Georgia State University
ScholarWorks @ Georgia State University

Nutrition Theses | Department of Nutrition

Summer 8-17-2011

The Relationship Between Vitamin D and Calcium/Dairy Intake and Obesity in Children

Jason Barry

Follow this and additional works at: https://scholarworks.gsu.edu/nutrition_theses

Part of the Nutrition Commons

Recommended Citation
Barry, Jason, "The Relationship Between Vitamin D and Calcium/Dairy Intake and Obesity in Children." Thesis, Georgia State University, 2011.
https://scholarworks.gsu.edu/nutrition_theses/14

This Thesis is brought to you for free and open access by the Department of Nutrition at ScholarWorks @ Georgia State University. It has been accepted for inclusion in Nutrition Theses by an authorized administrator of ScholarWorks @ Georgia State University. For more information, please contact scholarworks@gsu.edu.

ACCEPTANCE

This thesis, THE RELATIONSHIP BETWEEN VITAMIN D AND CALCIUM/DAIRY INTAKE AND OBESITY IN CHILDREN, by Jason A Barry was prepared under the direction of the Master's Thesis Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree Master of Science in the College of Health and Human Sciences, Georgia State University. The Master's Thesis Advisory Committee, as representatives of the faculty, certify that this thesis has met all standards of excellence and scholarship as determined by the faculty.

____
Anita M. Nucci, PhD, RD, LD
Committee Chair

____
Meera Penumetcha, PhD, RD
Committee Member

____
Catherine McCarroll, MPH, RD, LD
Committee Member

____
Date

AUTHOR'S STATEMENT

In presenting this thesis as a partial fulfillment of the requirements for the advanced degree from Georgia State University, I agree that the library of Georgia State University shall make it available for inspection and circulation in accordance with its regulations governing materials of this type. I agree that permission to quote, to copy from, or to publish this thesis may be granted by the professor under whose direction it was written, by the College of Health and Human Sciences director of graduate studies and research, or by me. Such quoting, copying, or publishing must be solely for scholarly purposes and will not involve potential financial gain. It is understood that any copying from or publication of this thesis which involves potential financial gain will not be allowed without my written permission.

____
Signature of Author

NOTICE TO BORROWERS

All theses deposited in the Georgia State University library must be used in accordance with the stipulations prescribed by the author in the preceding statement. The author of this thesis is:

Jason Barry
1360 North Avenue NE, Apt 1,
Atlanta, GA 30307

The director of this thesis is:

Anita M. Nucci, PhD, RD, LD
Assistant Professor and Graduate Program Director
Division of Nutrition, School of Health Professions
College of Health and Human Sciences
Georgia State University
Atlanta, Georgia 30302

VITA

Jason A. Barry, CSCS
1360 North Avenue Apt. 1, Atlanta, GA 30307 ♦ (912)220-5469 ♦ JaBarry85@gmail.com

EDUCATION: Georgia State University (August 2011)
M.S. Health Science and Nutrition ♦ GPA: 3.68
Thesis: The Relationship between Vitamin D and Calcium/Dairy Intake and Obesity in Children
Activities/Awards: Deans List, Presidents List, GSU Grappling Club Member

Armstrong Atlantic State University (May 2008)
B.S. Health Science ♦ GPA: 3.64 (Magna Cum Laude)
Activities/Awards: Deans List, Presidents List, AASU Flag Football Member

CERTIFICANTIONS: NSCA Certified Strength and Conditioning Specialist (CSCS)

SKILL SUMMARY: Medical Nutrition Therapy - Nutrition Care Process - Microsoft Office - SPSS - Food Processor SQL - Nutrition Maker Plus - EPIC Medical Records - Sports Nutrition

SUPERVISED PRACTICE EXPERIENCE (9/2009 – 9/2011)

Grady Hospital, Acute/Critical Care Intern
Senior Connections, Food Service Intern
Bright to Start, Dietetic Intern
Sweet Auburn Market Business Plan, Vendor Plan Coordinator
Georgia State Counseling Center, Dietetic Intern
Georgia State Recreation Center, Dietetic Intern
WIC, Dietetic Intern
DaVita Dialysis, Dietetic Intern
Dekalb Medical Center Diabetes Education, Dietetic Intern
Crestview Long Term Care, Dietetic Intern

PROFESSIONAL EXPERIENCE

After School All Stars, Cooking/Nutrition Instructor (9/2009-9/2011)
The Fitness Club, Personal Trainer (12/ 2008- 9/2009)
Pier 1 Imports, Stock Associate (5/2005 – 7/2008)
Coastal Therapy, Physical Therapy Technician (4/2007 –8/2007)

PROFESSIONAL GROUPS: American Dietetic Association, (2010-Present)

ABSTRACT

THE RELATIONSHIP BETWEEN VITAMIN D AND CALCIUM/DAIRY INTAKE AND OBESITY IN CHILDREN

By

Jason Barry

Background: Obesity rates are increasing at an epidemic rate, not only in the United States, but also worldwide. Some research has shown a positive association between weight loss or maintenance with increased vitamin D and calcium intake (particularly dairy products, in adults) while other research has found a negative association.

Objective: The aim of this study is to examine the relationship between vitamin D and calcium intake and obesity in a population of young adolescents who participated in a Vitamin D and Sunlight Exposure study in Pittsburgh, PA.

Participants/setting: 252 healthy 6 to 14.9 year old young adolescents (54% male, 69% African American) were recruited between June 2006 and December 2009.

Main outcome measures: Weight status, BMI, vitamin D intake, calcium intake, vitamin D and calcium rich food intake.

Statistical analysis: Frequency analysis was used to determine demographic proportions, mean anthropometric values and median intake of vitamin D and calcium. Differences in weight status by gender and race were calculated using the Chi-square test. Differences in intake by weight status were assessed using the Kruskal-Wallis Test. The Spearman's rho correlation statistic was used to determine the association between BMI and calcium and vitamin D intake.

Results: 59.3% of the population was normal weight, 17.7% was overweight and 23% was obese. A significant difference by race was observed with 30.1% of African Americans and 8.5% of Caucasians being obese ($P<0.01$). No difference was found by gender. Median (25%, 75%) vitamin D intake in the total population was 254.9 IU (146.8, 407.3) which is below the level recommended by the Institute of Medicine. Median calcium intake in the total population was 1193.6 mg (752.8, 1161.1) which met recommended guidelines. Median milk intake was reported at 2 servings/day and did not differ by race. Intake of additional foods rich in vitamin D and calcium differed by race, with African Americans consuming more cheese than Caucasians (1 serving/day vs. 0.5 servings/day, respectively; *P*=0.014) and orange juice (0.1 servings/day vs. 0 servings/day, respectively; *P*=0.045) but less yogurt (0 servings/day vs. 0.5 servings/day, respectively; *P*=0.031). Median vitamin D intake differed by weight status (normal, overweight, obese) in the total population (259.5 IU, 325.2 IU and 181.9 IU, respectively; *P*=0.015). A similar pattern was observed for calcium (1193.4 mg, 1416.3 mg and 911.6 mg, respectively; *P*=0.016). No correlation was found between vitamin D or calcium intake and BMI in the total population or by race and gender.

Conclusion: Although no correlation was found with BMI and calcium and vitamin D intake, vitamin D and calcium intake was significantly different based on weight status, particularly in obese and African American subjects. Vitamin D intake in the population was reportedly below recommended guidelines. Further research is necessary to determine the ideal vitamin D and calcium intake in children for optimal health status, including longitudinal studies to better assess the relationship between vitamin D and calcium intake and weight status.

THE RELATIONSHIP BETWEEN VITAMIN D AND CALCIUM/DAIRY INTAKE AND OBESITY IN CHILDREN

By

JASON BARRY

A Thesis

Presented in Partial Fulfillment of Requirements for the Degree of

Master of Science in Health Sciences

The College of Health and Human Sciences

Division of Nutrition

Georgia State University

Atlanta, Georgia
2011

ACKNOWLEDGMENTS

I would like to thank my committee members for all the help you provided me in making this thesis possible. Dr. Nucci, thank you for being so patient throughout this process. You are an incredible teacher and guided me, step by step through this process. Thank you Mrs. McCarroll for not only your help with this thesis, but for all the hard work and support you gave me throughout the program. I feel like you are my nutrition program mother, and I wouldn’t have made it through without you! And thank you Dr. Penumetcha for aiding me with your statistical and technical expertise, you are truly inspiring for a potential researcher to look up to!

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATIONS

25 (OH)D	25-hydroxyvitamin D
AAP	American Academy of Pediatrics
AI	Adequate Intake
BMI	Body Mass Index
CMP	Casein Macro-Peptides
CCK	Cholecystokinin
cm	centimeter
CSFII	Continuing Survey of Food Intakes by Individuals
DRI	Dietary Reference Intake
EAR	Estimated Average Requirement
f	Female
FFQ	Food Frequency Questionnaire
FNB	Food and Nutrition Board
FFQ	Food Frequency Questionnaire
GA	Georgia
GLP-1	Glucagon-Like Peptide-1
IOM	Institute of Medicine
IU	International Units
kg	kilogram
L	liter
LFFQ	Long Food Frequency Questionnaire

m	Male
mg	milligram
mL	milliliter
ng	nanogram
NHANES	National Health and Nutrition Examination Survey
nmoL	nanomole
PA	Pennsylvania
PTH	Parathyroid Hormone
RCT	Randomized Controlled Trial
RDA	Recommended Dietary Allowance
SD	Standard Deviation
SFFQ	Short Food Frequency Questionnaire
UPMC	University of Pittsburgh Medical Center
US	United States of America
USDA	United States Department of Agriculture

CHAPTER I

INTRODUCTION

Obesity rates are increasing at an epidemic rate, not only in the United States, but worldwide (1). Obesity has been found to increase the likelihood of poor health and increases all-cause mortality (1). Approximately one out of three children in the U.S. is now considered to be overweight or obese (2). Over the past few decades, research has shown positive and negative associations between weight loss and maintenance with increased vitamin D and calcium intake (particularly with dairy products) in adults (3, 4, 5, 6, 7, 8). Additionally, studies have demonstrated links between high body mass indices (BMI) and decreased sun exposure, as well as decreased vitamin D levels (9). However, there is a discrepancy in data with children, as fewer studies have been done and findings have been inconclusive(2, 4). Further complicating the issue, with increased soda/juice consumption as opposed to vitamin D fortified milk, increasingly westernized lifestyles, and decreased frequency of meals eaten at home, vitamin D production/intake and calcium intake are at all-time lows among children (9, 10). The research base concerning vitamin D and calcium intake and weight is conflicting in both children and adults, as it is not clear whether calcium alone affects weight status or whether the associations found between obesity and vitamin D deficiency are causal, among others (11). Factors such as race and sex in relation to calcium and vitamin D intake and weight status have not been explored thoroughly, particularly in children. The purpose of this study is to examine the relationship between vitamin D and calcium intake and childhood weight status and obesity in a population of young adolescents who participated in a Vitamin D and Sunlight Exposure study (2010) in Pittsburgh, Pennsylvania (PA) (12).

Hypothesis: 1. Vitamin D and calcium intake differ by weight status in young adolescents.

2. Vitamin D and calcium intake based on weight status differs between young adolescent males and females.

3. Vitamin D and calcium intake based on weight status differs between young adolescent Caucasians and African Americans.

CHAPTER II

LITERATURE REVIEW

Current Intake Recommendations For Vitamin D and Calcium

According to the Food and Nutrition Board (FNB) at the Institute of Medicine (IOM), the most recent Recommended Dietary Allowances (RDA) for vitamin D intake in male and female children 1 to 18 years of age is 600 IU per day, assuming minimal sun exposure (13). For calcium, the RDA is 700 mg/day for 1 to 3 year olds, 1000 mg/day

Dietary Reference Intakes for Calcium and Vitamin D

	Calcium			Vitamin D		
Life Stage Group	Estimated Average Requirement (mg/day)	Recommended Dietary Allowance (mg/day)	Upper Level Intake (mg/day)	Estimated Average Requirement (IU/day)	Recommended Dietary Allowance (IU/day)	Upper Level Intake (IU/day)
Infants 0 to 6 months	*	*	1,000	**	**	1,000
Infants 6 to 12 months	*	*	1,500	**	**	1,500
1–3 years old	500	700	2,500	400	600	2,500
4–8 years old	800	1,000	2,500	400	600	3,000
9–13 years old	1,100	1,300	3,000	400	600	4,000
14–18 years old	1,100	1,300	3,000	400	600	4,000
19–30 years old	800	1,000	2,500	400	600	4,000
31–50 years old	800	1,000	2,500	400	600	4,000
51–70 year old males	800	1,000	2,000	400	600	4,000
51–70 year old females	1,000	1,200	2,000	400	600	4,000
>70 years old	1,000	1,200	2,000	400	800	4,000
14–18 years old, pregnant/lactating	1,100	1,300	3,000	400	600	4,000
19–50 years old, pregnant/lactating	800	1,000	2,500	400	600	4,000

*For infants, Adequate Intake is 200 mg/day for 0 to 6 months of age and 260 mg/day for 6 to 12 months of age.
**For infants, Adequate Intake is 400 IU/day for 0 to 6 months of age and 400 IU/day for 6 to 12 months of age.

INSTITUTE OF MEDICINE OF THE NATIONAL ACADEMIES Advising the nation • Improving health

Dietary Reference Intakes for Calcium and Vitamin D (13) for 4 to 8 year olds, and 1300mg/day for those aged 9 to 18 (13). Although both calcium and vitamin D recommendations were recently changed, debate has primarily surrounded the changes to vitamin D intakes, as some researchers in the nutrition field believe levels should be raised well beyond the current RDAs (14). Toxicity is thought to be a risk at intakes over 10,000 IU/day over prolonged periods, but this value serves more as a conservative measure until more data are available (15). The IOM recommendations on calcium and vitamin D are based primarily on bone health studies and may not necessarily apply to intakes impacting weight status (16). Researchers also question whether to lower calcium recommendations if vitamin D recommendations are increased further (14). When supplemented with 400 IU vitamin D, a decrease in non-vertebral fracture risk was observed independent of calcium intake, suggesting parathyroid hormone (PTH) suppression and hip bone density only require higher calcium intakes if 25 (OH)D levels are low (14). As evidence emerges on mechanisms behind the interplay of vitamin D and calcium in the body, future research (and reflection on past research) in relation tc Dietary Reference Intakes for Calcium and Vitamin D (13)

Measuring Vitamin D Status : Serum Vitamin D Levels

A standard measure of vitamin D status is serum 25 (OH)D levels (16, 17). Although influenced by sun exposure, the measure gives researchers insight into dietary intake of vitamin D (16). Although controversial, it is generally agreed upon that healthy serum 25 (OH)D levels should be greater than 50 nmol/L (16, 18). Levels below 30 nmol/L have been associated with a wide range of diseases and conditions including rickets, secondary hyperparathyroidism, fractures, , obesity, diabetes, heart disease, and inflammatory bowel disease (14, 17, 18). In adults, there is evidence that levels above 50 nmol/L reflect more optimal measures of health including increased bone density among others (18), and levels from 75 nmol/L – 100 nmol/L reflect best for overall health (18). If these standards were applied to children in the US, two out of three have serum 25 (OH)D levels below 75 nmol/L, with nearly all African American children falling into this category (15). If adjusted to 50 nmol/L, half of African American children in the US have low 25 (OH)D levels (15).

On average, 80-90% of serum 25 (OH)D is produced endogenously from sunlight exposure (15). However, westernized lifestyles around the globe are contributing to decreased sunlight exposure, and more definitive dietary recommendations are necessary to compensate (18, 19). Evidence of optimal serum levels for children coincide with reference ranges for adults, but fewer studies have addressed 25 (OH)D levels in younger populations (15). Populations with darker skin tones also have increased need for vitamin D intake as sunlight exposure decreases (15, 17). For instance, African Americans require higher intakes of vitamin D than Caucasians, and significant differences in average 25 (OH)D levels have been documented (14, 18). Populations in northern latitudes receiving less sunlight also require more vitamin D through diet, such as Inuits who traditionally relied on fish and whale blubber as a primary source of vitamin D (although dependence on fishing decreased and lower 25 (OH)D levels have resulted) (18). Inverse relationships have been observed between serum 25 (OH)D levels and higher body fat percentages, BMI, and total body fat in overweight and obese populations (18). Lower serum 25 (OH)D levels may be due, at least in part, to increased vitamin D storage in fat cells, reducing bioavailability (18). When a control versus obese group was exposed to sunlight, similar amounts of vitamin D were produced, but blood concentrations 24 hours post sunlight exposure were 57% lower in the obese group (20). It may be that the subcutaneous fat cells hold onto serum 25 (OH)D synthesized in the skin. When the groups were compared with oral vitamin D2 intake versus sunlight exposure, similar results were found. However, vitamin D was more bioavailable through the oral intake method perhaps due to a delay in release of vitamin D into the bloodstream (20). Possible explanations for 25 (OH)D levels in relation to obesity have been explored, but more research is necessary.

Measuring Calcium Status: Diet

Serum levels of calcium are tightly regulated and are not impacted by dietary intake (16) as the body depends on bone resorption (if necessary) to regulate blood, muscular, and intracellular calcium levels. As such, measuring calcium intake status primarily relies on data from dietary assessment methods like food frequency questionnaires and food records. Not all calcium from the diet is bioavailable, as typically only 30% is absorbed (16) in the gut. Other factors impact calcium absorption such as competitive inhibition with other foods, the amount consumed, age, vitamin D intake, and calcitriol levels (16, 21).

Current Intake Status

Intakes of vitamin D and calcium fail to reach recommended levels for children in the US. It is estimated that only 30% of American children consume the recommended amounts of calcium per day (22). Dairy products such as milk are the primary source of calcium and vitamin D for most children in the US, contributing greater than 50% of daily calcium intake (23). With the rise of sweetened beverage intakes, milk consumption has significantly declined in children (23, 24). Young girls between 9 and 18 are significantly less likely to consume adequate amounts of calcium (16, 25). Lower dairy intakes accompany this statistic, and may be due to the belief amongst young females that dairy products cause unwanted weight gain (16, 25). From 1978 to 1998, milk consumption decreased by 36% among female adolescents (23). Meanwhile, sweetened beverage consumption increased by 127% in 11 – 13 year old girls, and by 93% in 14-17 year old girls (23).

Similar to calcium, vitamin D intakes are below recommended levels in US children (23). And as with calcium intakes, young girls are at risk as only 50% of those aged 9-13, and 32% of those aged 14-18 consume the recommended levels of vitamin D in their diets (23). According to an NHANES 2001-2005 analysis of serum 25 (OH)D levels in children, 9% were considered vitamin D deficient (<37 nmol/L), and 61% were considered vitamin D insufficient (37-72 nmol/L) (26, 27). Vulnerable populations in the study were minorities with darker skin, those who spent more time indoors, and those who drank <1 serving of milk per week. In an NHANES 2001-2006 analysis of children aged 1-11, 1% had 25 OHD levels <25nmol/L, 18% had levels below 50 nmol/L, and 69% were below 75nmol/L (15). When applied to the general population, the data represents millions of children with inadequate vitamin D levels.

Supplementation: Vitamin D

The most efficient way to increase vitamin D levels in deficient individuals is through supplementation, particularly in the obese (20). Supplemental forms of vitamin D are typically available as vitamin D2 and D3 (16). The two forms are considered metabolically equivalent based on their ability to cure rickets (16). Although vitamin D2 and D3 follow similar metabolic pathways, large doses of vitamin D2 may be less effective than equivalent doses of D3 (16). However, only one in three children in the US report taking a vitamin D supplement or supplement containing vitamin D (15). And of those consuming supplements (typically 100 – 400 IUs), 1 in 10 had 25 (OH)D levels below 50 nmol/L and more than half were below 75 nmol/L. Supplementation of 400 IU/day appears to raise 25 (OH)D levels by 10 nmol/L on average in most populations, and increases of 25 nmol/L are observed with intakes of 1000 IU/day, depending on vitamin D status before supplementation (14). However, as research continues to shed light on definitive 25 (OH)D levels for optimal health, recommendations for supplementation will need to be reconsidered.

Supplementation: Calcium

An estimated 43% of the US population consumes calcium in the form of a supplement (28). The two primary forms of calcium supplementation are calcium carbonate and calcium citrate (28). Both forms are absorbed similarly well, but those with more acidic stomachs may absorb citrate more efficiently. Calcium citrate can be absorbed equally with or without food, while calcium carbonate is better absorbed with food (28). The amount of calcium absorbed depends on several factors including what the calcium was taken with (calcium binding foods, medicines), how much elemental calcium is taken in at one time (more taken in at once results in decreased absorption), and current calcium status of the individual (28).

Dietary Assessment Methods

The most common methods used for dietary assessment of vitamin D and calcium intake are 3-day dietary records, food frequency questionnaires, 24 hour recall, and 7 day weighted food inventories. Each method has advantages and disadvantages. A 24-hour recall and 3-day dietary records are fast, relatively inexpensive, and can be executed with minimal effort (29). On the other hand, the two methods may not accurately reflect long term eating habits. A 7-day weighed food inventory is more accurate, but invasive and sometimes difficult to execute. Differing weighed food methods may require dietitians to weigh foods at the beginning and end of studies, and/or for all foods eaten to be weighed by the participants themselves (30). Food frequency questionnaires (FFQ) are subject to faulty recall and may lack validity when compared to 3-day dietary records and 24 hour recalls (29, 31). Of the studies reviewed, a mix of these methods was used, some alone, and others in combination.

Association between Vitamin D status, Dairy, and Calcium Intake and Weight Status

A 2003 study followed children from ages 2 months to 8 years to assess calcium intake and body fat in children (32). Researchers found that higher mean longitudinal calcium intakes and daily servings of dairy products (approximately 300 mg higher than the lower group) were associated with lower body fat, independent of caloric intake. The higher mean calcium group had approximately 1 kg less total body fat than the lower group. When body fat was examined in relation to diet and hereditary obesity patterns, low calcium intake consistently predicted a 2-9% higher body fat in the cohort. A similar cross sectional study was performed on 9-14 year old girls in Hawaii from 2000-2001, and associated higher dairy intakes with lower iliac skin-fold thickness, in addition to lower variance in body weight (33).

A study of 107 adolescents (69 f, 39 m) analyzing 3 day dietary recalls found an inverse relationship (r = -.488) between calcium intake and fat tissue amount in males, although females in the study showed no significant correlations (34). A negative correlation was found in a study published in 2005, when researchers gathering statistics from the Framingham Children's Study examined children 3-5 years of age through adolescence, from 1996 to 1999. Researchers concluded that over time, higher mean calcium intakes correlated with lower weight gain and body fat percentage (35). The correlation was stronger in children who consumed more dairy as a source of calcium versus children with similar calcium intakes from other sources (35).

A study of 196 normal weight pre-menarchal girls (8-12 years) followed subjects 4 years post menarche and analyzed their percent body fat, BMI, and intake of dairy (questionnaire). The researchers found no relation between BMI, body fat percentage and dairy intake after adjustment for energy intake (10). A 2006 study, using a seven-day food inventory for measures of calcium intake, followed 85 children between 7-10 years in London (25). The study found 48% of boys and 38% of the girls were overweight, despite girls having significantly lower mean calcium intakes. There was also no association between BMI or body weight and calcium intake. In 2008, overweight children (ages 8-10) were randomly assigned to either a high milk consumption group (4 servings) or low milk consumption group (1 serving). For 16 weeks, tests for glucose tolerance insulin, lipids, body weight measurements and body composition were monitored. Although the study did not show any significant body weight changes between the two groups, there was a trend toward reduced insulin output with the high milk consumption group (36).

Surveys of 12,829 children between the ages of 9 and 14 were collected over a 3 year period (4). A food frequency questionnaire as well as anthropometric measures were completed and returned annually by mail between 1996-1999. The study found that children who reportedly drank 3+ servings of milk daily had a significantly greater increase in BMI over time than those who only drank 1-2 glasses per day (4). However, after adjusting for calories, dairy fat, and total fat intake, the relationship between dairy servings and calcium in relation to BMI were not significant.

Mechanisms

A suggested hypothesis as to why calcium intake may help with weight loss and maintenance is through potential effects on appetite and food intake (37). Calcium may have acted as an indicator of food availability in the ancestral environment (37). When food is plentiful (high calcium intake), fat accumulation is halted, and when food is scarce (low calcium intake), fat accumulation is increased (37). A mechanism by which higher calcium intake may influence fat loss is through dietary calcium's ability to suppress calcitriol (the active form of vitamin D), which exerts genomic and non-genomic effects on adipocyte metabolism (38). Increased calcitriol levels up regulate genes that promote adipocyte proliferation, inflammatory factors, and inhibit adipocyte apoptosis (21). A strong research base seems to indicate vitamin D status is negatively correlated with weight status and BMI, but a conclusive relationship (as well as mechanisms) has not been determined. Of the few studies that have investigated both vitamin D and calcium, conclusions are mixed, and clinical trials are limited. Meanwhile, dairy contributes greater than 50% of daily calcium intake among adults and children (3). However, there are complicating factors involved with drawing conclusions from dairy intake as it has high satiety properties independent of its calcium and vitamin D content (37). Some constituents of dairy, such as casein macro peptides (CMP), may help regulate food intake, body composition, and body weight (37). Calcium and dairy may also have differing effects on gut hormones that regulate satiety, food intake, and gastric emptying like cholecystokin (CCK), ghrelin, and glucagon-like peptide-1 (GLP-1) (37). However, research is limited and more studies are necessary to reach conclusions.

REFERENCES

1. Kamycheva E, Joakimsen RM, Jorde R. Intakes of calcium and vitamin D predict body mass index in the population of northern Norway. J Nutr. 2002; 132: 102-106.

2. Santos LC, Cintra IP, Fisbesrg M, Martini LA. Calcium intake and its relationship with adiposity and insulin resistance in post pubertal adolescents. J Hum Nutr Diet. 2008; 21:109-116.

3. Harkness LS, Bonny AE. Calcium and vitamin D status in the adolescent: key roles for bone, body weight, glucose tolerance, and estrogen biosynthesis. J Pediatr Adolesc Gynecol. 2005; 18: 305-311.

4. Berkey CS, Rockett HRH, Willet WC, Colditz GA. Milk, dairy fat, dietary calcium, and weight gain: a longitudinal study of adolescents. Arch Pediatr Adolesc Med. 2005; 159: 543-550.

5. Troiano RP, Flegal KM. Overweight children and adolescents: description epidemiology, and demographics. Pediatrics. 1998; 101(3): 497-504.

6. Zemel MB. Role of dietary calcium and dairy products in modulating obesity. *Lipids.* 2003;38:139-146.

7. Pereira MA, Jacobs DR Jr, Van Horn L, Slattery ML, Kartashov AI, Ludwig DS. Dairy consumption, obesity, and the insulin resistance syndrome in young adults: the CARDIA Study. *JAMA*. 2002;287:2081-2089.

8. Teegarden D, Zemel MB. Dairy product components and weight regulation: symposium overview. *J Nutr*. 2003;133:243S-244S.

9. Kull M, Kallikorm R, Lember M. Body mass index determines sunbathing habits: implications on vitamin D levels. Intern Med J. 2009; 39: 256-258.

10. Phillips SM, Bandini LG, Cyr H, Colclough-Douglas S, Naumova E, Must A. Dairy food consumption and body weight and fatness studied longitudinally over the adolescent period. Int J Obes. 2003; 27: 1106-1113.

11. Garcia OP, Long KZ, Rosado JL. Impact of micronutrient deficiencies on obesity. Nutr Rev. 2009; 67 (10): 559-572.

12. Rajakumar K, Holick MF, Jeong K, Moore CG, Chen TC, Olabopo F, Haralam MA, Nucci A, Thomas SB, Greenspan SL. Impact of season and diet on vitamin D status of African American and Caucasian children. *Clin Pediatr.* 2011; 50(6):493-502.

13. Institute of Medicine. Reports at a Glance: DRIs for calcium and vitamin D. Issued November 30, 2011. Institute of Medicine Web site. http://www.iom.edu/Reports/2010/ Dietary-Reference-Intakes-for-Calcium-and-Vitamin-D/DRI-Values.aspx. Accessed April 11, 2011.

14. Ferrari HB. Vitamin D: What is an adequate vitamin D level and how much supplementation is necessary? Best Pract Res Clin Rheumatol. 2009; 23:789-795.

15. Mansbach JM, Ginde AA, Carlos CA. Serum-hydroxy vitamin D levels among US children aged 1 to 11 years: Do children need more vitamin D?. *Pediatrics.* 2009; 124: 1404–1410.

16. National Institutes of Health Office of Dietary Supplements. Dietary Supplement Fact Sheet: Vitamin D. Issued February 2011. National Institute of Health Web site. http://ods.od.nih.gov/factsheets/VitaminD-HealthProfessional/#h2. Accessed April 11, 2011.

17. Kulie T, Groff A, Redmer J, Hounshell J, Schrager S. Vitamin D: An evidence-based review. *J Am Board Fam Med* 2009; 22:698 –706.

18. Mosekielde L. Vitamin D requirement and setting recommendation levels: long term perspectives. Nutr Rev. 2008; 66: S170-S177.

19. Wagner CL, Greer FR. Prevention of rickets and vitamin D deficiency in infants, children, and adolescents. *Pediatr Rev*. 2008; 122(5): 1142-1152.

20. Wortsman J, Matsuoka LY, Chen TC, Lu Z, Holick MF. Decreased bioavailability of vitamin D in obesity. Am J Clin Nutr. 2000; 72(3):690-693.

21. Sun X, Morris KL, Zemel MB. Role of calcitriol and cortisol on human adipocyte proliferation and oxidative and inflammatory stress: A microarray study. *J Nutrigenet Nutrigenomics*. 2008; 1: 30-48.

22. Schrager S. Dietary calcium intake and obesity. J Am Board Fam Med. 2005; 18: 205-210.

23. Harkness LS, Bonny AE. Calcium and vitamin D status in the adolescent: Key roles for bone, bodyweight, glucose tolerance, and estrogen biosynthesis. *J Pediatr Adolesc Gynecol.* 2005; 18:305–311.

24. Keller KH, Kirzner J, Pietrobelli A, St-Onge MP, Faith MS. Increased sweetened beverage intake is associated with reduced milk and calcium intake in 3 to 7 year oldchildren at multi item laboratory lunches. *J Am Diet Assoc.* 2009;109:497-501.

25. Jennings A, Costarelli V, and Davies GJ. Habitual dietary calcium intake and body weight in 7-10 year old children. *Nutr & Food Sci.* 2006; 36(5): 337-342.

26. Melamed ML, Kumar J, Muntner P, Kaskel FJ, Hailpern SM. Prevalence and associations of 25-hydroxyvitamin D deficiency in children and adolescents in the United States: Results from NHANES 2001-2004. *Pediatrics.* 2009; 124(3): 362-370.

27. Kumar J, Muntner P, Kaskel FJ, Hailpern SM, Melamed ML. Prevalence and assocaitions of 25-hydroxy vitamin D deficiency in US children: NHANES 2001-2004. *Pediatr.* 2009; 124(3):e1-e9.

28. National Institutes of Health Office of Dietary Supplements. Dietary Supplement Fact Sheet: Calcium. Issued February 2011. National Institute of Health Web site. http://ods.od.nih.gov/factsheets/calcium/#h2. Accessed April 11, 2011.

29. Yang YJ, Kim MK, Hwang SE, Ahn Y, Shim JE, Kim DH. Relative validities of 3-day food records and the food frequency questionnaires. *Nutr Res Pract.* 2010; 4(2): 142-148.

30. Wise A, Birrell NM. Design and analysis of food frequency questionnaires – review and novel method. *Int J Food Sci Nutr.* 2002; (53) : 273-279.

31. Burroughs TL, Martin RJ, Collins CE. A systematic review of the validity of dietary assessment methods in children when compared with the method of doubly layered water. *J Am Diet Assoc.* 2010; 110(10): 1501-1510.

32. Skinner JD, Bounds W, Carruth BR, Ziegler P. Longitudinal calcium intake is negatively related to children's body fat indexes. *J Am Diet Assoc*. 2003; 103:1626-1631.

33. Novotny R, Daida YG, Acharaya S, Grove JS, Vogt TM. Dairy intake is associated with lower body fat and soda intake with greater weight in adolescent girls. *J Nutr*. 2004; 134: 1905-1909.

34. Goldberg TBL, Silva CC, Peres LNL, Berbel MN, Heigasi MB, Ribiero JMC, Suzuki K, Josue LMA, Dalmas JC. Calcium intake and its relationship with risk of overweight and obesity in adolescents. *Arch Latinoam Nutr*. 2009; 59(1): 14-21.

35. Huang TK, McCrory MA. Dairy intake, obesity, and metabolic health in children and adolescents: Knowledge and gaps .*Nutr Rev.*2005; 63(3):71-80.

36. St-Onge MP, Goree LLT, Gower B. High milk supplementation with healthy diet counseling does not affect weight loss but ameliorates insulin action compared with low milk supplementation in overweight children. *J Nutr*. 2008; 139: 933-938.

37. Teegarden D, Gunther CW. Can the controversial relationship between dietary calcium and bodyweight be mechanistically explained by alterations in appetite and food intake? *Nutr Rev.* 2008; 66(10): 601-605.

38. Sun X, Zemel MB. 1α, 25 dihydroxyvitamin D and corticosteroid regulate adipocyte nuclear vitamin D receptor. *Int J Obes*. 2008; 32: 1305-1311.

39. United States Department of Agriculture. Dietary Guidelines for Americans. Issued January 31, 2011. USDA Center for Nutrition Policy and Promotion Website. http://www.cnpp.usda.gov/ dietaryguidelines.htm. Accessed July 12, 2011.

CHAPTER III

MANUSCRIPT IN STYLE OF JOURNAL

TITLE: THE RELATIONSHIP BETWEEN VITAMIN D AND CALCIUM/DAIRY INTAKE AND OBESITY IN CHILDREN

Key words: vitamin D, calcium, obesity, children

Word count abstract: 402

Word count text: ####

Jason Barry

Graduate Nutrition Student

Georgia State University

jabarry85@gmail.com

Anita M. Nucci, PhD, RD, LD

Assistant Professor & Graduate Program Director

Georgia State University

Phone: (404) 413-1234

anucci@gsu.edu

Meera Penumetcha, PhD, RD

Assistant Professor

Georgia State University

nadmn@langate.gsu.edu

Phone: (404) 413-1228

Catherine McCarroll, MPH, RD, LD
Coordinated Program Director, Clinical Instructor
Georgia State University
Phone: 404-413-1232
cmccarroll@gsu.edu

Corresponding Author: Anita M Nucci, PhD, RD, LD

Georgia State University
Division of Nutrition
College of Health and Human Sciences
PO Box 3995
Atlanta, GA 30302-3995
Phone: (404) 413-1000

Abstract

Background: Obesity rates are increasing at an epidemic rate, not only in the United States, but also worldwide. Some research has shown a positive association between weight loss or maintenance with increased vitamin D and calcium intake (particularly dairy products, in adults) while other research has found a negative association. The aim of this study is to examine the relationship between vitamin D and calcium intake and obesity in a population of young adolescents who participated in a Vitamin D and Sunlight Exposure study in Pittsburgh, PA. Methods: 252 healthy 6 to 14.9 year old young adolescents (54% male, 69% African American) were recruited between June 2006 and December 2009. Weight status was determined, BMI was calculated and intake of vitamin D, calcium and vitamin D and calcium rich foods was self-reported. Results: 59.3% of the population was normal weight, 17.7% overweight and 23% obese. A significant difference by race was observed with 30.1% of African Americans and 8.5% of Caucasians being obese (P<0.01). No difference was found by gender. Median (25%, 75%) vitamin D intake in the total population was 254.9 IU (146.8, 407.3) which is below the level recommended by the Institute of Medicine. Median calcium intake in the total population was 1193.6 mg (752.8, 1161.1) which met recommended guidelines. Median milk intake was reported at 2 servings/day and did not differ by race. Intake of additional foods rich in vitamin D and calcium differed by race, with African Americans consuming more cheese than Caucasians (1 serving/day vs. 0.5 servings/day, respectively; P=0.014) and orange juice (0.1 servings/day vs. 0 servings/day, respectively; P=0.045) but less yogurt (0 servings/day vs. 0.5 servings/day, respectively; P=0.031). Median vitamin D intake differed by weight status (normal, overweight, obese) in the total population (259.5 IU, 325.2 IU and 181.9 IU, respectively; *P*=0.015). A similar pattern was observed for calcium (1193.4 mg, 1416.3 mg and 911.6 mg, respectively; *P*=0.016). No correlation was found between vitamin D or calcium intake and BMI in the total population or by race and gender. Conclusion: Although no correlation was found with BMI and calcium and vitamin D intake, vitamin D and calcium intake was significantly different based on weight status, particularly in obese and African American subjects. Vitamin D intake in our population was reportedly below recommended guidelines. Further research is necessary to determine the ideal vitamin D and calcium intake in children, as well as longitudinal studies to better assess the relationship between vitamin D and calcium intake and weight status.

Introduction

Obesity rates are increasing at an epidemic rate, not only in the United States, but worldwide (1). Obesity has been found to increase the likelihood of poor health and increases all-cause mortality (1). Approximately one out of three children in the U.S. is now considered to be overweight or obese (2). Over the past few decades, research has shown positive and negative associations between weight loss and maintenance with increased vitamin D and calcium intake (particularly with dairy products) in adults (3, 4, 5, 6, 7, 8). Additionally, studies have demonstrated links between high body mass indices (BMI) and decreased sun exposure, as well as decreased vitamin D levels (9). However, there is a discrepancy in data with children, as fewer studies have been done and findings have been inconclusive (2, 4). Further complicating the issue, with increased soda/juice consumption as opposed to vitamin D fortified milk, increasingly westernized lifestyles, and decreased frequency of meals eaten at home, vitamin D production/intake and calcium intake are at all-time lows among children (9, 10). The research base concerning vitamin D and calcium intake and weight is conflicting in both children and adults, as it is not clear whether calcium alone affects weight status or whether the associations found between obesity and vitamin D deficiency are causal, among others (11). Factors such as race and sex in relation to calcium and vitamin D intake and weight status have not been explored thoroughly, particularly in children. The purpose of this study is to examine the relationship between vitamin D and calcium intake and childhood weight status and obesity in a population of young adolescents who participated in a Vitamin D and Sunlight Exposure study (2006-2010) in Pittsburgh, Pennsylvania (PA) (12).

Hypothesis: Vitamin D and calcium intake differ based on weight status in young adolescents.

Methods

Participants

The population for this study was healthy 6-14.9 year old pre- and early adolescent African American and Caucasian children residing in Pittsburgh, PA. Subjects were participants in Dr. Rajakumar's (12) National Institutes of Health-funded (R03 and K23 grants) vitamin D clinical research protocols designed to assess seasonal variation and racial differences in vitamin D status of African American and Caucasian children (short longitudinal observational study, n=140) and refine the serum 25(OH)D thresholds for defining vitamin D insufficiency in children (randomized controlled trial [RCT] of

1000 IU of vitamin D3 vs. placebo for 6 months, n=116). Subjects were recruited from the Primary Care Center of the Children's Hospital of Pittsburgh between June 2006 and December 2009. Children with hepatic or renal disease, metabolic rickets, malabsorptive disorders, cancer, or those on treatment with anticonvulsants or systemic glucocorticoids were excluded. Subjects enrolled in the RCT were either not taking multivitamins for at least 1 month prior to enrollment or willing to stop the multivitamin for a 1 month washout period prior to study entry. Children on oral contraceptives or depot medoroxyprogesterone were also excluded from the clinical trial. There were a total of 252 children with a mean age of 10.4 $\pm$ 2.2 years. African American children represented 68% of the group. Phase 1 of the Vitamin D and Sunlight Exposure Study occurred between 2006 and 2008. Participants were monitored for vitamin D intake and sunlight exposure. Phase II of the study, which occurred between 2008 and 2009, included randomization to a vitamin D supplement or placebo. The Vitamin D and Sunlight Exposure study protocol was approved by the University of Pittsburgh Institutional Review Board and all participants provided written informed consent. The current study protocol was approved by the Georgia State University Institutional Review Board.

Diet Analysis

In both phases of the study, parents of all subjects were asked to complete both a long food frequency questionnaire (LFFQ; Appendix B) and a short vitamin D intake and sunlight exposure questionnaire (SFFQ, Appendix A) at two time points, 6 months apart. The LFFQ was a semiquantitative food frequency questionnaire with 7 food groups and 152 questions. Completed SFFQs were analyzed using Food Processor (version 10.4, ESHA Research; Salem, OR) by the Clinical Nutrition Department at the Children's Hospital of Pittsburgh of UPMC and graduate nutrition students at Georgia State University. The LFFQ, titled Eating Survey, K-95-1, (Harvard Medical School, © 1995 Brigham and Women's Hospital) was analyzed at Brigham and Women's Hospital. Vitamin D and calcium intake values were analyzed from the LFFQ as it was previously validated for use in children. The SFFQ included 21 questions to identify intake of foods high in vitamin D and calcium (e.g. cod liver oil, milk, cheese, yogurt, vitamin D and calcium fortified orange juice, fish and dried mushrooms) and had been validated against the LFFQ. After processing and analysis, nutrient intake data comprised 17 nutrients including total calories, dietary calcium, and vitamin D.

Research Design

The study was a cross sectional secondary quantitative data analysis of completed food frequency questionnaires from the Vitamin D and Sunlight Exposure study. Anthropometric data including height, weight, and BMI were calculated. Weight status was defined using Center for Disease Control growth charts. Subjects were classified as normal/underweight (<85th%ile), overweight (85^{th}-95^{th}%ile), or obese (>95%ile). Data were used to assess the correlation between vitamin D and calcium and BMI.

Data Analysis

All demographic, anthropometric and dietary intake data was entered into SPSS® (version 18, 2010, IBM Corp, Armonk, NY). Demographic characteristics and nutrient intake variables for the entire cohort as well as by gender and race were determined.

Normality statistics were run, with height, weight, age, and BMI being normally distributed. Vitamin D and calcium rich food sources were skewed, as well as vitamin D and calcium intake levels. Frequency analysis was used to ascertain proportions, anthropometric measures were analyzed, and median daily intake of vitamin D, calcium, and food servings were assessed. Differences in weight status by gender and race were assessed using the Chi-square test with Kendall's tau c to measure the strength of the association. Differences in intake by weight status were assessed using the Kruskal-Wallis Test; pairwise comparisons were assessed using the Mann-Whitney U test. The Spearman's rho correlation statistic was used to determine the association between BMI and calcium and vitamin D intake.

Results

A total of 252 adolescents participated in the study. Of these, 174 were self-reported as African American (55% male) and 78 as Caucasian (54% male). Participant age ranged from 6 to 14.9 years, with an average age of 10.4 $\pm$ 2.2 years ($\pm$SD). Body mass index (BMI) ranged from 13.78 to 46 kg/m^2, with an average of 20.2 $\pm$ 5.1 kg/m^2. Height and weight measures by gender and race are shown in Table 1. There were no significant differences between anthropometric values by race or gender (weight status by race and gender are in Table 2). Of the total population, 59.3% were classified as normal, 17.7% as overweight, and 23% as obese. There were no significant differences between weight status by gender. African Americans had a significantly higher proportion of obese participants (30.1%) than Caucasians (8.5%) (P=.001). Caucasian females had a significantly (P=.006) lower proportion of obese participants (2.9%) than African

American females who had the highest proportion overall (31.2%). A similar pattern was found in African American and Caucasian males (29.2% and 12.8% obesity, respectively), although the difference was not significant.

Median intake of vitamin D, calcium, and food sources were used in this analysis due to the skewed distribution of the data. For the total population, median daily intake (25%, 75%)of vitamin D and calcium was 254.9 IU (146.8, 407.3) and 1193.6 mg (752.8, 1161.1), respectively (Table 3). Males reported a higher median intake of vitamin D and calcium than did females, and African Americans reported higher intakes versus Caucasians. However, these differences were not statistically significant. Reported vitamin D and calcium intake by Caucasian females was the lowest among all subgroups. Caucasian males had the highest median daily intake of vitamin D (273.3 IU), while African American females reported the highest median daily intake of calcium (1237.4mg). The primary sources of vitamin D and calcium intake for the total population were milk and cheese (Table 4). There were no significant differences in food intakes by gender (Table 5). In both African American and Caucasian adolescents, milk was the primary source of vitamin D and calcium, with both groups consuming a median of 2 servings of milk per day. Significant differences existed by race, as African Americans consumed more cheese (P=0.014) less yogurt (P=0.031) than did Caucasians (Table 6). Significant differences were seen in vitamin D and calcium fortified orange juice consumption as well, with African Americans consuming more orange juice than Caucasians (P=.045). When stratified by race and then gender, there were no significant differences in intake by vitamin D and calcium rich food source between males and females (Table 7).

Median vitamin D and calcium intakes by weight status for the total population, by race, and by gender are shown in Tables 8 and 9. For the total population, median vitamin D intake differed significantly by weight status (259.5 IU for normal weight subjects, 325.2 IU for overweight subjects, and 181.9 IU for obese subjects; P=0.015). Overweight subjects had the highest median vitamin D intake in the total population and most demographic groups, while obese subjects had the lowest intake in the total population and all demographic categories except Caucasian females (who also had the smallest sample size). Significant differences in vitamin D intake between weight classes were seen in African Americans (P=0.006), which may explain the differences in the total population vitamin D intake as it was majority African American (68%). When looking at differences between weight classes for vitamin D intake in African Americans and the total population, no differences were observed between those in the normal and overweight classifications. However, significant differences in intake were found between overweight and obese, and normal and obese weight classes in both the total population (P=0.005 and 0.032, respectively) and African Americans (P=0.005 and 0.033, respectively).

Median calcium intakes by weight class were similar to vitamin D, with significant differences between classes seen in the total population (P=0.016) and African Americans (P=0.013) (Table 9). In the total population, median daily calcium intake was reported for normal, overweight and obese subjects at 1193.4 mg, 1416.3 mg and 911.6 mg, respectively. The obese weight class had the lowest median intake across all demographic subgroups except Caucasian females, and overweight subjects had the highest median calcium intake in the total population and most demographic groups.

(Table 9). Significant differences were seen in African Americans and the total population between normal and overweight subjects (P=0.023 and 0.011, respectively), and overweight and obese subjects (P=0.006 and 0.006, respectively). No significant correlation was found between vitamin D or calcium intake and BMI in the total population (Figures 1 and 2), by race, or by gender, when tested both with and without outliers.

Discussion

Although no correlation was found with BMI and calcium and vitamin D intake, vitamin D and calcium intake was significantly different based on weight status, particularly in obese and African American subjects. Vitamin D and calcium intake in this population was below recommended guidelines, with obese children consuming less than overweight and normal/underweight groups. The proportion of obese subjects was significantly different by race, with more African Americans being obese than Caucasians (30.1% vs 8.5%, respectively). However, median intake of vitamin D and calcium did not differ by race or gender.

Currently, the RDA for vitamin D in children ages 1 to 18 is 600 IU/day (13). For calcium, the current RDA is 1000 mg/day for 4 to 8 year olds, and 1300 mg/day for those 9 to 18 years (13). The median vitamin D intake for the total population was 254.9 IU, well below the RDA value and the Estimated Average Requirement (EAR) of 400 IU/day (the amount necessary to meet the needs of 50% of the population). The median value for calcium intake for the total population was 1193.6 mg, which is above the RDA for 4-8 year olds, but below the RDA for 9-18 year olds. More information continues to emerge regarding optimal 25 (OH)D levels, which has driven some researchers in the nutrition community to push for the RDA for vitamin D to be increased. Some of these researchers are also calling for a decrease in calcium intake as vitamin D intake rises (15). If raised further (some suggest to 2000 IU/day) (14), vitamin D intake in nearly the entire study population would be considered insufficient. Previous research has shown decreased vitamin D intake in children and adolescents, as only 50% of those aged 9-13 years and 32% of those aged 14-18 years consume sufficient vitamin D (23). Of the 252 subjects in our study, only 15 (6%) received at least the RDA of 600 IU, and only 66 (26.1%) consumed the EAR of >400 IU. The results from this study are consistent with previous findings of low/inadequate vitamin D and calcium intake among adolescents (9, 10, 15, 22, 23, 26).

It has been estimated that only 30% of American children consume the recommended amounts of calcium (22). 42.8% of participants in the current study consumed 1300mg or more calcium per day, which is well above national estimates, although still low. Previous studies have found milk to be the primary source of vitamin D and calcium in children's diets in the US, often contributing to more than 50% of daily calcium intakes (23). Data in this study are consistent for the most part, as milk was the most commonly consumed of the five vitamin D and calcium rich foods analyzed. When analyzed by race and gender, milk remained the most consumed product amongst the sources surveyed.

Generally speaking, experts consider healthy serum 25 (OH)D levels to be >50nmol/L, with greater than 75 nmol/L considered best for overall health (14, 17, 18). Considering the reduced sunlight exposure in westernized lifestyles (19), the vitamin D intakes reported by early-adolescents in this study are alarming, particularly among African Americans. Nearly half of all African American children have 25 (OH)D levels below 50 nmol/L, as minorities with darker skin tone require more direct sunlight for vitamin D production (15, 17), as well as higher dietary intakes to reach similar serum levels to Caucasians (14, 18). Although no significant differences in intakes of calcium or vitamin D were found across races, the relatively low median vitamin D intakes of African Americans were well below the RDA and EAR, and could be linked to increased incidences of diseases and conditions in African Americans such as obesity, diabetes, and heart disease (14, 17, 18), as well as partially explain the significantly higher proportion of obese subjects in the group. Research has shown that populations with <1 serving per week of milk are at increased risk of vitamin D deficiency (26). However, African Americans and Caucasians in this study consumed approximately 14 servings of milk per week (Table 6).

The USDA Dietary Guidelines (39) recommends children 4 – 8 years old should consume 2.5 servings of dairy or more, and children over 8 should consume at least 3 servings per day. Participants in this study consumed a median of 2 servings of milk per day, along with 1.3 servings of other dairy and vitamin D fortified foods per day (Table 4). Although consistent with USDA recommendations, when analyzed for calcium and vitamin D intake, nearly all in the study were below RDAs for vitamin D and a majority below the RDA s for calcium intake. One serving of fortified milk (1 cup) typically contains 120 IU vitamin D and 280 mg calcium. When considering vitamin D and calcium levels in dairy foods, three servings of dairy (milk in this case) do not meet RDA values. Alternate dairy sources are typically lower in calcium and vitamin D than milk, and help explain some of the subpar intakes seen in subjects in the study. Considering the sub-par levels of vitamin D and calcium intake in subjects in this study and in the general population, clearer guidelines may be necessary for recommended servings of dairy per day.

Males consumed more dairy servings per day than females, and although there was no significant difference in intakes by gender, females fell below the recommended 3 servings per day. African American subjects consumed significantly more cheese, and fortified orange juice, but less yogurt than Caucasians. Although significant differences were observed in intakes of these food sources, if total servings of vitamin D and calcium rich food sources are counted, African Americans consumed 3.1 servings of dairy, versus 3 servings for Caucasians.

When subjects were separated by weight classification, significant differences in vitamin D and calcium intake in African Americans and in the total population were observed. No significant differences were observed in other demographic groups. Obese subjects in all demographic groups reported the lowest vitamin D and calcium intakes, except for Caucasian females. Normal weight Caucasian females had the lowest vitamin D intake. An explanation for low intakes amongst Caucasian females could be lower overall energy intake, partially explained by low dairy consumption, as this group associates increased dairy consumption with weight gain (16, 25). Higher overall vitamin D and calcium intake was observed in overweight subjects. This finding may be partially explained by increased dairy servings and energy intake overall, resulting in higher weights as well as vitamin D and calcium intake. Although this group may have an overall higher energy intake, the increased vitamin D and calcium intakes may have a protective effect against obesity.. Further analysis of this data could investigate vitamin D sources by weight class. Eighty to ninety percent of vitamin D production is endogenous (15). However, sunlight exposure in modern times is limited with western lifestyles (19), and alternate methods of vitamin D intake must be considered for low intake populations. The most efficient way to increase vitamin D intake is through supplementation (20). Given their low intakes, and the latitude of subjects in the study, supplementation would be the most efficient method for the population to reach adequate intakes of vitamin D. African Americans and other dark skinned minorities in higher latitudes could potentially benefit from vitamin D supplements, as they require more sunlight exposure and dietary intake to reach 25 (OH)D levels similar to Caucasians (14, 18). Currently, only 1 in 3 American children consume vitamin D supplements (15). And of those supplementing (typically 100 -400 IU vitamin D2 or D3), 1 in 10 had 25 (OH)D levels below 50 nmol/L and 1 in 2 below 75 nmol/L (15). Higher calcium intakes can be encouraged through increases in calcium rich sources in the diet. However, additional calcium intake may not be necessary as the increased vitamin D may lower the need for dietary calcium (14). More research is necessary to determine the influence of increased dietary vitamin D intake and 25 (OH)D levels on calcium needs.

The prevalence of decreased calcium and vitamin D intake among obese subjects in the population is consistent with previous research (9, 10, 11). Inverse relationships have been observed between 25 (OH)D levels and body fat percentage, BMI, and total body fat (18). Although not analyzed, 25(OH)D levels would be assumed to be low in obese subjects due to the groups low intake levels and possible increased storage in adipocytes (20). The question then goes to why would low vitamin D intake contribute to obesity? Some believe it may be due to vitamin D rich food sources such as dairy, which are rich in calcium. Increased intakes of calcium have been associated with decreased BMI and body fat levels (37). A mechanism for this association may be explained through calcium's inhibition of the conversion of 25 (OH)D to calcitriol (21). Calcitriol has been shown to promote adipocyte proliferation, inflammatory factors, and inhibit adipocyte apoptosis (21). Higher calcium intakes have proven to be effective in stimulating weight loss and weight control (32, 33), so it may be possible that with increased vitamin D comes more efficient use of calcium by the body, and therefore decreased fat stores (21). It is speculated that calcium rich foods may be associated with increased satiety due to the presence of casein macro-peptides and through regulation of gut hormones (37). Taking into account skin color and its influence on vitamin D production, racial differences in proportions of obesity may be partially explained via vitamin D and calcium's synergistic mechanisms regulating fat deposition, despite relative the insignificance of intake levels between races.

This study has both strengths and limitations. The strengths of this study include the large sample size and the use of a validated and comprehensive FFQ. However, the FFQ is subject to recall bias as well as error, given that it was completed by parents of subjects in the study. Ideally, a combination of methods for dietary data collection should be used, as validated FFQs sometimes lack validity when compared to 3 day food diaries and 24 hour recalls (29, 31). Participants were recruited via convenience sample from a single pediatric healthcare clinic in Pittsburgh, Pennsylvania, and may not be representative of the general population. Other factors that can influence vitamin D status in an individual, such as amount of sunlight received, were not included in this analysis. Statistical software cannot account for variations in vitamin D and calcium content of different food sources, and may not accurately reflect intakes. Subjects were classified as being normal weight, overweight or obese. We do not know if any of the subjects in the normal weight category were underweight. In addition, given that this was a cross sectional secondary data analysis, it is possible to suggest an association between vitamin D and calcium intake and obesity, but impossible to determine cause and effect between the two variables. Future research is needed to draw sound conclusions. Sources of vitamin D and calcium intake by weight classification as well as the impact of total daily caloric intake on the association between nutrient intake and BMI should be determined. Phase II of Dr. Rajakumar's study is a randomized clinical trial which aims to determine the impact of vitamin D supplementation on serum vitamin D status. Secondary analysis of the impact of diet and supplementation will then be possible in this population.

Conclusion

The studies' findings were consistent with previous literature regarding inadequate vitamin D and calcium intake in children. Weight status, but not BMI was negatively associated with vitamin D and calcium intake in young adolescents, particularly in African Americans. Significant differences were not seen by gender. The proportion of obese subjects was significantly different by race, with more African Americans classified obese than Caucasians (30.1% vs 8.5%). However, median intake of vitamin D and calcium did not differ by race or gender. Future research is necessary to determine the complex interactions of vitamin D and calcium intakes/status in obese children.

References

1. Kamycheva E, Joakimsen RM, Jorde R. Intakes of calcium and vitamin D predict body mass index in the population of northern Norway. J Nutr. 2002; 132: 102-106.

2. Santos LC, Cintra IP, Fisbesrg M, Martini LA. Calcium intake and its relationship with adiposity and insulin resistance in post pubertal adolescents. J Hum Nutr Diet. 2008; 21:109-116.

3. Harkness LS, Bonny AE. Calcium and vitamin D status in the adolescent: key roles for bone, body weight, glucose tolerance, and estrogen biosynthesis. J Pediatr Adolesc Gynecol. 2005; 18: 305-311.

4. Berkey CS, Rockett HRH, Willet WC, Colditz GA. Milk, dairy fat, dietary calcium, and weight gain: a longitudinal study of adolescents. Arch Pediatr Adolesc Med. 2005; 159: 543-550.

5. Troiano RP, Flegal KM. Overweight children and adolescents: description epidemiology, and demographics. Pediatrics. 1998; 101(3): 497-504.

6. Zemel MB. Role of dietary calcium and dairy products in modulating obesity. Lipids. 2003;38:139-146.

7. Pereira MA, Jacobs DR Jr, Van Horn L, Slattery ML, Kartashov AI, Ludwig DS. Dairy consumption, obesity, and the insulin resistance syndrome in young adults: the CARDIA Study. JAMA. 2002;287:2081-2089.

8. Teegarden D, Zemel MB. Dairy product components and weight regulation: symposium overview. J Nutr. 2003;133:243S-244S.

9. Kull M, Kallikorm R, Lember M. Body mass index determines sunbathing habits: implications on vitamin D levels. Intern Med J. 2009; 39:256-258.

10. Phillips SM, Bandini LG, Cyr H, Colclough-Douglas S, Naumova E, Must A. Dairy food consumption and body weight and fatness studied longitudinally over the adolescent period. Int J Obes. 2003; 27: 1106-1113.

11. Garcia OP, Long KZ, Rosado JL. Impact of micronutrient deficiencies on obesity. Nutr Rev. 2009; 67 (10): 559-572.

12. Rajakumar K, Holick MF, Jeong K, Moore CG, Chen TC, Olabopo F, Haralam MA, Nucci A, Thomas SB, Greenspan SL. Impact of season and diet on vitamin D status of African American and Caucasian children. Clin Pediatr. 2011; 50(6):493-502.

13. Institute of Medicine. Reports at a Glance: DRIs for calcium and vitamin D. Issued November 30, 2011. Institute of Medicine Web site. http://www.iom.edu/Reports/2010/Dietary-Reference-Intakes-for-Calcium-and-Vitamin-D/DRI-Values.aspx. Accessed April 11, 2011.

14. Ferrari HB. Vitamin D: What is an adequate vitamin D level and how much supplementation is necessary? Best Pract Res Clin Rheumatol. 2009; 23:789-795.

15. Mansbach JM, Ginde AA, Carlos CA. Serum-hydroxy vitamin D levels among US children aged 1 to 11 years: Do children need more vitamin D?. Pediatrics. 2009; 124: 1404–1410.

16. National Institutes of Health Office of Dietary Supplements. Dietary Supplement Fact Sheet: Vitamin D. Issued February 2011. National Institute of Health Web site. http://ods.od.nih.gov/factsheets/VitaminD-HealthProfessional/#h2. Accessed April 11, 2011.

17. Kulie T, Groff A, Redmer J, Hounshell J, Schrager S. Vitamin D: An evidence-based review. J Am Board Fam Med 2009; 22:698 –706.

18. Mosekielde L. Vitamin D requirement and setting recommendation levels: long term perspectives. Nutr Rev. 2008; 66: S170-S177.

19. Wagner CL, Greer FR. Prevention of rickets and vitamin D deficiency in infants, children, and adolescents. Pediatr Rev. 2008; 122(5): 1142-1152.

20. Wortsman J, Matsuoka LY, Chen TC, Lu Z, Holick MF. Decreased bioavailability of vitamin D in obesity. Am J Clin Nutr. 2000; 72(3):690-693.

21. Sun X, Morris KL, Zemel MB. Role of calcitriol and cortisol on human adipocyte proliferation and oxidative and inflammatory stress: A microarray study. J Nutrigenet Nutrigenomics. 2008; 1: 30-48.

22. Schrager S. Dietary calcium intake and obesity. J Am Board Fam Med. 2005; 18: 205-210.

23. Harkness LS, Bonny AE. Calcium and vitamin D status in the adolescent: Key roles for bone, bodyweight, glucose tolerance, and estrogen biosynthesis. J Pediatr Adolesc Gynecol. 2005; 18:305–311.

24. Keller KH, Kirzner J, Pietrobelli A, St-Onge MP, Faith MS. Increased sweetened beverage intake is associated with reduced milk and calcium intake in 3 to 7 year oldchildren at multi item laboratory lunches. J Am Diet Assoc. 2009;109:497-501.

25. Jennings A, Costarelli V, and Davies GJ. Habitual dietary calcium intake and body weight in 7-10 year old children. Nutr & Food Sci. 2006; 36(5): 337-342.

26. Melamed ML, Kumar J, Muntner P, Kaskel FJ, Hailpern SM. Prevalence and associations of 25-hydroxyvitamin D deficiency in children and adolescents in the United States: Results from NHANES 2001-2004. Pediatrics. 2009; 124(3): 362-370.

27. Kumar J, Muntner P, Kaskel FJ, Hailpern SM, Melamed ML. Prevalence and assocaitions of 25-hydroxy vitamin D deficiency in US children: NHANES 2001-2004. Pediatr. 2009; 124(3):e1-e9.

28. National Institutes of Health Office of Dietary Supplements. Dietary Supplement Fact Sheet: Calcium. Issued February 2011. National Institute of Health Web site. http://ods.od.nih.gov/factsheets/calcium/#h2. Accessed April 11, 2011.

29. Yang YJ, Kim MK, Hwang SE, Ahn Y, Shim JE, Kim DH. Relative validities of 3-day food records and the food frequency questionnaires. Nutr Res Pract. 2010; 4(2): 142-148.

30. Wise A, Birrell NM. Design and analysis of food frequency questionnaires – review and novel method. Int J Food Sci Nutr. 2002; (53) : 273-279.

31. Burroughs TL, Martin RJ, Collins CE. A systematic review of the validity of dietary assessment methods in children when compared with the method of doubly layered water. J Am Diet Assoc. 2010; 110(10): 1501-1510.

32. Skinner JD, Bounds W, Carruth BR, Ziegler P. Longitudinal calcium intake is negatively related to children's body fat indexes. J Am Diet Assoc. 2003; 103:1626-1631.

33. Novotny R, Daida YG, Acharaya S, Grove JS, Vogt TM. Dairy intake is associated with lower body fat and soda intake with greater weight in adolescent girls. J Nutr. 2004; 134: 1905-1909.

34. Goldberg TBL, Silva CC, Peres LNL, Berbel MN, Heigasi MB, Ribiero JMC, Suzuki K, Josue LMA, Dalmas JC. Calcium intake and its relationship with risk of overweight and obesity in adolescents. Arch Latinoam Nutr. 2009; 59(1): 14-21.

35. Huang TK, McCrory MA. Dairy intake, obesity, and metabolic health in children and adolescents: Knowledge and gaps .Nutr Rev.2005; 63(3):71-80.

36. St-Onge MP, Goree LLT, Gower B. High milk supplementation with healthy diet counseling does not affect weight loss but ameliorates insulin action compared with low milk supplementation in overweight children. J Nutr. 2008; 139: 933-938.

37. Teegarden D, Gunther CW. Can the controversial relationship between dietary calcium and bodyweight be mechanistically explained by alterations in appetite and food intake? Nutr Rev. 2008; 66(10): 601-605.

38. Sun X, Zemel MB. 1α, 25 dihydroxyvitamin D and corticosteroid regulate adipocyte nuclear vitamin D receptor. Int J Obes. 2008; 32: 1305-1311.

39. United States Department of Agriculture. Dietary Guidelines for Americans. Issued January 31, 2011. USDA Center for Nutrition Policy and Promotion Website. http://www.cnpp.usda.gov/ dietaryguidelines.htm. Accessed July 12, 2011.

Table 1. Mean Anthropometric Values at Baseline by Gender and Race*

	N	Age (years)	Mean Height (cm)	Mean Weight (kg)	Mean BMI (kg/m²)
Total Population	252	10.4 ± 2.2	141.2 ± 14.3	41.6 ± 16.8	20.2 ± 5.1
Male	137	10.4 ± 2.2	140.9 ± 14.3	39.3 ±14.4	19.2 ± 4.1
Female	115	10.4 ± 2.2	141.4 ± 14.3	44.2 ± 18.9	21.4 ± 5.8
African American	174	10.3 ± 2.2	142.3 ± 14.3	43.5 ± 18.5	20.8 ± 5.7
Male	95	10.5 ± 2.2	142.9 ± 14.3	41.2 ± 15.9	19.6 ± 4.6
Female	79	10.1 ± 2.2	141.6 ± 14.4	46.2 ± 20.7	22.2 ± 6.4
Caucasian	78	10.6 ± 2.1	138.9 ± 14.2	37.5 ± 11.5	18.9 ± 3.1
Male	42	10.2 ± 2.2	137.2 ± 13.7	35.6 ± 10.1	18.5 ± 2.7
Female	36	10.9 ± 1.9	141.2 ± 14.3	39.9 ±12.0	19.5 ± 3.6

*Mean ± SD

Table 2. Weight Classification Percentages at Baseline by Race and Gender

		Weight Status		
	N	Normal	Overweight	Obese
Total Population	252	59.3%	17.7%	23.0%
Male	137	61.0%	15.4%	23.5%
Female	115	57.1%	20.5%	22.3%
African American	174	53.0%	16.9%	**30.1%***
Male	95	55.1%	15.7%	29.2%
Female	78	50.6%	18.2%	31.2%*
Caucasian	78	72.0%	19.5%	**8.5%**
Male	42	72.3%	14.9%	12.8%
Female	36	71.4%	25.7%	2.9%

*P<0.01

Table 3. Median Vitamin D and Calcium Intake by Race and Gender

	N	Vitamin D (IU) (25%, 75%)	Calcium (mg) (25%, 75%)
Total Population	252	254.9 (146.8, 407.3)	1193.6 (752.8, 1161.1)
Male	137	272 (146.8, 422.7)	1196.3 (736.5, 1686.6)
Female	115	229.8 (147.4, 387.8)	1154.6 (789.4, 1158.5)
African American	174	259 (150.7, 407.7)	1211.9 (751, 1674.1)
Male	95	270.7 (143.8, 414.1)	1180.3 (699.7, 1725.3)
Female	79	244.3 (166.5, 395)	1237.4 (837.4, 1600.9)
Caucasian	78	222.6 (133.1, 410.8)	1188 (762.2, 1556.5)
Male	42	273.3 (163.1, 428.1)	1236.1 (770.9, 1631.4)
Female	36	182.3 (143.8, 414.1)	927.4 (695.2, 1444.4)

*Median (25%, 75%)

Table 4. Median Daily Food Intake for the Total Population

Servings Per Day	N	Median (25%, 75%)
Milk	245	2 (1, 3)
Special Milk*	200	0 (0, 1)
Cheese	232	1 (1, 2)
Vitamin D & Calcium Fortified Orange Juice	200	0 (0, 1)
Yogurt	226	0.03 (0, 1)

*Special milk – chocolate milk, soy milk, Lactaid®; **Median (25%, 75%)

Table 5. Median Daily Food Intake by Gender

Servings Per Day	N	Male (25%, 75%)	N	Female (25%, 75%)	*P*-value
Milk	135	2 (1, 3)	110	1.5 (1, 2.5)	0.336
Special Milk*	104	0 (0, 1.38)	96	0 (0, 1)	0.891
Cheese	124	1 (1, 2)	108	1 (1, 2)	0.766
Vitamin D & Calcium Fortified Orange Juice	107	0 (0, 1)	93	0.1 (0, 1)	0.560
Yogurt	123	0.1 (0, 1)	103	0 (0, 1)	0.813

*Special milk – chocolate milk, soy milk, Lactaid®; **Median (25%, 75%)

Table 6. Median Daily Food Intake by Race*

	African American		Caucasian		
Servings per day	N	Median (25%, 75%)	N	Median (25%, 75%)	*P*-value
Milk	164	2 (1, 3)	81	2 (1, 3)	0.760
Special Milk*	133	0 (0, 1.5)	67	0 (0, 1)	0.389
Cheese	152	1 (1, 2)	80	0.5 (1, 1.88)	0.014
Vitamin D & Calcium Fortified Orange Juice	137	0.1 (0, 1)	63	0 (0, .5)	0.045
Yogurt	150	0 (0, 1)	76	0.5 (0, 1)	0.031

*Special milk – chocolate milk, soy milk, Lactaid®; **Median (25%, 75%)

Table 7. Median Daily Food Intake by Race and Gender*

	African American (N=174)			Caucasian (N=78)		
Servings per day	Male (25%, 75%)	Female (25%, 75%)	*P*-value	Male (25%, 75%)	Female (25%, 75%)	*P*-value
Milk	2 (1, 3)	1.5 (1, 2.5)	0.234	2 (1, 2.5)	1.5 (1, 3)	0.969
Special Milk*	0 (0, 1.5)	0.5 (0, 1)	0.733	0 (0, 1.25)	0 (0, 1.5)	0.960
Cheese	1.25 (1, 3)	1 (1, 2)	0.564	1 (0.5, 2)	1 (0.88, 1.63)	0.964
Vitamin D & Calcium Fortified Orange Juice	0 (0, 1)	0.35 (0, 1)	0.710	0 (0, 0.5)	0 (0, 1)	0.856
Yogurt	1 (0, 1)	0 (0, 1)	0.793	0.3 (0, 1)	1 (0, 1)	0.830

*Special milk chocolate milk, soy milk, Lactaid®; **Median (25%, 75%)

Table 8. Median Vitamin D Intake (IU) by Weight Classifications, Race and Gender*

	N	Normal Weight (n=148)	Overweight (n=45)	Obese (n=59)	P -Value
Total Population	252	259.5 (150.7, 407.5)†	325.2 (205.9, 497.6)‡	181.9 (118.3, 330.1)	0.015
Male	137	323.2 (163.5, 431.1)	307.2 (207.6, 440.3)	184.4 (124.4, 396.7)	0.203
Female	115	210.5 (132.8, 348)	342 (188.1, 532.7)	166.9 (104.4, 327.6)	0.127
African American	174	254.9 (162.4, 411.5)†	342 (224.2, 460.5)‡	177.1 (120, 329.5)	0.006
Male	95	289.9 (161.4, 421.7)	307.2 (245.5, 415.3)	186.9 (131.9, 407.7)	0.294
Female	78	215.4 (159.8, 382)	359.3 (215, 502.5)	166.9 (107.5, 324.6)	0.155
Caucasian	78	273.3 (132.4, 406.1)	244.4 (141.2, 645.8)	181.9 (107.1, 444.3)	0.486
Male	42	344.8 (163.1, 445.8)	293.7 (163.8, 603.1)	181.9 (114.5, 490.9)	0.352
Female	36	198.8 (125.5, 344.2)	230.2 (135.7, 686)	264.6 (**)	1

*Median (25%, 75%); (**)= Sample too small for percentile rank;†=Difference between normal and obese (P<0.05)

‡=Difference between overweight and obese (P<0.01)

Table 9. Median Calcium Intake (mg) by Weight Classification, Race and Gender*

	Normal Weight (N=148)	Overweight (N=45)	Obese (N=59)	*P*-Value
Total Population	1193.4 (758.1, 1586.8)†	1416.3 (938.8, 1925.6)‡	911.6 (598, 1580.7)	0.016
Male	1229.7 (754.6, 1651.4)	1444.8 (937.8, 1777.3)	905.5 (563.3, 1506.2)	0.107
Female	1020.5 (765.9, 1483.3)	1407.6 (938.8, 2188.1)	911.7 (626.2, 1580.8)	0.063
African American	1202.5 (771.8, 1661.5)†	1534 (1128.3, 1865.1)‡	903.2 (601.1, 1570.3)	0.013
Male	1225 (751, 1674.1)	1535.5 (1074.6, 1806.9)	751.5 (538.3, 1538.9)	0.139
Female	1111.9 (793.6, 1426.6)	1505.5 (1169.8, 2188.1)	911.7 (645.7, 1580.8)	0.060
Caucasian	1193.4 (745.8, 1506)	1088.9 (796.9, 2028.6)	1049.6 (552.4, 1697.7)	0.486
Male	1236.1 (758.1, 1528.1)	1114.4 (832.9, 1840.6)	1049.6 (583.9, 1847.4)	0.352
Female	939.1 (694.5, 1500.6)	1073.1 (780.2, 2588.7)	1104.9 (**)	1.000

*Median (25%, 75%); (**)= Sample too small for percentile rank;†=Difference between normal and overweight (P<0.05);

‡=Difference between overweight and obese (P<0.01)

Figure 1. Correlation between BMI and Calcium Intake for the Total Population

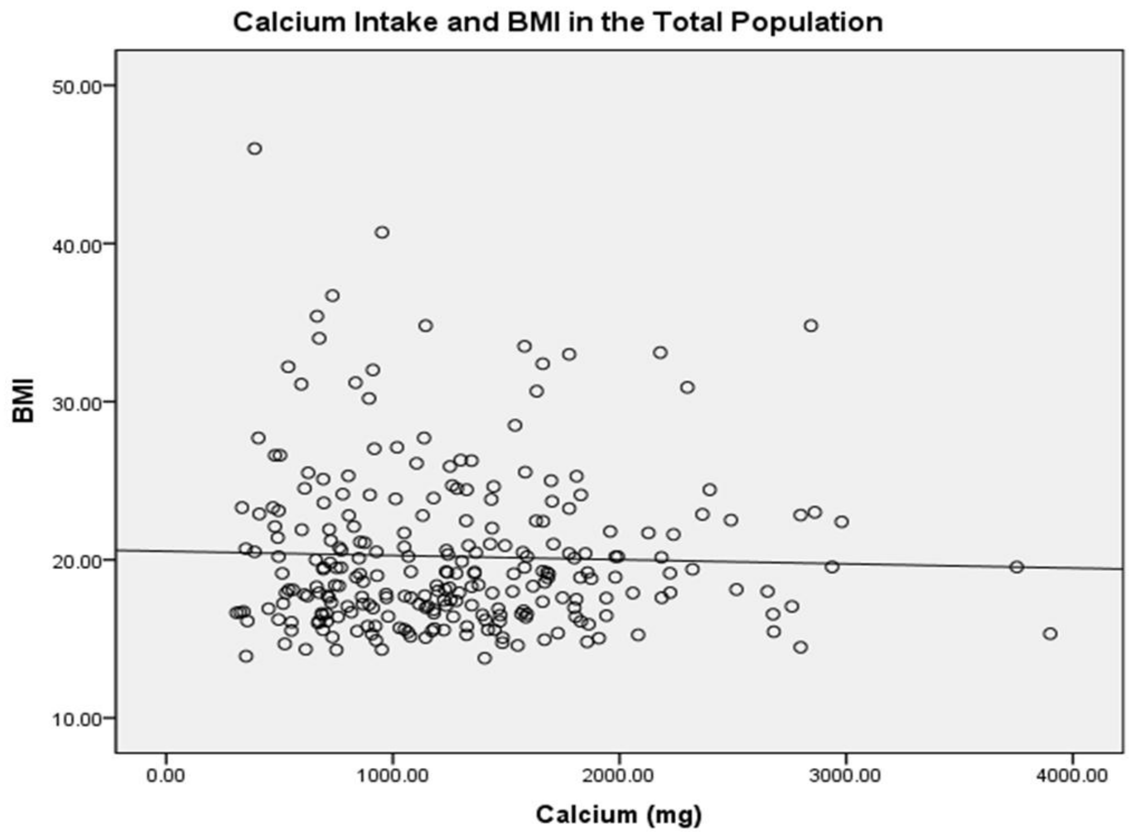
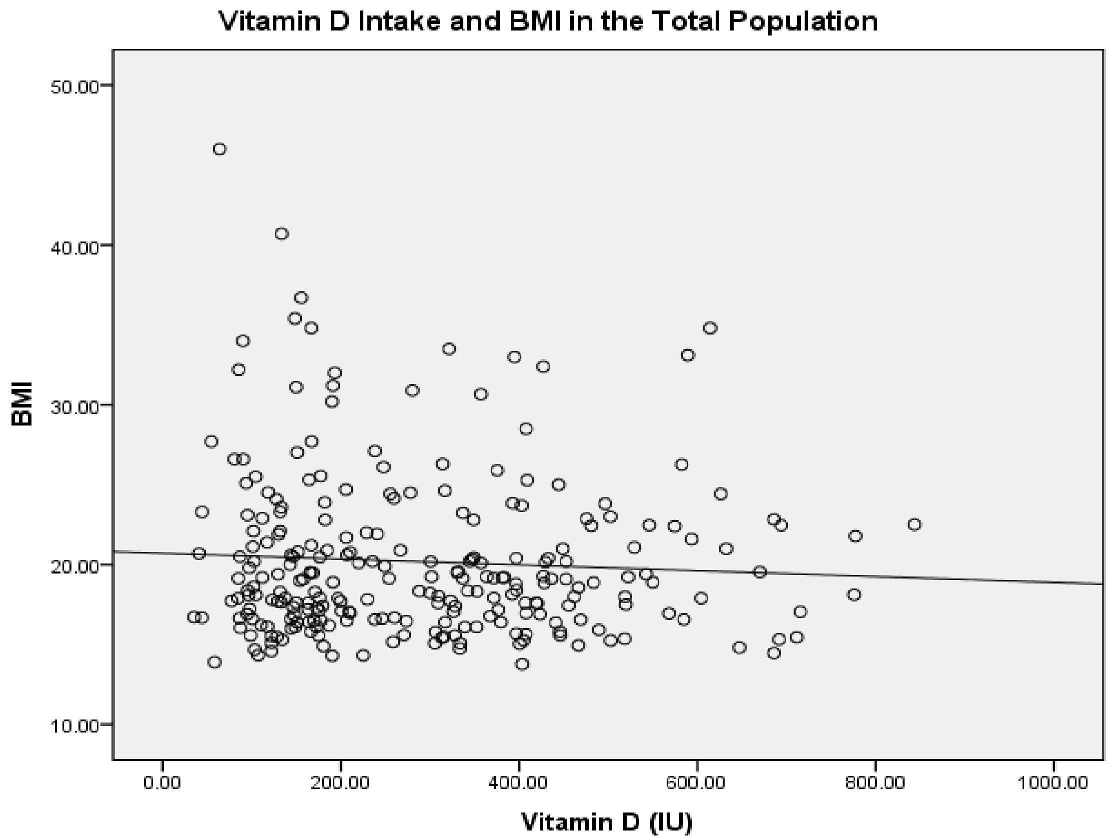


Figure 2. Correlation between BMI and Vitamin D Intake for the Total Population



APPENDIX A

C 564201

Rajakumar, Kumaravel

VITAMIN D & SUNLIGHT EXPOSURE QUESTIONNAIRE*

Subject ID: 564201 **Subject Initials:** AC **Interview Date:** 5-4-09

1. DOB: 9-19-95
2. Age: 13
3. Height (cm): 158.5cm
4. Weight: (kg): 61.6kg

5. Ethnic Group:
   - ☐ Hispanic or Latino
   - ☒ Not Hispanic or Latino
   - ☐ Unknown/Declined

6. Race:
   - ☐ American Indian/Alaskan Native
   - ☐ Asian American
   - ☐ Native Hawaiian/Pacific Islander
   - ☐ Black or African American
   - ☒ White or Caucasian
   - ☐ More than one race

7. Does your child take a multivitamin?
   - ☒ Yes ☐ No
   - If yes,
     - Specify brand: Flintstones
     - How often does he/she take the Multivitamin: Daily

8. Does your child take a calcium supplement?
   - ☐ Yes ☒ No
   - If yes,
     - Specify brand: ____
     - How often does he/she take the Calcium supplement: ____

9. Does your child take a vitamin D supplement?
   - ☐ Yes ☒ No
   - If yes,
     - Specify brand: ____
     - How often does he/she take the Vitamin D supplement: ____

10. Does your child take Cod Liver Oil?
    - ☐ Yes ☒ No
    - If yes, specify how much per day: ____

1

C564201

Rajakumar, Kumaravel

11. On average, how many glasses (8 ounce/glass) of milk does your child drink per day?
___one___

12. Besides milk, does your child take other dairy foods that may have been fortified with vitamin D?

If yes,

How many glasses (8 ounce/glass) of Soymilk or Lactaid milk or Chocolate milk does your child drink per day? ___0___

How many servings of cheese (1 ounce per serving or slice) does your child eat per day? ___2___

How many servings (1 cup/serving) of yogurt does your child eat per day?
___0___

13. Does your child take vitamin D-fortified orange juice?

If yes,

How many glasses (8 ounce/glass) of vitamin D fortified orange juice does your child drink per day? ___0___

14. On average, how many times per month does your child eat the following foods?

		None (0)	1x/month	2x/month	3x/month	>4x/month, if >4, write in #
14a	Baked/fried fish	X				
14b	Lox	X				
14c	Herring	X				
14d	Salmon	X				
14e	White fish	X				
14f	Sardines	X				
14g	Mackerel	X				
14h	Dried Mushrooms	X				

15. Does your child drink a nutrition supplement like Ensure, Pediasure or Carnation Instant Breakfast?

☐ Yes ☒ No

If yes,

How many times per day: ______________

Specify brand: ______________

16. Does your child eat breakfast cereal?

☒ Yes ☐ No

If yes,

How many bowls per week: ___7___

Specify brand (s): ___Coco puffs · Shredded wheat___

C564201

Rajakumar, Kumaravel

17. Does your child take breakfast bars or protein bars?
☐ Yes ☒ No
If yes,
How many servings (1 bar/serving) per week: ___________
Specify brand (s): ___________________________________

18. On average, in the summer how many hours per day does your child spend outside in the sun each day?
☐ 2 hours or less ☒ More than 2 hours
If more than 2 hours specify the number of hours: 6

19. When your child spends time outside, which of the following body parts are usually exposed?

		No (0)	Yes (1)
19a	Face		/
19b	Hands		/
19c	Arms		/
19d	Legs		/

20. Do you apply sunscreen on your child when he or she goes outside?
☐ Yes ☒ No
If yes,
20a. What brand do you use? _______________
20b. What SPF (Sun Protection Factor) do you use? _______________
20c. How often do you use sunscreen on your child?
☐ Often ☐ Sometimes ☐ Seldom

21. Did your child travel to a sunny location for a holiday?
☐ Yes ☒ No
If yes,
21a. Where did your child visit: ___________
21b. When did your child travel: ___________
21c. How many days did your child spend in the sunny location: _______

**Adapted from Dr. Michael Holick's vitamin D questionnaire*

APPENDIX B

PAGE ONE EATING SURVEY K-95-1 HARVARD MEDICAL SCHOOL

MARKING INSTRUCTIONS

- Use a **NO. 2 PENCIL** only.
- Do not use ink or ballpoint pen.
- Darken in the circle completely.
- Erase cleanly any marks you wish to change.
- Do not make any stray marks on this form.

The RIGHT way to mark your answer! ●

The WRONG way to mark your answers! ⊘⊗◒⊙

USE NO. 2 PENCIL ONLY

1. What is your AGE?
○ Less than 9
○ 9
○ 10
○ 11
○ 12
○ 13
○ 14
○ 15
○ 16
○ 17
○ 18 or older

2. Are you:
○ Male
○ Female

3. Your Height
FEET | INCHES

4. Your Weight (lbs)

Questionnaire refers to what you ate over the past year.

5. Do you now take vitamins (like Flintstones, One-A-Day, etc.)?
○ No ○ Yes → **If yes)**

a) How many vitamin pills do you take a week?
○ 2 or less
○ 3 - 5
○ 6 - 9
○ 10 or more

b) For how many years have you been taking them?
○ 0 - 1 years
○ 2 - 4
○ 5 - 9
○ 10+ years

6. How many teaspoons of sugar do you ADD to your beverages or food each day?
○ None/less than 1 teaspoon per day
○ 1 - 2 teaspoons per day
○ 3 - 4 teaspoons per day
○ 5 or more teaspoons per day

7. Which cold breakfast cereal do you usually eat?

○ Never eat cold breakfast cereal

8. Where do you usually eat breakfast?
○ At home
○ At school
○ Don't eat breakfast
○ Other

9. How many times each week (including weekdays and weekends) do you usually eat breakfast prepared away from home?
○ Never or almost never
○ 1 - 2 times per week
○ 3 - 4 times per week
○ 5 or more times per week

Copyright© 1995 Brigham and Women's Hospital. All rights reserved worldwide.

123203

10. How many times each week (including weekdays and weekends) do you usually eat lunch prepared away from home?

- ○ Never or almost never
- ○ 1 - 2 times per week
- ○ 3 - 4 times per week
- ○ 5 or more times per week

11. How many times each week do you usually eat after-school snacks or foods prepared away from home?

- ○ Never or almost never
- ○ 1 - 2 times per week
- ○ 3 - 4 times per week
- ○ 5 or more times per week

12. How many times each week (weekdays and weekends) do you usually eat dinner prepared away from home?

- ○ Never or almost never
- ○ 1 - 2 times per week
- ○ 3 - 4 times per week
- ○ 5 or more times per week

13. How many times per week do you prepare dinner for yourself (and/or others in your house)?

- ○ Never or almost never
- ○ Less than once per week
- ○ 1 - 2 times per week
- ○ 3 - 4 times per week
- ○ 5 or more times per week

14. How often do you have dinner that is ready made, like frozen dinners, Spaghetti-O's, microwave meals, etc.

- ○ Never/less than once per month
- ○ 1 - 2 times per week
- ○ 3 - 4 times per week
- ○ 5 or more times per week

15. How many times each week (including weekdays and weekends) do you eat late night snacks prepared away from home?

- ○ Never/less than once per month
- ○ 1 - 2 times per week
- ○ 3 - 4 times per week
- ○ 5 or more times per week

16. How often do you eat food that is fried at home, like fried chicken?

- ○ Never/less than once per week
- ○ 1 - 3 times per week
- ○ 4 - 6 times per week
- ○ Daily

17. How often do you eat fried food away from home (like french fries, chicken nuggets)?

- ○ Never/less than once per week
- ○ 1 - 3 times per week
- ○ 4 - 6 times per week
- ○ Daily

DIETARY INTAKE

How often do you eat the following foods:

Example If you drink one can of diet soda 2 - 3 times per week, then your answer should look like this:

E1. Diet soda
(1 can or glass)

- ○ Never
- ○ 1 - 3 cans per month
- ○ 1 can per week
- ● 2 - 6 cans per week
- ○ 1 can per day
- ○ 2 or more cans per day

BEVERAGES

FILL OUT ONE BUBBLE FOR EACH FOOD ITEM

18. Diet soda (1 can or glass)
- ○ Never/less than 1 per month
- ○ 1 - 3 cans per month
- ○ 1 can per week
- ○ 2 - 6 cans per week
- ○ 1 can per day
- ○ 2 or more cans per day

19. Soda - not diet (1 can or glass)
- ○ Never/less than 1 per month
- ○ 1 - 3 cans per month
- ○ 1 can per week
- ○ 2 - 6 cans per week
- ○ 1 can per day
- ○ 2 or more cans per day

20. Hawaiian Punch, lemonade, Koolaid or other non-carbonated fruit drink (1 glass)
- ○ Never/less than 1 per month
- ○ 1 - 3 glasses per month
- ○ 1 glass per week
- ○ 2 - 4 glasses per week
- ○ 5 - 6 glasses per week
- ○ 1 glass per day
- ○ 2 or more glasses per day

21. Iced Tea - sweetened (1 glass, can or bottle)
- ○ Never/less than 1 per month
- ○ 1 - 3 glasses per month
- ○ 1 - 4 glasses per week
- ○ 5 - 6 glasses per week
- ○ 1 or more glasses per day

22. Tea (1 cup)
- ○ Never/less than 1 per month
- ○ 1 - 3 cups per month
- ○ 1 - 2 cups per week
- ○ 3 - 6 cups per week
- ○ 1 or more cups per day

23. Coffee - not decaf. (1 cup)
- ○ Never/less than 1 per month
- ○ 1 - 3 cups per month
- ○ 1 - 2 cups per week
- ○ 3 - 6 cups per week
- ○ 1 or more cups per day

24. Beer (1 glass, bottle or can)
- ○ Never/less than 1 per month
- ○ 1 - 3 cans per month
- ○ 1 can per week
- ○ 2 or more cans per week

N/A

25. Wine or wine coolers (1 glass)
- ○ Never/less than 1 per month
- ○ 1 - 3 glasses per month
- ○ 1 glass per week
- ○ 2 or more glasses per week

N/A

26. Liquor, like vodka or rum (1 drink or shot)
- ○ Never/less than 1 per month
- ○ 1 - 3 drinks per month
- ○ 1 drink per week
- ○ 2 or more drinks per week

N/A

Example If you eat:

3 pats of margarine on toast
1 - 2 pats of margarine on sandwich
1 pat of margarine on vegetables

5 - 6 pats total all day

then answer this way →

E2. Margarine (1 pat) - not butter
- ○ Never
- ○ 1 - 3 pats per month
- ○ 1 pat per week
- ○ 2 - 6 pats per week
- ○ 1 pat per day
- ○ 2 - 4 pats per day
- ● 5 or more pats per day

DAIRY PRODUCTS

27. What TYPE of milk do you usually drink?
- ○ Whole milk
- ○ 2% milk
- ○ 1% milk
- ○ Skim/nonfat milk
- ○ Don't know
- ○ Don't drink milk

28. Milk (glass or with cereal)
- ○ Never/less than 1 per month
- ○ 1 glass per week or less
- ○ 2 - 6 glasses per week
- ○ 1 glass per day
- ○ 2 - 3 glasses per day
- ○ 4+ glasses per day

29. Chocolate milk (glass)
- ○ Never/less than 1 per month
- ○ 1 - 3 glasses per month
- ○ 1 glass per week
- ○ 2 - 6 glasses per week
- ○ 1 - 2 glasses per day
- ○ 3 or more glasses per day

123203

30. Instant Breakfast Drink (1 packet)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

31. Whipped cream
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

32. Yogurt (1 cup) - Not frozen
- ○ Never/less than 1 per month
- ○ 1 - 3 cups per month
- ○ 1 cup per week
- ○ 2 - 6 cups per week
- ○ 1 cup per day
- ○ 2 or more cups per day

33. Cottage or ricotta cheese
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 or more times per week

34. Cheese (1 slice)
- ○ Never/less than 1 per month
- ○ 1 - 3 slices per month
- ○ 1 slice per week
- ○ 2 - 6 slices per week
- ○ 1 slice per day
- ○ 2 or more slices per day

35. Cream cheese
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 or more times per week

36. What TYPE of yogurt, cottage cheese & dairy products (besides milk) do you use mostly?
- ○ Nonfat
- ○ Lowfat
- ○ Regular
- ○ Don't know

37. Butter (1 pat) - NOT margarine
- ○ Never/less than 1 per month
- ○ 1 - 3 pats per month
- ○ 1 pat per week
- ○ 2 - 6 pats per week
- ○ 1 pat per day
- ○ 2 - 4 pats per day
- ○ 5 or more pats per day

38. Margarine (1 pat) - NOT butter
- ○ Never/less than 1 per month
- ○ 1 - 3 pats per month
- ○ 1 pat per week
- ○ 2 - 6 pats per week
- ○ 1 pat per day
- ○ 2 - 4 pats per day
- ○ 5 or more pats per day

39. What FORM and BRAND of margarine does your family usually use?
- ○ None
- ○ Stick
- ○ Tub
- ○ Squeeze (liquid)

WHAT SPECIFIC BRAND AND TYPE (LIKE "PARKAY CORN OIL SPREAD")?

Leave blank if you don't know.

40. What TYPE of oil does your family use at home?
- ○ Canola oil
- ○ Corn oil
- ○ Safflower oil
- ○ Olive oil
- ○ Vegetable oil
- ○ Don't know

MAIN DISHES

41. Cheeseburger (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ One per week
- ○ 2 - 4 per week
- ○ 5 or more per week

42. Hamburger (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ One per week
- ○ 2 - 4 per week
- ○ 5 or more per week

43. Pizza (2 slices)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

44. Tacos/burritos (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ One per week
- ○ 2 - 4 per week
- ○ 5 or more per week

45. Which taco filling do you usually have:
- ○ Beef & beans
- ○ Beef
- ○ Chicken
- ○ Beans

46. Chicken nuggets (6)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

47. Hot dogs (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ One per week
- ○ 2 - 4 per week
- ○ 5 or more per week

48. Peanut butter sandwich (1) (plain or with jelly, fluff, etc.)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ One per week
- ○ 2 - 4 per week
- ○ 5 or more per week

49. Chicken or turkey sandwich (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ One per week
- ○ 2 or more per week

50. Roast beef or ham sandwich (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ One per week
- ○ 2 or more per week

51. Salami, bologna, or other deli meat sandwich (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ One per week
- ○ 2 or more per week

52. Tuna sandwich (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ One per week
- ○ 2 or more per week

53. Chicken or turkey as main dish (1 serving)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

54. Fish sticks, fish cakes or fish sandwich (1 serving)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 or more times per week

55. Fresh fish as main dish (1 serving)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

56. Beef (steak, roast) or lamb as main dish (1 serving)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

57. Pork or ham as main dish (1 serving)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

58. Meatballs or meatloaf (1 serving)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

59. Lasagna/baked ziti (1 serving)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 or more times per week

60. Macaroni and cheese (1 serving)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 or more times per week

61. Spaghetti with tomato sauce (1 serving)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

62. Eggs (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 eggs per month
- ○ One egg per week
- ○ 2 - 4 eggs per week
- ○ 5 or more eggs per week

63. Liver: beef, calf, chicken or pork (1 serving)
- ○ Never/less than 1 per month
- ○ Less than once per month
- ○ Once per month
- ○ 2 - 3 times per month
- ○ Once per week or more

64. Shrimp, lobster, scallops (1 serving)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 or more times per week

65. French toast (2 slices)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 or more times per week

66. Grilled cheese (1)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 or more times per week

67. Eggrolls (1)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 or more times per week

MISCELLANEOUS FOODS

68. Brown gravy
- Never/less than 1 per month
- Once per week or less
- 2 - 6 times per week
- Once per day
- 2 or more times per day

69. Ketchup
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

70. Clear soup (with rice, noodles, vegetables) 1 bowl
- Never/less than 1 per month
- 1 - 3 bowls per month
- 1 bowl per week
- 2 or more bowls per week

71. Cream (milk) soups or chowder (1 bowl)
- Never/less than 1 per month
- 1 - 3 bowls per month
- 1 bowl per week
- 2 - 6 bowls per week
- 1 or more bowls per day

72. Mayonnaise
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 6 times per week
- Once per day

73. Low calorie/fat salad dressing
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 6 times per week
- Once or more per day

74. Salad dressing (not low calorie)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 6 times per week
- Once or more per day

75. Salsa
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 6 times per week
- Once or more per day

76. How much fat on your beef, pork, or lamb do you eat?
- Eat all
- Eat some
- Eat none
- Don't eat meat

77. When you have chicken or turkey, do you eat the skin?
- Yes
- No
- Sometimes

BREADS & CEREALS

78. Cold breakfast cereal (1 bowl)
- Never/less than 1 per month
- 1 - 3 bowls per month
- 1 bowl per week
- 2 - 4 bowls per week
- 5 - 7 bowls per week
- 2 or more bowls per day

79. Hot breakfast cereal, like oatmeal, grits (1 bowl)
- Never/less than 1 per month
- 1 - 3 bowls per month
- 1 bowl per week
- 2 - 4 bowls per week
- 5 - 7 bowls per week
- 2 or more bowls per day

80. White bread, pita bread, or toast (1 slice)
- Never/less than 1 per month
- 1 slice per week or less
- 2 - 4 slices per week
- 5 - 7 slices per week
- 2 - 3 slices per day
- 4+ slices per day

81. Dark bread (1 slice)
- Never/less than 1 per month
- 1 slice per week or less
- 2 - 4 slices per week
- 5 - 7 slices per week
- 2 - 3 slices per day
- 4+ slices per day

82. English muffins or bagels (1)
- Never/less than 1 per month
- 1 - 3 per month
- 1 per week
- 2 - 4 per week
- 5 or more per week

83. Muffin (1)
- Never/less than 1 per month
- 1 - 3 muffins per month
- 1 muffin per week
- 2 - 4 muffins per week
- 5 or more muffins per week

84. Cornbread (1 square)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more per week

85. Biscuit/roll (1)
- Never/less than 1 per month
- 1 - 3 per month
- 1 per week
- 2 - 4 per week
- 5 or more per week

86. Rice
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

87. Noodles, pasta
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

88. Tortilla - no filling (1)
- Never/less than 1 per month
- 1 - 3 per month
- 1 per week
- 2 - 4 per week
- 5 or more per week

89. Other grains, like kasha, couscous, bulgur
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 or more times per week

90. Pancakes (2) or waffles (1)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 or more times per week

91. French fries (large order)
- Never/less than 1 per month
- 1 - 3 orders per month
- 1 order per week
- 2 - 4 orders per week
- 5 or more orders per week

92. Potatoes - baked, boiled, mashed
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

FRUITS & VEGETABLES

93. Raisins (small pack)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ 1 per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

94. Grapes (bunch)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

95. Bananas (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ 1 per week
- ○ 2 - 4 per week
- ○ 5 or more per week

96. Cantaloupe, melons (1/4 melon)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ 1 per week
- ○ 2 or more times per week

97. Apples (1) or applesauce
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ 1 per week
- ○ 2 - 6 per week
- ○ 1 or more per day

98. Pears (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ 1 per week
- ○ 2 - 6 per week
- ○ 1 or more per day

99. Oranges (1), grapefruit (1/2)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ 1 per week
- ○ 2 - 6 per week
- ○ 1 or more per day

100. Strawberries
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 or more times per week

101. Peaches, plums, apricots (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ 1 per week
- ○ 2 or more per week

102. Orange juice (1 glass)
- ○ Never/less than 1 per month
- ○ 1 - 3 glasses per month
- ○ 1 glass per week
- ○ 2 - 6 glasses per week
- ○ 1 glass per day
- ○ 2 or more glasses per day

103. Apple juice and other fruit juices (1 glass)
- ○ Never/less than 1 per month
- ○ 1 - 3 glasses per month
- ○ 1 glass per week
- ○ 2 - 6 glasses per week
- ○ 1 glass per day
- ○ 2 or more glasses per day

104. Tomatoes (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ 1 per week
- ○ 2 - 6 per week
- ○ 1 or more per day

105. Tomato/spaghetti sauce
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

106. Tofu
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

107. String beans
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

123203

108. Beans/lentils/soybeans
- ○ Never/less than 1 per month
- ○ Once per week or less
- ○ 2 - 6 times per week
- ○ Once per day

109. Broccoli
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

110. Beets (not greens)
- ○ Never/less than 1 per month
- ○ Once per week or less
- ○ 2 or more times per week

111. Corn
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

112. Peas or lima beans
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

113. Mixed vegetables
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

114. Spinach
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once a week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

115. Greens/kale
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

116. Green/red peppers
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once a week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

117. Yams/sweet potatoes (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once a week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

118. Zucchini, summer squash, eggplant
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

119. Carrots, cooked
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

120. Carrots, raw
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

121. Celery
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

122. Lettuce/tossed salad
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 6 times per week
- ○ One or more per day

123. Coleslaw
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 or more times per week

124. Potato salad
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 or more times per week

Think about your usual snacks. How often do you eat each type of snack food.

Example If you eat poptarts rarely (about 6 per year) then your answer should look like this:

E3. Poptarts (1)
- ● Never/less than 1 per month
- ○ 1 - 3 per month
- ○ 1 - 6 per week
- ○ 1 or more per day

SNACK FOODS/DESSERTS

125. Fill in the number of snacks (food or drinks) eaten on school days and weekends/vacation days.

Snacks	School Days					Vacation/Weekend Days				
	NONE	1	2	3	4 OR MORE	NONE	1	2	3	4 OR MORE
Between breakfast and lunch	○	○	○	○	○	○	○	○	○	○
After lunch, before dinner	○	○	○	○	○	○	○	○	○	○
After dinner	○	○	○	○	○	○	○	○	○	○

126. Potato chips (1 small bag)
- ○ Never/less than 1 per month
- ○ 1 - 3 small bags per month
- ○ One small bag per week
- ○ 2 - 6 small bags per week
- ○ 1 or more small bags per day

127. Corn chips/Doritos (small bag)
- ○ Never/less than 1 per month
- ○ 1 - 3 small bags per month
- ○ One small bag per week
- ○ 2 - 6 small bags per week
- ○ 1 or more small bags per day

128. Nachos with cheese (1 serving)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 or more times per week

129. Popcorn (1 small bag)
- ○ Never/less than 1 per month
- ○ 1 - 3 small bags per month
- ○ 1 - 4 small bags per week
- ○ 5 or more small bags per week

130. Pretzels (1 small bag)
- ○ Never/less than 1 per month
- ○ 1 - 3 small bags per month
- ○ 1 small bags per week
- ○ 2 or more small bags per week

131. Peanuts, nuts (1 small bag)
- ○ Never/less than 1 per month
- ○ 1 - 3 small bags per month
- ○ 1 - 4 small bags per week
- ○ 5 or more small bags per week

132. Fun fruit or fruit rollups (1 pack)
- ○ Never/less than 1 per month
- ○ 1 - 3 packs per month
- ○ 1 - 4 packs per week
- ○ 5 or more packs per week

133. Graham crackers
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ 1 - 4 times per week
- ○ 5 or more times per week

134. Crackers, like saltines or wheat thins
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ 1 - 4 times per week
- ○ 5 or more times per week

123203

135. Poptarts (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 poptarts per month
- ○ 1 - 6 poptarts per week
- ○ 1 or more poptarts per day

136. Cake (1 slice)
- ○ Never/less than 1 per month
- ○ 1 - 3 slices per month
- ○ 1 slice per week
- ○ 2 or more slices per week

137. Snack cakes, Twinkies (1 package)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ Once per week
- ○ 2 - 6 per week
- ○ 1 or more per day

138. Danish, sweetrolls, pastry (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ 1 per week
- ○ 2 - 4 per week
- ○ 5 or more per week

139. Donuts (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 donuts per month
- ○ 1 donut per week
- ○ 2 - 6 donuts per week
- ○ 1 or more donuts per day

140. Cookies (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 cookies per month
- ○ 1 cookie per week
- ○ 2 - 6 cookies per week
- ○ 1 - 3 cookies per day
- ○ 4 or more cookies per day

141. Brownies (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ 1 per week
- ○ 2 - 4 per week
- ○ 5 or more per week

142. Pie (1 slice)
- ○ Never/less than 1 per month
- ○ 1 - 3 slices per month
- ○ 1 slice per week
- ○ 2 or more slices per week

143. Chocolate (1 bar or packet) like Hershey's or M & M's
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ 1 per week
- ○ 2 - 6 per week
- ○ 1 or more per day

144. Other candy bars (Milky Way, Snickers)
- ○ Never/less than 1 per month
- ○ 1 - 3 candy bars per month
- ○ 1 candy bar per week
- ○ 2 - 4 candy bars per week
- ○ 5 or more candy bars per week

145. Other candy without chocolate (Skittles) (1 pack)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

146. Jello
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

147. Pudding
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

148. Frozen yogurt
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

149. Ice cream
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

150. Milkshake or frappe (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ 1 per week
- ○ 2 or more per week

151. Popsicles
- ○ Never/less than 1 per month
- ○ 1 - 3 popsicles per month
- ○ 1 popsicle per week
- ○ 2 - 4 popsicles per week
- ○ 5 or more popsicles per week

152. Please list any other foods that you usually eat at least once per week that are not listed (for example, coconut, hummus, falafel, chili, plantains, mangoes, etc. . .)

FOODS	HOW OFTEN?
a) ______	a) ______
b) ______	b) ______
c) ______	c) ______
d) ______	d) ______

a	b	c	d
0 0 0	0 0 0	0 0 0	0 0 0
1 1 1	1 1 1	1 1 1	1 1 1
2 2 2	2 2 2	2 2 2	2 2 2
3 3 3	3 3 3	3 3 3	3 3 3
4 4 4	4 4 4	4 4 4	4 4 4
5 5 5	5 5 5	5 5 5	5 5 5
6 6 6	6 6 6	6 6 6	6 6 6
7 7 7	7 7 7	7 7 7	7 7 7
8 8 8	8 8 8	8 8 8	8 8 8
9 9 9	9 9 9	9 9 9	9 9 9

a	b	c	d
0 0	0 0	0 0	0 0
1 1	1 1	1 1	1 1
2 2	2 2	2 2	2 2
3 3	3 3	3 3	3 3
4 4	4 4	4 4	4 4
5 5	5 5	5 5	5 5
6 6	6 6	6 6	6 6
7 7	7 7	7 7	7 7
8 8	8 8	8 8	8 8
9 9	9 9	9 9	9 9

THANK YOU FOR COMPLETING THIS SURVEY!

Mark Reflex® by NCS EM-201370-1:171615 Printed in U.S.A.

1 2 3 4 5 6 7 8 9 10 11 12 93 94 95 96 97 98 99

123203