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Abstract

Background: Calcium is important to various aspects of health and is necessary for life. Inadequate calcium intake has serious consequence on health, such as osteoporosis, impaired muscle and nerve functions and obesity. Similarly, excessive intake is associated with cardiovascular risks and urinary tract stone formation. Therefore a balanced calcium intake is of utmost importance especially knowing that maximum calcium storage potential in bones is reached roughly in late 20s of age and starts gradually declining thereafter.

Objective: The objective of this study is to explore calcium intake patterns in the United States population in association with a number of selected demographic and Socio Economic Status-associated factors.

Methods: The 2009–2010 National Health and Nutrition Examination Survey (NHANES) data, obtained from the Center for Disease Control and Prevention (CDC)'s National Center for Health Statistics (NCHS), was used for this investigation. This study is a cross-sectional study using a sample of 8,675 respondents (N= 8,675) within the age range of 2-69 years. A number of demographic and SES-related factors were analyzed on three consecutive stages by Univariate and Multivariate Linear Regressions on the estimated daily calcium intake of respondents.

Results: Calcium intake was demonstrated to be associated with a number of the variables included in this study. Of these, the statistically significant associations (P-Value <0.01) included Gender, Age, Race/ Ethnicity and Education. In addition, for some of the respondents within this study coverage by Medicaid or by Private Health Insurance also had some association with calcium intake levels.

Conclusions: The estimated daily calcium intake levels were higher among white, older females in the study population and were lower among the youngest age groups and respondents with the lowest levels of education among the oldest population. They were also lower among Non-White population in general. Coverage by Medicaid is associated with lower calcium intake levels among young children (4-8 years of age).Conversely, coverage by private health insurance was associated with higher levels of calcium intake among female respondents. Further studies are needed to assess the reasons for these patterns and to identify public health measures that can be taken to improve calcium intake levels in the Non-white population (especially those at the extremes of age range), the younger population, and people with lower levels of education.

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Chapter I

Introduction

I.1 Background

Calcium intake affects various aspects of health. The association of calcium intake with bone and teeth structure and health is well established and demonstrated by previous research. Calcium plays a regulatory role in blood clotting and has implications on cardiovascular health. It affects the metabolic and homeostatic status with effects on appetite and digestion and is therefore associated with weight control. Calcium also has a major role in neurological and muscular functions.

Previous research demonstrated that calcium intake has to be maintained at different levels with different age stages and across the two genders. It demonstrated that the need for calcium increases in different physiologic states (such as puberty, pregnancy, lactation, and aging) and pathologic states (such as malabsorption, vitamin D deficiency and cancer). On the other hand, too much calcium also has adverse effects on health. Higher doses decrease the absorption rate of calcium and have other additional harmful effects; specifically, cardiovascular and neurologic adverse effects, and urinary calcium stones formation.

I.2 Purpose of the Study

The diversity of the roles calcium plays in health and the importance of its timely intake and of accurate dosage raised our interest in exploring the patterns of calcium intake in the U.S. population in order to identify the demographic characteristics and socioeconomic factors that affect these patterns, to identify any notable issues with those patterns that may warrant public health interventions, and to develop recommendations to better these patterns if needed.

Chapter II

Literature Review

II.1 Health Roles of Calcium and Importance of a balanced Calcium intake

Many researchers explored the different health benefits of calcium and the necessity of adequate intake. “Calcium is an essential nutrient as all living cells require calcium to remain viable; calcium is also required for a number of specific roles in the body… As well as having a skeletal function, calcium plays a regulatory role in a number of specialized functions in the body. Calcium plays a role in muscle (including cardiac muscle contraction), neurotransmitter secretion, digestion and blood coagulation (clotting). Calcium also plays a structural role outside of the skeleton, for example in organelles and membranes.” (Theobald, 2005).

One of the major roles of calcium is in the structure of bones. “An adequate intake of calcium is one of a number of factors which are important for acquiring bone mass and attaining peak bone mass (PBM). Diets containing insufficient amounts of calcium may lead to a low bone mineral density, which may have implications for bone health, notably risk of osteoporosis, in later life”. (Theobald, 2005)

A group of researchers; (Prentice, et al., 2013) stated that among women not taking personal calcium or vitamin D supplements at baseline, the hazard ratio for hip fracture occurrence in the CT following 5 or more years of calcium and vitamin D supplementation versus placebo was less than one, indicating a protective role of calcium supplements on bone health. “Long-term use of calcium and vitamin D appears to confer a reduction that may be substantial in the risk of hip fracture among postmenopausal women.”

There was a controversy about the role of calcium in protecting against cancer. While the (Prentice, et al., 2013) study reported that evidence for a reduction in breast cancer risk and total invasive cancer risk among calcium plus vitamin D users was only suggestive, these findings contradicted to some extent with another study demonstrating a protective

role against Gastro-Intestinal Tract cancer. In the latter, Meta-Analysis of 26,335 cases from 60 observational studies had shown that milk intake was unrelated to rectal cancer risk, high calcium intake had a greater protective effect against tumors of the distal colon and rectal cancer vs. proximal colon and more specifically; higher consumption of milk/dairy products reduced the risk of colon cancer, and high calcium intake reduced the risk of colorectal cancer. In this study, the risk reduction associated with calcium was similar for dietary and supplemental sources. (Huncharek, Muscat, & Kupelnick, 2009).

Calcium has to be taken in adequate amounts and in a timely manner during growth. “A low intake of calcium during growth has implications for bone mass, as the amount of calcium consumed in the diet influences the amount of calcium that can be retained by the skeleton during periods of growth. An inadequate intake of calcium combined with adequate energy and protein intakes may result in a low calcium content of bone, which may have implications for bone health later in life.” (Theobald, 2005)

One study stated that ““The calcium-rich diet has been linked to a reduced risk of cardiovascular disease, diabetes, metabolic syndrome, and hypertension. Dietary calcium has not been linked to any increase in risk of cardiovascular events… the real risk is when people exceed the daily recommended intake”. (Best way to get your calcium. Do food sources trump supplements?, 2012)

The extent of harm that may result in from excessive calcium intake has been assessed by researchers, but there’s no clear consensus among them in this regard. While a Harvard Health Letter stated that :” …high doses of calcium supplements have been linked to kidney stones…” (Best way to get your calcium. Do food sources trump supplements?, 2012), the study by (Prentice, et al., 2013) did not report a pronounced risk. The latter study did find a notable connection between calcium intake and bone health; however, other health benefits and risks of supplementation at doses considered by the researchers in this study appeared to them to be modest and approximately balanced. For example,

they stated that supplementation effects were not apparent on the risks of myocardial infarction, coronary heart disease, total heart disease, stroke, overall cardiovascular disease, colorectal cancer, or total mortality.

II.2 Factors that Affect Calcium Intake

Previous studies have demonstrated the importance of a balanced calcium intake for every age. According to a study published in a Harvard Health Letter, current guidelines for calcium intake for bone health recommend between 1,000 and 1,200 milligrams (mg) per day, depending on age and gender. It can be obtained from a supplement, from food, or both. (Best way to get your calcium. Do food sources trump supplements?, 2012)

II.2.1 Demographic Factors:

Review of literature has guided this study to explore 5 demographic factors shown to be associated with different levels of calcium intake. Age, Gender, Physiologic Conditions (For instance pregnancy), Race/ Ethnicity, and Country of Birth. These are described in the next 3 sections.

II.2.1.1 Age, Gender And Physiologic Conditions:

Calcium Recommended Daily Allowances (RDAs) vary according to age, gender and physiologic changes (like pregnancy and lactation). Therefore something as simple as not changing dietary habits with age and change in physiologic functions status might compromise balanced calcium intake. “The FNB [Food and Nutrition Board] established RDAs for the amounts of calcium required for bone health and to maintain adequate rates of calcium retention in healthy people”. (Health Information / Calcium, 2013) The RDAs for calcium are listed in Table 1 below (In milligrams per day).

Table 1: Recommended Dietary Allowances (RDAs) for Calcium[1]

Age	Male	Female	Pregnant	Lactating
0–6 months[2]	200 mg	200 mg		
7–12 months[2]	260 mg	260 mg		
1–3 years	700 mg	700 mg		
4–8 years	1,000 mg	1,000 mg		
9–13 years	1,300 mg	1,300 mg		
14–18 years	1,300 mg	1,300 mg	1,300 mg	1,300 mg
19–50 years	1,000 mg	1,000 mg	1,000 mg	1,000 mg
51–70 years	1,000 mg	1,200 mg		
71+ years	1,200 mg	1,200 mg		

[1] Adopted from a table from: (Health Information / Calcium, 2013)
[2]Adequate Intake (AI)

Furthermore, faulty conceptions about how much exactly is required for a specific gender, age or physiologic condition can result in a change in the balance of calcium intake. For example, according to the Harvard Health Letter cited above; "On average in the US, women get 700 mg of calcium from dietary sources, so most women would need 500 mg or less in calcium supplements. However, many women also take supplements of 1,000 mg or more. This is concerning because high doses of calcium supplements have been linked to kidney stones as well." (Best way to get your calcium. Do food sources trump supplements?, 2012)

II.2.1.2 Race/Ethnicity

The differences in calcium intake among different races and ethnicities is well documented in literature. One study found that although "total daily dietary and supplemental calcium intakes do not differ, but calcium intake from dairy foods and from grains differ in older black and white women matched in age and SES." (Mojtahedi, Plawecki, Chapman-Novakofski, McAuley, & Evans, 2006)

Another study noted African Americans may face a more negative chronic health condition trajectory compared with their white counterparts, (Kahng, 2010) (Farmer & Ferraro, 2005), and concluded that "Nutrition- and Health-Related

Psychosocial Factors (NHRPF) may explain very few, but SES may contribute some of the racial/ethnic disparities in diet, exercise, and weight status in the United States." (Wang & Chen, 2011)

Among different racial/ethnic groups, there are additional differences as noted in a study that compared food group intake in a sample of African American vs. Hispanic low-income children in Atlanta, GA; "Food group intake patterns among low-income children differ by ethnic group." (Salvo, Frediani, Ziegler, & Cole, 2012)

II.2.1.3 Country of Birth

The environment has complex interactions that can potentially affect many facets of the lives of people. It is intuitive to assume that dietary habits vary by the place of residence, and this is indeed well documented in literature.

One study compared 10 European countries in terms of dietary intakes and found that "Intakes of minerals vary substantially throughout Europe, with some geographical variability in their food sources." (Welch, et al., 2009)

Another study in France implicated geography and income tax level independently from each other; "the relationship between educational level and adherence to the national nutritional health guidelines differs from one region of France to another, suggesting that nutrition education programs should perhaps be adapted on a regional basis. In contrast, guideline adherence is correlated with income tax level independently of geographical factors, suggesting that financial constraints on food choices are uniform across France." (Wyndels, et al., 2011)

II.2.2 Socio-Economic Factors:

Three aspects are discussed within this study as proxies for socio-economic status that have been associated in literature with dietary intake.

II.2.2.1 Education

Literature contrasted in the role nutrition-related knowledge contributed to dietary intake pattern. On one hand, a study in Lebanon concluded that “Although both groups [High- and low-SES groups] showed good nutrition-related knowledge, SES significantly affected dietary intake in a sample of Lebanese adolescents. This warrants consideration of other factors, such as cost and environment, that may modulate eating behavior among adolescents from different socioeconomic strata.” (Nabhani-Zeidan, Naja, & Nasreddine, 2011). On the other hand, another study in Canada concluded that “Calcium self-efficacy, calcium barriers, and osteoporosis knowledge predicted calcium intake, whereas exercise self-efficacy and health motivation predicted physical activity” (Gammage & Klentrou, 2011)

Whether education level is directly associated with health and nutrition knowledge is to be explored further. A peculiar finding was noted among medical students in one study in the U.S. with regard to micronutrients; “Dietary intakes of male students were consistently inadequate for vitamin E, vitamin D, calcium, magnesium and potassium across … six cohorts. Despite a significant increase over time in the number of vegetable servings consumed, the intakes of female students revealed the same inadequacies, as well as inadequate folate and iron intakes.” (Seabolt, Spence, & Silver, 2012)

II.2.2.2 Economic Status

As mentioned above from the previously cited study in Lebanon; "[… factors, such as cost and environment…may modulate eating behavior among adolescents from different socioeconomic strata" (Nabhani-Zeidan, Naja, & Nasreddine, 2011)

In the United States, this is indeed notable and stated in literature. According to one study; "Recent research further suggests that low calcium intakes are more prevalent among low-income, African-American women. For this group, research suggests that calcium intakes are significantly below the Recommended Dietary Allowances [RDA]".

(Dore, Yarbrough, & Fournet, 2001)

II.2.2.3 Health Insurance Coverage

An interesting study demonstrated that while "It has been well established that heath care in the United States is not the main determinant of health status of the population", "Nevertheless, availability and accessibility to consistent and high quality health care does influence the health status of the U.S. population, particularly for those at increased risk of various health problems and those with special health care needs". The study further demonstrates this influence by suggesting "…universal health insurance coverage for the elderly may explain, at least in part, why one measure of health status for which the U.S. ranks higher than many nations in the Organization for Economic Cooperation and Development is life expectancy among those over 65 years of age". (Brouse & Basch, 2010)

Chapter III

Methods

III.1 Subjects and Study Design

III.1.1 Data Source

The 2009–2010 National Health and Nutrition Examination Survey (NHANES) data that were used for this investigation were obtained from the Center for Disease Control and Prevention (CDC)'s National Center for Health Statistics (NCHS) (National Health and Nutrition Examination Survey/ NHANES 2009-2010, 2013).

NHANES is based on complex cross-sectional multistage sampling designs performed to select a nationally representative sample of about 5,000 civilian non-institutionalized individuals each year. These persons are located in counties across the country, 15 of which are visited each year. The sample for the survey is selected to represent the U.S. population of all ages. To produce reliable statistics, NHANES over-samples persons 60 and older, African Americans, and Hispanics.

Every year, approximately 5,000 individuals of all ages are interviewed in their homes and complete the health examination component of the survey conducted in mobile examination centers (MECs).

Beginning in 2007 some changes were made to the domains being oversampled. The primary change is the oversampling of the entire Hispanic population instead of just the Mexican American (MA) population, which has been oversampled in NHANES since 1988. Sufficient numbers of MAs were retained in the current sample design so that trends in the health of MAs can continue to be monitored. Similar to previous cycles, persons 60 and older, blacks and low income persons are also oversampled. In addition, for each of the race/ethnicity domains, the 12-15 and 16-19 year age domains were combined and the 40-59 year age minority domains were split into 10 year age domains 40-49 and 50-

59. This has led to an increase in the number of participants aged 40+ and a decrease in 12-19 year olds from cycles prior to 2007.

The NHANES study protocols were approved by the institutional review board of U.S. National Center for Health Statistics. Oral and written informed consent was obtained from adult participants. Assent was obtained from subjects under the age of 16 after obtaining oral and written informed consent from their parents.

For this study data from the National Health and Nutrition Examination Survey, 2009-2010 (NHANES 2009-2010) was used. The data files available online contains data for 10,537 individuals of all ages. Data were collected between January 2009 and December 2010.

One concern is that the NHANES 2009-2010 data files do not have the same number of records in each file. The number of records in each data file varies depending on gender and age profiles for the specific component(s). For instance, the different target population groups for the topics within and between NHANES questionnaire sections. The questionnaire that contained information about dietary intake of dairy products (Dietary Screener) was targeted to the 2-69 years of age respondents. Since dairy products consumption is a major contributor to calcium intake, the study population was chosen to include only people who were eligible for taking this particular survey and the age limit for this study was set to be 2-69 years. In addition confidential and administrative data are not released in the NHANES website and some variables have been recoded to protect the confidentiality of survey participants.

This current study was exempt from acquiring a new IRB approval as it's using secondary data from NHANES. However, the application for designation of "not human subjects' research" was needed to determine if IRB review is required. The request was granted and this study was exempt from acquiring a new IRB review.

III.1.2 Study Population

In this study, only subjects within the age range of 2-69 years were eligible for investigation. These were subjects who completed the “dietary screener” survey with information pertaining to dairy (milk and cheese) consumption. Subjects that were outside this age range were excluded from this study. This narrowed the study population from the original 10,537 respondents to a total of 8675. These were further limited to a final total of 7,053 respondents that had valid values for the dependent variable “TotalCalcium” that provided an estimate of the daily calcium intake of the respondents drawing information from the dietary screener survey and from two additional variables; Calcium supplement and antacid intake.

Sequence number [SEQN] is one of the status variables that provided core information on the survey participant in the original data source. This is a unique ID number assigned to each sample person and was required to match the information on the demographic file to the rest of the NHANES 2009-2010 data.

Five demographic characteristics were included in this study. These are factors that potentially have an effect on calcium intake and include: Age, gender, Race / Ethnicity, Country of Birth, and pregnancy status.

In addition four facets that reflect Socio-Economic Status aspects of the study population were examined. These included: Level of Education, Economic Status, and Health Insurance Coverage.

III.2 Statistical Analysis

Statistical programs available in Statistical Package for the Social Sciences for Windows (IBM SPSS Statistics 20) was used in this analysis.

The study sample size (N) was equal to 7,053 based on the inclusion criteria described above for the study population.

This study is a cross-sectional study as it draws the data used from a primary source that originally designed their own study as a cross-sectional set of surveys and examinations.

The 2-year sample weight variable “WTINT2YR” provided in the original data source was used for weighing the Linear Regression analyses described below.

There were 5 steps for the analysis as described below:

- Frequencies and percentages of the 19 selected demographic and socioeconomic status variables were obtained for the study sample and reported in descriptive tables and charts in the results section below.
- Derivation of the dependent variable (TotalCalcium) that summarizes information from the original data set and creates an estimate of daily calcium intake.
- Univariate Weighted Least Squares Linear regression on each of the demographic and socio-economic variables as independent variables with the dependent variable of interest; “TotalCalcium”. A probability level (p-value) of <.01 was used to determine significance of associations demonstrated by the Univariate analyses.
- The statistically significant associations from the previous step were the basis for selection of the 8 variables included in the following step in the analysis; the Multivariate Weighted Least Squares Linear Regression). The latter demonstrated statistically significant associations between four of the independent variable with the variable of interest (TotalCalcium). Once again a probability level (p-value) of <.01 was used to determine significance of associations.

- Based on the results of the multivariate analysis the data was stratified four times; once by each of the variables that maintained statistical significance in both the Univariate and the multivariate analyses from the two earlier steps. A multivariate linear regression was run each time by including all but the variable stratified on each time.

Chapter IV

Results

IV.1 Description of Variables of Interest

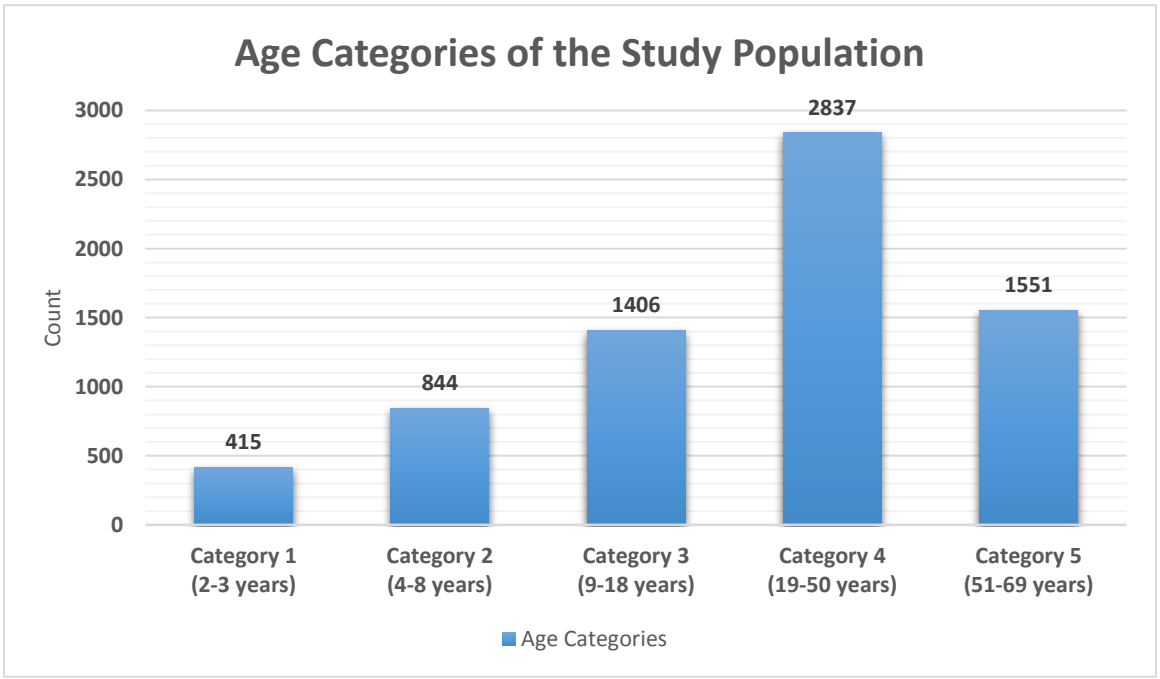
IV.1.1 Demographic Variables

Each of the 5 demographic variables of interest are described in the next 5 sections. In addition a table with a summary of all of them is included in the 6th section (Table 2).

IV.1.1.1 Age Categories

Age at screening in years from the original data source was used. In this study, age was recoded into a new variable (AgeCategories) which divided the study population into 5 age categories, 1 through 5, that represented age ranges (2-3 years), (4-8 years) , (9-18 years) , (19-50 years) and (51-69 years), respectively. The choice of the ranges described above was based on the different Recommended Dietary Allowances of Calcium for those age ranges as described in Table 1 above adopted from an original table by the Food and Nutrition Board (Health Information / Calcium, 2013). Figure 1 below is a chart demonstrating the age categories in this study population.

Figure 1- Age categories and count for eligible respondents in the study population



IV.1.1.2 Gender

In NHANES, gender and race/ethnicity status were based on self-reports. In this study, the population had close numbers of respondents across the two genders (See table 2 below).

IV.1.1.3 Race / Ethnicity

Racial/ethnic groups were categorized in this study as White and Non-White. The latter included Blacks, Mexican Americans and other Hispanics and Others (including Multiracial). The Non-White category included two of the over-sampled populations of the original data source, namely: Blacks and Hispanics. Respondents who refused to respond to the question about Race/ Ethnicity or didn't know the answer were excluded and set to be missing in this study. (See table 2 below)

IV.1.1.4 Country of Birth

The country of birth is reported in the original NHANES data and is recoded for the purposes of this study and arranged into 2 categories; U.S and Other (including Mexico) Respondents who refused to respond to these questions or didn't know the answer were excluded from the variables and set to be missing. The majority of respondents in this study were born in the U.S (79.5 %). Respondents who refused to respond to the question about Country of Birth or didn't know the answer were excluded and set to be missing in this study. These included 4 respondents (0.1 %) (See table 2 below)

IV.1.1.5 Pregnancy Status

In the original NHANES data pregnancy status at the time of the health examination was ascertained for females 8–59 years of age but it's only released for women 20-44 years of age for disclosure risks. The information used to code the pregnancy status values included urine pregnancy test results and self-reported pregnancy status.

If the subject reported they were pregnant but the urine test was negative the status was coded as 'pregnant at exam'. If the respondent stated that they were not pregnant and the urine pregnancy results were negative the respondent was coded 'not pregnant at exam'. If the respondent did not know her pregnancy status and the urine pregnancy results were negative the respondent was coded 'could not be determined'. This latter category also included persons who were interviewed, but not examined. For the purposes of this study the 'could not be determined' category was excluded and values for this response were set to be missing.

IV.1.1.6 Summary of Demographic Characteristics

Table 2 below is a summary of the demographic characteristics of the study population.

Table 2 – Summery of the Demographic Characteristics of the Eligible Respondents in the Study Population

Demographic Characteristics		N	Percent	Cumulative Percent
Age Categories (Range in years)				
	1 (2-3 years)	415	5.9	5.9
	2 (4-8 years)	844	12.0	17.9
	3 (9-18 years)	1406	19.9	37.8
	4 (19-50 years)	2837	40.2	78.0
	5 (51-69 years)	1551	22.0	100.0
Gender				
	Male	3486	49.4	49.4
	Female	3567	50.6	100.0
Race/Ethnicity				
	White	2894	41.0	41.0
	Non-White (Black, Hispanic or Other Including Multiracial)	4159	59.0	100
Country of Birth				
	U.S	5608	79.5	79.5
	Other (Including Mexico)	1441	20.4	99.9
	Missing (System)	4	.1	100.0
Pregnancy Status[1]				
	Yes	61	1.7	1.7
	No	1035	29	30.7
	Missing (System)	2471	69.3	100.0

[1] Pregnancy Status percentages were calculated From female respondents total N only

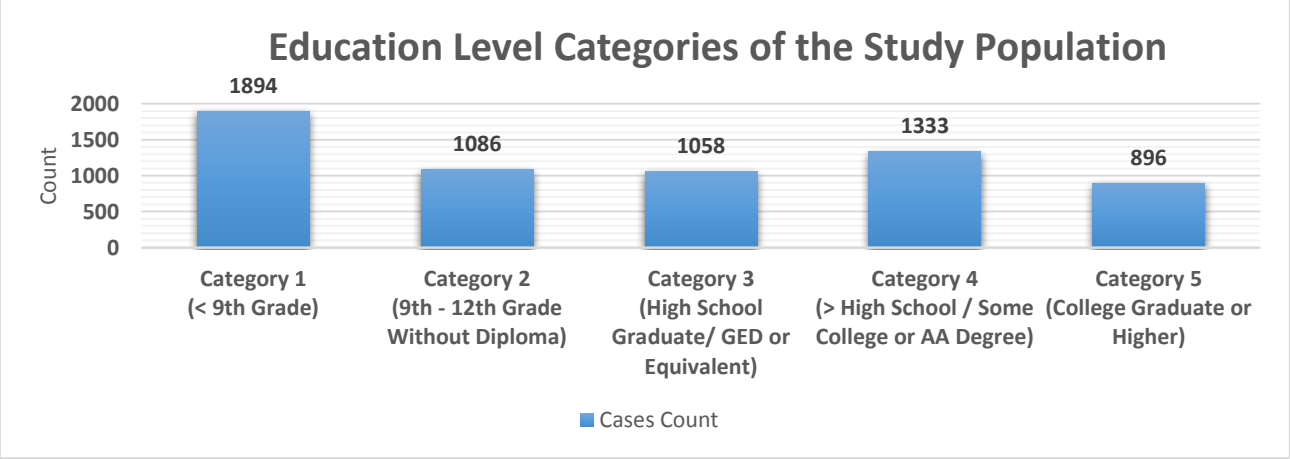
IV.1.2 Socio-Economic Status factors

In this study, four aspects were considered for assessing the socioeconomic factors that can potentially affect calcium intake. These included level of education, household food security, income-related factors, and health insurance details.

IV.1.2.1 Education

In the original data source, NHANES, education was reported separately for respondents under 20 years old and those 20 years and older. For the purpose of this study the two variables for education for these age groups were combined in one variable entitled [Education] after unifying the originally different categories among the two variables. In the newly created variable, Education, 5 categories were created. A score of 1 was assigned to respondents with education under 9th Grade. The highest score of 5 was assigned to college graduates and higher education. Scores of 2 through 4 were assigned for respondents between 9th and 12th grade with no diploma, High school graduates or those with a GED or equivalent, and those higher than high school or with some college or AA degree, respectively. A considerable number of the study respondents had missing values for the education variable amounting for 11.1 % of the study population. These were excluded from analysis. Figure 2 below demonstrate the education categories in the study population. (Also see table 3- part 1 below)

Figure 2- Education Level of Eligible Respondents in the Study Population



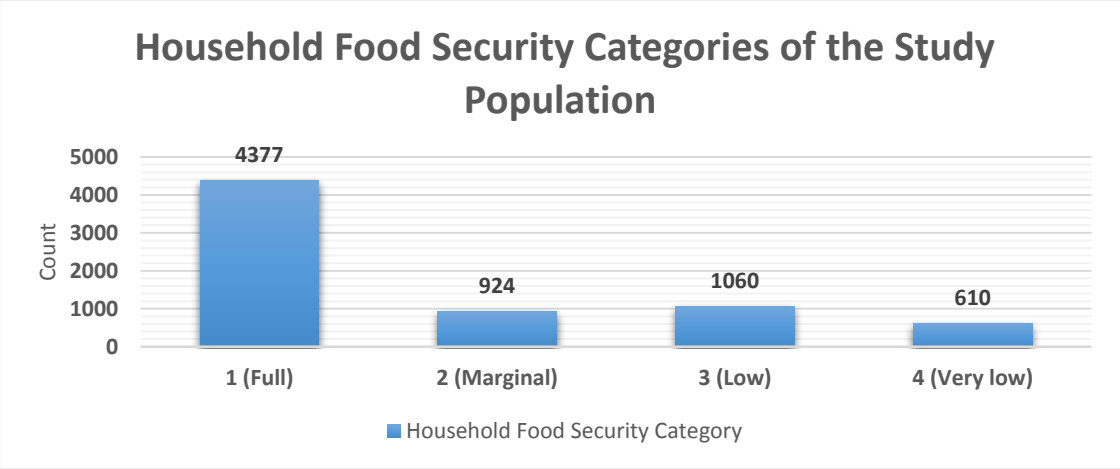
IV.1.2.2 Economic Status

Three parameters of social class were assessed as detailed below

IV.1.2.2.1 Household Food Security Category

The original variable in NHANES was calculated at the household level from household interviews where an adult responded to the US Food Security Survey Module (US FSSM) questions with the questions referring to all household members, not just NHANES participants. There are 18 items for households with children under age of 18 years and 10 items for households without children. 4 categories are derived from the responses to the 10 or 18 US FSSM items where full, marginal, low and very low is assigned for the values of FSSM responses (0), (1-2), (3-5 for households without child or 3-7 for households with child) and (6-10 for households without child or 8-18 for households with child), respectively. Figure 3 below demonstrates the 4 categories within the household food security variable for the study population. (Also see table 3-Part 1 below)

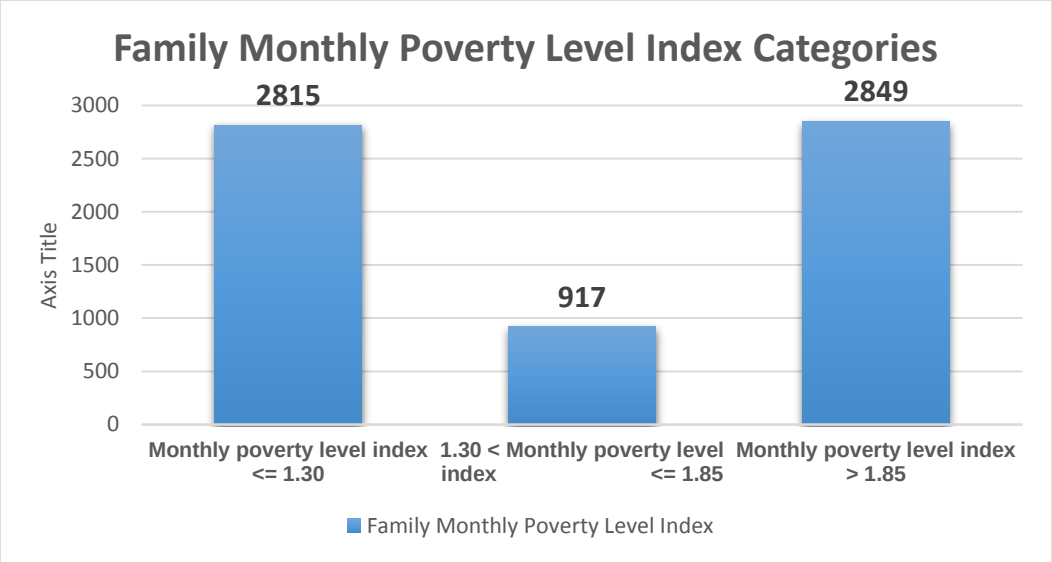
Figure 3- Household Food Security Categories for Eligible Respondents in the Study Population



IV.1.2.2.2 Family Monthly Poverty Level Index Category

In the original data source, (National Health and Nutrition Examination Survey/ NHANES 2009-2010, 2013), the respondents were asked to report total family income, received last month in dollars, for themselves and the other members of their family. The 2009 Department of Health and Human Services' (HHS) poverty guidelines were used as the poverty measure to calculate a "Family monthly poverty level index" by dividing family income by the poverty guidelines, specific to family size, as well as the appropriate year and state. The index was then grouped into three categories (≤1.30), (>1.30 and ≤ 1.85), and (>1.85), respectively and reported in the variable "Family Monthly Poverty Level Index Category". These categories were chosen by the original data source researchers because they represented commonly used percentages of the poverty guidelines (i.e., 130 percent and 185 percent of the guidelines), by federal programs, in determining eligibility. This variable grouped the study population into 3 categories. In this study the frequencies and percentages of respondents within these categories are provided in table 3 part 1. Figure 4 below also demonstrates these categories in the study population.

Figure 4- Family Monthly Poverty Level Index Categories for Eligible Respondents in the Study Population



IV.1.2.2.3 Governmental Financial Programs Supporting Family Members

Variable sources of income from different governmental financial assistance programs were assessed by the original data source study. The respondents were asked if they or any of their family members received any income from these programs during the preceding year. For the purpose of this study only programs that covered at least 3% of the study population were assessed. These included five programs categories; retirement or survivor pension, Social Security or Railroad Retirement, Supplemental Security, State/ County Cash Assistance and/or other disability pension. In addition a new variable was created as a score of the number of governmental financial support programs covering each respondents or one or more of their family members. (See table 3- Part 1 below)

IV.1.2.3 Health insurance

In this study, information about health insurance was assessed. This was through two categorical variables with responses to whether health insurance plan, if any, covered prescriptions, and whether or not the respondent was not covered by health insurance for some time during the past year. Furthermore, the study assessed a number of health insurance plans to see if the use of those particular plans affected calcium intake. These plans assessed included only plans that covered at least 3% of the respondents within the study population and those were: “private insurance”, “Medicaid”, “military health care”, “single service plan” and/ or “state-sponsored health plan. Plans that had very small numbers of respondents or had respondents outside the study’s age range were excluded from this study. Details of the variables included for health insurance coverage are provided in table 3- Part 2 below.

Table 3 – Part 1 Descriptive Summary of SES- Associated Factors in the Eligible Respondents in the Study (Education and Economic Status/ Social Class-Related variables)

Demographic Characteristics	N	Percent	Cumulative Percent
Education			
< 9th grade	1894	26.9	26.9
9th -12th grade without diploma	1086	15.4	42.3
High school Graduate / GED or Equivalent	1058	15.0	57.3
> High School / Some college or AA degree	1333	18.9	76.2
College graduate or above	896	12.7	88.9
Missing (System)	786	11.1	100.0
Family monthly poverty level category			
Monthly poverty level index <= 1.30	2815	39.9	39.9
1.30 < Monthly poverty level index <= 1.85	917	13.0	52.9
Monthly poverty level index > 1.85	2849	40.4	93.3
Missing (System)	472	6.7	100
Household food security category			
1	4377	62.1	62.1
2	924	13.1	75.2
3	1060	15.0	90.2
4	610	8.6	98.8
Missing (System)	82	1.2	100
Number of Governmental financial support plans covering one or more of a respondent's family members			
No Plan	5057	71.7	71.7
1 Plan	1160	16.4	88.1
2 Plans	552	7.8	95.9
3 Plans	161	2.3	98.2
4 Plans	16	.2	98.4
5 Plans	13	.2	98.7
Missing (System)	94	1.3	100
Income from retirement/survivor pension			
No	6479	91.9	91.9
Yes	475	6.7	98.6
Missing (System)	99	1.4	100.0
Income from Supplemental Security Income			
No	6438	91.3	91.3
Yes	519	7.4	98.7
Missing (System)	96	1.4	100.0
Income from Social Security or RR			
No	5908	83.8	83.8
Yes	1046	14.8	98.6
Missing (System)	99	1.4	100.0
Income from other disability pension			
No	6482	91.9	
Yes	474	6.7	
Missing (System)	97	1.4	
Income from state/county cash assistance			
No	6594	93.5	
Yes	362	5.1	
Missing (System)	97	1.4	

Table 3 – Part 2 Descriptive Summary of SES- Associated Factors in the Eligible Respondents in the Study (Health Insurance Information)

Demographic Characteristics	N	Percent	Cumulative Percent
Number of health insurance plans covering the respondent			
1 Plan	5175	73.4	73.4
2 Plans	98	1.4	74.8
3 Plans	3	.0	74.8
Missing (System)	1777	25.2	100
Do plans cover prescriptions?			
No	268	3.8	91.9
Yes	5174	73.4	98.6
Missing (System)	1611	22.8	100.0
Covered by private insurance?			
No available information	3692	52.3	91.3
yes	3361	47.7	98.7
Covered by Medicaid?			
No available information	5908	83.8	83.8
yes	1046	14.8	98.6
Covered by state-sponsored health plan?			
No available information	5914	83.9	83.9
yes	1139	16.1	100

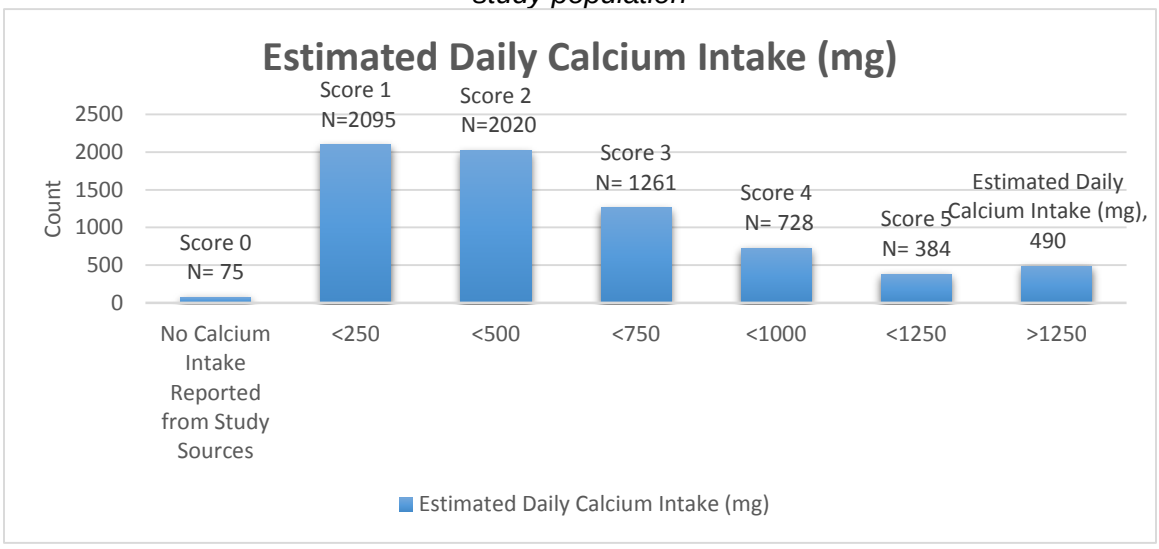
IV.2 Derivation of Calcium Intake (Dependent) Variable

The variable of interest "TotalCalcium" was computed by combining information from 4 original variables to create a score (1-7) for an estimate of consumption of calcium per day. The lowest score of 1 was assigned for subjects with no calcium intake reported from any of the study considered sources. The highest score of 7 was assigned for subjects with an estimated calcium intake in excess of 1250 mg per day. Scores from 2 through 6 reflected estimated ranges of intake of (250-499 mg), (500-749 mg), (750-999 mg) and (1000-1249 mg), respectively. Table 4 and figure 5 below describe and demonstrate the categories of estimated daily calcium intake for the study population.

Table 4- Estimated daily calcium intake for eligible respondents in the study population

Categories	Description	Frequency	Percent
1	No Calcium Intake Reported from Study Sources	75	1.1
2	<250	2095	29.7
3	<500	2020	28.6
4	<750	1261	17.9
5	<1000	728	10.3
6	<1250	384	5.4
7	>1250	490	6.9
	Total	7053	100.0

Figure 5- Categories of Estimated Daily Calcium Intake for eligible respondents in the study population



Two of the original variables reflecting the daily intake of milk and of cheese over the past 30 days were combined together in one categorical variable named “dairy”. Under this variable, intake under once per day (< 30 times a month) was given a score of 1. The maximum score of 6 was assigned for subjects that consumed any amount in excess of 5 times per day (150 times a month or higher). Scores of 2 through 5 were assigned for the ranges (30-59), (60-89), (90-119) and (120-149) times per month, respectively.

The third variable factored in the “TotalCalcium” variable was the variable “supplement” which was a categorical variable computed by creating scores for ranges within the original continuous variable that reflected the dose of calcium supplement intake (dietary supplement use over the past 30 days). A score of 1 was assigned for respondents taking less than 250 mg per day. The highest score of 6 was assigned for respondents taking 1250 mg per day or higher. Scores of 2 through 5 were assigned for respondents with Calcium supplement dose within the ranges (250-499), (500-749), (750-999) and (1000-1249) mg/day, respectively.

The final variable factored within the “TotalCalcium” variable was antacid intake. Subjects that consumed antacids were given one additional score unit.

IV.3 Univariate Analysis

This was done by means of Weighted Least Squares Linear Regression of each of the total of 19 independent variables of interest (Demographic and SES related) on the dependent variable of interest, (TotalCalcium). The 2-year sample weight variable "WTINT2YR" provided in the original data source was used for weighing for the Linear Regression. A probability level (p-value) of <.01 was used to determine significance of associations.

Table 5 below is a summary of the Univariate analysis results.

Table 5 - Results of Univariate Linear Regression[1] for a number of Demographic and SES-Related Variables with the Dependent Variable (TotalCalcium) in Eligible Respondents within the Study Population

	Variables	Standardized Coefficient (Beta)	P- Value
1	**Gender**	**.068**	**< 0.01**
2	**AgeCategories**	**.179**	**< 0.01**
3	**Education**	**.146**	**< 0.01**
4	**Race/Ethnicity**	**-.086**	**< 0.01**
5	Country of Birth	.007	.553
6	Pregnancy Status at Exam	-.023	.445
7	**Family monthly poverty level category**	**.084**	**< 0.01**
8	**Household food security category**	**-.052**	**< 0.01**
9	Number of governmental plans covering a family member	.009	.431
10	Income from retirement/survivor pension	.008	.520
11	Income from Social Security or RR	.014	.229
12	Income from other disability pension	-.003	.826
13	Income from Supplemental Security Income	.002	.848
14	Income from state/county cash assistance	-.001	.933
15	Do plans cover prescriptions?	.005	.711
16	Number of health insurance plans	-.001	.954
17	**Covered by private insurance**	**.087**	**< 0.01**
18	**Covered by Medicaid**	**-.081**	**< 0.01**
19	Covered by state-sponsored health plan	-.014	.257

[1] Weighted Least Squares Regression - Weighted by Full Sample 2 Year Interview Weight

As demonstrated in table 8 above, a total of 8 variables (displayed in bold script in the table) demonstrated statistically significant associations with the dependent variable “TotalCalcium” (P-Value < 0.01). Of the 11 variables for which the association had a positive direction, 5 were statistically significant, and of the 9 variables with a negative direction of association 3 were statistically significant (P-Value < 0.01). The positive sign of the standardized Coefficient suggest that a higher value of a factor is associated with an increasing level of calcium intake. Inversely, a negative sign of a standardized coefficient suggests that a lower value of the factor is associated with the higher intake of calcium.

For gender, the higher value (2) was assigned for females. For Age categories the highest value (5) was assigned for the oldest among the eligible respondents. For “Education” the 5 levels categories ranged from (<9^{th} Grade) to (College Graduate or Higher). For Race and Ethnicity the order was: White (1) and Non-White (2). For Country of Birth, respondents born in the U.S had the lowest value (1), those born elsewhere had a value of (2). The two categorical variables that described Family monthly poverty level and Household food security had 3 and 4 categories in them, respectively. The two variables that described the number of governmental financial support plans covering a family member and the number of health insurance plans covering the respondent ranged from (1-5) and from (1-3), respectively. For the remainder 10 (Yes/No) type of questions a value of (1) was assigned for an answer with “No” and a value of (2) for an answer with “Yes”.

Notably, all of the associations were weak in general, with the strongest association being with “AgeCategories” (β=.179), followed by “education” (β=.146). Both of these associations were statistically significant at the <0.01 P-value level.

The total of 8 variables that demonstrated statistically significant associations were selected to be the basis for further analysis.

IV.4 Multivariate Analysis

The 8 variables that demonstrated statistically significant associations (P-Value < 0.01) with the level of calcium intake from the Univariate analysis were submitted to a Multivariate Weighted Least Squares Linear Regression. The 2-year sample weight variable "WTINT2YR" provided in the original data source was used for weighing for the Linear Regression. The results of which are listed in table 6 below.

Table 6 - Results of Multivariate Weighted Least Squares Linear Regression[1] for a Number of Variables[2] with the Dependent Variable (TotalCalcium) from the Univariate Linear Regression in Eligible Respondents in the Study Population.

Variables	Standardized Coefficients (Beta)	P-Value
Gender	**.076**	**< 0.01**
AgeCategories	**.118**	**< 0.01**
Education	**.049**	**< 0.01**
Race/Ethnicity	**-.051**	**< 0.01**
Family monthly poverty level category	.021	.187
Household food security category	-.005	.737
Covered by private insurance	.025	.113
Covered by Medicaid	-.009	.517

[1] Weighted by Full Sample 2 Year Interview Weight
[2] The Variables were selected based on showing statistically significant associations with the dependent variable "TotalCalcium" from the Univariate Linear Regression performed in an earlier step of analysis

This was done in order to see the isolated association between each of the factors controlling for each of the others, assumed at this stage to have a confounding effect on the association. Indeed, after running the multivariate analysis, only 4 variables maintained statistically significant weak associations; "Gender" (β=.076) and "AgeCategories" (β=.118), "Education" (β=.049) and "Race/ Ethnicity" (β= -.051).

These 4 variables were selected to be the basis for the next step of statistical analysis.

IV.5 Stratified Multivariate Analysis

Based on the results of the Multivariate Linear Regression described above, the study data set was stratified by the four factors; “Gender”, “AgeCategories”, “Race/Ethnicity” and “Education” in four separate steps. Multivariate Weighted Least Squares Linear Regression was repeated four times, each time with all but the stratifying factor regressed on the dependent variable “TotalCalcium”. The rationale for this stratification is that since these 4 factors did demonstrate having statistically significant associations with the dependent variable from previous analyses, they can potentially alter associations with the rest of the factors. The purpose of this analysis is to isolate the effect of each of the factors from the effects of the rest, and to demonstrate any associations hidden by the effect of stronger effective factors. The results of the latter analyses are demonstrated in the tables 7 through 10 below.

- When Stratifying by “Gender” (See table 7 below), the associations are slightly different among the variables in the two strata. For both male and female respondents, there are statistically significant (P-value <0.01) associations between calcium intake and two variables; “AgeCategories” and “Race/Ethnicity”. For “Age Categories, the association is positive meaning that the older the respondent the higher their estimated daily calcium intake is. This association with is stronger among female respondents (β=.177) than among male respondents (β=.060).”Race/ Ethnicity” variable’s association with the dependent variable is negative meaning that the Estimated daily calcium intake is higher among respondents with the category coded with a smaller number, “White”, as compared to the “Non-White” category. Furthermore, “Coverage by Private Health Insurance” showed a positive statistically significant association with the dependent variable (β=.060) (P-value <0.01) among female respondents meaning that coverage with private health insurance is associated with higher levels of estimated daily calcium intake among female respondents.

Table 7 - Results of Multivariate Weighted Least Squares Linear Regression[1] for a number of variables[2] with the Dependent Variable (TotalCalcium) in Eligible Respondents within the Study Population- Stratified by Gender

Variables	Male		Female	
	Standardized Coefficients Beta	**P-Value**	**Standardized Coefficient (Beta)**	**P-Value**
AgeCategories	**.060**	**< 0.01**	**.177**	**< 0.01**
Education	.050	.039	.044	.051
Race/Ethnicity	**-.052**	**< 0.01**	**-.053**	**< 0.01**
Family Monthly Poverty Level Category	-.004	.872	.045	< 0.05
Household Food Security Category	-.005	.805	-.007	.729
Covered by Private Health Insurance	-.021	.341	**.066**	**< 0.01**
Covered by Medicaid	-.008	.710	-.009	.665

[1] Weighted by Full Sample 2 Year Interview Weight
[2] The Variables were selected based on showing statistically significant associations with the dependent variable "TotalCalcium" from the Non-Stratified Multivariate Linear Regression performed in an earlier step of analysis

- When stratifying by age categories (See table 8 below) statistics could not be computed for category 1 (2-3 years of age) because of lack of valid cases within this category for eligible respondents within the study population. In addition, for age category 2 (4-8 years of age) there were no valid cases for the variable "Education" in this study population. There were statistically significant (P-Value <0.01) negative associations between "Race/ Ethnicity" categories and the dependent variable among respondents within the age categories 4 and 5. This means that estimated daily calcium intake levels are higher among white respondents within the age range (19-69) in the study population. There were also statistically significant positive associations (P-Value <0.01) among respondents within age category 5 (51-69 years of age) between education level and gender on one hand, and the dependent variable on the other. This indicates that the estimated daily calcium intake levels are higher among female respondents and among respondents with higher education levels, independently, within the age range (51-69 years) in the study population. Among respondents within the age category 2 (4-8 years of age) there is a statistically significant negative association between the dependent

variable and Medicaid coverage. This means that the estimated daily calcium intake levels were lower among respondents within this age range covered by Medicaid.

Table 8 - Results of Multivariate Weighted Least Squares Linear Regression[1] for a number of variables[2] with the Dependent Variable (TotalCalcium) in Eligible Respondents within the Study Population- Stratified by Age Categories[3]

Age Categories[3]	2 (4-8 years)		3 (9-18 years)		4 (19-50 years)		5 (51-69 years)	
Variables	**Beta[4]**	**P-Value**	**Beta[4]**	**P-Value**	**Beta[4]**	**P-Value**	**Beta[4]**	**P-Value**
Gender	-.065	.161	.041	.137	.046	< 0.05	**.188**	**< 0.01**
Race/Ethnicity	-.037	.439	.022	.459	**-.061**	**< 0.01**	**-.093**	**< 0.01**
Education[5]	-	-	.026	.344	.014	.511	**.108**	**< 0.01**
Family monthly poverty level category	-.004	.942	.015	.670	.033	.173	.009	.772
Household food security category	.064	.210	-.040	.210	-.026	.238	.058	< 0.05
Covered by private insurance	.024	.692	.022	.536	-.011	.625	.077	< 0.05
Covered by Medicaid	**-.166**	**< 0.01**	-.015	.656	-.004	.855	.024	.384

[1] Weighted by Full Sample 2 Year Interview Weight
[2] The Variables were selected based on showing statistically significant associations with the dependent variable "TotalCalcium" from the Non-Stratified Multivariate Linear Regression performed in an earlier step of analysis
[3]There are no valid cases in one of the split files (Age Category 1). Statistics cannot be computed.
[4] Beta is the Standardized Coefficient
[5] There are no valid cases in the variable "Education" for the age category 2

- When stratifying by Education Level Categories (See table 9 below) the variables that demonstrate statistically significant associations with the dependent variable are again "Gender", "Race/ Ethnicity" and "Age Category" for some of the respondents' different levels of education. Age category shows statistically significant positive association with the dependent variable in the higher 4 education level categories, 2 through 5. This indicates that for respondents with education higher than 9th grades, the older a respondent, the higher their estimated daily calcium intake. There's also statistically significant positive association of the dependent variable with gender among respondents with education level categories 4 and 5 (Education > High School, GED or Equivalent), meaning that for these respondents being a female was associated with higher estimated daily calcium intake. In respondents within the education category 3 (High School graduate, GED or Equivalent) estimated daily calcium intake level was associated, with statistical significance, with Race/ Ethnicity being higher among Whites.

Table 9- Results of Multivariate Weighted Least Squares Linear Regression[1] for a number of variables[2] with the Dependent Variable (TotalCalcium) in Eligible Respondents within the Study Population- Stratified by Education Level Categories

Education Category	**1**		**2**		**3**		**4**		**5**	
	< 9th Grade		**9th -12th Grade without Diploma**		**High School Graduate / GED or Equivalent**		**> High School / Some College or AA degree**		**College Graduate or Higher**	
Variables	**Beta[4]**	**P-Value**	**Beta[4]**	**P-Value**	**Beta[4]**	**P-Value**	**Beta[4]**	**P-Value**	**Beta[4]**	**P-Value**
Gender	.028	.250	.050	.111	.041	.201	**.080**	**< 0.01**	**.215**	**< 0.01**
AgeCategories	.040	.115	**.123**	**< 0.01**	**.110**	**< 0.01**	**.138**	**< 0.01**	**.173**	**< 0.01**
Race/Ethnicity	.007	.788	-.072	< 0.05	**-.138**	**< 0.01**	-.032	.266	-.032	.331
Family monthly poverty level category	.022	.466	-.044	.238	-.028	.453	.043	.199	.055	.145
Household food security category	.021	.419	-.038	.279	-.014	.695	-.001	.980	.020	.582
Covered by private insurance	.011	.717	.046	.221	.023	.531	.018	.570	.022	.560
Covered by Medicaid	-.050	.073	.028	.414	-.025	.448	-.029	.327	.036	.293

[1] Weighted by Full Sample 2 Year Interview Weight
[2] The Variables were selected based on showing statistically significant associations with the dependent variable "TotalCalcium" from the Non-Stratified Multivariate Linear Regression performed in an earlier step of analysis
[3] Selecting only cases for which Education >= 1 (< 9th grade)
[4] Beta is the Standardized Coefficient

- When stratifying by "Race/ Ethnicity" (See table 10 below), again, the variables that demonstrated statistically significant associations with the dependent variables were "Gender", "AgeCategories" and "Education". "Gender" and "AgeCategories" both had positive associations with the dependent variable for both "Race/Ethnicity" categories, with slightly higher β values among Whites. This means higher levels of estimated daily calcium intake in females and older respondents in all races included in the study population. However, higher education levels were associated with higher levels of estimated daily calcium intakes in Non-White respondents as demonstrated by the statistically significant (P-Value <0.01) positive association of Education Level with the dependent variable, "TotalCalcium" among eligible study respondents.

Table 10- Results of Multivariate Weighted Least Squares Linear Regression[1] for a number of variables[2] with the Dependent Variable (TotalCalcium) in Eligible Respondents within the Study Population- Stratified by Race/ Ethnicity

Race Categories	**White**		**Non- White (Black, Hispanic or other)**	
Variables	**Beta[3]**	**P-Value**	**Beta[3]**	**P-Value**
Gender	**.101**	**< 0.01**	**.055**	**< 0.01**
AgeCategories	**.174**	**< 0.01**	**.080**	**< 0.01**
Education	.015	.537	**.064**	**< 0.01**
Family monthly poverty level category	-.004	.885	.036	.082
Household food security category	-.029	.195	.015	.427
Covered by private insurance	.030	.209	.023	.235
Covered by Medicaid	-.017	.443	-.009	.639

[1] Weighted by Full Sample 2 Year Interview Weight
[2] The Variables were selected based on showing statistically significant associations with the dependent variable "TotalCalcium" from the Non-Stratified Multivariate Linear Regression performed in an earlier step of analysis
[3] Beta is the Standardized Coefficient

Chapter V

Discussion

V.1 Research Question

The choice of this topic was for the importance of a balanced timely intake of calcium for health, and the burden of the consequences of the lack of this balanced intake on public health.

Bones provide the major storage of calcium in the body. Inadequate intake of calcium in the years before maximum bone maturity and reaching maximum Bone Mineral Density (BMD) in the late 20s – early 30s of age results in higher incidence of osteoporosis in later life years. This carries risk of serious, potentially life-threatening bone fractures in older population.

Furthermore, excessive calcium intake in response to poorly designed public health campaigns and messages is not devoid of risks. Recent research raised concern about a potential cardiovascular risks and increased incidence of urinary stones formation in association with excessive calcium intake. However, this recent research has shown some debate over how serious these risks are, therefore the focus of this study was on meeting the Recommended Dietary Allowances (RDAs), and combined all intake levels above the maximum recommended allowance in one category.

For the reasons mentioned above, it is necessary to assess the patterns of calcium intake in the general population to identify whether or not they are consistent with the healthy balanced intake for every life stage, between the two gender and in otherwise vulnerable populations. This study is intended to take a close cross-sectional look at the patterns of intake in the most recent available nationally representative sample, with a mindset of preparing for future studies that facilitate

the scientific application of public health principles and taking public health action to insure adequate and balanced calcium intake in a timely manner.

V.2 Methods

The latest publically available nationally-representative data set from NHANES, the 2009-2010 survey, was used for this study. (National Health and Nutrition Examination Survey/ NHANES 2009-2010, 2013). A sample was of 8,675 respondents was selected from the original 10,537 in an age range of 2-69 years based on the age range of respondents who completed the “dietary screener” survey with information pertaining to dairy (milk and cheese) consumption. Although the original study already has a variable that provides these values, this information was not publically available and not accessible to the researchers in this current study. It was necessary to limit the study to this population in order to obtain an estimate of daily calcium intake. The study population was further limited to a total of 7,053 respondents who had valid values of the variable that conveyed information about the estimated daily calcium intake “TotalCalcium”. Respondents with missing values for this variable were excluded from this study.

Five demographic factors and 14 Socio-Economic Status (SES)-associated factors in a total of 19 variables were assessed for association with the level of calcium intake estimated by combining information about dietary dairy, calcium supplements and antacid intake.

The demographic aspects explored were gender, age, race/ ethnicity, country of birth, and pregnancy status. The SES aspects were education, Economic Status (as estimated through Family’s Monthly Poverty Index Category, Household’s Food Security Category, and Family members’ receiving some form of governmental finance support with a closer look at some specific governmental programs) and health insurance coverage (with an assessment of the quality of health insurance (covering prescriptions), number of health insurance plans, and a closer look at some forms of Health Insurance Plans, namely Medicaid, Private Health insurance and state-sponsored plans) .

While exploring these factors mentioned above the following requires notice:

- Age was assessed as a categorical variable with values dividing study population into 5 age categories based on the different levels of Recommended Dietary Allowances described by the Food and Nutrition Board (Health Information / Calcium, 2013).
- Race/ ethnicity variable had 2 major categories; White and Non-White (Including Blacks, Mexican Americans and other Hispanics, and others, including multi-racial)
- Country of birth included 2major categories; U.S. and Other (Non-U.S)
- Pregnancy status data in the original data set was ascertained for females 8-59 years of age but released only for respondents within the age range of 20-44 years of age. The remaining data was withheld from release for disclosure risks concerns.
- Education level was reported in two variables in the original data set. One for respondents 6-19 years of age and the other for respondents 20 years of age and older. In this study this data was combined in one variable, “Education”. The categories in the original 2 variables were changed into 5 categories in the new education variable, ranging from 1 to 5 to reflect the levels ranging from those with education under 9^{th} grade to college graduates and higher education levels, respectively.
- Level of income was assessed by three major aspects; the respondent’s Family Monthly Poverty Level Category, the respondent’s family food security category and receiving one of a number of governmental financial support income sources (the latter was assessed by the number of plans covering a respondent’s family member and also by receiving some specific plans including income from: Retirement or Survivor Pension, Social Security or Railroad Retirement, other disability pension, Supplemental Security Income or State/ County Cash Assistance.).
- Health insurance was assessed in three aspects; the number of health insurance plans covering the respondent, the health plan’s coverage of prescriptions, and the specific type of the health plan.

- After assigning the variables of interest, they were run through linear regression on the variable with the estimated level of calcium intake in three consecutive steps.
- 1st a Univariate linear Regression was performed with each of the 19 variables of interest alone on the dependent variable “TotalCalcium” to identify the factors that have statistically significant associations with the estimated calcium intake level. This level of association reflects the relationship with all the potentially confounding factors working in concert with each other.
- Then a multivariate Linear Regression was done by including the 8 variables that demonstrated statistically significant associations with the estimated calcium intake level from the previous step of analysis. Now, this level of association reflects the effect each of the 8 factors exhibit individually in isolation from the effect of the other factors.
- Finally the 4 variables that maintained statistically significant association from the multivariate Linear Regression (Gender, AgeCategories, Race/Ethnicity and Education) were selected for stratification, and the multivariate Linear Regression was run again after stratifying once by each of the 4 variables. This is done because these factors were proven, by the previous step, to have statistically significant effect on associations with the dependent variable; therefore it was necessary to look for associations within their own categories in order to unmask any potential associations hidden under their effect.

V.3 Summary of Results

- Based on the results of the analysis in this study; calcium intake is indeed associated with a number of the variables included in this study. Table 11 below provides a summary for all the statistically significant associations (P-Value <0.05) demonstrated by the final levels of analysis; Stratified Multivariate Linear Regression.
- The factors that demonstrated consistent statistically significant association across the levels of analysis performed in this study, and after controlling for potential confounders, were gender, Age, Race/ Ethnicity and Education. This is in spite of loss of some of these associations within some of the strata created for analysis.
- Age categories demonstrated consistent statistically significant positive associations with the dependent variable across all the strata. (I.e. for both genders, for all levels of education and for both White and Non-White Respondents). This means that for all the respondents within the study population, estimated daily calcium intake increased with age.
- Education levels, however, only showed statistically significant positive associations within the oldest respondents' age category (51-69 years of age) and among Non-White respondents. I.e higher education levels were associated with higher estimated daily calcium intakes in respondents within this study.
- Race/ Ethnicity showed statistically significant negative associations with the dependent variable in both genders, in older respondents (ranging 19-69 years of age) and in respondents with education level category 3 (High School Graduates/ GED or equivalent). This means that for both genders and for these subgroups within the study population being Non-White was associated with lower levels of estimated daily calcium intake.
- Female gender was associated with higher levels of calcium intake in all races and in the higher educated respondents within the study population (Education level categories

4 and 5; higher than High School graduates or GED or Equivalent) It's also higher in female respondents of the oldest age category in the study (51-69 years of age) This is demonstrated by the statistically significant positive associations of this factor with the dependent variable in these subgroups of the study population.

- Coverage by Medicaid was associated with lower levels of estimated daily calcium intake in the respondents within the 2nd age category (4-8 years of age) when controlling for confounders.
- Coverage by private Health Insurance was associated with slightly higher levels of estimated daily calcium intakes among female respondents when controlling for confounders.

Table 11- Summary of standardized Coefficients (β) for statistically significant associations (P-value<0.01) between factors of interest and estimated daily calcium intake in the study population

Stratification Levels	Variables	Gender	Age Categories	Race/ Ethnicity	Education	Family Monthly Poverty Level Index Category	Medicaid Coverage	Private Insurance Coverage
Gender								
	Male	-[1]	.060	-.052				
	Female		.177	-.053				.066
Age Categories								
	1							
	2						-.166	
	3		-[1]					
	4			-.061				
	5	.188		-.093	.108			
Race/Ethnicity								
	White	.101	.174	-[1]				
	Non-White	.055	.080		.064			
Education Level Categories								
	1							
	2		.123					
	3		.110	-.138	**-[1]**			
	4	.080	.138					
	5	.215	.173					

[1] A variable is excluded from the multivariate Linear Regression when stratifying by it

V.4 Limitations

IV.4.1 The nature of this study, being a cross-sectional study, eliminates the possibility for drawing conclusions about the nature of the demonstrated associations being causal or not. In addition, being based on secondary data limits the potential for a more specific, detailed and/or topic-targeted approach. It also necessitates the use of proxies for defining socio-economic status rather than an extensive detailed account.

IV.4.2 Another more specific limitation was related to the main variable of interest; calcium intake. A potentially more accurate account of this value was obtained by the primary researchers in the original study, but this data was not released for public use, and requires special permission to get and use it. This made it necessary to derive an estimate of daily intake using parameters that vary in nature amongst each other and combine the information in one variable. For instance, the dietary intake was estimated through considering dairy (milk and cheese) intake. The latter had no details about the type of milk or cheese and whether or not the intake was the dairy product alone or in combination with other foods that might interfere with calcium absorption or with appetite. The use of antacid was assumed important to consider since the dose of calcium in a calcium-containing antacid is considerable. However, the variable describing this intake in the original study also included the magnesium-based antacids.

IV.4.3 Some of the variables assessed in this study had missing values that are actually obtained in the original primary research, but withheld for confidentiality and disclosure risks concerns. This could have potentially affected the quality of information obtained from this current study. This is especially true when

considering the role of pregnancy status. Data for this factor was ascertained for females 8–59 years of age but only released for respondents 20-44 years of age. This is particularly important to consider since pregnancy status is closely associated with the balance of calcium intake and utilization.

V.5 Recommendations

V.5.1 Special attention is recommended for calcium intake levels of the following population subgroups:

1. Younger population as this study revealed that calcium intake levels increase with age in both genders, all races and across all levels of education. Although the Recommended Daily Allowances are in fact higher for older people and do increase with age, but calcium intake is time sensitive and should be adequate before the age of bone maturity around late twenties and early thirties.
2. Older population with low education, and Non-White population with low education.
3. Non-White population of both genders, as this subgroup of this study population demonstrated lower levels of estimated daily calcium intakes as compared to the Whites in this study. This is specifically true for the older people in this race category.
4. Under-Educated population especially the younger population and Non-White races.
5. Young children (4-8 years of age) covered by Medicaid.

V.5.2 Further studies are needed in order to :

1. Explore the underlying reasons for the finding that calcium intake levels where highest among older females (19-69 years of age), highly educated females and for females covered by private health insurance. This is recommended to identify if there were some measures that can be taken to mimic the factors that contribute to these higher levels of intake and applying them to the more vulnerable population; the young, Non-white and/ or the under-educated if needed.
2. Identify if these levels of calcium intake are higher than needed and might potentially cause harm to this sectors of the U.S. population (Older, White Highly-educated women)

3. Identify the underlying reasons for the lower calcium intake levels for Young children (4-8 years of age) covered by Medicaid and if something need to be done for these children.

Chapter VI

Conclusions

- White, older females had the highest estimated daily calcium intake levels among respondents in the study population. The estimated daily calcium intake levels were lower for the youngest age groups, and for the respondents with the lowest levels of education among the oldest population and among the Non-White population. They were also lower among Non-White population in general.
- Coverage by Medicaid is associated with lower calcium intake levels among young children (4-8 years of age).Conversely, coverage by private health insurance was associated with higher levels of calcium intake among female respondents.
- Further studies are needed to assess the reasons for these patterns and to identify public health measures that can be taken to improve calcium intake levels in the Non-white population (especially those at the extremes of age range), the younger population, and people with lower levels of education.

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