56% - 85% of children in school consume at least one soft drink a day, with adolescent males having the highest consumption of 4 or more servings per day (AAP, 2004). A recent study followed the eating patterns of children from third to eighth grade. Results revealed that milk consumption dropped from 2.5 times a day in third grade to less than 1.9 times a day in eighth grade. However, soft drink consumption more than tripled between the two grades, most often replacing milk and fruit juice (McBean, 2000). In addition, according to the AAP (2004), sweetened drinks are associated with obesity. Each 12 oz.

soft drink per day increases a child's risk of obesity by 60%. Adolescents not only lose calcium and other important nutrients when they drink soda, but gain unwanted weight and increase their risk for other chronic conditions.

Cheese. Cheese is a concentrated source of many of milk's nutrients. It is a wonderful milk substitute. The type of milk/milk product used (e.g. whole, reduced fat, cream, nonfat, whey) and the manufacturing process used influence the nutrient content of specific cheeses. The water-insoluble nutrients of milk such as protein, colloidal minerals (calcium, zinc, or phosphorus), vitamin A, fat, and protein, which is primarily retained in the curd, are concentrated in cheese, whereas, lactose, soluble minerals, and Vitamin B_{12} are removed with the whey (McBean, 2004). Cheese has grown in popularity over the last 20 years due to its nutrient content, versatility, convenience, and great taste.

About 10 pounds of milk is used to make one pound of cheese. Since the first cheese factory opened in the U.S. in the 1850s, the amount and variety of cheese and cheese products consumed and manufactured has increased tremendously (International Dairy Foods Association, 2001). Americans today consume 2.5 times as much cheese as they did in 1970. More than one-third of all cow's milk produced in the U.S. each year is used to make cheese (Gerrior, Putnam, & Bente, 1998). In addition, between 1990 and 2000, per capita consumption of cheese increased by 21% (McBean, 2004).

Cheese is an important source of calcium and offers a number of health benefits. Cheese is an excellent alternative for individuals with lactose maldigestion (lactose intolerance). Lactose maldigesters have difficulty digesting lactose, the principle carbohydrate in milk, due to a deficiency of lactase, the enzyme necessary to metabolize lactose. Cheeses, particularly aged cheeses, contain negligible amounts of lactose. Pribila,

Hertzler, Martine, Weaver and Savaino (2000) demonstrated in a study of 17 African American girls (aged 11 to 15 years) who were fed a dairy rich diet (1200 mg of calcium/day) for 21 days that they did not show increased intolerance. Also, they did not experience abdominal pain, bloating, flatulence, or diarrhea. Similarly, women who were lactose intolerant were able to consume 1,500 mg calcium/day from a diet containing 2 oz. cheese, 2 cups milk, and 1 cup of yogurt, without developing symptoms (McBean, 2004). Therefore, the American Academy of Pediatrics (2004) recommends that children and adolescents with lactose intolerance include cheese, and then slowly add other dairy products in their diet.

Cheese also protects teeth against tooth decay and demineralization (McBean, 2004). Both experimental animal and human epidemiological studies demonstrate that calcium and phosphorus in cheese may help remineralize tooth enamel (Kashket & Dominick, 2002). In British adults, when dental plaque samples were obtained before and 5 minutes after intake of cheese cubes, plaque calcium concentrations were significantly higher in subjects consuming cheese than those who did not consume the cheese (McBean, 2004). The American Academy of Pediatric Dentistry advises parent to choose cheese as caries-protective snacks for kids (Pribila et al., 2000).

Whey, a by-product of cheese making, has many potential health benefits. Whey contains many nutrients and has antimicrobial, antiviral, immune-boosting components along with the potential to enhance physical performance and positively affect cardiovascular health (McBean, 2003). The full health providing potential of whey is unknown because research has focused on in-vitro studies. Additional research in humans is needed to substantiate whey's role in health and in preventing disease.

The high nutritional value of cheese and its beneficial role in health make it an important dairy food to include in an adolescents' diet. Adolescents like the taste of cheese. In a study by Auld, Boushey, Bock and Bruhn (2002) a convenience sample of two groups of girls (11-12, or 16-17) were interviewed regarding their consumption of milk products. It was found they liked pizza, ice cream and cheese. Cheese appears to be a great food to add to adolescents' diets. Even adolescents who are interested in watching their weight and reducing fat in their diets can include cheese (McBean, 2004).

Weight Reduction

An increased intake of calcium has been shown by several studies to trigger weight reduction (Heaney, 2003; Teegarden & Zemel, 2003). Heaney (2003) reevaluated data from previously published studies on women and bone health to determine if calcium intake played a role in the risk of being overweight during midlife. He found that women who consumed lower amounts of calcium gained an average of nearly a pound a year by midlife. Conversely, women who consumed three servings of milk, cheese or yogurt averaged a slight weight loss. In another study, Jacqmain and his associates (2003) found that women who consumed less than 600 mg of calcium a day were found to have a higher weight and body fat than women who consumed higher amount of calcium. Furthermore, both men and women who consumed as average of 1000 mg of calcium a day had better cholesterol levels than those who consumed less than 600 mg of calcium a day. Finally, in a study of adolescent girls age 9-14 who consumed diets rich in calcium, these girls weighed less and had less abdominal fat than girls who consumed less calcium. For every 300 milligrams of calcium consumed, girls were 1.9 pounds lighter, on average (NDC, 2003).

The modern eating environment has influenced the way children and adolescents eat. Family meal patterns have changed, leading adolescents towards poor calcium intakes. The findings of a study by Neumark-Sztainer and associates (2003) provide clear evidence of a strong positive association between frequency of family meals and calcium intake. A family that never ate together had a calcium intake of 870 mg/day whereas a family that ate together 3-6 times a week averaged 955 mg/day. Finally, a family that ate together more than 7 times had a calcium intake of 1,906 mg/day. Similarly, in another study of 18,000 adolescents, in which food intake interviews were completed in participants' homes, it was found that adolescents who ate 6-7 family meals were 27% less likely to report poor dairy intake (Videon, & Manning, 2003).

Children's beverage patterns become set as early as preschool, according to Fisher, Mitchell, Smiciklas-Wright, Mannino and Birch (2004). The group studied nearly 200 mothers and daughters for five years, when the daughters were age 5 to 9 years. Results showed that 41% of the girls met the recommended 1300 mg/day calcium intake. The reason for the increased calcium intake was that they had moms who drank milk and were more likely to serve milk at mealtime. As well, when mothers dislike milk they are less likely to introduce it into a child's diet. In addition, a recent study by Lee and Reicks (2003) found that only 20% of Asian American, low-income girls of average age of 13, met calcium recommendations. In addition to parental encouragement, the girls' responses indicated they would increase their dairy intake if their friends encouraged milk drinking, if they had access to yogurt and cheese at home, or if their fathers drank milk. Thus, if parents are not good role models at an early age, adolescents will be less likely on a daily basis to meet their calcium intake requirement.

Exercise

In addition to having a good calcium intake, exercise is another behavior that plays an important role in encouraging bone formation. Having a high calcium intake cannot counteract the effects of physical inactivity (Heaney, 1996). Regular weight-bearing exercise is an essential stimulus to increase bone mass at an early age and to maintain it later in life (Durst, 2000; Volek, Gomez, Scheett, Sharman, French, Rubin et al., 2003). Exercise involving weight bearing has been shown to both decrease bone loss and increase bone mass (Ali & Siktberg, 2001; Volek et al., 2003). If regular intensive effort is expended in a physical activity, it can maintain normal bones as sufficiently strong bones until very old age (Durst, 2000; Kulak & Bilezikian, 1998). Therefore, the optimal time to begin an exercise program that will enhance bone structure is during adolescence.

During childhood and adolescence most people are active, however, recently adolescents have chosen to live a sedentary lifestyle. Physical activity declines during adolescence by almost 50%, with females becoming more sedentary than males (Garcia, Broda, Frenn, Coviak, Pender, & Ronis, 1995). Obesity rates are on the rise with 13% of children and adolescents being overweight (NDC, 2003).

Several studies have found that children who compete in sports have a higher BMD than children who do not participate in sports. Cassell, Benedict, and Specker (1996) found that total body BMD was higher in elite gymnasts 7 to 9 years old compared to that of children who did not participate in sports. Two longitudinal nonrandomized studies reported an increased BMD in children who participated in an exercise program. Both studies discovered that a regular program of weight bearing activity for 30 minutes per day, 3 days per week, during an 8-10 month period, increased the participants' BMD

significantly (Morris, 1992 as cited in Specker, 2002). Finally, Ali and Siktberg (2001) assessed calcium consumption and physical activity in a sample of 293 adolescent females ages 14 to 19. These young women were more likely to participate in the physical activities than increase their calcium intake. Barriers to the intake of calcium were skipping meals and trying to lose weight. Unfortunately, according to Specker (2002) it appears that the benefits of exercise on bone are only observed when calcium intakes are greater than 1100 mg/day. Therefore, vigorous exercise without an adequate intake of calcium may be futile to increase bone density and prevent osteoporosis in later life.

Adolescents' Perceived Barriers and Knowledge

Adolescence is a period of transition in which teenagers develop behavioral patterns that will affect them for the rest of their lives. Unfortunately, during this time period, adolescents often engage in behaviors that negatively impact their health (Spear & Kulbok, 2001). In an investigation by Harel et al. (1998) it was discovered that adolescents are aware of the main health benefits of calcium, but lack specific information regarding daily calcium requirements and the calcium content of various dietary selections. Therefore, it is imperative that research focuses on examining how adolescents can become more informed regarding calcium requirements and specific serving sizes.

Numerous factors, including lifestyle choices such as cost, taste, or convenience, parental influences, and knowledge affect dairy food and calcium intake among children and adolescents. Many adolescents do not eat three regular meals. Skipping breakfast can contribute to many children's low calcium intake. Compared to breakfast skippers, breakfast eaters are more likely to consume milk. According to government data, children ages 6 to 19 consume 23 to 30% of their daily calcium intake at breakfast. Unfortunately,

25% of adolescent girls and 22% of adolescent boys, on average, skip morning meals (McBean, 1999). In addition, not choosing milk at lunch compromises the calcium intake of adolescents. A recent investigation of children ages 5 to 17 found that only those who drank milk at the noon meal met or exceeded recommended dietary calcium intakes for that meal, or for the entire day (McBean, 1999)

The taste of dairy foods is another factor that influences children and adolescents' intake of calcium rich foods. According to one study, adolescents who enjoyed the taste of dairy foods were more likely to consume these foods frequently and, as such, had higher calcium intakes than adolescents who did not like the taste of dairy foods (McBean, 1999). Providing children with opportunities to become aware of and familiar with a wide variety of dairy foods can help improve acceptance of these foods. Lactose intolerance, either real or perceived, may reduce some adolescents' milk intake. However, research by Harnack, Stang, and Story (1999) demonstrated that individuals who have a limited ability to digest lactose can consume the recommended number of servings of milk and other dairy foods with meals. Further, increasing intake of lactose-containing dairy foods may improve tolerance to lactose (McBean & Miller, 1998).

Concerns about dietary fat intake and body weight may mislead parents or adolescents to limit dairy food and, subsequently, calcium intake. Nearly 40% of students nationwide are trying to lose weight and nearly one-third has been on a diet to lose weight or keep from gaining weight (McBean, 1999). Adolescents are more concerned about their body weight than calcium intake, which is supported by media messages targeted to this population (Field, Cheung, Wolf, Herog, Gortmaker, & Colditz, 1999). An analysis of teen and women's magazines revealed that weight loss was emphasized in teen magazines

whereas relatively little attention was given to calcium ingestion (Patterson, Satia, Kristal, Neuhouser, & Drewnowski, 2001). In addition, adolescents who engage in unhealthful weight control practices may reduce their intake of calcium (Story, Neumark-Sztainer, Sherwood, Stang, & Murry, 1998). Studies demonstrate that children who reduce their total fat intake consume fewer dairy foods and have lower calcium intakes than children with higher fat intakes (Neumark-Sztainer, Hannan, Story, Croll, & Perry, 2003).

Lack of knowledge or awareness about how much calcium is needed and about dietary sources of this nutrient is another factor that can limit adolescents' dairy food and calcium intake. For example, researchers surveyed 1,117 adolescents in Rhode Island and found that those who were knowledgeable about calcium consumed more of this nutrient than adolescents who were less aware of calcium. Only 10% of the adolescents knew the calcium content of various dairy foods; only 19% knew how many of dairy servings they should consume, and only 45% were knowledgeable about nondairy sources of calcium (Harel, et al., 1998).

Image, family influence, and eating-away-from home also impact adolescents' intake of dairy foods and consequently their calcium intake. Adolescents are more likely to drink milk if their friends or peers also consume this beverage (National Institute of Child Health & Human Development, 2004). Parents, mothers in particular, play an important role in shaping children's eating behaviors by their own dietary behaviors, their attitudes toward food, and the availability of food in the home (Fisher, Mitchell, Smiciklas-Wright, & Birch, 2000; Neumark-Sztainer, 2003; Neumark-Sztainer, Story, Perry, Casey, 1999).

The trend toward eating away-from-home at restaurants and fast food establishments also compromises the calcium intake of adolescents, mainly because of the availability of beverages other than milk (Bowman, 2002). A comparison of the nutritional quality of home versus away-from-home foods revealed that the calcium density of home foods was 425mg/1,000 kcal and that of away-from-home foods was 343mg/1,000 kcal (McBean, 1999).

In summary, milk, and milk products like cheese, yogurt, or frozen dairy treats, are the main sources of calcium intake for adolescents and contribute roughly 75% of the calcium in the US food supply. However, interestingly, the per-capita level of calcium in the current US food supply is insufficient to meet the population-weighted average recommended for calcium (Gerrior, Putnam, Bente, 1998). This means that the overall population, including adolescents, is not consuming enough calcium, and that is a critical health problem.

The above literature review reveals that adolescents do not consume adequate dairy and their food preferences have changed over the past 20 years. A number of factors that can be modified influence their eating habits. Much has been studied in adolescent girls, yet research is lacking when it comes to adolescent boys. Also, more studies are needed to analyze the eating preferences of adolescent boys. Therefore, this study will contribute in describing which calcium-rich foods adolescents prefer to consume on a daily basis.

Research Questions

The following questions were tested in this study:

1. Is there a statistically significant difference in the amount of calcium adolescents consume in a week from cheese compared to that of drinking milk?
2. Is there a difference between adolescent boys and adolescent girls in the amounts of milk consumed on a daily basis?
3. What is the relative percent of adequate servings (4.5) from dairy products contributed by milk to the amounts adolescent boys consume, compared to adolescent girls?

CHAPTER THREE

METHODS

Research Design

This study was a secondary analysis of data collected in late fall of 2003, which examined calcium intake in adolescents from two Texas suburban middle schools. The Healthy Bones for Teens Study was collaboration between Grand Valley State University and Texas Women's University's (TWU) Institute for Women's Health.

For this analysis the dependent variable is calcium measured as the number of servings, estimated as milligrams.

Sample and Setting

A convenience sample of 255 adolescents was used for this study. Data collection took place in two middle schools located in north Texas. Students who had active consents signed by parents were allowed to participate in the study. The sample consisted of a multiethnic group, however, the majority of adolescents reported Caucasian ethnicity. All adolescents in grades 7 and 8 were recruited to be subjects for the study.

Characteristics of the Sample

Table 1 summarizes the number of participants as a whole in each grade level, with boys and girls combined together (N=255). The boys' sample was smaller in number (N=115) than the girls' (N=136). The mean age of the adolescents was 13.0 (SD=0.7). The ages ranged from 12 to 15 years for the group as a whole.

Table 1

Number of Male and Female participants as a Whole in Each Grade

Grade	*Boys & Girls* ($n = 255$)
7th	114
8th	136
9th	1

Note. Five students did not list current grade

Table 2 summarizes ethnicity of the adolescents. The sample of adolescents created a multiethnic group with the majority being of Caucasian decent.

Table 2

Ethnicities of the Adolescents

Ethnicity	*n*
White/Caucasian	161
Mexican American/ other Latino	41
African American/Caribbean African or African origin	16
Native American/American Indian	4
Asian/Pacific Islander	2
More than one ethnicity declared [a]	26

Note. Five students did not list an ethnicity

[a] *Adolescents who listed more than one ethnicity were counted in this category.*

Instruments

This study used the Calcium Inventory (see Appendix A), which was part of a booklet of questionnaires. The booklet contained not only the calcium inventory, but also

social support, social norms, and modeling scales. For this study, only the data collected with the Calcium Inventory is used.

The Calcium Inventory was adapted from a questionnaire originally developed by the United Dairy Industry of Michigan (UDIM). Prior to the development of the current calcium inventory instrument the UDIM had drafted and utilized a questionnaire that asked respondents to report their "usual" numbers or servings of a variety of dairy products. This instrument did not specify the serving sizes for the full range of calcium food sources. Original versions of the calcium inventory were based on the UDIM questionnaire. After pilot testing, and reviews of the literature regarding appropriate serving sizes and nutritional recommendations, researchers at Grand Valley State University drafted the current instrument.

Prior to use in the Texas study, the inventory was pilot-tested with middle and elementary school students in Michigan. The Calcium Inventory is made up of 13 questions asking students how much calcium they ate or drank. The students put a check next to the box that indicates the frequency that most applies to them. The students were asked to indicate how many servings of each food item that they consumed, either per day, per week, or per month and to compare the servings they ate or drank to a commonly standardized object such as game dice or tennis balls. In addition, there were questions asking how often they consumed orange juice, bread, or cereals fortified with calcium and how often they took vitamins or extra calcium supplements. However, for this study, only the questions involving cheese or milk consumption were used.

The Calcium Inventory was tested for reliability. The results of the stability testing revealed the students were not consistent in answering the calcium intake questions.

Students (N=30) between times 1 and 2 were not consistent in answering how much total milk they consumed ($r = 0.991$). In addition, the correlation of total cheese consumption by the students (N=31) between times 1 and 2 was not significant ($r = 0.456$). Likewise, students' total dairy (sum of milk, cheese, yogurt, ice cream, and shakes) consumption (N=36) was not consistent between times 1 and 2 ($r = 0.980$).

Procedure

Initial approval to conduct the Healthy Bones for Teens Study was obtained from the Institutional Review Board (IRB) at Texas Women's University (See Appendix B). The Human Research Review Committee at Grand Valley State University concurred with the IRB approval granted by TWU and approved the study (See Appendix C). In addition, students for the two middle schools were recruited with permission from the superintendent of the intermediate school district and the principals of the participating middle schools. Letters were sent home with students at the participating schools explaining the study and requesting parental permission for the students' participation. Signed consent forms were obtained from parents/guardians (See Appendix D).

For this secondary analysis approval was obtained from the Grand Valley State University Human Research Review Committee (See Appendix F). Permission to use the data from the calcium inventory data was obtained from Martin (See Appendix E).

The questionnaires were administered to 255 students in grades 7 and 8 at two middle schools in north Texas. Three researchers and three graduate students from TWU administered the questionnaires. For school A, the questionnaires were administered in the auditorium during the lunch period to students who had written parental consent. All students who had permission participated. Test administrators introduced themselves and

instructed students to complete the background information page of the instrument. Students were reassured that their answers would be kept private and not be part of any grade. To protect confidentiality, the identity of respondents was known only to the researchers. Students were asked to hand in the questionnaire after 45 minutes. After the administration of the questionnaires, lunch was provided to all participants. The name of each student who participated was also entered into a drawing for a gift certificate to a local sporting goods store. One name was drawn for each grade. Approximately two weeks later, all students who completed questionnaires were invited to complete the questionnaire a second time. The same procedure for administering the questionnaires was followed.

For school B, two research team members went into the science classrooms of grades 7 and 8, and administered the questionnaire using the same procedure as described for school B. The questionnaires were administered to students in school B one time only. Likewise, for participating in the study, each student was provided a free lunch and entered into a drawing for a gift certificate.

CHAPTER FOUR
DATA ANALYSIS

Two hundred and fifty-five adolescents completed the Calcium Intake Inventory. The Statistical Package for Social Sciences (SPSS) was used for analysis of the data. Data analysis was performed to describe demographic characteristics of the adolescents and to answer the research questions. All data were tested using a 95% confidence level, thus a p-value of $<.05$ was considered significant.

The actual number of servings was calculated using the estimated serving size from the adolescents. Any time the adolescents reported never consuming a food or beverage zero was scored. All the servings were converted to a specific frequency (daily/ weekly) by dividing the reported number by 30 (from month, to day) or 7 (from week, to day). The number of milk servings was a combination of the amounts they would drink and the amounts consumed on cereal. Total servings for cheese included cheese slices, shredded cheese, cheese cubes, string cheese, and pizza with cheese. Total dairy was the sum of total milk servings, total cheese servings plus servings from yogurt, shakes and ice cream. Finally, total dairy was divided by adequate servings (4.5) and multiplied by 100 to find the relative percent.

Research Question One

The first research question asked, "Is there a statistically significant difference in the amount of calcium adolescents consume in a week from cheese compared to that of drinking milk?" To answer this, the sample as a whole was first tested using a paired t-

test, then tested by gender using an independent t-test. On average, the adolescents consumed 8.32 (SD = 9.68) servings of cheese per week and 23.33 (SD = 23.29) servings of milk. The results of the t-test showed that there was a significant difference between the amounts of calcium the adolescents consumed from cheese compared to milk (t = -8.502, p = .000).

In analyzing the data by gender, no significant difference was found between boys and girls in their weekly consumption of either cheese or milk. Table 3, below, summarizes the results.

Table 3

Tests of Differences Between Adolescent Boys' and Girls' Weekly Consumption of Cheese and Milk

Dairy Servings	*t*	*p*	*Boys (SD)*	*Girls (SD)*
Cheese, per week[a]	0.698	0.486	8.73 (10.13)	7.78 (9.13)
Milk, per week[b]	1.825	0.070	26.27 (25.60)	20.20 (20.47)

[a] *boys n = 84, girls n = 121*
[b] *boys n = 83, girls n = 109*

Research Question Two

The second question of this study asked, "Is there a difference between adolescent boys and adolescent girls in the amounts of milk consumed on a daily basis?" The mean number of milk servings for boys was 3.75 (SD=3.66) and 2.89 (SD=2.92) for girls. Table 4 summarizes daily milk intakes for both boys and girls.

The results of an independent t-test showed there was not a significant difference between boys and girls in the amount of milk they consume on a daily basis ($t = 1.825$, $p = 0.070$).

Table 4

Servings of Daily Milk Intake for Adolescent Boys and Girls

Milk Servings	*Boys* ($n = 83$)	*Girls* ($n = 109$)
Minimum milk intake	.071	.071
Maximum milk intake	18.00	16.50
Median	3.00	1.71
Mean (SD)	3.75 (3.66)	2.89 (2.92)

Research Question Three

The third question of this study asked, "What is the relative percent of total calcium adequate intake servings (4.5 per day) contributed by milk for both adolescent boys compared to adolescent girls?" The average relative percent of total calcium intake contributed by milk for adolescent boys (N = 83) was 62.86% (SD = 24.96) and for girls (N = 109) was 56.70% (SD = 26.67). Table 5 illustrates the conversion of the relative percent of calcium into servings and milligrams.

Table 5

Overall Number of Milligrams and Servings of Calcium Contributed by Milk

Adolescents (n=194)	*Daily Servings*	*Milligrams Daily, Contributed by Milk*
Milk	3.28	947.6

The results of an independent t-test showed there was no significant difference between boys' and girls' relative percentages of total calcium contributed by milk (t =-1.630, p = 0.105).

Findings of Interest

In examining the descriptive statistics for milk intake by gender it was noted that the medians were lower than the means for each group, indicating a skewed distribution. To further explore this finding, the numbers of students taking in an amount less than adequate intake (0-3 Servings), approximately equal to the AI (3-5 Servings), and greatly over the AI (> 5 Servings), were determined. Table 6 illustrates those serving distributions.

Table 6

Servings of Daily Milk Intake for Adolescent Boys and Girls

Milk Servings	*Boys* (n =83)	*Girls* (n = 109)
0-3 servings	50	73
3-5 servings	14	18
5 + servings	19	18
Median	*3.00*	*1.71*
Mean	*3.75*	*2.89*

Pearson's chi square was run to determine if the number of boys with milk intakes categorized in the 3 serving categories was significantly different from number of girls in each serving category. The results showed the number of boys and girls in the categories did not differ.

When examining the maximum number of servings that students reported (18.00 servings by boys, 16.5 by girls) it is to be noted that these amounts would be approximately equal to a gallon of milk. This raises doubt about the accuracy of these reports and any that are greater than 12 servings per day.

CHAPTER FIVE

DISCUSSION AND IMPLICATIONS

Discussion

The purpose of this study was to examine the consumption of dairy products by suburban adolescents. Past research literature shows that adolescent boys and girls are not meeting their adequate intake of calcium. It also indicates calcium is important in the prevention of osteoporosis. Therefore, a dietary calcium recall provides vital information regarding the dietary habits of adolescents on a daily basis.

Findings

The first research question was asked to determine if adolescents consumed differing amounts of calcium from cheese and milk on a weekly basis. Based on literature, it was expected that adolescents' calcium intake would vary between their consumption of cheese and milk. T-test results verified that assumption. Subsequently, the results were further tested by gender to see if their calcium intake of milk and cheese differed. It was found that there was no difference between girls and boys in their weekly consumption of cheese or milk. This means that both sexes were comparable in the amount of calcium they obtained from cheese compared to milk.

The findings of this study were inconsistent with most studies regarding dairy consumption. Recent studies state that cheese consumption is rising while adolescents are replacing milk with sodas and fruit juices (Bowman, 2002; Gerrior, Putnam, & Bente, 1998; International Dairy Foods Association, 2001; McBean, 2004). According to

Bowman (2002) milk consumption has decreased by 36% since 1970. Cheese consumption has more than doubled since 1970. More than one third of all milk produced in the United States is used to make cheese (Gerrier, Putnam, & Bente, 1998).

The adolescents consumed on average 8.32 servings of cheese per week and 23.33 servings of milk. This means that the adolescents only consumed about 1 serving of cheese per day to 3+ of milk per day. However, research suggests that adolescents like and prefer cheese. A study by Auld, Boushey, Bock, and Bruhn (2003) surveyed adolescent girls regarding their consumption of milk products and they found that pizza, ice cream and cheese were their favorite choices.

The second research question explored whether there was a difference between adolescent boys and girls in their daily milk consumption. This question was asked because research has emphasized the low dairy intake of adolescent girls and ignored the fact that adolescent boys are also not meeting their daily dairy requirements (Batson & Finch, 2002; NDC, 2003). The majority of studies demonstrate that adolescent males do have a higher dairy intake than females; however, when body size is taken into consideration their intakes may be very similar. The results of this study showed that there was not a significant difference in the amounts of milk adolescent boys and girls consumed on a daily basis. This means that both adolescent boys and adolescent girls are not consuming their recommended daily servings of milk.

The findings of interest in this study are consistent with those of the National Dairy Association (2001). Adolescent boys had higher milk consumption. On average boys consumed 3.75 servings of milk per day while girls consumed 2.89 servings. These findings raise some questions. Adolescent boys consumed approximately one more

serving of milk per day compared to adolescent girls, yet if compared to total caloric intake would the ratio be similar for both genders? In addition, has enough focus been put on adolescent boys and their dietary habits?

The third research question looked at what percentage of the adolescents' total recommended servings of calcium was contributed by milk intake. Adolescent boys and girls were compared. This question was asked to see whether adolescents are getting the majority of their calcium from milk. According to the American Academy of Pediatrics, milk is the main source of calcium intake in the typical American diet (Hampton, 2004). Similarly, Abertson, Tobelmann, and Marquart (1997) found that milk contributed more than half of the total calcium intake for adolescent girls. However, milk consumption has decreased as the eating patterns of adolescents have changed. Soft drinks, sports drinks and fruit juice have replaced milk in the typical adolescent American diet (Bowman, 2002).

This study revealed that there was no significant difference between boys' and girls' relative percentages of total calcium contributed by milk. In addition, milk contributed only 62.86% of adolescent boys' calcium servings and only 56.70% of girls'. Therefore, adolescents are getting just over half their total adequate calcium intake from milk or other milk products. Such findings are very distressful. However they are consistent with those of McBean (2000) and the NDC who state milk consumption has decreased as other beverages have replaced milk.

Relationship of Findings to Theoretical Framework

The HPM provides a framework to assess why adolescents are not consuming an adequate amount of dairy. Prior research using the model as guide to promote health

behavior changes in adolescents is limited, making it difficult to relate possible findings to other studies that may have used the HPM with adolescents.

The model proposed four reasons as to how adolescents' dietary habits are negatively influenced by parents, peers, prior behaviors, external environments, and the adolescent them self. However, additional research would be required in order to determine which reasons deter adolescents the most from consuming adequate calcium in their diet.

Following Pender's model, a change in the adolescent's prior related behavior, personal factors and interpersonal influences would be expected to guide the adolescent towards healthier eating habits. But without some sort of educational intervention, by parents, health professionals or the dairy industry, adolescents will not be apt to change their calcium intake in an attempt to prevent osteoporosis.

Limitations

This study had several limitations. One limitation of this study was that it is a secondary analysis. Since this was a secondary analysis, the investigator did not have the ability to collect the exact data that might have been desired for analysis (Polit & Hungler, 1999). In this study there was not an opportunity to be more specific regarding serving sizes and possibly other dietary practices that may inhibit dairy intake.

The calcium inventory is a new instrument and a major limitation of this study. Correlations between times 1 and times 2 were found to be insignificant, indicating that the students were unable to answer consistently. There are a number of possible reasons why the instrument demonstrated poor stability with the retesting. The calcium inventory was in the last section of the questionnaire; students may have become tired and carelessly

filled in that section. Also, at time one researcher A administered the test with the assistance of researcher B. Researcher B and a graduate student administered time 2. The differences in administrators may have influenced the consistency of responses on the survey. In addition, the retest took place near Thanksgiving, which may have been distracting to the students' concentration. Finally, because the adolescents had already filled out the questionnaire once, they may have discounted the importance of answering the questionnaires accurately a second time.

Another limitation to this study is that the serving sizes were approximated. The dietary recall asked adolescents to estimate their serving size compared to a common object. Therefore, the serving sizes used in the study were only rough estimates. Furthermore, milligrams were estimated from the serving sizes.

The main threat to the external validity in this study is the experimenter effects. The performance of the adolescents may have been affected by the characteristics of the researchers (Polit & Hungler, 1999). The researchers may have mistakably shared their expectations with the adolescents during the study or left an impression leading students believe it was desired to have high scores on the calcium inventory. Again, changes in the research team at time 2 would have been likely to augment these possibilities.

A final limitation to the study is the convenience sample of adolescents. First, the sample size of boys (N=115) and girls (N=136) was small. Second, the majority of students were Caucasian, and this limits generalizability of the findings to all groups of adolescents. Third, the sample included adolescents attending one of two schools that were willing to have the study conducted and it may not be assumed that the subjects were at all interested in sharing their dietary habits. Even though the adolescents were not

required to participate, they may have felt uncomfortable declining. This may have had an effect on the effort then put into filling out the calcium inventory.

Implications and Recommendations

This study reveals that adolescents are calcium deficient and lack adequate dairy in their daily diets. One implication of this study is that not just adolescent girls, but boys as well, do not drink enough milk, rendering them susceptible to developing osteoporosis later in life. Further research needs to look for ways to increase milk intake in adolescents. School meal programs must include adequate amounts of dairy. Both parents and health professionals should encourage eating breakfast, and calcium rich snacks. Unique high calcium snacks are needed because adolescents often eat on the run. Their diets often consist of snack foods.

Implications regarding nursing practice include making adolescents aware of the health risks of a low dairy diet, educating adolescents on healthy dietary habits, and enlightening adolescents and their parents that osteoporosis is prevented during adolescence, not later in life. But educating adolescents is not an easy task. Most dietary habits are already ingrained during childhood prior to adolescence. Therefore, research in the future should focus on investigating what factors are most influential in adolescents' dietary habits, and what factors motivate adolescents to change negative health behaviors.

The dairy industry and healthcare professionals need to work together to change the negative stimuli surrounding milk and weight gain. Many adolescents believe milk is fattening. Therefore, they stop drinking milk and turn to diet soft drinks. However, research indicates that dairy foods can be consumed without increasing calorie or fat

intake, body weight, or percent body fat (Miller, Jarvis, & McBean, 2001). This research must be presented to the public to educate them, but also methods for adding milk to adolescents' diets with the least amount of calories must be investigated.

The calcium inventory was unable to accurately determine a true calcium intake for the adolescents. The inventory in a test-retest demonstrated poor stability. Therefore, in future studies the inventory should be revamped. It should accommodate current trends in dairy serving sizes. For example, milk often comes in plastic 8-10 oz cartons now, instead of cardboard box cartons. Therefore, it is impracticable to ask an adolescent to compare that to a 12 oz can of pop. Those sizes appear the same, but are not. In addition it would be sensible to display examples of the serving sizes during the inventory testing so adolescents can make visual comparisons.

Summary

In conclusion, the main purpose of this study was to examine the consumption of dairy products by suburban adolescents. The study focused on trying to find what types of dairy adolescents are consuming. The findings indicate that adolescent boys and girls are not meeting their adequate intake for calcium. One major reason is that they are not drinking enough milk. However, not all adolescents need to increase their dairy intake, but the majority of adolescents' diets severely lack recommended calcium intakes. Further studies need to be done to discover the major reasons why adolescents choose to not consume dairy. Also, better methods of obtaining accurate dietary information from adolescents must be developed. Pender's HPM model should be used to provide a solid foundation where future research can be started.

APPENDIX

APPENDIX A

How Much Calcium Do You Eat and Drink?

Please answer the following questions to see how much calcium you eat and drink.

Milk to drink: All flavors And fat levels	How often do you drink milk? ☐ Every day ☐ Every Week ☐ Never	How many servings do you drink? _____per ***day*** ***or week*** (circle one)	Compare your servings to a pop can. Are your servings: ☐ Much smaller ☐ The same amount ☐ Much larger

Milk on cereal: All flavors And fat levels	How often do you have milk on cereal? ☐ Every day ☐ Every week ☐ Never	How many servings of milk and cereal do you have? _____per ***day*** ***or week*** (circle one)	Compare how much milk you put on cereal to the amount of milk in a milk carton in a school lunch. Is it: ☐ Much smaller ☐ The same amount ☐ Much larger
Yogurt: All flavors And fat levels EXCEPT frozen Yogurt	How often do you eat yogurt? ☐ Every day ☐ Every week ☐ Every month ☐ Never	How many servings do you eat? _____per ***week*** ***or month*** (circle one)	Compare your servings to a pop can. Are your servings: ☐ Much smaller ☐ The same amount ☐ Much larger
Shredded Cheese	How often do you eat shredded cheese? ☐ Every week ☐ Every month ☐ Never	How many servings do you eat? _____per ***week*** ***or month*** (circle one)	Compare your servings to the size of a ping pong ball. Are your servings: ☐ Much smaller ☐ The same amount ☐ Much larger
Cheese slices	How often do you eat sliced cheese? ☐ Every day ☐ Every week ☐ Every month ☐ Never	How many servings do you eat? _____per ***day*** or ***week*** ***or month*** (circle one)	Compare your servings to a floppy disc. Are your servings: ☐ Much smaller ☐ The same amount ☐ Twice as large
Cheese cubes or chunks	How often do you eat cheese in cubes or chunks? ☐ Every Day ☐ Every week ☐ Every month ☐ Never	How many cheese chunks or cubes do you have? _____per ***day*** or ***week*** or ***month*** (circle one)	Compare how much cheese you eat as cubes or chunks to four regular sized dice. Are your servings: ☐ Much smaller ☐ The same amount ☐ Much larger

String Cheese All types	How often do you eat string cheese? ☐ Every Day ☐ Every week ☐ Every month ☐ Never	How many whole strings do you eat: _____per ***day*** or ***week*** or ***month*** (circle one)	Compare your string to a thick magic marker. Is yours: ☐ Much smaller ☐ The same size ☐ Much larger
Ice Cream or Frozen Yogurt	How often do you eat ice cream or frozen yogurt? ☐ Every week ☐ Every month ☐ Never	How many servings do you eat : _____per ***week*** ***or month*** (circle one)	Compare your servings to a tennis ball. Are your servings: ☐ Much smaller ☐ The same amount ☐ Much larger
Tofu	How often do you eat Tofu? ☐ Every week ☐ Every month ☐ Never	How many servings do you eat? _____per ***week*** ***or month*** (circle one)	Compare your servings to a ping pong ball. Are your servings: ☐ Much smaller ☐ The same amount ☐ Much larger
Dark green vegetables such as Broccoli and Swiss Chard	How often do you have dark green vegetables? ☐ Every day ☐ Every week ☐ Never	How many servings of dark green vegetables do you have: _____per ***day*** ***or week*** (circle one)	Compare your servings to a tennis ball. Are your servings: ☐ Much smaller ☐ The same amount ☐ Much larger
Salmon Sardines, smelt and other fish with bones	How often do you eat fish with bones? ☐ Every week ☐ Every month ☐ Never	How many servings of fish do you eat: _____per ***week*** or **month** (circle one)	Compare your servings to a deck of cards. Are your servings: ☐ Much smaller ☐ The same amount ☐ Much larger
Pizza With cheese	How often do you eat pizza with cheese? ☐ Every week ☐ Every month ☐ Never	How many servings do you eat: _____per ***week*** ***or month*** (circle one)	Compare your serving to the size of a frisbee. Are your servings as big as: ☐ One fourth of a frisbee ☐ Half a frisbee ☐ A whole frisbee
Milk Shakes	How often do you drink milk shakes? ☐ Every week ☐ Every month ☐ Never	How many servings do you drink: _____per ***week*** ***or month*** (circle one)	Compare your serving to a pop can. Are yours: ☐ Much smaller ☐ The same amount ☐ Much larger

When you eat or drink any of these foods or drinks do they have calcium added to them?
If they do, put a **check** (√) or **X** next to the food or drink. Then **circle** how often you have that food or drink.

Calciuminvent.doc

_____ Orange Juice.....Every day.....Every week.....Every month

_____ Bread.....Every day.....Every week.....Every month

_____ Cereals..... Every day.....Every week.....Every month

Do you take any vitamins, tablets, or powders for extra calcium?____ yes _____no

If yes, how many tablets? _____ **or** How much powder? _____

How much calcium is in one vitamin, tablet or the amount of powder you take?_____ (mgs.)

Do you take TUMS? ____ yes _____no. If you take TUMS, how many in a **week** or **month**? _____
(circle one)

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APPENDIX B

TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Institutional Review Board
Office of Research and Sponsored Programs
P.O. Box 425619, Denton, TX 76204-5619
940-898-3378 Fax 940-898-3416
e-mail: IRB@twu.edu

August 26, 2003

Dr. David Nichols
Department of Kinesiology

Dear Dr. Nichols:

Re: Follow-up Assessment of Bone Density and Anthropometric Variables in Middle School and High School Boys and Girls

The above referenced study has been reviewed by the TWU Institutional Review Board (IRB) and appears to meet our requirements for the protection of individuals' rights.

If applicable, agency approval letters must be submitted to the IRB upon receipt PRIOR to any data collection at that agency. A copy of the approved consent form with the IRB approval stamp and a copy of the annual/final report are enclosed. Please use the consent form with the most recent approval date stamp when obtaining consent from your participants. The signed consent forms and final report must be filed with the Institutional Review Board at the completion of the study.

This approval is valid one year from August 01, 2003. According to regulations from the Department of Health and Human Services, another review by the IRB is required if your project changes in any way. If you have any questions, feel free to call the TWU Institutional Review Board.

Sincerely,

[redacted]

Dr. Linda Rubin, Chair
Institutional Review Board - Denton

enc.

cc. Dr. Charlotte Sanborn, Department of Kinesiology

APPENDIX C

From: Paul Huizenga
To: Martin, Jean
Date: 10/22/2003 3:24:58 PM
Subject: Collaborative Research Project Approval

Jean,
I have received the consent forms which you sent via fax.
I concurr with the IRB approval from TWU.
Consider this e-mail as approval from me for this collaborative project entitled: "Follow-up Assessment of Bone Density and Anthropometric Variables in Middle School and High School Boys and Girls."
This approval is in effect for one year from October 22,203.Please notify me if there are any changes in your project.

Sincerely,
Paul A. Huizenga, Chair, GVSU Human Research Review Committee

APPENDIX D

TWU
TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Department of Kinesiology
College of Health Sciences
P.O. Box 425647, Denton, TX 76204-5647
940-898-2575 Fax 940-898-2581

Dear Parent,

As researchers at Texas Woman's University (TWU), we have been involved in the fight to prevent osteoporosis (brittle bone disease) for many years. We are continuing our efforts, but we need your help. Although osteoporosis primarily affects adults, calcium intake and exercise during childhood and adolescents are keys to prevention of this disease.

We are asking your permission for your child to participate in this project. For the present study, your child will complete questionnaires that ask about knowledge and behavior to promote bone health. These questionnaires will be filled out during the school day with the cooperation of the teachers.

The attached consent form describes the study and any potential risks involved. Participation is strictly voluntary. If you and your child agree to participate, please sign the enclosed consent form and have your child return it to his/her teacher. A copy of the signed consent form will be sent home with your child. For participation in the study, your child will be entered into a drawing with a chance to win a $70.00 gift certificate to Oshman's. **Please return signed consent by Friday November 14, 2003.**

If you have any questions or concerns, please call either David Nichols or Charlotte (Barney) Sanborn at 898-2575. Thank you very much for your time and effort in this valuable research project.

Sincerely yours,

[redacted]

David L. Nichols, Ph.D.

[redacted]

Charlotte (Barney) Sanborn, Ph.D.

Simply the **BEST**

TEXAS WOMAN'S UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

Follow-up assessment of bone density and anthropometric variables in middle school and high school boys and girls

INVESTIGATORS:	CONTACT INFORMATION
1. David L. Nichols, Ph.D.	(940) 898-2522; email: dnichols@twu.edu
2. Charlotte (Barney) Sanborn, Ph.D.	(940) 898-2575; email: csanborn@twu.edu
3. Jean Martin, DNSc, RN-C, PNP	(940) 898-2792; email: martinj@gvsu.edu

Your child is being asked to participate in a research study as a follow-up to the previous Healthy Bones study conducted at Texas Woman's University. Although your child may not have taken part in that study, we want to establish the long-term effectiveness of that study by determining the knowledge of your child concerning the need for healthy bones. For the present study, your child will be asked to fill out questionnaires that ask about knowledge and behavior to promote bone health. These questionnaires will be filled out during the school day with the cooperation of the teachers. The Denton Independent School District and your child's teacher have approved this study.

Your child will be asked to answer questions specifically related to the role of calcium and exercise in building strong bones and preventing osteoporosis (brittle bone disease). Example questions include: My chances of getting osteoporosis are high; I am more likely than the average person to get osteoporosis; not eating or drinking milk products each day makes it more likely I will get osteoporosis. Possible answer choices then include: not at all true, not very true, in-between, sort of true, very true. It will take approximately 30 to 40 minutes for your child to complete the questionnaires.

This consent form describes the risk associated with your child filling out these questionnaires. Please feel free to ask any questions that you have at any time.

POSSIBLE RISKS

Loss of confidentiality – No names or other identifying information will be used. Data will be stored either in locked filing cabinets in the principal investigator's office or in password protected computer files. All data recorded on paper will be kept in a locked file for 10 years at which time it will be shredded. Computer data will be kept indefinitely, but no identifying information will be stored with the data. No names will ever be used in publications or presentations that may be associated with this study. Confidentiality will be protected to the extent allowed by law.

Embarassment – There may be some embarassment associated with answering certain questions. Your child is free to skip any question or procedure that would cause any embarassment and they are also free to stop the procedures entirely at any time.

Loss of Class Time - The questionnaires will be administered at school but will be done so only with the cooperation and consent of the classroom teacher so that no academic material will be missed by the participants

Parent/guardian initials

The researchers will try to prevent any problem that could happen because of this research. You should let the researchers know at once if there is a problem and they will help you. However, TWU does not provide medical services or financial assistance for injuries that might happen because of your participation in this research.

PARTICIPATION AND BENEFITS:
Your participation in this study is voluntary. You and your child may decide not to participate or discontinue participation at any time. There will be no cost to you, and following the completion of the study, you can receive a summary of the results of the study if you desire. In addition, your child will have a chance to win a $70.00 gift certificate to Oshman's.

QUESTIONS REGARDING THE STUDY
You are free to ask questions at any time. If you have any questions about the study, you may ask the researchers. Their phone numbers are at the beginning of this form. If you have questions about your rights as a subject or about how this research study has been conducted, you may call the Texas Woman's University Office of Research & Sponsored Programs at 940-898-3377 or via email at IRB@twu.edu. You will be given a copy of the consent form to keep.

Date	Signature of Child
Date	Signature of Parent/Guardian

If you would like to receive a summary of the results of the study, please provide your address here:

_____

_____

_____

Approved by the
Texas Woman's University
Institutional Review Board
Approved: Aug. 1, 2003
Revised: Nov. 11, 2003

APPENDIX E

GRAND VALLEY
STATE UNIVERSITY
www.gvsu.edu

July 06, 2004

Simie Bredeweg-DeJager
2010 Greenly St
Grandville, MI 49418

Dear Simie Bredeweg-DeJager,

This letter acknowledges that fact that you and I discussed and agreed that you may use data from the Calcium Inventory for your thesis. This data was collected at middle schools in north Texas during fall 2003 as part of the Healthy Bones for Teens Study.

Sincerely,

[redacted]

Dr. Jean Martin
Director of MSN program
Grand Valley State University

Kirkhof School of Nursing • Cook-DeVos Center for Health Sciences
301 Michigan St. NE • Grand Rapids, MI 49503 • Phone: (616) 331-3538 • Fax: (616) 331-2510

APPENDIX F

GRAND VALLEY
STATE UNIVERSITY
www.gvsu.edu

August 3, 2004

Simie Bredeweg-DeJager
2010 Greenly St.
Grandville, MI 49418

RE: Proposal #05-07-H

Dear Simie:

Your proposed project entitled **The Role of Dairy Products in the Calcium Intake of Suburban Adolescents** has been reviewed. It has been approved as exempt from the regulations by section 46.101 of the Federal Register 46(16):8336, January 26, 1981.

Sincerely,

[redacted]

Paul Huizenga, Chair
Human Research Review Committee

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