Advance Journal of Food Science and Technology 6(3): 333-343, 2014
DOI:10.19026/ajfst.6.32
ISSN: 2042-4868; e-ISSN: 2042-4876

Submitted: September 24, 2013 Accepted: October 26, 2013 Published: March 10, 2014

Research Article

The Association of Calcium Intake and Other Risk Factors with Cardiovascular Disease among Obese Adults in USA

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Abstract: In this study, we used a cross-sectional study design to examine the relationship between the calcium intake and risk factors for CVD among obese adults by using continuous waves of National Health and Nutrition Examination Survey (NHANES) data 1999-2010. The association between calcium intake and risk factors of CVD (hypertension, total cholesterol, HDL, glycohemoglobin), CRP, albuminuria) is assessed among obese adults in USA. The incidence of Cardiovascular Disease (CVD) is high among obese people. The potential effects of inadequate calcium intake on CVD are receiving increased epidemiologic attention. Understanding the association between risk factors for CVD and calcium intake among obese adults is important for the advancement of CVD, nutrition and obesity research. Data collected from the National Health and Nutrition Examination Survey from 1999-2010 were examined, utilizing a subset of 14,856 obese subjects. Analysis of Variance statistical tests were conducted to determine associations between calcium intake and CVD risk. Simple and multiple linear and logistic regression analyses were conducted to determine the predicted value of calcium intake with CVD. After adjusting for energy intake and other potential risk factors, systolic blood pressure, diastolic blood pressure, C-reactive protein, glycosylated hemoglobin and albuminuria were negatively associated with calcium intake at $\alpha = 0.05$ level in both linear and logistic regression analyses. In a comparison of calcium intake by quartiles, results reveal that total cholesterol had a weak negative association with calcium intake at $\alpha = 0.1$ level. The implications of these study results are important as the importance of adequate calcium intake and its potential to decrease CVD among obese adults has incredible preventive value for populations. Additional research that focuses on dietary intake, calcium thresholds and impacts on total cholesterol levels in the body is warranted.

Keywords: Blood pressure, calcium, cardiovascular, cholesterol, epidemiologic, hypertension, logistic regression, NHANES, obese, quartiles

INTRODUCTION

Cardiovascular Disease (CVD) is the leading cause of mortality in the United States (U.S.), accounting for about one in every four deaths (Kochanek *et al*., 2011). About 600,000 people die of CVD in the U.S. every year (Lawes *et al*., 2006). People of all ages and backgrounds are at risk for this condition (Hansen *et al*., 2007; Chobanian *et al*., 2003; Kearney *et al*., 2005). The prevention and control of CVD is a priority area for the U.S. as articulated in the Healthy People 2020 objectives for the nation. Obesity is a major risk factor for CVD and the incidence of CVD is high among obese people (Goran *et al*., 2003). During the past 20 years, there has been a dramatic increase in obesity in the U.S. More than one-third of U.S. adults (35.7%) are currently obese (Overweight and Obesity, 2012). The medical care costs of obesity in the U.S. are staggering. In 2008, these costs totaled approximately $147 billion (Finkelstein *et al*., 2009). The prevention and control of obesity is highly influenced by lifestyle modification, specifically through diet (Committee on Public Health Priorities to Reduce and Control Hypertension in the U.S. Population, Institute of Medicine, 2010). In this study, we used a cross-sectional study design to examine the relationship between the calcium intake and risk factors for CVD among obese adults by using continuous waves of National Health and Nutrition Examination Survey (NHANES) data 1999-2010. The association between calcium intake and risk factors of CVD (hypertension, total cholesterol, HDL, glycohemoglobin), CRP, albuminuria) is assessed among a group of obese adults.

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LITERATURE REVIEW

Nutritional, clinical and demographic risk factors for CVD: Researchers explore nutritional elements and their role in both obesity and CVD. One particular mineral of continued interest is calcium. Calcium, the most abundant mineral in the body, is required for vascular contraction and vasodilation, muscle function, nerve transmission, intracellular signaling and hormonal secretion. Calciumintake is critical to bone development and maintenance, particularly in children and elderly adults. It plays a vital role in many bodily functions, including: blood clotting, bone formation and maintenance, muscle and tissue development, as well as maintaining protein structure (Stanton, 2006). The potential effects of limited calcium intake on non-skeletal health outcomes such as CVD are receiving increasing attention (Peterlik and Cross, 2005). Some epidemiologic studies report associations between inadequate calcium intake and adverse CVD risk factor profiles as well as increased risk of CVD events (Osborne *et al*., 1996; Bostick *et al*., 1999). Moreover, in a randomized, placebo-controlled, clinical trial designed to evaluate CVD outcomes, showed, post hoc analysis revealed atwo-fold increase in the incidence of myocardial infarction over 7 years among women who consumed 1000 mg calcium citrate supplements relative to the controls (women receiving a placebo) (Bolland *et al*., 2008). Complete understanding of the most beneficial source, such as dairy versus supplementation, as well as the most therapeutically protective level of calcium has not been established. However, even a small, adverse effect of oral calcium on the vascular system could have major public health consequences because of the high prevalence of CVD, as well as the low cost and wide availability of calcium supplements. Other important clinical risk factors for CVD include: hypertension, total cholesterol, High-Density Lipoproteins (HDL), glycohemoglobin, C-Reactive Protein (CRP) and albuminuria. These factors are highly associated with morbidity and mortality for CVD (Heart Disease Conditions, 2012; Khaw *et al*., 2004; Friões *et al*., 2003; Cooney *et al*., 2009; Romero-Corral *et al*., 2008; Gerstein *et al*., 2001; Hillege *et al*., 2002).

In addition to dietary habits, disparities in CVD risk and outcomes also exist among specific subgroups of the American population based on ethnicity, poverty status, educational attainment, age and gender. Based upon the recognized behavioral/nutritional, clinical, demographic risk factor research regarding CVD, the purpose of this study was to conduct a secondary analysis of cross-sectional survey data collected from the National Health and Nutrition Examination Survey (NHANES) data over an 11 year period (1999-2010). The research questions were to determine if identified risk relationships between calcium intake and behavioral/nutrition, clinical and demographic risk factors for CVD persist-using a robust national sample of obese adults in the United States. The association between calcium intake and hypertension, total cholesterol, HDL, glycohemoglobin, CRP, albuminuria and diabetes as well as the influence of demographic covariates (race, educational attainment, age, poverty and behavioral risk (smoking and alcohol use) were assessed among a sample of obese adults using an 11 year span of survey data.

METHODOLOGY

Study population: Data from six administrations (waves) of the National Health and Nutrition Examination Study (NHANES) were analyzed in this study. NHANES, which began in 1999 and is conducted every 2 years, is a national probability survey conducted by the National Center for Health Statistics (2008), U.S. Centers for Disease Control and Prevention. It is designed to estimate the prevalence of common chronic conditions and associated risk factors for chronic disease prevention. The sample for the survey was obtained through a complex multistage cluster design which yields a nationally representative sample of about 5,000 persons. Participants reside in counties across the country, of which 15 are visited each year. The NHANES interview includes demographic, socioeconomic, dietary and health-related questions. The examination component consists of medical, dental and physiological measurements, as well as laboratory tests administered by highly trained medical personnel.

Interview and laboratory data from adult participants (age≥20 years) were examined among those meeting the criteria for obesity. An observation was classified as obese if it fell within the limits of generalized or central obesity categorization. According to the National Cholesterol Education Program-Adult Treatment Panel III, generalized obesity is defined as having a Body Mass Index (BMI) ≥30 kg/m^2 (Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults, 2001). Central obesity is classified as having a waist circumference ≥102 cm for men and ≥88 cm for women (Alberti *et al*., 2005). Cases were not included in the analyses if any of the following conditions were met: subjects were pregnant, response was provided by a proxy, or data for reported calcium intake were missing.

Study variables:

Demographic characteristics: Age in years was recorded during the interview. Educational attainment was defined as respondents reported number of years in school. Three educational categories were created: less than high school, completion of high school and attended college or above. Race categories included non-Hispanic White, non-Hispanic Black, Mexican-American, other Hispanic and other race. Poverty was defined as a Poverty Index Ratio (PIR) <1.0. The PIR is the ratio of the family's total income to the family's appropriate poverty threshold. It is calculated using the family's mean income and number of individuals in their household (National Center for Health Statistics, 2008). Additional independent variables examined in this study included self-reported smoking and alcohol use (classified into binary categories: users and never use). A final variable considered participants' self-reported diagnosis of diabetes by a physician, with a binary response of 'yes' or 'no'.

Dietary characteristics: The Institute of Medicine (IOM) recommends that dietary assessment in relation to Dietary Reference Intakes be based on usual intake distributions of nutrients (National Health and Nutrition Examination Survey, 2004). To this end, the NHANES dietary interview data was used as the source of detailed dietary intake information for the study analyses. Dietary intake data were used to estimate the types and amounts of foods and beverages consumed during the 24-h period prior to the interview (midnight to midnight) and to estimate intakes of energy, nutrients and other food components from those foods and beverages. The dietary interview was structured to include: an inventory from a quick food list, food brand names and amount consumed (using a unit list). Interviewers followed a script to ask the same probing questions when asking participants about consumption (National Center for Health Statistics, 2008). Interview dietary data were collected using United States Department of Agricultural (USDA) dietary data collection instrument, the Automated Multiple Pass Method (AMPM), was designed to provide an efficient and accurate means of collecting intakes for large-scale national surveys. The accuracy of the AMPM is also assessed in the USDA AMPM Validation Study using biomarker data. The extent of misreporting dietary intakes will be determined by comparing estimated value (Moshfegh *et al*., 2003).

Half of the 1999-2002 dietary recall surveys were completed in-person and half were completed via telephone. Each participant was randomly assigned to either a morning exam session or an afternoon/evening exam session. The telephone dietary interview was scheduled and conducted 4-10 days after the health examination. Examinees who were lacking a telephone or who could not schedule the interview component within the 4-10 day timeframe completed the interview in-person (National Health and Nutrition Examination Survey, 1999). The 2003-2010 dietary recall was conducted within two days of intake data for each participant. The interview was administered via telephone within 3 to 10 days of the health examination.

Interview data were coded and processed by Survey Net and Food and Nutrient Database for Dietary Studies, 2.0 (FNDDS 2.0), which were computer-assisted food coding and data management system developed by USDA. The FNDDS includes comprehensive information that can be used to code individual foods and portion sizes reported by participants and also include nutrient values for calculating nutrient intakes. The underlying nutrient values for FNDDS 2.0 were based on values in the USDA National Nutrient Database for Standard (National Health and Nutrition Examination Survey, 2004; Agricultural Research Service, Beltsville Human Nutrition Research Center, Food Surveys Research Group, Beltsville, MD, 2013; Moshfegh *et al*., 2003). Calcium intake and energy intake were calculated based upon a individuals 24 h food and beverage consumption reporting. The nutrient intakes do not include nutrients obtained from other sources such as dietary supplements, antacids and medications. Standard units of measurement for calcium and energy intake, milligram and kilocalorie, are, respectively recorded in the NHANES interview (National Center for Health Statistics, 2008).

Cardiovascular risk factors: Hypertension status was established by history and Blood Pressure (BP) level. Administration of NHANES physical exams required a certified technician to perform BP measurements using a mercury sphygmomanometer and a standardized procedure (Frohlich *et al*., 1988; Chobanian *et al*., 2003). A cuff size appropriate for participants' arm circumference was used. Four BP readings were taken, with the average of the last 3 readings used for these analyses. Hypertension was defined as an average Systolic BP (SBP) of 140 mm Hg or greater, or an average Diastolic BP (DBP) of 90 mm Hg or greater. Serum total cholesterol concentration and serum High-Density Lipoprotein (HDL) cholesterol concentration were measured enzymatically at the Lipoprotein Analytical Laboratory at The Johns Hopkins Hospital. Individuals with total cholesterol concentrations of 200 mg/dL or greater were considered to have high total cholesterol levels (National Health and Nutrition Examination Survey, 2004; Stamler *et al*., 1993). According to the Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (2001), the recommended cut-off value to indicate low HDL cholesterol is <40 mg/d Land this value was utilized in these analyses. Glycohemoglobin was tested with boronate affinity in high performance liquid chromatography and NHANES utilizes the University of Missouri-Columbia laboratories for processing, storage and analysis for all blood samples. Participants were considered to have elevated glycohemoglobin if the blood measurement of glycohemoglobin ≥7.0% (National Center for Health Statistics, 1992). To quantify C-Reactive Protein (CRP), a diluted solution of CRP was mixed with latex particles coated with mouse monoclonal anti-CRP antibodies. Antigen-antibody complex formation will occur in test samples positive for CRP. High plasma CRP was defined as CRP concentrations >3 mg/L (Pearson *et al*., 2003). Serum albumin levels were measured using an albumin test system with a bromcresol purple reagent. Albuminuria was assessed by using a urinary albumin: creatinine ratio with a cut-off level of 30 mg/g (Gerstein *et al*., 2001).

Statistical analysis: Statistical analyses adhered to The National Health and Nutrition Examination Survey Analytic and Reporting Guidelines (2006) and Analytic Note Regarding 2007-2010 Survey Design Changes and Combining Data Across other Survey Cycles (2011). The analysis sample was stratified by quartiles of calcium intake. ANOVA tests were used to compare age, calcium intake and cardiovascular risk factors according the calcium intake quartiles. Other variables and categorical cardiovascular risk factors were compared between calcium intake quartile groups using Chi-square tests.

To compare the individual CVD risk factors for different calcium intake levels, simple logistic regression models and simple linear regression models were conducted for each of the categorical and continuous risk factors, respectively, using a continuous format and a quartile format of calcium intake as an independent variable. Multiple logistic regressions and multiple linear regression analysis were used to adjust covariates including age, gender, education, race, poverty index, diabetes, smoking status and alcohol use. Multiple regression models were calculated by using the backward variable selection method at a 0.10 significance level. Data analyses were conducted using SAS (version 9.2; SAS Institute Inc, Cary, NC). Statistical hypotheses were tested using $p<0.05$ as the determined level of statistical significance.

RESULTS

The final sample of eligible cases used in this analysis consisted of 14,856 obese adults, with ages ranging from 20 to 85 years. The range of calcium intake was between 0 and 8,701 mg/d and the mean was

Table 1: Characteristics of obese adults by quartile of calcium intake in U.S. (1999-2010)

	Quartile of calcium intake				
	1 (n = 3714)	2 (n = 3714)	3 (n = 3714)	4 (n = 3714)	p-value
Age, years	55.30	55.08	53.36	50.57	<0.0001[1]
Gender (male), %	30.34	33.58	39.66	51.76	<0.0001[2]
Poverty (PIR<1), %	23.11	18.35	16.61	15.55	<0.0001[2]
Education (%)					<0.0001[2]
Less than high school	41.17	33.09	29.13	24.49	
High school	24.95	26.17	24.90	22.95	
College or above	33.88	40.74	45.97	52.56	
Race (%)					<0.0001[2]
Mexican American	20.54	21.35	20.79	18.38	
Other hispanic	6.44	6.52	6.81	6.03	
Non-hispanic white	39.63	46.88	53.18	60.32	
Non-hispanic black	30.40	22.32	16.88	12.71	
Other race	2.99	2.93	2.34	2.56	
Smoking (yes), %	43.63	39.66	36.91	37.00	<0.0001[2]
Alcohol use (yes), %	67.23	70.75	73.47	75.37	<0.0001[2]
Diabetes, %	18.09	16.75	15.72	12.25	<0.0001[2]
Calcium intake, mg	339.30	604.77	867.33	1460.45	<0.0001[1]
SBP					
Mean, mm Hg	130.61	128.45	126.72	125.72	<0.0001[1]
Elevated, ≥140 mm Hg, %	28.38	24.78	21.85	19.32	<0.0001[2]
DBP					
Mean, mm Hg	71.39	70.47	70.55	71.72	<0.0001[1]
Elevated, ≥90 mm Hg, %	7.77	6.38	6.14	6.95	0.0311[2]
Hypertension, %	33.44	29.56	26.36	23.77	<0.0001[2]
Total cholesterol					
Mean, mg/dL	204.65	201.08	202.68	202.43	0.0054[1]
Elevated, >200 mg/dL, %	51.04	49.41	50.08	49.73	0.5503[2]
HDL cholesterol					
Mean, mg/dL	50.86	50.35	49.94	48.54	<0.0001[1]
Elevated, <40 mg/dL, %	25.53	25.15	28.42	31.19	<0.0001[2]
CRP					
Mean, mg/dL	0.64	0.56	0.52	0.52	<0.0001[1]
Elevated, >0.3 mg/dL, %	56.95	53.38	50.38	49.54	<0.0001[2]
Glycohemoglobin					
Mean, %	5.94	5.88	5.84	5.78	<0.0001[1]
Elevated, >7%, %	11.92	10.27	9.15	8.34	<0.0001[2]
Albuminuria					
Mean, ratio	8.33	4.97	4.39	4.32	<0.0001[1]
Elevated, >30 mg/g, %	18.05	15.05	13.55	13.27	<0.0001[2]

Quartiles of calcium intake are numbered from the lowest (quartile 1) to highest (quartile 4) intake levels; [1]: One-way ANOVA F-test; [2]: Chi-square test; SBP: Systolic blood pressure, DBP: Diastolic blood pressure; HDL cholesterol: High-density lipoprotein cholesterol; CRP: C-reactive protein; p-value: Comparing proportions, such as gender, among four groups defined by quartiles of calcium intake using chi-square test, or comparing means, such as SBP, among four groups using one-way ANOVA F-test

Table 2: Simple and multiple linear regression analyses of cardiovascular risk factors by calcium intake quartiles and other predictors among obese adults in the U.S. (1999-2010)

	Estimates (S.E.)							
	SBP		DBP		Total cholesterol		HDL cholesterol	
	Crude	Adjusted	Crude	Adjusted	Crude	Adjusted	Crude	Adjusted
Calcium intake								
Quartile 1	4.89 (0.47)***	2.44 (0.50)***	-0.32 (0.32)	2.32 (0.54)***	2.22 (1.01)**	4.04 (1.32)***	2.32 (0.35)***	-0.79 (0.61)
Quartile 2	2.72 (0.47)***	0.49 (0.46)	-1.24 (0.32)***	0.67 (0.50)	-1.36 (1.01)	-0.38 (1.21)	1.82 (0.35)***	-1.02 (0.55)*
Quartile 3	1.00 (0.47)**	-0.38 (0.44)	-1.17 (0.32)***	0.26 (0.48)	0.25 (1.00)	0.38 (1.38)	1.40 (0.35)***	-0.14 (0.52)
Age	0.49 (0.01)***	0.51 (0.01)***	-0.14 (0.01)***	-0.16 (0.01)***	0.17 (0.02)***	0.23 (0.03)***	0.13 (0.01)***	0.18 (0.01)***
Gender	-1.07 (0.34)***	$^{+}$	-3.18 (0.23)***	-3.06 (0.35)***	6.01 (0.73)***	7.92 (0.86)***	10.08 (0.24)***	10.73 (0.40)***
Race								
Mexican American	-0.09 (1.08)	-0.94 (0.98)	-1.75 (0.75)**	$^{+}$	-0.96 (2.32)	-3.06 (2.72)	-0.97 (0.80)	1.41 (1.31)
Non-hispanic black	3.09 (1.08)***	1.89 (0.98)*	0.18 (0.75)	$^{+}$	-3.93 (2.33)*	-7.76 (2.72)***	4.94 (0.80)***	6.56 (1.30)***
Non-hispanic white	0.87 (1.05)	-2.79 (0.94)***	-2.19 (0.73)***	$^{+}$	1.63 (2.24)	-3.35 (2.63)	0.81 (0.77)	1.75 (1.25)
Other hispanic	-2.60 (1.21)**	-3.42 (1.09)***	-1.92 (0.84)**	$^{+}$	-0.97 (2.60)	-5.74 (3.03)*	-0.60 (0.89)	0.81 (1.49)
Education								
Less than high school	4.95 (0.39)***	2.01 (0.38)***	-1.92 (0.27)***	-0.49 (0.39)	0.55 (0.83)	$^{+}$	-1.73 (0.29)***	-1.98 (0.47)***
High school	3.02 (0.42)***	1.89 (0.38)***	-0.48 (0.29)*	0.82 (0.41)**	1.88 (0.90)**	$^{+}$	-1.41 (0.31)***	-1.73 (0.45)***
Poverty	0.95 (0.45)**	$^{+}$	0.35 (0.31)***	$^{+}$	1.92 (0.91)**	$^{+}$	1.86 (0.34)***	1.84 (0.50)***
Smoking	-5.33 (0.47)***	$^{+}$	1.60 (0.34)***	-0.63 (0.37)*	2.42 (1.09)**	$^{+}$	-3.32 (0.37)***	-2.50 (0.42)***
Alcohol use	-4.44 (0.40)***	$^{+}$	1.96 (0.28)***	$^{+}$	2.42 (0.89)***	2.33 (0.91)***	1.81 (0.31)***	3.96 (0.42)***
Diabetes	5.78 (0.46)***	$^{+}$	-4.16 (0.31)***	-2.84 (0.45)***	-11.78 (0.99)***	-12.81 (1.16)***	-2.66 (0.34)***	-3.75 (0.52)***
Energy intake	-0.00 (0.00)***	-0.00 (0.00)***	-0.00 (0.00)***	-0.00 (0.00)***	-0.00 (0.00)	-0.00 (0.00)***	-0.00 (0.00)***	-0.00 (0.00)

	Estimates (S.E.)					
	CRP		Glycohemoglobin		Albuminuria	
	Crude	Adjusted	Crude	Adjusted	Crude	Adjusted
Calcium intake						
Quartile 1	0.12 (0.02)***	0.07 (0.04)*	0.16 (0.03)***	-0.00 (0.03)	4.51 (0.92)***	3.75 (1.23)***
Quartile 2	0.05 (0.02)**	-0.02 (0.03)	0.10 (0.03)***	-0.02 (0.03)	0.65 (0.92)	-0.19 (1.13)
Quartile 3	0.01 (0.02)	-0.05 (0.03)	0.05 (0.03)*	-0.04 (0.02)*	0.07 (0.92)	0.04 (1.07)
Age	-0.00 (0.00)***	$^{+}$	0.01 (0.00)***	0.01 (0.00)***	0.11 (0.02)***	0.04 (0.03)*
Gender	0.15 (0.01)***	0.12 (0.02)***	-0.10 (0.02)***	-0.08 (0.01)***	-1.24 (0.67)*	$^{+}$
Race						
Mexican American	0.06 (0.05)	0.04 (0.08)	-0.02 (0.06)	-0.04 (0.05)	0.46 (2.12)	$^{+}$
Non-hispanic black	0.21 (0.05)***	0.15 (0.08)*	0.08 (0.06)	0.03 (0.05)	2.17 (2.12)	$^{+}$
Non-hispanic white	0.02 (0.04)	0.06 (0.08)	-0.30 (0.06)***	-2.67 (0.05)***	-2.39 (2.05)	$^{+}$
Other hispanic	0.05 (0.05)	0.05 (0.09)	-0.05 (0.07)	-0.08 (0.06)	-0.04 (2.37)	$^{+}$
Education						
Less than high school	0.05 (0.02)***	$^{+}$	0.34 (0.02)***	0.10 (0.02)***	4.06 (0.76)***	$^{+}$
High school	0.02 (0.02)	$^{+}$	0.11 (0.02)***	0.06 (0.02)***	1.60 (0.82)**	$^{+}$
Poverty	-0.15 (0.02)***	-0.08 (0.03)***	-0.13 (0.03)***	-0.04 (0.02)*	-3.27 (0.86)***	-2.53 (1.02)**
Smoking	0.10 (0.02)***	0.09 (0.02)***	-0.14 (0.03)***	$^{+}$	-1.13 (1.02)	$^{+}$
Alcohol use	-0.10 (0.02)***	-0.08 (0.03)***	-0.34 (0.02)***	$^{+}$	-4.63 (0.83)***	-2.54 (0.86)***
Diabetes	0.10 (0.02)***	0.09 (0.03)***	1.80 (0.02)***	1.67 (0.02)***	16.94 (0.89)***	16.34 (1.09)***
Energy intake	-0.00 (0.00)***	-0.00 (0.00)	-0.00 (0.00)***	-0.00 (0.00)**	-0.00 (0.00)***	-0.00 (0.00)

$^{+}$: The predictor not included in the final multiple linear regression model; *: p<0.10; **p<0.05, ***: p<0.01; Quartiles of calcium intake are numbered from the lowest (quartile 1) to highest (quartile 4) intake levels; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HDL cholesterol: High-density lipoprotein cholesterol; CRP: C-reactive protein

818.01±486.12 mg/d. Every quartile included 3,714 individuals. Calcium intake levels of quartile 1 were less than 487 mg/d; quartile 2 levels were between 487 and 726 mg/d; levels of calcium intake in quartile 3 were between 726 and 1036.89 mg/d; and quartile 4 intake levels were higher than 1,036.89 mg/d. Average age decreased as quartile of calcium intake increased. The percentage of males was higher in quartile 4 than that in other quartiles. Participants with higher incomes and higher educational attainment tended to have higher dietary calcium intake levels. The percentage of Non-Hispanic whites increased as quartile increased. There were fewer smokers but a greater number of alcohol users in the fourth quartile compared to the other quartiles. The percentage of adults with diabetes decreased as quartile of calcium intake increased. All of the continuous risk factors were significant within each quartile of calcium intake. The risk factors, SBP, DBP, hypertension, CRP, HDL, glycohemoglobin and albuminuria had a statistically significant difference (p<0.05) when they were analyzed in categorical format. The variations in elevated total cholesterol were not found to be statistically significant among quartiles (Table 1).

The risk factors, SBP, HDL, CRP, glycohemoglobin and albuminuria were associated with quartiles of calcium intake, especially the first quartile, the low calcium intake. Those risk factors were also

Table 3: Simple and multiple linear regression analyses of cardiovascular risk factors by calcium intake and other predictors among obese adults in the U.S. (1999-2010)

	Estimates (S.E.)							
	SBP		DBP		Total cholesterol		HDL cholesterol	
	Crude	Adjusted	Crude	Adjusted	Crude	Adjusted	Crude	Adjusted
Calcium intake (100 mg)	-0.37 (0.05)***	-0.18 (0.04)***	0.05 (0.02)*	-0.19 (0.04)***	-0.16 (0.07)**	-0.35 (0.10)***	-0.23 (0.03)***	0.06 (0.05)
Age	0.49 (0.01)***	0.51 (0.01)***	-0.14 (0.01)***	-0.16 (0.11)***	0.17 (0.02)***	0.22 (0.03)***	0.13 (0.01)***	0.18 (0.01)***
Gender	-1.07 (0.34)***	$^{+}$	-3.18 (0.23)***	-3.05 (0.35)***	6.01 (0.73)***	7.88 (0.86)***	10.08 (0.24)***	10.72 (0.40)***
Race								
Mexican American	-0.09 (1.08)	-1.00 (0.98)	-1.75 (0.75)**	$^{+}$	-0.96 (2.32)	-2.95 (2.72)	-0.97 (0.80)	1.40 (1.31)
Non-hispanic black	3.09 (1.08)***	1.95 (0.98)**	0.18 (0.75)	$^{+}$	-3.93 (2.33)*	-7.59 (2.72)***	4.94 (0.80)***	6.54 (1.30)***
Non-hispanic white	0.87 (1.05)	-2.80 (0.94)***	-2.19 (0.73)***	$^{+}$	1.63 (2.24)	-3.13 (2.64)	0.81 (0.77)	1.74 (1.25)
Other hispanic	-2.60 (1.21)**	-3.49 (1.09)***	-1.92 (0.84)**	$^{+}$	-0.97 (2.60)	-5.66 (3.03)*	-0.60 (0.89)	0.84 (1.48)
Education								
Less than high school	4.95 (0.39)***	2.11 (0.38)***	-1.92 (0.27)***	-0.45 (0.39)	0.55 (0.83)	$^{+}$	-1.73 (0.29)***	-2.00 (0.47)***
High school	3.02 (0.42)***	1.91 (0.38)***	-0.48 (0.29)*	0.83 (0.41)**	1.88 (0.90)**	$^{+}$	-1.41 (0.31)***	-1.74 (0.45)***
Poverty	0.95 (0.45)**	$^{+}$	0.35 (0.31)***	$^{+}$	1.92 (0.91)**	$^{+}$	1.86 (0.34)***	1.86 (0.50)***
Smoking	-5.33 (0.47)***	$^{+}$	1.60 (0.34)***	-0.65 (0.37)*	2.42 (1.09)**	$^{+}$	-3.32 (0.37)***	-2.52 (0.42)***
Alcohol use	-4.44 (0.40)***	$^{+}$	1.96 (0.28)***	$^{+}$	2.42 (0.89)***	2.23 (0.91)**	1.81 (0.31)***	3.96 (0.42)***
Diabetes	5.78 (0.46)***	$^{+}$	-4.16 (0.31)***	-2.76 (0.45)***	-11.78 (0.99)***	-12.78 (1.16)***	-2.66 (0.34)***	-3.75 (0.52)***
Energy intake	-0.00 (0.00)***	-0.00 (0.00)***	-0.00 (0.00)***	-0.00 (0.00)***	-0.00 (0.00)	-0.00 (0.00)***	-0.00 (0.00)***	-0.00 (0.00)

	Estimates (S.E.)					
	CRP		Glycohemoglobin		Albuminuria	
	Crude	Adjusted	Crude	Adjusted	Crude	Adjusted
Calcium intake (100 mg)	-0.01 (0.00)***	-0.00 (0.00)	-0.01 (0.00)***	-0.00 (0.00)*	-0.29 (0.07)***	-0.23 (0.09)**
Age	-0.00 (0.00)***	$^{+}$	0.01 (0.00)***	0.01 (0.00)***	0.11 (0.02)***	0.04 (0.02)*
Gender	0.15 (0.01)***	0.12 (0.02)***	-0.10 (0.02)***	-0.08 (0.02)***	-1.24 (0.67)*	$^{+}$
Race						
Mexican American	0.06 (0.05)	0.04 (0.08)	-0.02 (0.06)	-0.04 (0.05)	0.46 (2.12)	$^{+}$
Non-hispanic black	0.21 (0.05)***	0.16 (0.08)**	0.08 (0.06)	0.03 (0.05)	2.17 (2.12)	$^{+}$
Non-hispanic white	0.02 (0.04)	0.06 (0.08)	-0.30 (0.06)***	-0.27 (0.05)***	-2.39 (2.05)	$^{+}$
Other hispanic	0.05 (0.05)	0.06 (0.09)	-0.05 (0.07)	-0.08 (0.06)	-0.04 (2.37)	$^{+}$
Education						
Less than high school	0.05 (0.02)***	$^{+}$	0.34 (0.02)***	0.10 (0.02)***	4.06 (0.76)***	$^{+}$
High school	0.02 (0.02)	$^{+}$	0.11 (0.02)***	0.06 (0.02)***	1.60 (0.82)**	$^{+}$
Poverty	-0.15 (0.02)***	-0.09 (0.03)***	-0.13 (0.03)***	-0.04 (0.02)*	-3.27 (0.86)***	-2.65 (1.02)***
Smoking	0.10 (0.02)***	0.09 (0.02)***	-0.14 (0.03)***	$^{+}$	-1.13 (1.02)	$^{+}$
Alcohol use	-0.10 (0.02)***	-0.08 (0.03)***	-0.34 (0.02)***	$^{+}$	-4.63 (0.83)***	-2.62 (0.86)***
Diabetes	0.10 (0.02)***	0.09 (0.03)***	1.80 (0.02)***	1.67 (0.02)***	16.94 (0.89)***	16.33 (1.09)***
Energy intake	-0.00 (0.00)***	-0.00 (0.00)*	-0.00 (0.00)***	-0.00 (0.00)**	-0.00 (0.00)***	-0.00 (0.00)

$^{+}$: The predictor not included in the final multiple linear regression model; *: $p<0.10$, **: $p<0.05$, ***: $p<0.01$; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HDL cholesterol: High-density lipoprotein cholesterol; CRP: C-reactive protein

associated with race, education, poverty, smoking, alcohol and diabetes and energy intake (Table 2). When analyzing calcium intake as a continuous variable, all risk factors, with the exception of HDL and CRP, were negatively associated with increased calcium intake by 100 mg. HDL and CRP were not significantly associated with calcium intake after adjusting for potential confounders (Table 3).

After categorizing the risk factors, the probability of elevated SBP, HDL, CRP, glycohemoglobin and albuminuria significantly associated with quartile of calcium intake. After adjusting for potential confounders, the first quartile had a higher risk of elevated SBP and DBP ($p<0.05$) (SBP OR: 1.324, 95% CI: 1.066-1.644; DBP OR: 1.874, 95% CI: 1.344-2.612) when comparing to the fourth quartile of calcium intake. There was a similar relationship between the fourth quartile and the first quartile of calcium intake for HDL, CRP and albuminuria ($p<0.1$) (HDL OR: 1.131, 95% CI: 0.924-1.383; CRP OR: 1.131, 95% CI: 0.950-1.347; glycohemoglobin OR: 1.191, 95% CI: 0.830-1.709; albuminuria OR: 1.071,

Table 4: Simple and multiple logistic regression analyses of cardiovascular risk factors by calcium intake quartiles and other predictors among obese adults in the U.S. (1999-2010)

	ORs (95% CI)							
	SBP		DBP		Total cholesterol		HDL cholesterol	
	Crude	Adjusted	Crude	Adjusted	Crude	Adjusted	Crude	Adjusted
Calcium intake (quartiles 4)								
Quartile 1	1.66 (1.48, 1.85)***	1.32 (1.07, 1.64)**	1.13 (0.94, 1.35)*	1.87 (1.34, 2.61)***	1.05 (0.96, 1.16)	1.03 (0.87, 1.23)	1.32 (1.19, 1.47)***	1.31 (0.92, 1.38)*
Quartile 2	1.38 (1.23, 1.54)***	1.07 (0.87, 1.31)	0.91 (0.76, 1.10)	1.23 (0.89, 1.70)	0.99 (0.90, 1.08)	0.91 (0.77, 1.07)	1.35 (1.22, 1.50)***	1.15 (0.96, 1.39)
Quartile 3	1.17 (1.04, 1.31)***	1.00 (0.82, 1.21)	0.88 (0.73, 1.06)	1.03 (0.76, 1.41)	1.01 (0.92, 1.11)	0.98 (0.84, 1.14)	1.14 (1.03, 1.26)**	1.17 (0.98, 1.38)
Age	1.06 (1.06, 1.06)***	1.05 (1.05, 1.06)***	0.99 (0.99, 1.00)***	0.99 (0.99, 0.99)**	1.01 (1.01, 1.01)***	1.01 (1.01, 1.01)***	0.98 (0.98, 0.98)***	0.98 (0.97, 0.98)***
Gender (male)	0.91 (0.84, 0.98)**	+	1.88 (1.65, 2.14)***	1.69 (1.34, 2.13)***	0.80 (0.74, 0.85)***	0.75 (0.67, 0.84)***	0.29 (0.27, 0.31)***	0.28 (0.24, 0.32)***
Race (ref = other race)								
Mexican American	1.07 (0.82, 1.38)	+	0.62 (0.42, 0.92)**	+	1.04 (0.84, 1.28)	+	1.04 (0.82, 1.31)	0.85 (0.56, 1.30)
Non-hispanic black	1.40 (1.08, 1.81)**	+	1.24 (0.86, 1.80)	+	0.89 (0.72, 1.11)	+	0.58 (0.45, 0.73)***	0.58 (0.38, 0.89)**
Non-hispanic white	1.11 (0.86, 1.42)	+	0.62 (0.43, 0.89)***	+	1.11 (0.91, 1.37)	+	1.01 (0.80, 1.26)	1.09 (0.73, 1.64)
Other hispanic	0.83 (0.62, 1.12)	+	0.65 (0.42, 0.92)*	+	1.00 (0.79, 1.28)	+	1.03 (0.79, 1.33)	1.02 (0.63, 1.65)
Education (Ref = college above)								
Less than high school	1.59 (1.45, 1.74)***	1.17 (1.00, 1.36)*	0.91 (0.78, 1.06)	+	1.03 (0.95, 1.11)	+	1.23 (1.17, 1.39)***	1.57 (1.35, 1.83)***
High school	1.37 (1.24, 1.51)***	1.22 (1.03, 1.43)**	1.01 (0.86, 1.18)	+	1.06 (0.97, 1.15)	+	1.20 (1.09, 1.31)***	1.37 (1.18, 1.60)***
Poverty (low)	0.99 (0.89, 1.10)	+	1.04 (0.88, 1.24)	+	0.91 (0.84, 1.00)**	+	0.78 (0.71, 0.86)***	0.83 (0.71, 0.96)**
Smoking (yes)	0.58 (0.51, 0.65)***	+	1.29 (1.06, 1.56)**	+	1.05 (0.96, 1.16)	+	1.59 (1.43, 1.76)***	1.29 (1.14, 1.47)***
Alcohol use (yes)	0.62 (0.56, 0.68)***	+	1.02 (0.87, 1.20)	+	1.14 (1.05, 1.23)***	1.20 (1.07, 1.36)***	0.83 (0.77, 0.91)***	0.70 (0.61, 0.80)***
Diabetes (yes)	1.70 (1.54, 1.87)***	+	0.84 (0.69, 1.01)*	+	0.59 (0.54, 0.65)***	0.54 (0.47, 0.63)***	1.28 (1.16, 1.42)***	1.59 (1.36, 1.87)***
Energy intake	1.00 (1.00, 1.00)***	1.00 (1.00, 1.00)*	1.00 (1.00, 1.00)***	1.00 (1.00, 1.00)***	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)**	1.00 (1.00, 1.00)**	1.00 (1.00, 1.00)

	ORs (95% CI)					
	CRP		Glycohemoglobin		Albuminuria	
	Crude	Adjusted	Crude	Adjusted	Crude	Adjusted
Calcium intake (quartiles 4)						
Quartile 1	1.35 (1.23, 1.48)***	1.13 (0.95, 1.35)*	1.49 (1.27, 1.74)***	1.19 (0.83, 1.71)*	1.44 (1.27, 1.64)***	1.07 (0.84, 1.37)*
Quartile 2	1.17 (1.06, 1.28)***	1.07 (0.91, 1.25)	1.26 (1.07, 1.48)***	1.25 (0.90, 1.75)	1.16 (1.01, 1.32)**	1.01 (0.81, 1.27)
Quartile 3	1.03 (0.94, 1.14)	0.94 (0.80, 1.09)	1.11 (0.94, 1.31)	0.92 (0.66, 1.27)	1.02 (0.90, 1.17)	0.86 (0.69, 1.07)
Age	0.99 (0.99, 1.00)***	+	1.03 (1.02, 1.03)***	+	1.03 (1.03, 1.03)***	1.03 (1.03, 1.04)***
Gender (male)	0.60 (0.56, 0.65)***	0.67 (0.60, 0.76)***	1.28 (1.14, 1.43)***	1.41 (1.12, 1.77)***	1.25 (1.14, 1.37)***	1.33 (1.13, 1.56)***
Race (ref = other race)						
Mexican American	1.23 (1.00, 1.53)*	+	1.15 (0.83, 1.59)	+	0.87 (0.66, 1.14)	+
Non-hispanic black	1.52 (1.23, 1.89)***	+	1.18 (0.85, 1.64)	+	0.92 (0.70, 1.20)	+
Non-hispanic white	0.93 (0.76, 1.15)	+	0.53 (0.39, 0.73)***	+	0.65 (0.50, 0.84)***	+
Other hispanic	1.12 (0.88, 1.42)	+	0.91 (0.63, 1.32)	+	0.76 (0.56, 1.03)*	+
Education (Ref = college above)						
Less than high school	1.24 (1.14, 1.34)***	+	2.11 (1.86, 2.40)***	1.54 (1.20, 1.99)***	1.72 (1.55, 1.91)***	+
High school	1.06 (0.98, 1.16)	+	1.16 (1.00, 1.35)*	1.03 (0.77, 1.37)	1.19 (1.06, 1.34)***	+
Poverty (low)	1.47 (1.34, 1.60)***	1.34 (1.17, 1.55)***	1.47 (1.28, 1.69)***	1.34 (1.02, 1.76)**	1.31 (1.17, 1.48)***	1.40 (1.16, 1.70)***
Smoking (yes)	1.36 (1.23, 1.50)***	1.24 (1.10, 1.38)***	0.76 (0.65, 0.90)***	+	0.81 (0.71, 0.93)***	1.28 (1.07, 1.52)***
Alcohol use (yes)	0.82 (0.76, 0.89)***	0.84 (0.74, 0.94)***	0.47 (0.41, 0.53)***	+	0.53 (0.48, 0.59)***	0.80 (0.68, 0.94)***
Diabetes (yes)	1.30 (1.19, 1.42)***	+	38.57 (38.51, 44.39)***	32.83 (26.12, 41.26)***	4.16 (3.75, 4.61)***	3.51 (2.97, 4.15)***
Energy intake	1.00 (1.00, 1.00)***	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)***	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)***	1.00 (1.00, 1.00)

+: The predictor not included in the final multiple linear regression model; *: P<0.10; **: p<0.05; ***: p<0.01; Quartiles of calcium intake are numbered from the lowest (quartile 1) to highest (quartile 4) intake levels; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HDL: High-density lipoprotein; CRP: C-reactive protein

95% CI: 0.836-1.371). In all of the regression models, there was no significant difference between the second and fourth quartile and third and fourth quartile. Total cholesterol was not significantly different in quartiles of calcium intake (Table 4). The results of the simple logistic regression analysis with calcium intake as a continuous variable were similar to the results analyzing quartiles calcium intake. After adjusting for confounding, SBP and DBP were significantly negatively associated with calcium intake in continuous variable form (p<0.05). Glycohemoglobin was related to calcium intake at a 0.1 level. There was no relationship between HDL, CRP and albuminuria and calcium intake in continuous variable form Table 5.

DISCUSSION

This nutritional epidemiologic study, investigating calcium intake among a large sample of obese Americans at risk for CVD, is important in many ways. CVD has been identified as one of the most costly conditions to treat in the U.S. (Micronutrients/Minerals, 2013). If scientists can demonstrate that increased calcium intake can predict reduced CVD rates, the economic and health implications might be immense (Effectiveness of Health Communication Campaigns That Include Mass Media and Health-Related Product Distribution, 2013). The purpose of this study was to examine calcium intake among a national sample of

Table 5: Simple and multiple logistic regression analyses of cardiovascular risk factors by calcium intake and other predictors among obese adults in the U.S. (1999-2010)

	ORs (95%CI)							
	SBP		DBP		Total cholesterol		HDL cholesterol	
	Crude	Adjusted	Crude	Adjusted	Crude	Adjusted	Crude	Adjusted
Calcium intake (100 mg)	0.96 (0.95, 0.97)***	0.98 (0.96, 0.99)**	0.99 (0.98, 1.01)	0.95 (0.92, 0.98)***	0.99 (0.99, 1.00)*	0.99 (0.98, 1.00)	1.03 (1.02, 1.04)	1.00 (0.98, 1.01)
Age	1.06 (1.06, 1.06)***	1.05 (1.05, 1.06)***	0.99 (0.99, 1.00)***	0.99 (0.99, 0.99)***	1.01 (1.01, 1.01)***	1.01 (1.01, 1.01)***	0.98 (0.98, 0.98)***	0.98 (0.97, 0.98)***
Gender (male)	0.91 (0.84, 0.98)**	+	1.88 (1.65, 2.14)***	1.68 (1.34, 2.12)***	0.80 (0.74, 0.85)***	0.75 (0.67, 0.84)***	0.29 (0.27, 0.31)***	0.28 (0.24, 0.32)***
Race (ref = other race)								
Mexican American	1.07 (0.82, 1.38)	+	0.62 (0.42, 0.92)**	+	1.04 (0.84, 1.28)	+	1.04 (0.82, 1.31)	0.85 (0.56, 1.30)
Non-hispanic black	1.40 (1.08, 1.81)**	+	1.24 (0.86, 1.80)	+	0.89 (0.72, 1.11)	+	0.58 (0.45, 0.73)***	0.58 (0.38, 0.89)**
Non-hispanic white	1.11 (0.86, 1.42)	+	0.62 (0.43, 0.89)***	+	1.11 (0.91, 1.37)	+	1.01 (0.80, 1.26)	1.09 (0.72, 1.63)
Other hispanic	0.83 (0.62, 1.12)	+	0.65 (0.42, 0.92)*	+	1.00 (0.79, 1.28)	+	1.03 (0.79, 1.33)	1.01 (0.63, 1.63)
Education (Ref = college above)								
Less than high school	1.59 (1.45, 1.74)***	1.18 (1.01, 1.37)**	0.91 (0.78, 1.06)	+	1.03 (0.95, 1.11)	+	1.23 (1.17, 1.39)***	1.58 (1.35, 1.84)***
High school	1.37 (1.24, 1.51)***	1.22 (1.04, 1.43)***	1.01 (0.86, 1.18)	+	1.06 (0.97, 1.15)	+	1.20 (1.09, 1.31)***	1.38 (1.19, 1.60)***
Poverty (low)	0.99 (0.89, 1.10)	+	1.04 (0.88, 1.24)	+	0.91 (0.84, 1.00)**	+	0.78 (0.71, 0.86)***	0.71 (0.61, 0.83)***
Smoking (yes)	0.58 (0.51, 0.65)***	+	1.29 (1.06, 1.56)**	+	1.05 (0.96, 1.16)	+	1.59 (1.43, 1.76)***	1.43 (1.24, 1.64)***
Alcohol use (yes)	0.62 (0.56, 0.68)***	+	1.02 (0.87, 1.20)	+	1.14 (1.05, 1.23)***	1.20 (1.07, 1.35)***	0.83 (0.77, 0.91)***	0.67 (0.58, 0.77)***
Diabetes (yes)	1.70 (1.54, 1.87)***	+	0.84 (0.69, 1.01)*	+	0.59 (0.54, 0.65)***	0.55 (0.47, 0.64)***	1.28 (1.16, 1.42)***	1.60 (1.36, 1.87)***
Energy intake	1.00 (1.00, 1.00)***	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)***	1.00 (1.00, 1.00)***	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)***	1.00 (1.00, 1.00)**	1.00 (1.00, 1.00)

	ORs (95% CI)					
	CRP		Glycohemoglobin		Albuminuria	
	Crude	Adjusted	Crude	Adjusted	Crude	Adjusted
Calcium intake (100 mg)	0.98 (0.97, 0.99)***	0.99 (0.98, 1.01)	0.97 (0.96, 0.98)***	0.98 (0.95, 1.00)*	0.97 (0.96, 0.98)***	0.99 (0.97, 1.01)
Age	0.99 (0.99, 1.00)***	+	1.03 (1.02, 1.03)***	+	1.03 (1.03, 1.03)***	1.03 (1.03, 1.04)***
Gender (male)	0.60 (0.56, 0.65)***	0.67 (0.60, 0.76)***	1.28 (1.14, 1.43)***	1.41 (1.12, 1.77)***	1.25 (1.14, 1.37)***	1.33 (1.31, 1.56)***
Race (ref = other race)						
Mexican American	1.23 (1.00, 1.53)*	+	1.15 (0.83, 1.59)	+	0.87 (0.66, 1.14)	+
Non-hispanic black	1.52 (1.23, 1.89)***	+	1.18 (0.85, 1.64)	+	0.92 (0.70, 1.20)	+
Non-hispanic white	0.93 (0.76, 1.15)	+	0.53 (0.39, 0.73)***	+	0.65 (0.50, 0.84)***	+
Other hispanic	1.12 (0.88, 1.42)	+	0.91 (0.63, 1.32)	+	0.76 (0.56, 1.03)*	+
Education (Ref = college above)						
Less than high school	1.24 (1.14, 1.34)***	+	2.11 (1.86, 2.40)***	1.54 (1.20, 1.99)***	1.72 (1.55, 1.91)***	+
High school	1.06 (0.98, 1.16)	+	1.16 (1.00, 1.35)*	1.03 (0.77, 1.37)	1.19 (1.06, 1.34)***	+
Poverty (low)	1.47 (1.34, 1.60)***	1.40 (1.16, 1.70)***	1.47 (1.28, 1.69)***	1.34 (1.02, 1.76)**	1.31 (1.17, 1.48)***	1.41 (1.16, 1.70)***
Smoking (yes)	1.36 (1.23, 1.50)***	1.28 (1.07, 1.52)***	0.76 (0.65, 0.90)***	+	0.81 (0.71, 0.93)***	1.28 (1.07, 1.52)***
Alcohol use (yes)	0.82 (0.76, 0.89)***	0.81 (0.69, 0.95)***	0.47 (0.41, 0.53)***	+	0.53 (0.48, 0.59)***	0.80 (0.68, 0.94)***
Diabetes (yes)	1.30 (1.19, 1.42)***	+	38.57 (38.51, 44.39)***	32.97 (26.23, 41.45)***	4.16 (3.75, 4.61)***	3.51 (2.97, 4.15)***
Energy intake	1.00 (1.00, 1.00)***	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)***	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)***	1.00 (1.00, 1.00)

+: The predictor not included in the final multiple linear regression model; *: P<0.10; **: p<0.05; ***: p<0.01; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HDL cholesterol: High-density lipoprotein cholesterol; CRP: C-reactive protein

Americans meeting the criteria for obesity and to explore associations of CVD and demographic risk. Findings from this study are important because the research team was able to make comparisons of calcium intake and comprehensively assess dietary, behavioral and demographic risk patterns among obese adults in the U.S. who are at a greater risk for CVD morbidity and mortality. These analyses expand on previous work (McCarron and Heaney, 2004; Chalupka, 2012; Soares *et al*., 2012; Samelson *et al*., 2012) demonstrating associations between calcium intake and other important CVD risk factors.

These data presented here indicate important demographic and behavioral patterns. Calcium intake was inversely associated with advancing age. This finding is supported by a review conducted by Wakimoto and Block (2001). Their synthesis of studies examining micronutrient intake patterns over the lifespan decreased with age (Misteli, 2012). In this study, males had the highest calcium intake levels, which parallels results reported by Sigal *et al*. (2007) in a comparative study of Strong Heart Study participants with NHANES analyses (Wakimoto and Block, 2001). In both groups, mean calcium intake were higher for men and women, although there were significantly different ranges of intake noted between samples. Respondents who had a lower PIR, presence of diabetes and were from a minority ethnic background had an inverse relationship with increasing quartile of calcium intake. In this analysis, the average respondent did not meet the Dietary Reference Intakes (DRIs) for calcium (Sigal *et al*., 2007). Inadequate calcium intake has been linked with other essential nutritional insufficiencies. This can highlight opportunities for early intervention that may decrease or inhibit CVD processes in the body. Enhancing calcium supplementation is a feasible, cost-effective possibility even on a population level. Methods for enriching stable foods with calcium or including calcium supplements for high risk individuals (obese adults with CVD) through need-based health insurance policies are intervention strategies that could be explored.

Cardiovascular disease remains to be the number one cause of mortality in the U.S. for adults (Leading

Causes of Death, 2013). Examination of nutritional balance, related to essential micronutrients, is crucial to understand and better address CVD prevention. Results of this analysis reveal important relationships with calcium intake, where higher consumption is linked to lower SBP, DBP, CRP, glycohemoglobin and albuminuria. These are allrisk factors that play a major role in the development of many chronic health conditions and have the greatest overall treatment costs in the U.S.

Results from this study indicate three distinct avenues for future research: advanced nutritional intake, longitudinal epidemiologic investigation and health promotion pilot intervention development (Wang *et al*., 2012). In terms of nutritional examination, it is necessary to assess calcium intake in relation to consumption of other important micronutrients such as, magnesium, phosphorus, vitamins, potassium and niacin (Hypertension Care Strategies: Closing the Quality Gap, 2004; Nestle and Nesheim, 2013) and to examine data sources that include interview items related to intake of specific micronutrient supplementation behaviors and more specific information on fortified foods. The extent that NHANES assesses use of supplements (by asking yes/no questions to intake of supplements, limits researchers' ability to quantitatively examine thresholds levels and protective values of critical micronutrients that may be associated with hypertension (Witte *et al*., 2001). A further examination of these research questions using the NHANES datasets that include supplement items is underway. Additionally, the long-term trajectory of obese individuals adhering to DRIs of calcium is not well understood and cannot be assessed given the current design of this study. A more robust study design would shed light on how increased calcium intake impacts CVD rates, comorbidities and mortality over time. The insights from such an undertaking would build evidence to support aggressive calcium consumption health promotion campaigns as well as avenues to fortify foods (Liu *et al*., 2005). Finally, it is imperative to further examine the demographic variations of calcium intake by gender, age, ethnicity and PIR so that intervention efforts and health communication messaging can be culturally sensitive and tailored to segments of the American population with the highest CVD risk. Establishing a deeper understanding of food preferences and dietary practices is warranted so that health promotion efforts can be optimally designed.

CONCLUSION

Increased calcium intake was associated with significantly less hypertension, healthy systolic blood pressure levels and diabetes status. Interventions to enhance calcium intake have proven to be effective (Soares *et al*., 2012) and health communication campaigns continue to build evidence that messaging can translate into successful behavior change (Weaver, 1998). Results of this analysis indicate a need for additional efforts to understand calcium intake among obese Americans, as the data shows the majority of our sample had less-than-recommended intakes of calcium. Further exploration of how calcium is associated with other essential nutrients and how to improve health communication channels to reach segments of the most at-risk subpopulations for CVD is warranted. The behavioral and economic implications of promoting calcium intake may prove to be cost-effective strategies in reducing CVD burden for disadvantaged populations must be viewed as a public health priority. Timely translation of these epidemiologic findings into intervention research is of the essence, as tailoring enhanced calcium intake among populations segments at risk for CVD can be accomplished and negative health outcomes may be prevented if adequate support is rendered.

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