INFLUENCE OF SUGAR SWEETENED MILK AND UNSWEETENED MILK ON FOOD GROUP CONSUMPTION

by

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ABSTRACT

Diets of children and adolescents do not meet current national dietary recommendations for food groups. Yet these diets include higher than recommended consumption of added sugars. Food group servings decrease as low-nutrient, energy-dense sugar-sweetened beverages increase. The purpose of this study was to examine whether the consumption of meats, grains, vegetables, and fruits are influenced by consumption of sugar-sweetened milk. Consumption was evaluated in kindergarten, third, and sixth grade students.

Results indicate that consumption of sugar-sweetened milk decreased fruit consumption in all grades, with a significant decrease in sixth grade. All grades had mixed results with meat and vegetable consumption. Grain consumption increased in all grades with sugar-sweetened milk. Further research using sweetened milk with larger groups is needed to document trends in eating patterns that may indicate nutrient dilution through decreased food group consumption.

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CHAPTER ONE: INTRODUCTION

Rationale

Children in the United States (US) follow eating patterns that do not meet national dietary recommendations for food group servings of vegetables, fruits, whole grains, and milk; whereas consumption of added-sugars, primarily from sugar-sweetened beverages exceed current recommendations (1-10). Data from the 2001-2004 National Health and Nutrition Examination Survey (NHANES) indicate that of children 4 to13 years of age, 92% to 96% consume less than the recommended total servings of vegetables. More than 99% consumed less than recommended amounts of dark-green vegetables; 69% to 79% consumed less than recommend whole fruit; and more than 99 % fail to consume the minimum recommended amounts of whole grains. Forty-two percent of children ages 4 to 8 years, more than 67% of boys 9 to 13, and over 83% girls 9 to 13 do not consume recommended amounts of milk (11). This presents a substantial public health concern, as food groups contain nutrients known to be targets of concern in children – calcium, vitamin E, folate, iron, magnesium, potassium, and fiber (2,6,12), and food habits and patterns of nutrient intake acquired in childhood track into adolescence and adulthood (2, 6, 12-14). Without necessary nutrients, children are at risk for growth retardation, iron-deficiency anemia, poor academic performance, development of psychosocial difficulties, and an increased likelihood of developing chronic diseases such as heart disease, diabetes, and osteoporosis during adulthood (15).

High intakes of added sugars and their link to obesity and cardiovascular disease have heightened concern about the adverse effects of excessive consumption of sugars (7). Sugar-sweetened beverages are the primary source of added sugars in Americans' diets (9, 16, 17). Excessive intakes of added sugars are associated with the displacement of food groups and micronutrients in children's diets and have been linked to health concerns, including overweight and obesity, type 2 diabetes or prediabetes, inflammation, and cardiovascular disease (13, 18-22). The form in which added sugars are consumed appears to be an important modifier of the impact of nutrient dilution (7). Beverages that are major contributors of the naturally occurring sugars, such as lactose in milk and fructose in fruit juice have been positively associated with nutrient adequacy (20, 23). The Dietary Guidelines for Americans 2010 (DGA'10), the Academy of Nutrition and Dietetics (AND), American Heart Association (AHA), and the American Academy of Pediatrics (AAP) all recommend moderating intakes of total added sugars (2, 7, 18, 24).

Over the past 40 years, milk consumption has decreased as sweetened beverage consumption has increased (17). Fluid milk and milk products are the most bioavailable sources of calcium and the major sources of calcium in typical American diets (12). Most people's eating patterns can accommodate only a limited number of calories from added sugars. The DGA'10 suggests these calories are best used to increase the palatability of nutrient-dense foods such as fat-free chocolate milk (2).

Children's eating behaviors are strongly influenced by the foods available in their immediate environments (8). Two key settings that impact children's diets are home and school (8). Briefel and colleagues' analyses of data from the Third School Nutrition Dietary Assessment (SNDA-III) study found that overall, 68% of all school children consumed sugar-sweetened beverages at some location during the day, one-half consumed them at home and one fourth at school (25). The United States Department of Agriculture (USDA) regulates the nutrient content of meals provided by the National School Lunch Program (NSLP), which has a profound impact on children's daily nutrition needs (8). Results of SNDA-III show that many schools have improved the nutritional quality of the NSLP school meals. However, there is much more room for improvement. Although the majority of US schools offer NSLP lunches that meet the standards for key nutrients, children are not consuming enough fruits, vegetables, and whole grains (8). Many public schools are constrained in providing better meals because of limited funds (8).

The Healthy, Hunger-Free Kids Act of 2010 improves nutrition in schools by authorizing the USDA to set nutritional standards, based on the Dietary Guidelines for Americans. Additionally, this legislation provides additional funding to schools to meet updated nutritional standards for the NSLP. When fully implemented, the law will provide program monitoring to ensure that schools adhere to nutritional standards (26).

Extensive studies have shown sugar-sweetened beverages decrease nutritional quality and that sugar-sweetened milk increases nutritional status by increasing the shortfall nutrients that are available from milk. Research lacks investigation of the relationship between consumption of sugar-sweetened milk and consumption of the other food groups – meat, grain, vegetables, and fruit. Determining eating behaviors associated with consuming SSM could lead to improved nutrition education and health promotion messages for children and their parents, as well as identify areas for school wellness policies to target.

Statement of the Problem

The objective of this study was to determine if the consumption of meats, grains, vegetables, and fruits decreased when sugar-sweetened milk (SSM) was consumed, compared to unsweetened milk (USM), in kindergarten (K), third (3^{rd}), and sixth (6^{th}) grade students, (a) within each class and (b) between grades.

Statement of the Research Questions

1. Are there significant decreases in food group consumption within grades K, 3^{rd}, and 6^{th} when SSM versus USM is selected with meals?
2. Are there significant decreases in food group consumption between grades when SSM versus USM is selected with meals?

Assumptions

1. This study assumes that children in K, 3^{rd}, and 6^{th} grades are of average grade-related ages, 5, 8, and 11, respectively.

2. This study assumes students did not exchange tray identification tags during meals.

Definitions

Added sugars: "Also known as caloric sweeteners, are sugars and syrups that are added to foods at the table or during processing or preparation, which supply calories but few or no nutrients" (2).

Sugar sweetened beverages: "Includes sodas, energy drinks, sports drinks, sweetened bottled water including vitamin water" (2).

Sodas: Includes carbonated beverages, energy drinks, sports drinks, and sweetened bottled water including vitamin water (4).

Fruit drinks: Includes fruit-flavored drinks, fruit juice drinks, and fruit punch with less than a certain amount of real juice—mainly composed of sugar and water (2).

Shortfall nutrient: A high prevalence of inadequate dietary intake of a nutrient constitutes a *shortfall* nutrient (12).

Nutrient dense: Indicates the nutrients and other beneficial substances in a food have not been "diluted" by the addition of calories from added sugars or fats (2).

Empty calorie allowance: "The balance of calories remaining in a person's energy allowance after accounting for the number of calories needed to meet recommended nutrient intakes through healthful foods" (2).

CHAPTER TWO: REVIEW OF LITERATURE

Introduction

"Consumption of added sugars has increased dramatically in the United States" (27). The AHA 's 2009 scientific statement proposed the upper limit for added sugar consumption as half of the extra calorie allowance within appropriate energy intakes, based on the USDA food patterns (7). Yet, greater than 90% of American children aged 2 to 8 years are getting more than half of their extra calorie allowance from added sugars (11). "The top 5% of American teenage boys aged 14 to 18 years consume >1000 calories from added sugars daily" (11). Children's consumption of added-sugars replaces nutrient-dense foods, increases shortfalls in essential nutrients, and makes it difficult to achieve intake of food groups and nutrients as recommended in the 2010 Dietary Guidelines for Americans (DGA'10), and Healthy People 2020 (19). Survey data from the National Health and Nutrition Examination Survey (NHANES) 2005-2006, show consumption of sugar-sweetened beverages alone, among both males and females 9-13 years old, effectively "use up" or exceed their extra calorie allowance (9, 28).

The Institute of Medicine (IOM), in its 2002 report, included a Dietary Reference Intake (DRI) of 25 % or less of total calories from added sugar (20). This cut-point was "based on dietary intake survey data showing that people with diets at or above this level of added sugars were more likely to have poorer intakes of important essential nutrients" (20). The DGA'10 suggests consumption

of extra calories from solid fat and added sugar range from 8% to 10% of total energy for ages 4 to 11 (2). The AHA, in the 2009 Scientific Statement, recommended an upper limit of all added sugar intake at half of the extra calories allowed, as determined by the USDA food intake patterns (7). It is the position of the Academy of Nutrition and Dietetics that children can safely enjoy added sugars when consumed in a diet that is guided by current federal nutrition recommendations and individual health goals (18).

Added Sugars

Sugar sweetened beverages (SSBs) represented the top sources of calories from added sugars among nearly all age and demographic groups (28). "Among all racial/ethnic and income groups, sugar-sweetened beverages contributed almost half (45-50%) of the daily energy intake from added sugars" (1). Studies showed a decreased intake of at least one micronutrient with higher levels of added sugar intake (22, 29). Similarly, children who consumed more added sugars had lower intakes of fruits and vegetables, dairy, vitamin A, calcium, and folate. (22, 29). Shortfall nutrients in children are an indicator of low intakes of food groups (19).

Fungwe, Guenther, et.al. examined the diets of children, ages 2 to 5, 6 to 11, and 12 to 17 years, by analyzing their Healthy Eating Index (HEI)-2005 component and total scores, as estimated from the National Health and Nutrition Examination Survey (NANES), 2003-04. They determined that all children's total scores ranged from 54.7 to 59.6 out of a possible 100 points and "needed

improvement." Particularly, "children need to increase the consumption of whole fruit, whole grains, and dark green and orange vegetables and legumes" (30); however, scores for extra calories from added sugars suggested intake levels should be reduced (30). Comparably, this score represents a significant decrease from the two HEI assessments in 1989 and 1998 with children ages 2 to 9, which had an approximate total scores of 70 points for all ages in both years (31).

Kranz and colleagues investigated varying levels of added sugars, from < 10 % to > 25 % of total energy, on food group consumption, using data from the Continuing Survey of Food Intakes by Individuals (CSFII) (29). The change in food group consumption was small, but statistically significant. Children with the lowest added sugar level consumed approximately one serving more of grains, fruits, and dairy compared with children in the highest added sugar intake group (29).

In summary, investigations have examined total added sugar intake related to beverage consumption, food group intake, and sociodemographic characteristics. There is a need for research to determine the effect that consuming milk with added sugar has on food group intake during meals.

Milk

Milk contributes about 60% of the calcium needs for children age 2-5 and 54% for age 6-11(32). Calcium is a shortfall nutrient for boys and girls, age 4 to 18 years (33). Children's consumption of beverages has changed dramatically during the past several decades (34, 35). Milk intake has decreased and intake of

carbonated or fruit-flavored drinks has increased with increasing age (35, 36). Previous studies have shown that milk is the beverage of choice among young children, but with increasing age milk intake decreases and intake of other beverages, especially sodas, increases (35). Children's beverage consumption has become an important focus of investigation because of its potential to contribute positively or negatively to adequate nutrient intake (23, 36).

Numerous studies show that consumption of plain and sugar-sweetened milk is positively associated with nutrient intake and increases the likelihood of children meeting the Estimated Average Requirement for shortfall nutrients (37). Johnson and colleagues found that children who consumed flavored milk were more likely to drink more milk overall and meet their calcium needs, than those who did not consume flavored milk (38). Similarly, Murphy and colleagues examined the milk drinking status of children, 2 to 18 years old, and found children and adolescents who drank flavored milk, either exclusively or in combination with plain milk, had higher intakes of vitamin A, calcium, phosphorus, magnesium, and potassium, and had body mass indexes that were lower or comparable to those of non-milk drinkers (37).

Clark and Fox assessed the relationship between children's participation in the NSLP and the nutritional quality of their diets using data from the SNDA-III. They reported that elementary-aged NSLP participants had overall mean intakes of calcium that were significantly higher, 112% of the Adequate Intake (AI),

indicating the prevalence of calcium inadequacy was likely to be low in this age group (39).

In summary, sugar-sweetened (flavored) milk provides nine essential nutrients, yet it does not have the nutrient density of plain milk and children's preference for sweetness underlies high consumption (18). Studies show that children who include flavored milk have better-quality diets than non-milk drinkers (23, 37). However, in these studies diet quality is assessed with intake of the nutrients present in milk. Data suggest that school-aged children's access to sugar-sweetened milk in school may help to promote milk consumption and improve the quality of children's and adolescents' diets (37). Research that considers the association between the consumption of milk with added sugar and diet quality related the intake of the core food groups - fruits, vegetables, grains, and meat/beans, has not been addressed.

National School Lunch Program

More than 101,000 U.S. schools and 100% of public schools in Tennessee participate in the NSLP (8, 40). The USDA administers the NSLP that provides reduced price or free meals to schoolchildren from low-income families. The most recent USDA data indicate that the average school lunch provides more than one-third of the Recommended Dietary Allowances for all targeted nutrients, which include protein, vitamins A and C, calcium, iron, and fiber (41). According to Crepinsek and colleagues, the majority (48%) of NSLP schools are using the Traditional Food-Based Menu Planning approach, which allows schools

to serve one meal pattern (the same portion sizes established for grades 4 to 12) to all children in a school system (42). Additionally, 78% of elementary schools used offer-versus-serve, a policy that allows children to refuse one or two menu items with the goal of reducing food waste (41). More than 85 % of lunches *offered* met nutrient standards, but slightly fewer lunches (>72%) *served* did so, suggesting that students given "offer-versus-serve" did not select all meal components (41, 42). Protein was the only meal component offered and served 100%, all other nutrients were offered more than served (41).

To promote bone health and contribute to an overall healthful diet, the DGA'10 stresses the importance of consuming fat-free and lowfat milk , especially during childhood and adolescence (2). Flavored milk is available in virtually all school lunch menus. The widespread availability of flavored milks and the large proportion of participants consuming flavored milk may raise concerns about added sugars (43).

The USDA sponsored the third School Nutrition Dietary Assessment study (SNDA-III), during the school year 2004-2005, to up-date information on the NSLP (8). Data were collected from a nationally representative sample of public school children in grades 1 through 12; to provide a comprehensive picture of the food and nutrient content of school meals (8).

Comprehensive studies have assessed the SNDA-III data and policy implication for improving the health of US children. The NSLP increases the probability that children will have improved nutritional status with consumption

of more food groups than non-participants (8). Children in the NSLP eat more fruits, vegetables, and milk, than non-participants (44). Most schools (>70%) serve meals that meet standards for many nutrients that contribute to healthful diets and NSLP participants consume more of six key nutrients at lunch than do nonparticipants (45). Fresh fruits and raw vegetables in NSLP lunches were significantly less common in schools with a higher percentage of low-income students (46). However, a key finding from Clark and Fox was "that NSLP participants consumed more nutrients at lunch than matched nonparticipants, even after adjusting for differences in observable characteristics" (39).

Children's Eating Pattern

Lifestyles and eating behaviors, which change throughout the life cycle, influence the types of foods consumed (47). For example, as children get older, the percentage consuming fruits, vegetables, breads/grains, and milk decrease (47). In a recent review of literature on determinants of fruit and vegetable consumption among children and adolescents, ten papers found that fruit and vegetable consumption appears to decline with age, in nine papers no effect of age was observed (44).

"A preference for sweet-tasting foods underlies high sugar consumption (18). Diet preferences including the preference for sweetness are present in infancy and persist into adult life" (18). When offered a simultaneous choice between milk and a sweetened drink, children usually choose the sweetened drink (48). Mrdjenovic and Levitsky explored the relationship between a sweetened drink,

milk consumption, and energy intake in a small group (n=30) of children 6-13 years of age, measured over 4 to 8 weeks. The intervention study was conducted in a "day camp where children could drink all the unlimited amounts of 2% milk and fruit-flavored sweetened beverages (powdered and diluted with water drinks). Children served themselves any drink they wanted whenever they wanted, but were asked to record the amounts consumed. There were no vending machines with soft drinks at the campsite." They found children drank significantly less milk on those days when they consumed more sweetened drinks. They observed the trend for every child. "Despite the profound suppressive effect sweetened drink consumption had on milk, it had a very small effect on the intake of solid foods. An increase in energy intake happened because children did not eat less solid foods to adjust for the additional energy from sweetened drinks" (48).

Children in the US spend about 32 hours each week at school (49). Because of the widespread availability, the NSLP is in a unique position to influence children's eating pattern. Nearly all the nation's public schools participate in the NSLP and any child in a participating school is eligible to obtain a school lunch. Children who participate in the NSLP are, on average, lower-income and may have different attitudes about healthful eating or different preferences for particular foods (39). However, with repeated exposure, children can develop an increased preference for foods (6). Children's intake of a novel food increased

during meals when they observed a teacher enthusiastically consuming that food (50).

In summary, children are born with a preference for sweet tastes (15). The NSLP accommodates that preference with flavored milk to specifically increase intake of the dairy food group (43). The NSLP may promote development of children's food acceptance pattern by offering opportunities for children to enjoy a variety of fruits and vegetables (18). Research needs to examine the impact of flavored milk consumption on the selection and consumption of other core food groups during school lunch.

Extensive research has shown that sugar-sweetened beverages decrease nutritional quality; flavored milk is positively related to increased nutrient intake, specifically the micronutrients present in milk, and most children's diets do not meet the recommended food group servings (2, 18, 37). No studies were found that examined the association between consumption of the added-sugar in milk and likelihood of meeting dietary recommendations for other core food group intake.

Plate Waste

In plate waste studies, several methods may be used to measure food intake; however, most of these methods have limitations when applied to real-life settings. For example, direct observation of meals is considered the "gold standard" of dietary assessment tools; "because it is practical, independent of the subject's memory, and can provide unbiased information about the subject's

actual intake" (51). Though relatively unobtrusive, "observers who are trained to quickly estimate food selection and plate waste must be present in the dining location" (51); and the accuracy of methods that rely on self-report have been questioned (52). Children have recall problems and in randomly recruited adolescents and adults, comparison of intake and expenditure records indicated habitual underreporting of food intake, which is more prevalent and severe among overweight and obese people (53, 54). "Directly weighing food selections and plate waste provide an accurate measure of food intake, yet this method is costly and disruptive to participants"(55).

"Digital photography is a method for unobtrusively and accurately measuring food intake in naturalistic settings"(56). When using this method, "the plate of foods selected by an individual is photographed with a digital camera prior to eating the meal, and plate waste is photographed following the meal" (55). Reference portions of measured quantities of the foods are also photographed. A trained registered dietitian estimated meal consumption using the plate waste photographs (55). Williamson and colleagues "validated this research method, finding a .92 correlation between visual assessment using digital photography and food intake weight" (56). This method is easier and more accurate than other methods of measuring food intake, and it has been found to be highly reliable and valid when used "to measure children's food selection, plate waste, and food intake in a school cafeteria" (55). The findings from literature demonstrate the utility of using digital photography to assess food intake in an unhurried

laboratory environment (53, 55, 56). This method has the advantages of "rapid acquisition of data in the eating environment, convenience for participants and researchers, and relatively unhurried evaluation of foods that are studied in photographs, as opposed to in the immediate eating environment" (56).

Food intake varies over time, "suggesting that measuring food intake on any single day might not provide a reliable and representative sample of food intake behavior" (55). In testing the reliability and validity of measuring children's food intake, over five days, with digital photography, Martin and colleagues found that "assessing food intake over 3 days provides a reliable and representative measurement of food intake" (55).

CHAPTER THREE: METHODS

Study Design

A cross-sectional study design was used to compare food group consumption when sugar-sweetened versus unsweetened milk was selected. Data were collected using digital photography to capture images of food selections and plate waste. A registered dietitian used the pre and post-lunch images to estimate food intake. The study was conducted in the cafeteria of a Murfreesboro City elementary school, during spring 2010. Permission from the Director of Schools, the Coordinator of Instruction, and Principal was obtained for this study.

Participants

Study grades were selected by convenience sampling, one class each from K, 3rd, and 6th grades in an elementary school located in Murfreesboro, Tennessee. The particular school was chosen for this study because it offered the NSLP, which must offer five food components (milk, fruits, vegetables, grains, meat/meat alternates), meal participation was high, and it consented to participate. Kindergarten, 3rd, and 6th grades were selected based on the supposition that children's eating behaviors change with age and influence the types of foods consumed.

Data collection occurred over three non-consecutive lunch periods. The same class from each grade was observed on all study days. The numbers of students eating varied. The 6th grade class was absent from school for a field trip on the first study day and absenteeism accounted for slight participant changes. Due to

small class size, data from all days were combined into three groups by grade. Data were not collected on lunches brought from home. Initially, there were 45, 43, and 28 lunch samples from K, 3rd and 6th grades, respectively. Prior to the lunch period, teachers of study classes were informed of the data collection procedures, which they relayed to their class before coming to lunch. Based on "offer-versus-serve" (OVS), participants were allowed to decline some food items offered.

This research focused on lunches, rather than students. At no time were individual students associated with particular lunches, and no personal identifying information about students was collected. No photographs of students were taken as part of this research. This protocol was reviewed and approved by the Middle Tennessee State University Institutional Review Board.

Procedures for Data Collection

A modified version of procedures used by Martin, et al. to measure children's food intake with digital photography over multiple days was used in this study (55). Three research associates participated in the study and assisted with pre and post-lunch photos, milk and chip weights, and adjusted post-meal trays to make certain all items were visible in the photograph. For example, orange peelings, chip bags, ketchup packets, or bread pieces and other waste was separated from the surface of uneaten food portions each study day.

Prior to the lunch period, the research team set-up two tables in the cafeteria. One small 2' x 1.5' x 20" table was placed near the serving line exit,

where students would place their meal tray for the pre-lunch photograph before eating. A mat, the size of a meal tray, was taped to the table to ensure optimal placement and visibility of the meal in the photograph. The other 8' x 4' x 29" table was placed on the side of the waste window, where the research team placed all plate waste for post-lunch photos. Each table was set-up with an Olympus C-3020 Zoom digital camera fixed on tripod (Velbon CX 300). The cameras were set 14 inches above the trays at approximately a 45˚ angle. A reference lunch tray was photographed each study day, using the same camera angle and distance from the tray, so that the apparent size of all foods remained constant across photographs. This task was essential, to accurately estimate portion size and plate waste of study trays.

As students exited the serving line, stickers color-coded for each grade with pre-printed unique numbers were affixed to each tray. Students placed their tray on the table for the pre-lunch photo. Once the research team became experienced in this procedure, each tray took approximately five seconds to situate and photograph. Therefore, data collection occurred quickly with little inconvenience to the participants. Cafeteria monitors instructed students to leave trays, and waste, on the table. The research team transferred trays to the side table for post-lunch photos. The weights of cartons with waste milk were recorded. The weight from an unopened carton of white, chocolate, and strawberry milk was recorded.

The photo analysis focused on the food groups – meat, grain, vegetable, and fruit. Lunches were analyzed in two groups, those with 2% unsweetened milk

(USM) and sugar-sweetened milk (SSM), which included fat-free chocolate and fat-free strawberry milk. Digitally captured plate waste and reference plates were printed in color on white, 92 Bright, 8.5″×11″ paper, leaving a margin of 0.25″. For each lunch, a Registered Dietitian analyzed digital images for food selection, plate waste (PW), and food group intake. To do this, the dietitian compared pre-lunch images to the reference tray image for that meal, to determine foods offered versus foods served. Next, photographs of the pre and post-lunch were viewed simultaneously, to estimate the percent of plate waste.

The study used a modified Comstock assessment method, which was developed for use in school cafeterias, to estimate children's plate waste (57). Plate waste food items were estimated and recorded as a percentage, in units of 0%, 25%, 50%, 75%, or 100%. The amount of food eaten was calculated by subtracting the estimated percent plate waste from 100% of food item served. Milk consumed was calculated by subtracting the recorded waste milk weight from the full carton weight of the same type milk, before assigning percentage units. Meals offered to students on the data collection days are presented in Table 1 (Appendix A).

Statistical Analyses

The dependent variables are the changes in food group consumption; the independent variables are USM and SSM. The two-factor, analysis of variance (ANOVA) independent-measures design was conducted to identify significant mean differences between food group consumption among K, 3rd, and 6th grades

when SSM versus USM was selected with lunch. The independent measures 1-tailed *t*-test was used to analyze significant mean differences in eating patterns within grades when SSM and USM were selected. There was a large discrepancy between the final number of K, 3rd, and 6th lunches; USM: K = 8, 3rd = 8, 6th = 5, and SSM: K = 34, 3rd = 25, 6th = 5. The *p*-value from the significance test may not be reliable because of misleading effects of unequal sample sizes. Therefore, all groups were computer randomized to $n = 5$ for the between grade ANOVA. In the 1-tail *t*-test, K and 3rd grades were randomized to $n = 8$ and $n = 5$ for the 6th grade. Confidence Interval of 95% was determined using Z scores to minimize the chance of smaller groups being unrepresentative of the total grades. However, the small *n* sizes provided limited statistical power to detect significant differences between groups. As a result, patterns of substantive differences between all groups are discussed, even though some of these differences are not statistically significant at the 5% level. Differences in mean intake were determined to be statistically significant at level of $P < 0.05$. All data were entered into Microsoft Excel (version 14.0, 2010, Microsoft Corp., Redmond, WA).

CHAPTER FOUR: RESULTS

Descriptive Statistics

A total of 115 "pre" lunch pictures were taken over three study days from K (n = 44), 3rd (n = 43), and 6th grade (n = 28) students. All grades selected one of three types of milk (Figure 1). All kindergarteners selected milk; more than half of this was SSM. Half of the 6th graders selected milk while one-third selected no beverage. Only 3rd and 6th grades included water or chose no beverage with lunch (Figure 1 in Appendix B).

Eighty-five post-photos were usable for food and milk comparisons (Table 2 in Appendix A). Lunches excluded from the study included those with water or no beverage in the pre-lunch photo. Nine lunches did not have post-lunch photos taken; these included one tray that fell on the floor after starting the meal, three meals eaten outside of the cafeteria, two lunches from which students had given away or received food, and three lunches were not found for post-lunch photos. Based on cafeteria monitors' comments, teachers allow students to eat meals in their classroom as a "reward" for achievement. Giving away or receiving food is a common practice in NSLP elementary schools (58). The missing trays were possibly due to students disposing of trays in the trash as usual instead of bringing them to the side table as previously requested.

Lunch on day-1 included breaded chicken or beef, two vegetables (green beans, mixed vegetables), cookie, and orange. Day-2 included taco salad or

burrito, two vegetables (pinto beans, corn), grapes, and corn chips. Day-3 included ham or turkey croissant sandwich with lettuce, tomato, and pear.

Descriptive analysis of food groups offered and not served is presented in Figure 2 (Appendix B). Sixth grade did not eat on study day-1 (meat, green beans, mix vegetable, grapes). Meat and corn were offered and served to all lunches in the study. No lunches were served lettuce, a component of the taco salad and only five lunches (6%) were served lettuce and fresh tomato, which were components of the croissant sandwich. On each day, 50% of one or more grades were not served fruit, which was expected (59).

Descriptive analysis of food group consumption is presented in Figures 3 and 4 (Appendix B). Data indicate that when SSM was served, all grades consumed less fruit, K and 3rd consumed less meat, 6th ate the same amount; all grades ate more grains; only K ate more vegetables.

Tests of Research Questions

The data for differences in mean portions of food groups consumed within grades K, 3rd, and 6th, when SSM or USM were selected with meals are presented in Table 3 (Appendix A). When SSM was selected, K consumed less meat and fruit, more grain and vegetable, but these differences were not significant. Third grade consumed less meat, vegetable, and fruit with SSM, yet more grain without significant difference. The 6th grade consumed significantly less fruit (20%) with SSM than when USM (80%) was selected, $t(8) = 2.12$, $P = 0.03$. Data for mean

differences in food group consumption between grades are presented in Table 4. Analysis of variance indicates there were no significant differences with USM or SSM.

CHAPTER FIVE: CONCLUSIONS

Findings

This observational study is the first known to report the effect of drinking milk with added-sugar on the consumption of other food groups. The purpose of this study was to observe and evaluate changes in food group consumption, when SSM versus USM was selected, both within and between each grade of K, 3rd, and 6th NSLP students using digital photography to measure lunch selection, plate waste, and estimate food intake in a school cafeteria. Within grades, results showed SSM associated with K eating less meats and fruits, but more grains and vegetables; 3rd consumed less meats, vegetables, and fruits, but more grains; and 6th ate less vegetables and fruits, and more grains, yet the same amount of meats with both types milk. Between grades, results showed SSM associated with all grades eating less fruits and meats, although meat intake in 6th did not change; all grades increased grain consumption. There were no significant changes in food group consumption between grades. However, within grades, 6th ate significantly less fruit when drinking SSM.

Studies have consistently shown that diets of children do not meet current national dietary recommendations for fruits, vegetables, and whole grains (2, 6, 59). While research confirms SSM is positively associated with both higher milk intake and higher intakes of the nutrients present in milk compared to non-milk drinkers (37), other researchers have examined decreased food group consumption with low-nutrient, energy-dense sugar-sweetened beverage (LNED

SSBs) consumption (23). Findings from this study may extend these results by confirming the negative association between sugar-sweetened beverage consumption and decreased food group intake, using a nutrient-dense beverage with added-sugar instead of the extensively examined LNED SSBs.

The associations found in this study between consumption of SSM and food groups were not as consistent as might be hypothesized, given the intuitive nature of the association. Consistent with expectation were the decreases in the vegetable and fruit food groups, which agrees with findings of Frary and colleagues (23). The higher grain consumption within and across all grades agrees with other research that found children who consumed more added sugars also consumed more grains (22). However, it is probable that these results would be greatly attenuated if the grains offered on study day-1 and 2, had not been low-nutrient, energy-dense chocolate chip cookies and corn chips, respectively (60). On day-1, 22 of 26 lunches selected SSM; while some students ate less, 69% ate 100% of the cookie. The high intake of sweetened grain is expected and consistent with previous literature (61). On day-2, 19 of 27 lunches selected SSM and 56% of students consumed 100%. This finding agrees with the high level consumption of low-nutrient, energy-dense foods eaten by elementary children at school (25). The higher K vegetable intake appears to contradict results from the investigation by Forshee and Storey that children who consume more added sugars consumed less vegetables (22). It is probable that high K vegetable consumption with SSM is explained by a casual vegetable eating pattern over the three study days. On day-

1, 15 of 15 lunches were served two vegetables (green beans and mixed vegetables); all vegetables were observed to be untouched, with one exception, one student ate 100% of each vegetable; this lunch had SSM. On day-3, 4 of 14 lunches ate all or part of the vegetables served; the only three lunches with USM were not served any vegetables offered. Systematically serving vegetables is in accord with a number of study interventions conducted in school settings, designed to increase vegetable consumption by offering them in multiple ways (61, 62); and omitting vegetables is consistent with the OVS goal of reducing food waste (41, 42). Although offering vegetables daily in school lunches was associated with consumption of vegetables in elementary school children, analysis of vegetable consumption in this study did not support this association (61). One of the vegetables offered on day-2 was corn. Although corn is one of the most commonly acceptable vegetables to children, with most eating a 100% serving; only three lunches selected USM on day-2; thus, giving the distorted appearance of high vegetable consumption with SSM (39, 63).

Forshee and Storey observed and noted that children who consumed more sugar, ate more meat (22). In contrast, Kranz and colleagues found that the amount of meat eaten did not change significantly with varying levels of added sugars (29). Sixth graders ate full servings of meat with both the SSM and USM. Eating 100% meat may be partially due to higher energy needs and appetites that were not satiated after eating 0% vegetables and 20% fruit.

Limitations

The data from cross-sectional observation implies a need to be cautious about interpretations of relationships in the data. The focus of this study was to examine changes in food group consumption when SSM and USM were consumed. However, the cross-sectional nature of the data implies that it may not be possible to distinguish the effects of the added-sugar in milk on children's consumption from the effects of unobserved factors. Future research using a longitudinal design to observe children's diet in school, measure changes in school practices, environment, and the effects on children's eating pattern, would address this limitation, but this would be difficult and costly to undertake.

The study samples were small and statistical power was limited. The samples may not be representative of all schoolchildren in Tennessee; thus, the results may not be generalizable to the entire state. Assessing food intake over two days for 6th graders may not provide a reliable and representative sample of food intake behavior.

The research team was unable individually to monitor each child's actual consumption. Thus, food exchange may have occurred with more lunches than those listed as excluded from the study due to observed food trading or sharing.

One analyst estimating plate waste and food intake does not allow for a test of agreement between the measurements. This study did not use weighed portions of food to test the validity of visual assessment. While inclusion of this step would have further validated visual assessment, the use of digital

photography in this study approximated children's food consumption more accurately than self-reports.

Implications

Findings from this study as well as prior research on food group consumption suggest that children's intake of vegetables and fruits are inadequate, regardless of beverage selection, with or without added sugar (59). Data from the SNDA-III demonstrate that children do not always make healthy choices. For example, about half of all children who participated in school lunch did not consume any fruit or vegetable during the school day (64). Environmental factors such as parental influence, taste, preference, eye appeal, foodservice practices, and others have a significant role in food selection (12). Research is needed to understand more about obstacles to improving school meals and acceptance among children (12, 64).

Sugar-sweetened flavored milk is available in virtually all school lunch menus. Research suggests that the positive contribution of SSM in children's diets may outweigh the potential negative effect of the added sugar, because consumers are more likely to drink more milk than non-consumers and have higher intakes of the short-fall nutrients contained in milk (43). The indication in this study that SSM consumption further decreased food group intake, suggests quantitative research with substantially larger groups is needed to document trends in eating patterns with SSM, to determine which nutrient dilution is more

harmful – a greater deficiency in multiple food groups, or a greater deficiency in milk and its nutrients.

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APPENDICES

APPENDIX A: TABLES

Table 1. Meals offered to elementary students on study days

	Day 1	Day 2	Day 3
Food Group			
[a]Meat	Chicken nuggets or Beef Fingers	Taco meat or Burrito	Turkey or Ham
Grain	Cookie	Corn chips	Croissant
[b]Vegetable	[c]Winter Blend Green Beans	Pinto Beans, Corn [d]Lettuce	Lettuce Tomato
Fruit	Orange slices	Grapes	[e]Pears

[a]One selection per lunch

[b]May select all vegetables offered, a combination, or none

[c]Contained carrots, broccoli, and califlower

[d]Offered as salad base for taco meat

[e]Canned

Table 2. Characteristics of kindergarten, third, and sixth grade school lunches participating in a study assessing consumption of food groups with sugar-sweetened milk (SSM) and unsweetened milk (USM)

Characteristic	**Total**	**USM[a]**	**SSM[b]**
	n	*n*	*n*
Total lunches in sample	85	21	64
Grade			
Kindergarten	42	8	34
Third	33	8	25
Sixth	10	5	5

[a]USM: white, no added-sugar, 2% reduced fat milk

[b]SSM: Fat-free chocolate and fat-free strawberry milk

Table 3. Within grade mean food group consumption, when unsweetened milk (USM) or sweetened milk (SSM) was selected in Kindergarten (K), Third (3rd), and sixth (6th) grade

	Lunches											
	K (n = 16)				3rd (n = 16)				6th (n = 10)			
	USM	SSM	*t* - Test[a] (df = 14)		USM	SSM	*t* - Test[a] (df = 14)		USM	SSM	*t* - Test[a] (df = 8)	
Food Groups	**Mean (SE)**	**Mean (SE)**	***t* Stat**	**P value**	**Mean (SE)**	**Mean (SE)**	***t* Stat**	**P value**	**Mean (SE)**	**Mean (SE)**	***t* Stat**	**P value**
Meat	0.75 (0.13)	0.53 (0.80)	1.00	0.17	0.88 (0.13)	0.84 (0.12)	0.18	0.43	1.00 (0.00)	1.00 (0.00)	0.00	0.00
Grain	0.59 (0.16)	0.69 (0.16)	-0.42	0.34	0.75 (0.14)	0.84 (0.08)	-0.57	0.29	0.80 (0.20)	1.00 (0.00)	-1.00	0.17
Vegetable	0.19 (0.13)	0.50 (0.27)	-1.05	0.16	0.59 (0.16)	0.50 (0.27)	0.30	0.38	0.20 (0.20)	0.00 (0.00)	1.00	0.17
Fruit	0.66 (0.16)	0.66 (0.17)	0.00	0.50	0.38 (0.18)	0.25 (0.16)	-1.42	0.09	0.80 (0.20)	0.20 (0.20)	2.12	0.03*
Milk	0.63 (0.12)	0.59 (0.14)	0.17	0.87	0.69 (0.15)	0.88 (0.07)	-1.11	0.29	0.65 (0.19)	0.30 (0.15)	1.48	0.18

[a]t - Test = one-tailed

*Consumption is significantly more with USM at P<0.05.

Table 4. Between grade mean food group consumption, when unsweetened milk (USM) or sweetened milk (SSM) was selected in Kindergarten (K), Third (3rd), and sixth (6th) grade

	Lunches							
	K (n = 10)		3rd (n = 10)		6th (n = 10)			
	USM	SSM	USM	SSM	USM	SSM	ANOVA[a] (df = 2, 24)	
Food Groups	**Mean (SE)**	**Mean (SE)**	**Mean (SE)**	**Mean (SE)**	**Mean (SE)**	**Mean (SE)**	***F***	**P value[b]**
Meat	0.65 (0.08)	0.75 (0.06)	0.80 (0.09)	0.90 (0.02)	1.00 (0.00)	1.00 (0.00)	2.45	0.11
Grain	0.60 (0.09)	0.75 (0.06)	0.60 (0.09)	0.85 (0.02)	0.80 (0.09)	1.00 (0.00)	1.06	0.36
Vegetable	0.20 (0.09)	0.20 (0.09)	0.60 (0.09)	0.40 (0.36)	0.20 (0.09)	0.00 (0.00)	1.62	0.22
Fruit	0.85 (0.02)	0.85 (0.02)	0.40 (0.13)	0.40 (0.13)	0.80 (0.09)	0.20 (0.09)	3.05	0.07
Milk	0.65 (0.08)	0.55 (0.09)	0.70(0.08)	0.90 (0.02)	0.65 (0.08)	0.70 (0.05)	0.70	0.51

[a] ANOVA = analysis of variance.

[b] P<0.05.

APPENDIX B: FIGURES

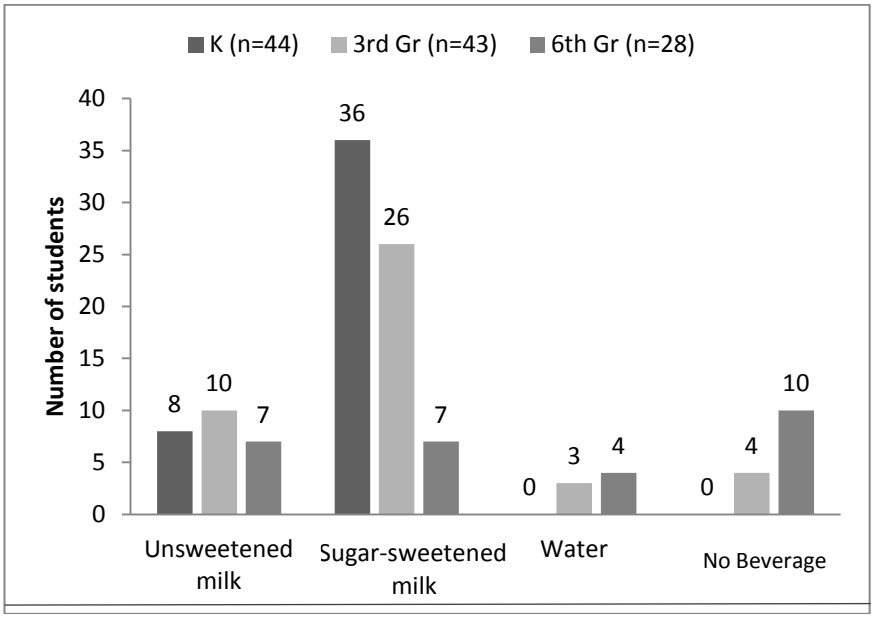

Figure 1. Comparison of beverage selections among kindergarten (K), third (3rd), and sixth (6th) grades

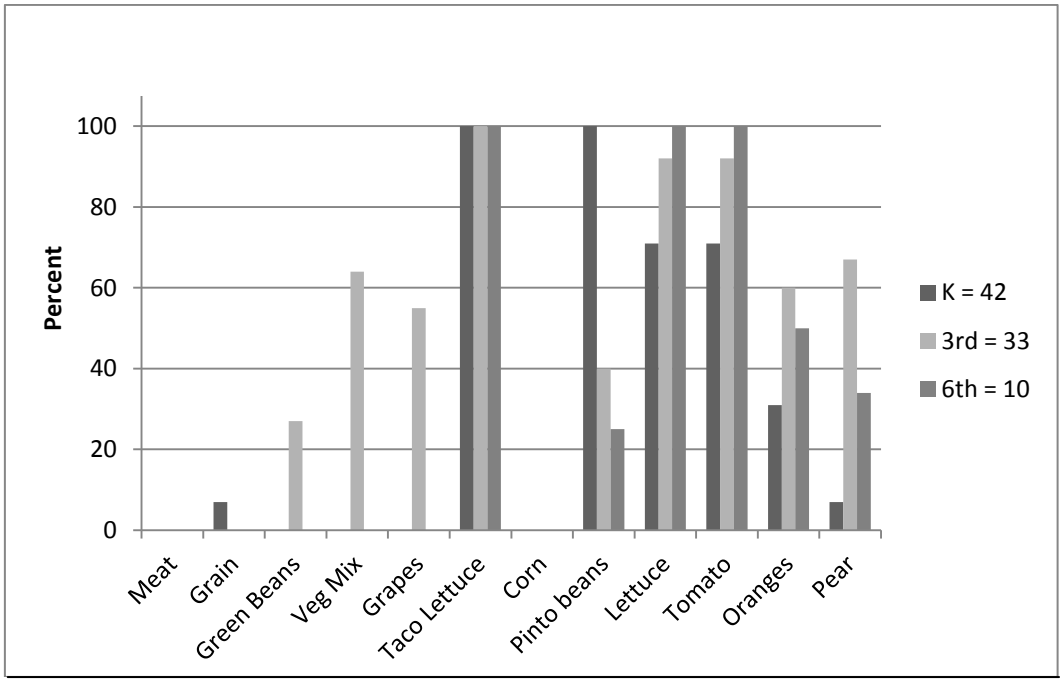

Figure 2. Foods offered versus not served in lunches to kindergarten (K), third (3rd), and sixth (6th) grades. Sixth grade was not available on day-1 when meat, grain, green beans, veg mix = vegetable mix (carrot, broccoli, cauliflower), and grapes were offered.

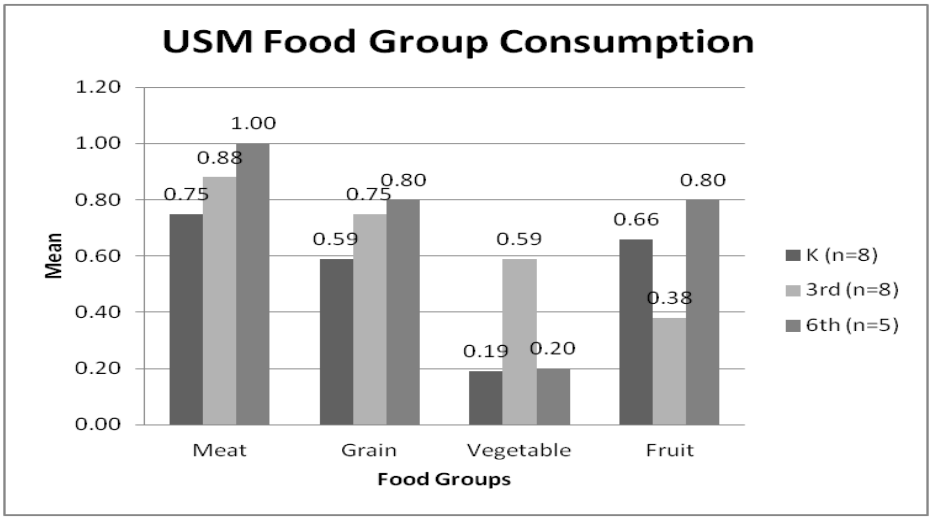

Figure 3. Mean portions of food groups consumed when unsweetened milk (USM) is selected by kindergarten (K), third (3rd), and sixth (6th) grade

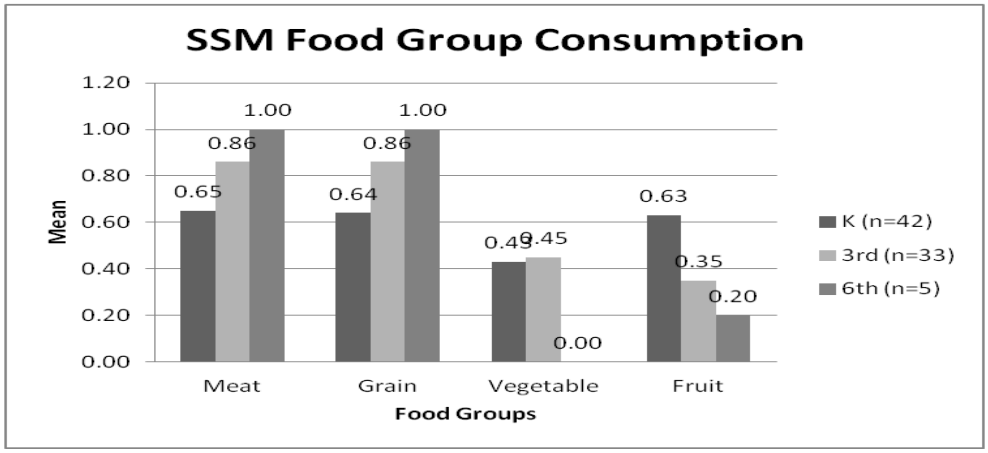

Figure 4. Mean portions of food groups consumed when sweetened milk (SSM) is selected by kindergarten (K), third (3rd), and sixth (6th) grade students. *Significantly different from unsweetened milk consumption at $P < 0.05$.

APPENDIX C:

INSTITUTIONAL REVIEW BOARD LETTER OF APPROVAL

March 10, 2010

Drs. Ida Fadzillah and William Leggett
Department of Sociology and Anthropology
ifadzill@mtsu.edu, wleggett@mtsu.edu

Protocol Title: "Assessing Tennessee's Immigrant Communities' Conceptions and Actual Usages of Nutritional Sources and Physical Activity"
Protocol#: 09-300

Dear Investigator(s):

I have reviewed your research proposal identified above and your requested changes. I approve of the following revisions to your study:

Adding Myrtis Walker as an investigator to your study and have sent her certificate to be scanned into your file.

Please note that any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918. Any change to the protocol must be submitted to the IRB before implementing this change.

You will need to submit an end-of-project report to the Office of Compliance upon completion of your research. Complete research means that you have finished collecting data and you are ready to submit your thesis and/or publish your findings. Should you not finish your research within the one (1) year period, you must submit a Progress Report and request a continuation prior to the expiration date. Please allow time for review and requested revisions. Your study expires **June 9, 2010.**

According to MTSU Policy, a researcher is defined as anyone who works with data or has contact with participants. Anyone meeting this definition needs to be listed on the protocol and needs to provide a certificate of training to the Office of Compliance. If you add researchers to an approved project, please forward an updated list of researchers and their certificates of training to the Office of Compliance before they begin to work on the project.

Please note, **all research materials much be retained** by the PI or **faculty advisor (if the PI is a student)** for at least **three (3) years after study completion**. Should you have any questions or need additional information, please do not hesitate to contact me.

Sincerely,

Tara M. Prairie
Compliance Officer
Middle Tennessee State University

June 9, 2009

Drs, Ida Fadzillah & William Leggett
Department of Sociology and Anthropology
ifadzill@mtsu.edu, wleggett@mtsu.edu

Protocol Title: "Assessing Tennessee's Immigrant Communities' Conceptions and Actual Usages of Nutritional Sources and Physical Activity"
Protocol#: 09-300

Dear Investigator(s):

The MTSU Institutional Review Board, or a representative of the IRB, has reviewed the research proposal identified above. The MTSU IRB or its representative has determined that the study poses minimal risk to participants and qualifies for an expedited review under 45 CFR 46.110 Categories 6 & 7.

Approval is granted for one (1) year from the date of this letter for **200** participants.

According to MTSU Policy, a researcher is defined as anyone who works with data or has contact with participants. Anyone meeting this definition needs to be listed on the protocol and needs to provide a certificate of training to the Office of Compliance**. If you add researchers to an approved project, please forward an updated list of researchers and their certificates of training to the Office of Compliance before they begin to work on the project.** Any change to the protocol must be submitted to the IRB before implementing this change.

Please note that any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918.

You will need to submit an end-of-project report to the Office of Compliance upon completion of your research. Complete research means that you have finished collecting and analyzing data**. Should you not finish your research within the one (1) year period, you must submit a Progress Report and request a continuation prior to the expiration date**. Please allow time for review and requested revisions. Your study expires **June 9, 2010.**

Also, all research materials much be retained by the PI for at least three (3) years after study completion. Should you have any questions or need additional information, please do not hesitate to contact me.

Sincerely,

Tara M. Prairie
Research Compliance Officer