



Intakes of Calcium and Magnesium and Obesity in Young African American and Hispanic Women

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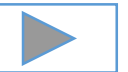
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Obesity

- Pandemic of adult obesity in the United States
- Obesity prevalence varied by age and gender
- Racial/ethnic disparities in obesity
- Obesity and women health



Overview of “what is energy balance”

- ✓ Energy balance refers to the integrated effects of diet, physical activity, and genetics on growth and body weight over an individual’s lifetime
- ✓ Weight, body composition, physical activity and diet affect many physiologic systems, and can alter metabolic diseases and cancers process at many points



- Obesity occurs when the body's usual metabolic processes are disrupted. It can
 - ✓ affect enzymes involved in the synthesis or metabolize of intermediates in the metabolism of carbohydrates, fat, proteins, or other nutrients;
 - ✓ have inherited or acquired risk factors
- There is an emerging need to understand the impact and mechanisms of diet and diet behavior on obesity, particularly in minority populations



- ❖ We conducted a series of analyses to study nutrition, socio-culture factors and obesity in minority populations.

- ❖ NHANES program:
 - The National Health and Nutrition Examination Survey (NHANES);
 - A cross-sectional survey designed to monitor the health and nutritional status of a nationally representative sample of the U.S. population including children and adults;
 - Began in early 1960s, from 1999, NHANES became a continuous program, releasing data every two years;



❖ NHANES program:

- A multi-stage sample design was used, and included around 10,000 persons every cycle;
- NHANES oversampled people 60 and over, African Americans, Asians and Hispanics to produce reliable statistics
- It combines interviews and physical examinations.
- NHANES interview includes demographic, socioeconomic, dietary, and health-related questions;
- The examination components consists of medical, dental and physiological measurements, as well as laboratory tests



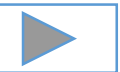
❖ NHANES program:

- Findings from the NHANES program will be used to determine the prevalence of major diseases, and risk factors for diseases;
- Assess nutritional status and its association with health promotion and disease prevention
 - What We Eat in America – help to develop dietary guidelines for Americans
- The basis for national standards for such measurements as height, weight and blood pressure.



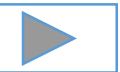
- ❖ Evaluated micronutrient intake status among women by race/ethnicity and their body weight status
 - ❖ Nutrition intake is associated with the risk of obesity, but also is highly dependent on ethnic/cultural environment and personal dietary habits.

- ❖ Included data of:
 - NHANES from 2003 to 2014
 - 5,406 women aged 19-39 years, race/ethnicity as non-Hispanic white, Mexican-Americans or non-Hispanic black
 - intakes of micronutrients were calculated from diet records using the NCI method
 - Body mass index (BMI) to assess overweight ($25 < \text{BMI} < 30$), obesity ($\text{BMI} \geq 30$)



Estimated daily usual micronutrient intakes from foods among women age 19-39 years by race/ethnicity, NHANES 2003-14

Micronutrients	Mean ± SE ^a			p-Value [*]
	Non-Hispanic White (n = 1916)	Mexican-American (n = 916)	Non-Hispanic Black (n = 1099)	
Vitamin A, µg	557.8 ± 21.0	454.6 ± 16.7	504.1 ± 16.9	<0.0001
Vitamin B ₂ , mg	2.0 ± 0.0	1.7 ± 0.0	1.8 ± 0.0	<0.0001
Vitamin B ₆ , mg	1.7 ± 0.1	1.7 ± 0.1	1.7 ± 0.1	0.03
Vitamin B ₁₂ , µg	4.4 ± 0.2	4.1 ± 0.2	4.3 ± 0.2	<0.0001
Vitamin C, mg	67.9 ± 3.2	89.4 ± 4.3	78.1 ± 3.4	<0.0001
Vitamin D, µg	3.9 ± 0.2	3.7 ± 0.2	3.8 ± 0.2	0.04
Folate, µg	367.7 ± 8.5	346.2 ± 9.8	356.6 ± 7.9	<0.0001
Calcium, mg	930.9 ± 23.0	849.2 ± 22.1	889.2 ± 20.5	<0.0001
Magnesium, mg	269.3 ± 5.6	262.8 ± 5.6	265.8 ± 4.8	0.02
Phosphorus, mg	1245.4 ± 24.0	1234.4 ± 27.6	1239.3 ± 23.4	0.26
Copper, µg	749.7 ± 32.7	720.4 ± 29.3	734.7 ± 30.0	0.12
Iron, mg	13.6 ± 0.3	13.8 ± 0.3	13.7 ± 0.2	0.34
Zinc, mg	10.3 ± 0.3	10.3 ± 0.3	10.3 ± 0.2	0.75
Energy, kcal	2053.0 ± 29.2	2099.4 ± 39.9	2075.9 ± 29.4	0.04



- ❖ We find:
 - ✓ Mexican-American women had the lowest dietary intakes for these micronutrients, except non-Hispanic white women had the lowest intake of vitamin C
 - ✓ Among Mexican-American women, obese women had the lowest dietary intake of vitamins A, B₂, C, and D
 - ✓ In non-Hispanic Black group, obese women had the least intakes of iron and zinc from foods



Dietary Reference Intakes: Estimated Average Requirements for Selected Nutrients

Food and Nutrition Board, Institute of Medicine, National Academies

Life-stage group	Calcium (mg/d)	Vit A (µg/d)	Vit C (mg/d)	Vit D (mg/d)	Folate (µg/d)	Magnesium (mg/d)
Females (years)						
9 - 13	1,100	420	39	10	250	200
14 - 18	1,100	485	56	10	330	300
19 - 30	800	500	60	10	320	255
31 - 50	800	500	60	10	320	265
51 - 70	1,000	500	60	10	320	265
> 70	1,000	500	60	10	320	265



Micronutrient Intakes and Body Weight Status

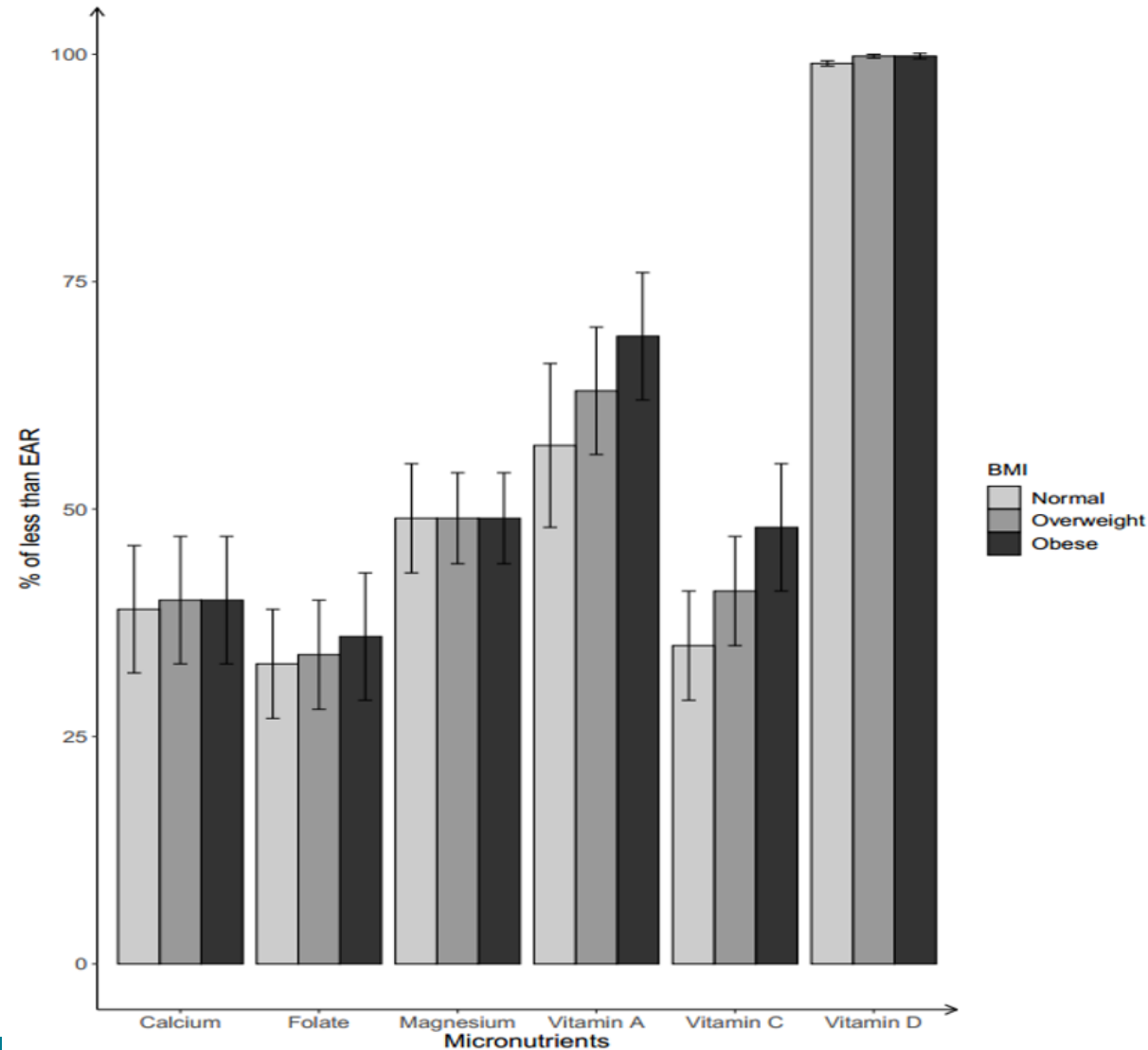


Figure 1. Percentage of Mexican-American women aged 19–39 years with dietary micronutrient intakes below the Estimated Average Requirements (EARs) by body weight status.

Liu J, et al. *Nutrients*, 2019; 11:2846.



Micronutrient Intakes and Body Weight Status

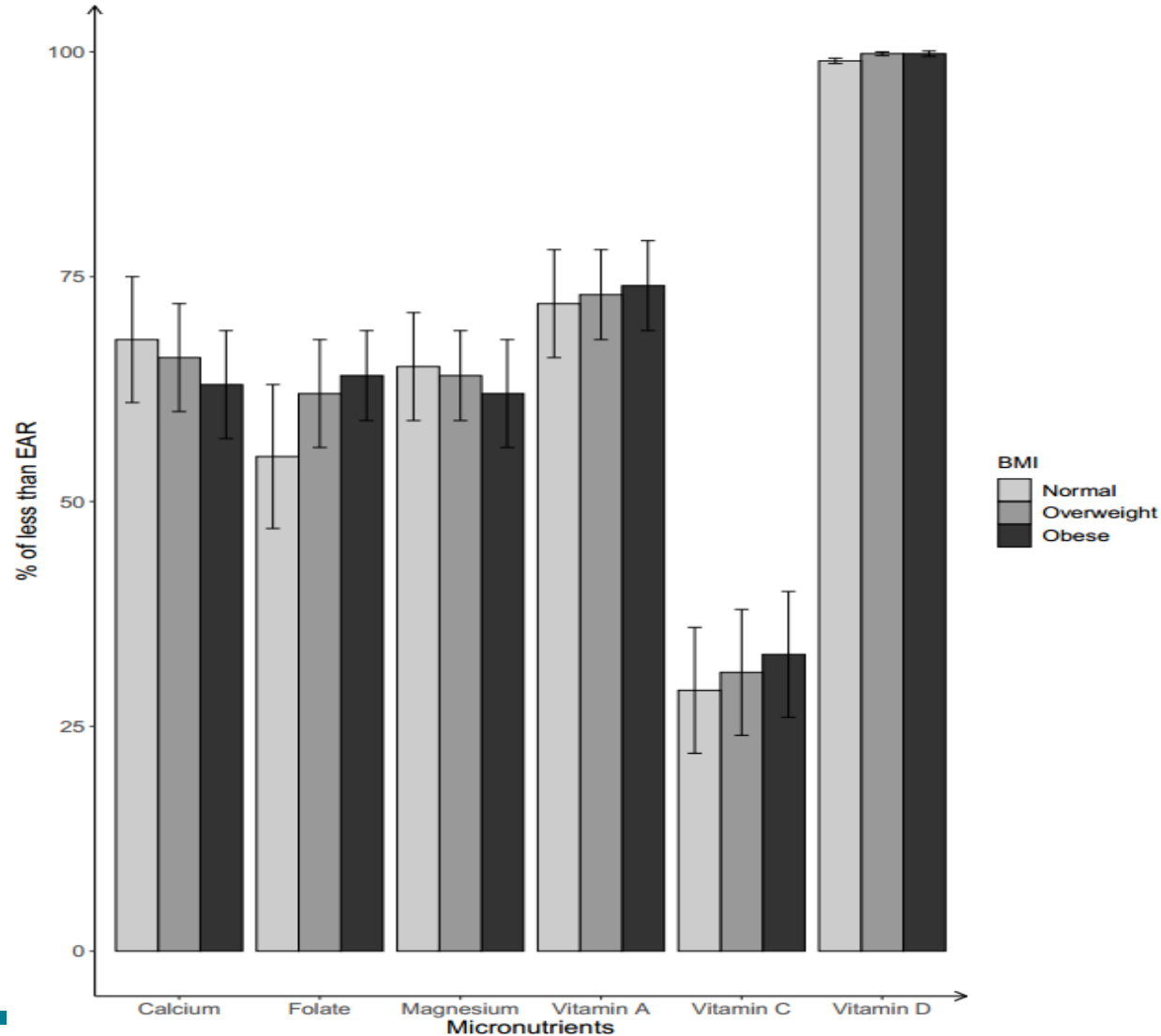


Figure 2. Percentage of non-Hispanic Black women aged 19–39 years with dietary micronutrient intakes below the Estimated Average Requirements (EARs) by body weight status.

Liu J, et al. *Nutrients*, 2019; 11:2846.



Magnesium, Calcium and Obesity

- Calcium and magnesium are important micronutrients in diet sources as well in supplements
- Status of calcium intake in young women
- Magnesium plays essential roles in hundreds of physiologic activities
 - has been linked with various chronic diseases
 - around 65% of American women aged 19-50 years with inadequate magnesium intake
 - disparities in dietary intakes of magnesium among young minority women



- Calcium interacts with magnesium in many physiological and biological activities, including (re)absorption
 - share the same sensing receptor (CaSR)
 - antagonized each other
- A few studies described the status of dietary intakes of calcium and magnesium in young minority women
- Few studies examined nutrient-nutrient interactions between calcium and magnesium on their associations with obesity in young Hispanic and African-American women



❖ We:

- evaluated status of calcium and magnesium intakes in African-American (AA) and Hispanic young women, and tested hypotheses that calcium intake and particularly its interaction with magnesium intake contribute to obesity in these minority groups

❖ Included data of:

- NHANES from 1999 to 2014
- Only 'reliable' in-person interviewed 24-hour recall was utilized;
- Supplemental intakes were obtained from a dietary supplement questionnaire interview
- Total magnesium intake was estimated using the NCI method
- Logistic regression models were applied



Table. Trend of dietary intakes of magnesium among Hispanics aged ≥ 20 years, NHANES 1999 – 2014*

	1999-2000 (n=1288)	2001-2002 (n=1087)	2003-2004 (n = 928)	2005-2006 (n=911)	2007-2008 (n=1475)	2009-2010 (n=1603)	2011-2012 (n=914)	2013-2014 (n=1098)	P value for Trend
Overall	275.1 \pm 7.2	275.7 \pm 7.5	290.9 \pm 6.2	302.8 \pm 7.2	296.4 \pm 7.5	307.2 \pm 5.4	315.1 \pm 8.7	319.2 \pm 7.5	<0.0001
Gender									
Male	317.1 \pm 10.3	317.9 \pm 6.9	328.2 \pm 10.3	333.6 \pm 9.3	336.3 \pm 7.9	354.6 \pm 8.3	339.8 \pm 11.9	364.7 \pm 9.8	<0.0001
Female	236.6 \pm 12.0	227.6 \pm 9.7	250.1 \pm 7.4	265.7 \pm 7.2	250.9 \pm 8.4	255.9 \pm 6.4	266.0 \pm 7.6	272.8 \pm 6.9	<0.0001
Race/Ethnicity									
Mexican-American	282.5 \pm 8.4	292.8 \pm 6.0	299.9 \pm 7.6	311.0 \pm 9.3	299.2 \pm 9.3	320.9 \pm 7.0	327.8 \pm 12.0	328.8 \pm 10.8	<0.0001
Other Hispanics	269.1 \pm 9.9	254.1 \pm 8.5	268.0 \pm 13.0	279.6 \pm 14.2	291.7 \pm 9.3	285.0 \pm 6.9	299.1 \pm 10.4	305.2 \pm 10.3	<0.0001
Age (years)									
20 – 34	284.3 \pm 11.0	278.4 \pm 8.4	319.8 \pm 13.0	301.2 \pm 8.9	293.6 \pm 12.5	316.1 \pm 9.8	320.3 \pm 11.8	324.8 \pm 13.6	<0.0001
35 – 49	283.9 \pm 10.3	278.1 \pm 8.3	278.9 \pm 12.5	317.9 \pm 9.4	318.9 \pm 10.9	318.7 \pm 10.0	329.8 \pm 11.6	319.3 \pm 4.4	<0.0001
50 – 64	264.8 \pm 18.8	290.4 \pm 16.8	264.0 \pm 13.1	300.0 \pm 20.0	290.5 \pm 7.8	290.2 \pm 6.0	304.6 \pm 12.3	326.9 \pm 12.1	<0.0001
65 and above	231.4 \pm 18.2	231.6 \pm 12.8	255.6 \pm 13.9	259.5 \pm 18.7	241.2 \pm 6.2	258.7 \pm 7.8	264.5 \pm 10.5	280.6 \pm 10.7	<0.0001



Table. Trend of total intakes of magnesium among Hispanics aged ≥ 20 years, NHANES 1999 – 2014*

	1999-2000 (n=1288)	2001-2002 (n=1087)	2003-2004 (n = 928)	2005-2006 (n=911)	2007-2008 (n=1475)	2009-2010 (n=1603)	2011-2012 (n=914)	2013-2014 (n=1098)	P value for Trend
Overall	303.9 \pm 7.4	296.7 \pm 6.7	312.4 \pm 6.0	323.7 \pm 8.4	313.3 \pm 8.3	323.3 \pm 5.8	329.9 \pm 9.2	331.8 \pm 8.1	<0.0001
Gender									
Male	343.2 \pm 8.1	317.9 \pm 6.9	347.6 \pm 11.5	353.7 \pm 10.7	356.2 \pm 11.0	370.2 \pm 8.7	372.7 \pm 12.4	373.0 \pm 10.5	<0.0001
Female	267.9 \pm 14.5	246.9 \pm 9.5	275.0 \pm 6.3	287.5 \pm 7.9	265.8 \pm 7.6	272.5 \pm 8.2	283.0 \pm 7.8	289.7 \pm 8.4	<0.0001
Race/Ethnicity									
Mexican-American	307.9 \pm 8.8	316.7 \pm 6.7	320.0 \pm 8.3	331.0 \pm 10.6	312.6 \pm 10.2	338.2 \pm 7.2	343.7 \pm 12.8	338.7 \pm 11.3	<0.0001
Other Hispanics	300.7 \pm 9.8	271.6 \pm 7.8	293.3 \pm 13.0	302.8 \pm 15.1	316.3 \pm 13.5	299.1 \pm 7.9	312.5 \pm 11.0	320.6 \pm 10.5	<0.0001
Age (years)									
20 – 34	302.9 \pm 10.5	292.8 \pm 6.2	329.9 \pm 12.6	315.9 \pm 11.1	311.1 \pm 14.8	328.3 \pm 9.7	325.2 \pm 11.9	330.5 \pm 13.6	<0.0001
35 – 49	318.3 \pm 13.0	299.2 \pm 9.9	297.6 \pm 11.6	340.5 \pm 12.4	333.3 \pm 10.3	332.4 \pm 11.4	353.8 \pm 14.6	330.9 \pm 5.9	<0.0001
50 – 64	305.1 \pm 25.6	322.2 \pm 15.7	306.8 \pm 20.9	320.9 \pm 15.9	312.6 \pm 8.5	316.1 \pm 7.8	324.8 \pm 14.7	341.3 \pm 13.7	<0.0001
65 and above	261.0 \pm 12.2	264.6 \pm 15.3	305.2 \pm 22.9	301.3 \pm 22.1	260.7 \pm 7.9	281.7 \pm 7.2	278.8 \pm 12.9	320.3 \pm 21.5	<0.0001



Recommended Dietary Allowance (RDA) for Magnesium

Food and Nutrition Board, Institute of Medicine, National Academies

Age (years)	Males (mg/d)	Females (mg/d)
9 - 13	240	240
14 - 18	410	360
19 - 30	400	310
31 - 50	420	320
> 50	420	320



Insufficient Magnesium Intakes among Hispanic Women

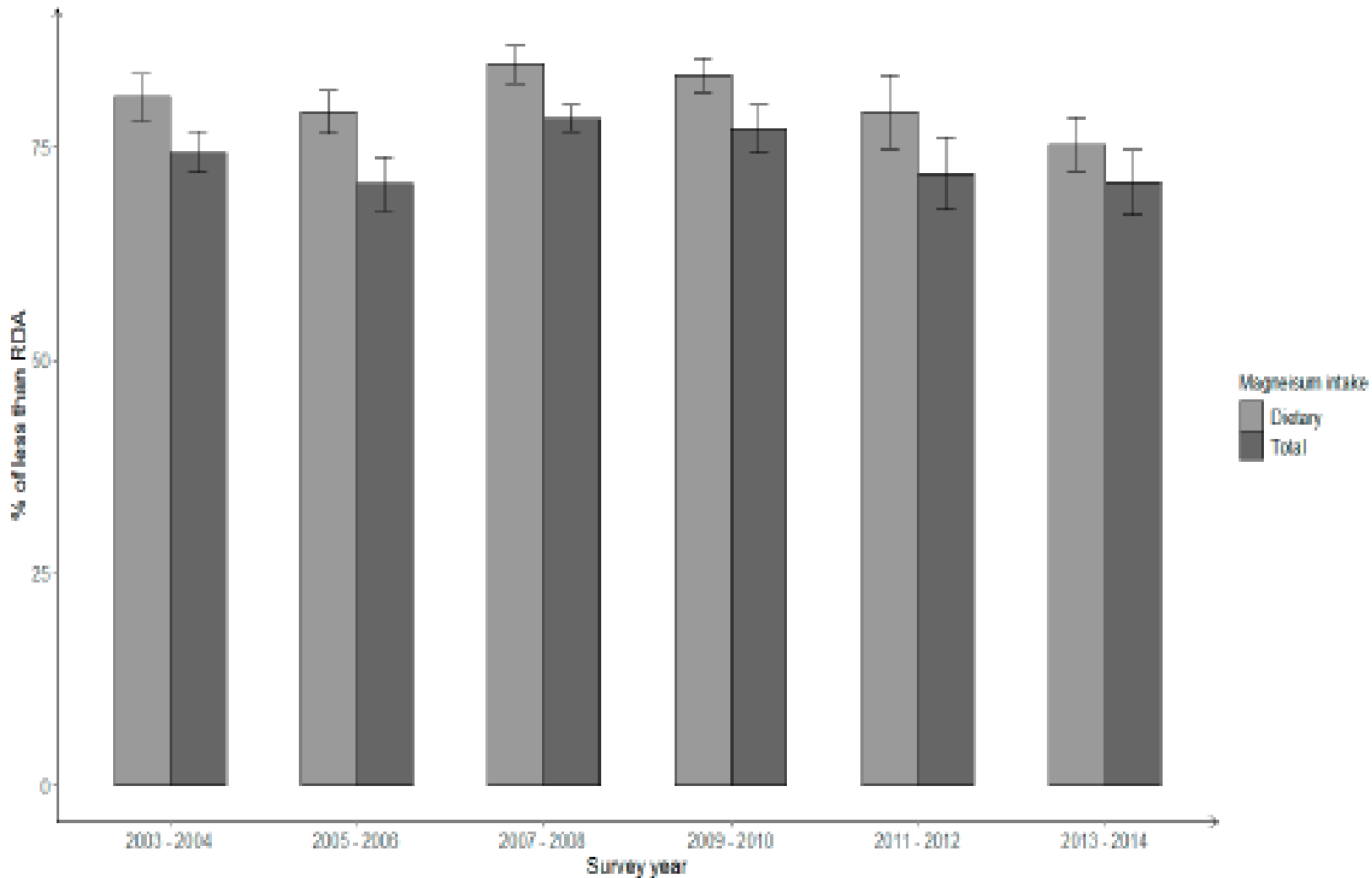


Figure 1. Percentage of insufficient dietary and total magnesium intake among Hispanic women aged ≥ 20 years across NHANES survey 2003-2014

Liu J, et al. *Nutrients*, 2019; 11:2867.



- ❖ We find:
 - ✓ Over the survey cycles, both dietary and total magnesium intakes were significantly increased
 - Magnesium intake lower in females, adults in other Hispanic-origin group, those aged ≥ 65 years old, and those with low income
 - ✓ The prevalence of magnesium intake inadequacy decreased significantly in males, but the changes were not significant in females
 - More than 70% of Hispanic males and females remained to have magnesium intake below the RDA
 - The prevalence increased among women 20-30-year-old and aged ≥ 65 years old



Magnesium, Calcium Intake and Body Weight Status

Table. Odds ratio (95% confidence interval) of being overweight by quartiles of total magnesium and calcium intakes (mg/day) among Hispanic women aged 20-39 years, NHANES 1999-2014

Nutrient intakes	mg/day	Overweight (n)	Normal weight (n)	Model I OR (95% CI)	Model II OR (95% CI)	Model III OR (95% CI)
Total Magnesium	Q1 <186.6	139	130	1.00	1.00	1.00
	Q2 186.6 to 257.9	133	130	0.70 (0.49, 1.01)	0.98 (0.63, 1.54)	1.03 (0.66, 1.61)
	Q3 258.0 to 351.9	118	128	0.74 (0.50, 1.10)	0.80 (0.46, 1.38)	0.89 (0.50, 1.50)
	Q4 ≥ 352.0	95	129	0.58 (0.39, 0.86)	0.72(0.39, 1.34)	0.90 (0.44, 1.81)
	<i>p</i> for trend			0.02	0.32	0.72
Total Calcium	Q1 <597.3	163	129	1.00	1.00	1.00
	Q2 597.3 to 886.9	125	130	0.79 (0.54, 1.17)	0.70 (0.47, 1.05)	0.64 (0.41, 1.00)
	Q3 887.0 to 1273.9	120	129	0.75 (0.54, 1.05)	0.71 (0.46, 1.09)	0.73 (0.44, 1.20)
	Q4 ≥ 1274.0	77	129	0.52 (0.36, 0.75)	0.51 (0.34, 0.75)	0.46 (0.26, 0.80)
	<i>p</i> for trend			<0.001	0.008	0.04



Magnesium, Calcium Intake and Body Weight Status

Table. Odds ratio (95% confidence interval) of being obesity by quartiles of total magnesium and calcium intakes (mg/day) among Hispanic women aged 20-39 years, NHANES 1999-2014

Nutrient intakes	mg/day	Obesity (n)	Normal weight (n)	Model I OR (95% CI)	Model II OR (95% CI)	Model III OR (95% CI)
Total Magnesium	Q1 <186.6	148	130	1.00	1.00	1.00
	Q2 186.6 to 257.9	152	130	0.80 (0.56, 1.13)	0.93 (0.58, 1.50)	0.96 (0.59, 1.56)
	Q3 258.0 to 351.9	140	128	0.78 (0.53, 1.16)	0.72 (0.43, 1.20)	0.78 (0.46, 1.32)
	Q4 ≥ 352.0	116	129	0.62 (0.42, 0.92)	0.61 (0.30, 1.24)	0.70 (0.33, 1.49)
	<i>p</i> for trend			0.03	0.12	0.30
Total Calcium	Q1 <597.3	170	129	1.00	1.00	1.00
	Q2 597.3 to 886.9	156	130	0.94 (0.67, 1.31)	0.87 (0.55, 1.39)	0.87 (0.53, 1.44)
	Q3 887.0 to 1273.9	126	129	0.78 (0.56, 1.09)	0.67 (0.40, 1.13)	0.70 (0.40, 1.21)
	Q4 ≥ 1274.0	104	129	0.61 (0.42, 0.87)	0.72 (0.45, 1.14)	0.71 (0.40, 1.25)
	<i>p</i> for trend			0.01	0.08	0.16



- ❖ We find:
 - ✓ After adjustment for known risk factors of obesity, and intakes of energy and total magnesium, higher intake of total calcium was associated with decreased odds of being overweight in Hispanic women aged 20-39 years (p trend = 0.04).
 - ✓ Non-significant associations with obesity were found for intakes of total calcium and total magnesium in young Hispanic women.
 - ✓ There were no associations of total intakes of calcium and magnesium with overweight/obesity in African American women aged 20-39 years



- ❖ We further examined whether dietary behavior, such as intakes of fruits, vegetables, and beans, mediate the association of acculturation with obesity among Hispanics

- ❖ We utilized 2009-2016 NHANES data, including data of:
 - ✓ 3,106 Hispanic adults aged ≥ 20 years
 - ✓ central obesity measured by waist circumference (≥ 85 cm for men, 80 cm for women)
 - ✓ acculturation score calculated by language spoken at home, country of birth, and length of stay in the US
 - ✓ mediator information - total fruits, vegetables, and beans and peas intakes were from 24 hour diet records
 - ✓ mediation analysis using logistic structure equation model with 1,000 bootstrapping method



- ❖ Approximately 80% Hispanic adults were overweight/obesity, and 50.5% were central obesity.
- ❖ Overall, we did not find the association between acculturation and odds of overweight/obesity, but found a positive association with central obesity.
 - The association of acculturation with central obesity is fully mediated through reduction in total fruits intake.
 - Total vegetables intake, beans and peas intake were not mediated in the association



Diet, Acculturation, and Obesity

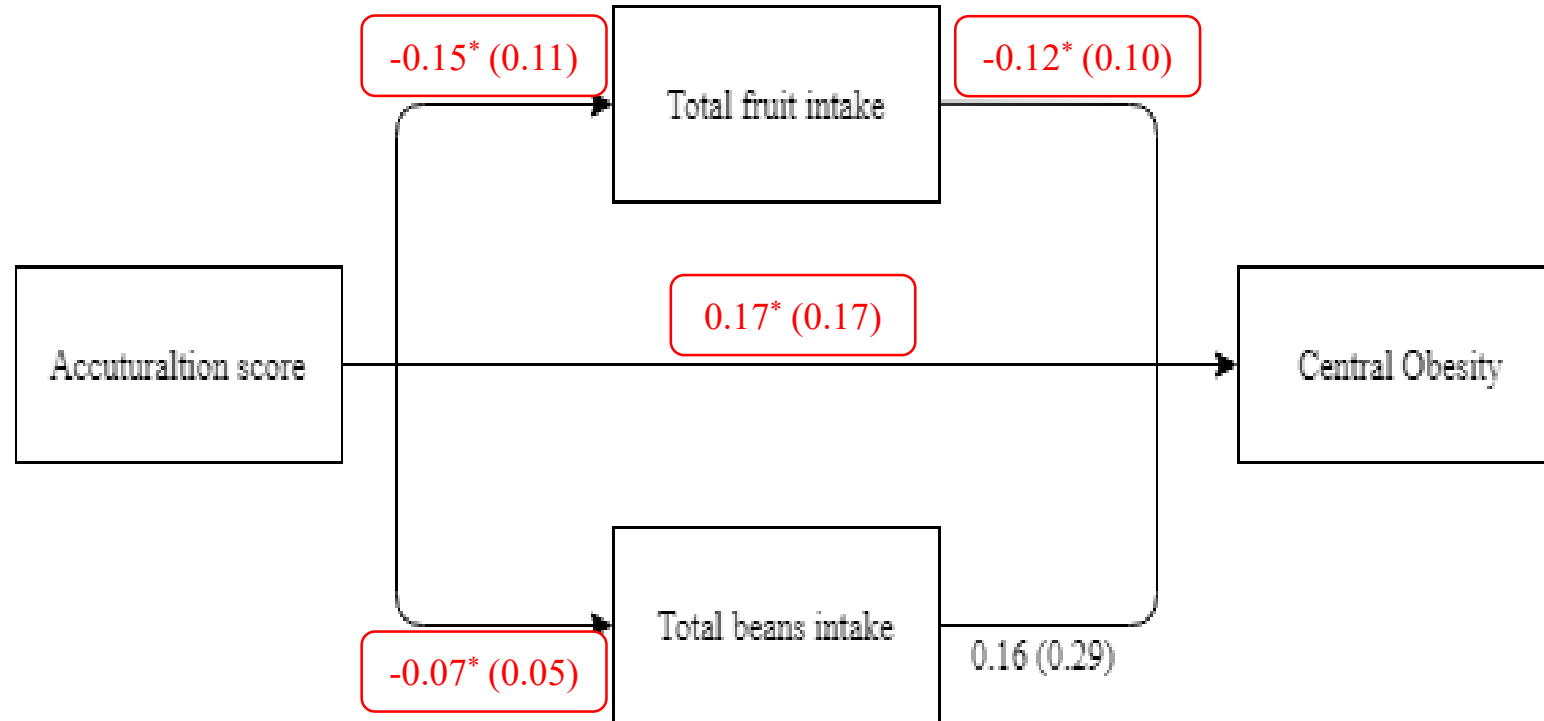


Figure. Path analysis used to assess mediation for association of acculturation with central obesity among Hispanic males.

Data presented on the top lines are beta coefficients (standard error). * p-value < 0.05



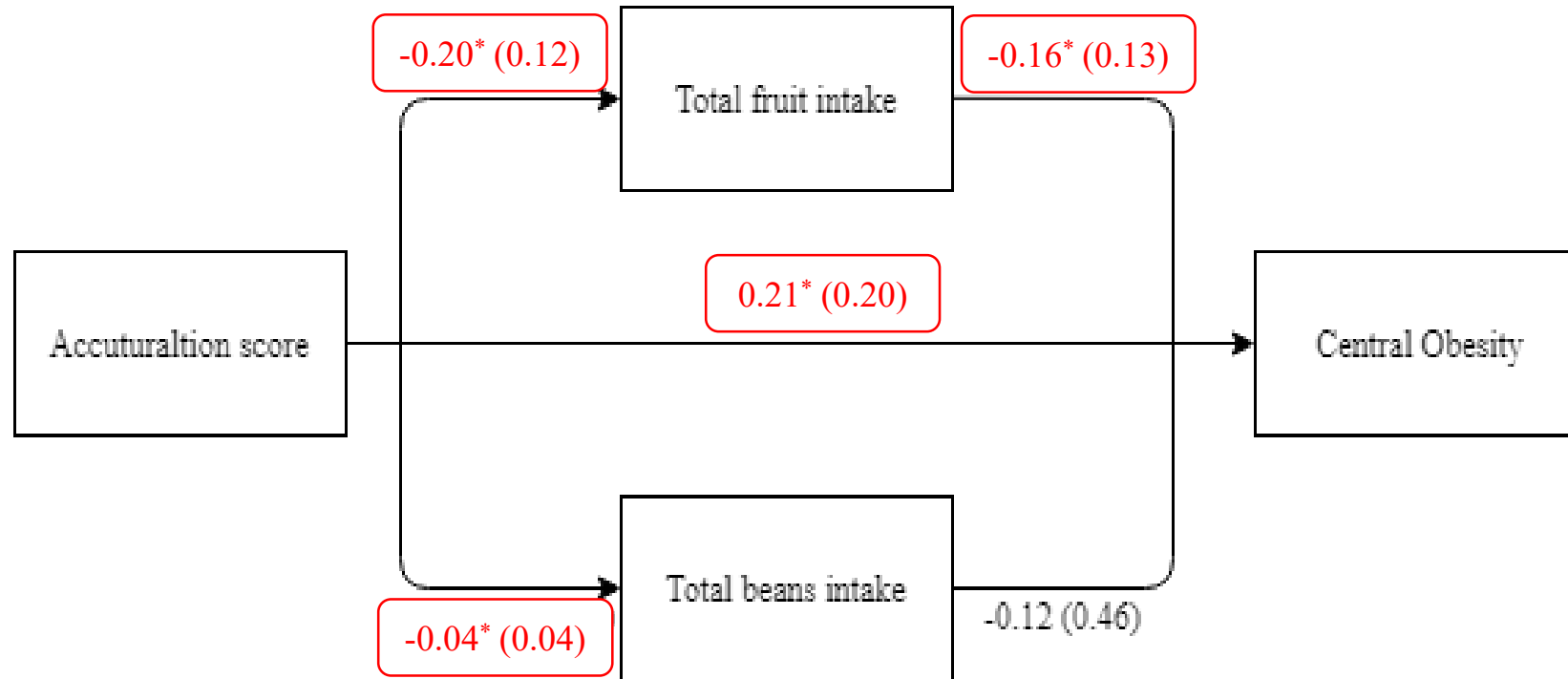


Figure. Path analysis used to assess mediation for association of acculturation with central obesity among Hispanics with poverty-income-ratio ≥ 1.85 .

Data presented on the top lines are beta coefficients (standard error). * p-value < 0.05



Summary: Nutrition and Obesity in Minority Populations

- Our results indicate that young minority women across different BMI status have a poor-quality diet, and the insufficiencies were more severe in overweight/obese groups
 - developing targeted and/or precise dietary supplement programs for women from different racial/ethnic groups

- From 1999 to 2014, despite several improvements in magnesium intakes having been identified, magnesium consumption remains suboptimal among the U.S. Hispanic adults.
 - food sources rich in magnesium are green vegetables, whole seeds, unmilled grains, legumes and nuts
 - suggesting to develop appropriate, multi-level prevention approaches to improve magnesium intakes from diet and supplementation



Summary: Nutrition and Obesity in Minority Populations

- Our results suggested a possible protective effect of calcium intake on overweight, suggesting
 - Higher intake of calcium may slow development of obesity through influence on insulin sensitivity

- Our findings suggest that central obesity in the US Hispanic population may be determined by acculturation
 - enhance total fruits, beans and peas intakes in more acculturated Hispanic adults to prevent central obesity



- Further study molecular mechanisms of socio-culture and diet on obesity etiology in minority populations
- Collaborate to expand studies of socio-culture and diet behavior interactions
 - Other metabolic diseases, e.g. metabolic syndrome/ fatty liver diseases
- Develop ethnicity specific intervention program in minority population



Acknowledgements

UNTHSC Texas Center for Health Disparities

U54 Center Grant PI:
Dr. Jamboor K. Vishwanatha

UNTHSC

Dr. Kimberly Fulda
Dr. Shande Chen
Jialiang Liu
Zhengqi Tan

Vanderbilt University

Dr. Qi Dai
Dr. Xiangzhu Zhu



Thank you!

