Type II Diabetes across Latino Subgroups: Results from the Multi-Ethnic Study of Atherosclerosis

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Spring 2017

ABSTRACT

Latinos constitute the largest ethnic minority in the United States and this ethnic designation comprises various subgroups that vary by national origin, culture, and traditions. Relative to non-Hispanic Whites, Latinos bear a disproportionate burden of diabetes in the population. This study aims to describe variability of type II diabetes mellitus prevalence and associations in Latinos from diverse backgrounds. This study analyzes data from the Multi-Ethnic Study of Atherosclerosis (MESA), a prospective longitudinal study of adults 45 to 84 years of age. Data from 3,758 participants from MESA who identify as Latino and Non-Hispanic White were selected for this project. This study describes variability in associations and prevalence associations across Latino subgroup via X^2 tests and regression models. Also, this study highlights associations between diabetes pathogenesis and diet, education, access to healthy food, and acculturation across Latino subgroups. *The results from the data analysis confirmed the hypothesis and reported variability of associations across subgroups. Additionally, the logistic odds ratio provided significant associations where Latinos born in the United States remained statistically significant after adjustment. Present findings contribute evidence of variability among Latino subgroups. Understanding such trend is significant to tailor interventions for specific subpopulations for future policy drafting and efforts to combat diabetes in high-risk groups. Future research should focus on evaluation of interventions that aim to tackle diabetes across Latinos from different backgrounds.*

INTRODUCTION AND BACKGROUND

Type II diabetes mellitus (T2D) is a chronic disease that features metabolic dysfunctions such as insulin resistance or deficiency primarily in muscles, liver, and fat tissue (CDC, 2014). T2D is associated with aging, obesity, family history of diabetes, a sedentary lifestyle, and low socioeconomic status. The Center of Disease Control (CDC) reports racial and ethnic disparities in the prevalence of T2D in adults of 7.6% in Non-Hispanic Whites compared to 12.8% for Latinos (CDC, 2014). Among Latinos, the prevalence values vary by subgroup: 10.2% in South Americans, 13.4% in Cubans, 17.7% in Central Americans, 18.0% in Dominicans and Puerto Ricans, and 18.3% in Mexicans (Schneiderman et al. 2014). Despite reports of T2D prevalence variability, there exist gaps in data regarding T2D pathogenesis among Latino subgroups. Most academic research on Latinos has been conducted on Mexicans and Mexican Americans who constitute 64.9% of the Latino population (Krogstad and Lopez, 2015) which potentially "hides trends among Hispanics with origins in other countries" (Martinez and Castillo, 2013). Furthermore, studies also categorize Central and South Americans as "Other Latinos," which misrepresents the heterogeneity among Latinos (Lopez, 2009). Regardless of correlations between person-level and environment-level risk factors and T2D pathogenesis, data on Latinos from diverse backgrounds remains limited and inconsistent. This study hypothesized that prevalence and associations of T2D varies in Latinos from different backgrounds. This study also describes associations of T2D among education, acculturation, diet, and neighborhood resources across Latino subgroups to provide a more-in depth understanding of diabetes pathogenesis. The results from this study confirmed variability of T2D rates across Latino background and risk factors, which is useful to expand knowledge on this population and implement adequate preventative interventions in the Public Health field.

Diet

Various factors surrounding acculturation, migration, and socioeconomic status play a role on dietary habits in Latinos. The assumption that Latinos experience negative dietary changes post-migration predominates literature in Public Health topic (Martinez, 2013). However, researchers now observe food globalization and dietary transitions in Latin America (Drago, 2012) to better study dietary patterns. The same way diabetes rates vary by Latino heritage, factors such as food preference, prices and preparation also differ by group (Drago, 2012). A study on diet quality on data using data from the HCHS/SOL reported variability in the associations between diet quality, risk of non-communicable disease, and a cluster of diabetes risk factors across Latino subgroups ($p<0.001$) (Mattei et al., 2016). Thus, the findings on diet variability by subgroup in the HCHS/SOL serve as basis to fill in research gaps on dietary patterns and diabetes across Latino subgroups in to create future appropriate nutrition interventions for Latinos.

Education

Educational achievement in Latinos varies by country of origin and immigration status. According to a study by the Pew Research Center, Latinos had a high school dropout rate of 12% in 2014 (Lopez, 2009). The same year, 66% of Latinos worked full-time or joined the military after high school instead of attending college to help their families compared to a 39% of Non-Hispanic Whites (Lopez, 2009). Therefore, those who immigrate are more likely to have financial family commitments which affects dropout and enrollment rates into college education (Lopez 2009) (Krogstad and Lopez, 2015). According to a nationally representative survey by the Pew Hispanic Center, parental involvement and language barriers were identified as main

factors for the Latino achievement gap (Lopez, 2009). Education level also differed by Latino subgroup in a study using data from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL), where Mexicans reported the lowest educational achievement rates and Cubans the highest (Schneiderman et al., 2014). Educational achievement is inversely associated with diabetes development in Latinos as a whole (Schneiderman et al., 2014); yet, little is known about subgroup variability, which highlights the importance to research the effect of education on various realms of life and the need for culturally competent education curricula.

Neighborhood Healthy Foods

Better neighborhood resources such as safety, social cohesion, and availability of healthy foods are associated with less hypertension risk of cardiovascular disease (Auchincloss et al. 2009). In addition, poor neighborhood conditions are concentrated in underserved communities mainly composed of racial/ethnic minorities (Bild et al., 2002). Consequently, individuals affected by inadequate neighborhood nutritional resources substitute nutritious foods for high energy-dense carbohydrates (Seligman et al., 2010). Thus, the quality and quantity of food in a neighborhood affects the development of chronic disease (Auchincloss et al., 2009). Area level measurements provide data of the interactions of the environment where people live and its effects on food accessibility and consumption. In the study *Proyecto Mercado FRESCO* performed Boyle Heights and East LA, two communities that are primarily Mexican-American, more vegetables and fruits were introduced in four stores with the intention to change the perception of food in the neighborhood (Ortega et al., 2015). Although the perception of healthy food changed among the neighborhood, the consumption and sale of these items did not vary. Thus, a priori analysis of variables that could be associated with purchase vegetables, cost, and

preference (Ortega et al., 2015) could improve interventions. Therefore, this study aims to provide data on the relationship between neighborhood resources and T2D pathogenesis in Latinos from different backgrounds.

Acculturation

Acculturation is "the process by which individuals adopt the attitudes, values, customs, beliefs, and behaviors of another culture" (Loue, 1998). In 2012, 18.8% of Latinos in the United States were foreign born and accounted for 52% of immigrants and bring traditions and sets of beliefs (Krogstad and Lopez 2015). The Latino Health Paradox hypothesizes that recent Latino migrants experience positive health outcomes on mental health and chronic illness despite social marginalization (Adelman et al. 2008). It is plausible to consider culture, familial unity, and spiritual faith as protective factors (Griego, 2015). However, this advantage vanishes the longer people live in the United States causing health deterioration (Adelman et al., 2008). Mainous et al. performed a study on associations between acculturation with less "desirable habits" on diet, smoking and lack of exercise and higher risk for diabetes (Mainous et al., 2008). Little is known about the impact of these factors in Latino subgroups. Thus, the effects of acculturation stress on the necessity to expand literature on its role on behaviors, lifestyle, and development of chronic disease among Latino subgroups that have different sets of beliefs, culture, and tradition.

Lastly, this study seeks to address the need for more research on non-communicable disease pathogenesis among Latinos from different backgrounds to fully understand the impact of this condition on a heterogeneous population. This project serves as a starting point for future research to look into specific sub-populations as a more effective way of combatting diabetes in the highest risk groups.

METHODS

This study uses data from the Multi Ethnic Study of Atherosclerosis (MESA), a longitudinal prospective cohort study performed by the National Heart, Lung, and Blood Institute from 2000-2008 that included 6,814 men and women aged 45-84 (Bild et al., 2002). MESA includes data from multiple ethnic and racial groups and risk factors, which make it ideal for comparisons across variables (Bild et al., 2002). Since few studies have focused specifically on Latinos' T2D pathogenesis, this study aims to highlight associations between four variables – diet, education, access to healthy food, and acculturation – and T2D prevalence across Latino subgroups. This study population consists of a subset of 3,758 subjects from MESA with 72.49% Non-Hispanic Whites and Latinos categorized by nativity as U.S. Born Latinos (12.35%), Puerto Ricans (Island Born) (3.70%), Mexicans (5.61%), South Americans (3.03%), and Central American (2.82%). Non-Hispanic Whites were included in this study in order to provide a comparison group. This quantitative data analysis employs X^2 tests to measure significant differences in T2D prevalence values and logistic regressions to study associations between Latino background and T2D.

Variables

The outcome, presence of T2D, was measured as a binary variable (Yes/No) based on self-reported physician diagnosis, insulin use, and fasting glucose value ≥ 126 mg/dL (Bild et al. 2002). Education was measured according to the highest level of educational achievement. The Adjusted Healthy Eating Index of 2010 (AHEI 2010) was used to determine data quality by measuring adherence to Dietary Guidelines for Americans based on foods groups associated with

lower risk of cardiovascular disease scored from 0 (no adherence) -110 (perfect adherence) (Chiuve. et al., 2012). Neighborhood resources are measured as a score from 1 (worst food availability) -5 (best food availability) as a conditional empirical Bayes estimate that combines survey questions and area-level measures (Bild et al., 2002). Acculturation was measured as a score from 0 (least acculturated) to 5 (most acculturated) composed of nativity status, years of residence in the United States, and language spoken at home (Kandula et al., 2008). The covariates of age (Male/female), smoking status (Yes/No), race/ethnicity, and nativity status were self-reported. BMI was categorized according to guidelines from the National Institutes of Health (NIH) as <25 (normal), 25-29.9 (overweight), and ≥30 (obese) (Losing Weight, Body Mass Index, NIH). Income was a categorical variable depending on household income from < $5,000 to ≥$40,000.

Statistical Analysis

Prevalence of T2D across sociodemographic characteristics was assessed via X^2 tests. Multivariable logistic regression models were used to calculate odds ratios as measures of association for developing T2D in Latino subgroups compared to Non-Hispanic Whites. An unadjusted model was performed to determine associations between Latino origin and T2D. Adjustments for age, sex, BMI, smoking status, diet, education, and income were made in Model 1. Model 2 included the variables from Model 1 as well as community resources for healthy foods in order to investigate the effect of food accessibility. Lastly, Model 3 adjusted for all previous covariates and included acculturation. All analyses were performed using STATA 12.

RESULTS

Of the 3,758 participants 89.9% reported AHEI 2010 scores, 99% subjects reported access to healthy neighborhood resources, and 94.7% reported acculturation scores. The mean age of participants was 62 years old and diabetes prevalence increased with age ($p < 0.05$). Latino subgroups reported T2D prevalence variability as follows: 50.65% for U.S. Born Latinos, 47.48% for Puerto Ricans, 45.02% for Mexicans, 41.43% for South Americans, and 49.06% for Central Americans. All subgroups reported a higher prevalence percentage compared to Non-Hispanic Whites (33.85%).

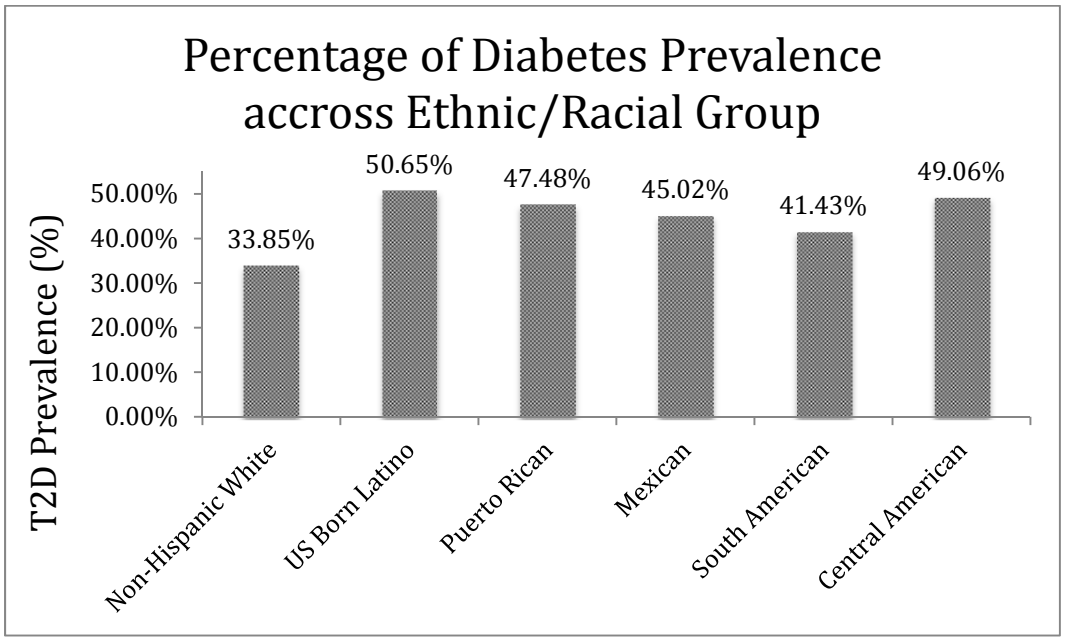

FIGURE 1: This graph shows T2D prevalence percent among in the study population. Latino subgroups reported higher prevalence of T2D compared to Non-Hispanic Whites and variability.

Latinos born in the U.S. reported the highest prevalence of diabetes across all levels of education ($p < 0.05$) (See Figure 2). Higher educational achievement was associated with lower levels of diabetes prevalence as seen in participants who completed their post-secondary education. Even among participants who did not complete high school, participants of Latino

origin still reported significantly higher diabetes prevalence than non-Hispanic Whites and variability among them (p <0.05). As expected, lower prevalence of T2D was associated with better diet quality (higher AHEI 2010 scores). The highest T2D prevalence was observed in participants who scored from 19.9-34 for the total AHEI 2010 score where Central Americans (100%) reported the highest prevalence (p <0.05). For community resources, only Non-Hispanic Whites and South Americans reported trends with decreasing prevalence of diabetes among higher scores (p <0.05). For acculturation results, South Americans, and Central Americans reported higher levels of acculturation scores associated with higher diabetes prevalence (p <0.05). Lastly, Latinos born in the U.S. reported significantly higher prevalence T2D (51%) compared to Non-Hispanic Whites (31%) for acculturation scores of 5 (p <0.05) (Figure 3).

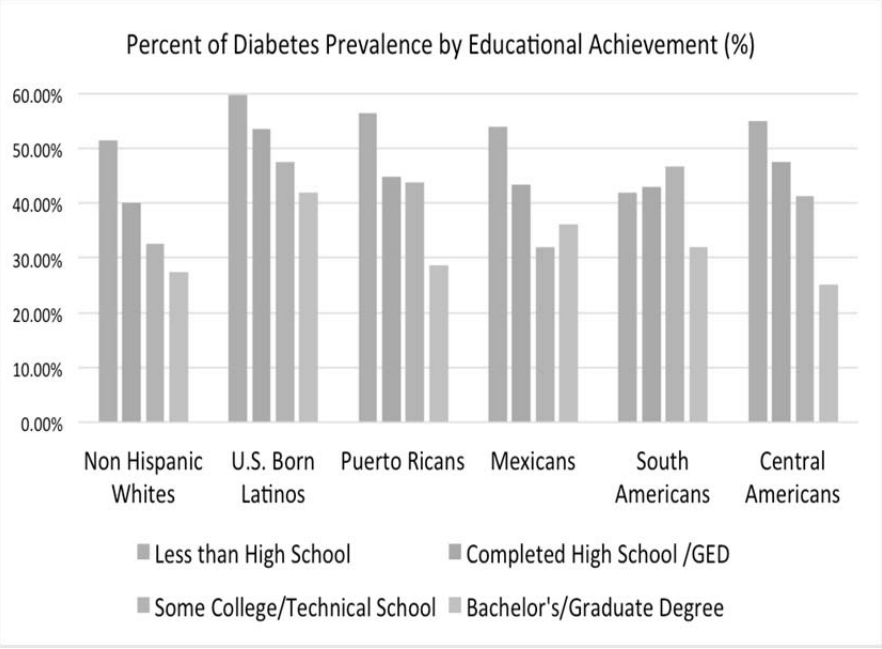

FIGURE 2: This graph illustrates the prevalence of Type II Diabetes by educational achievement

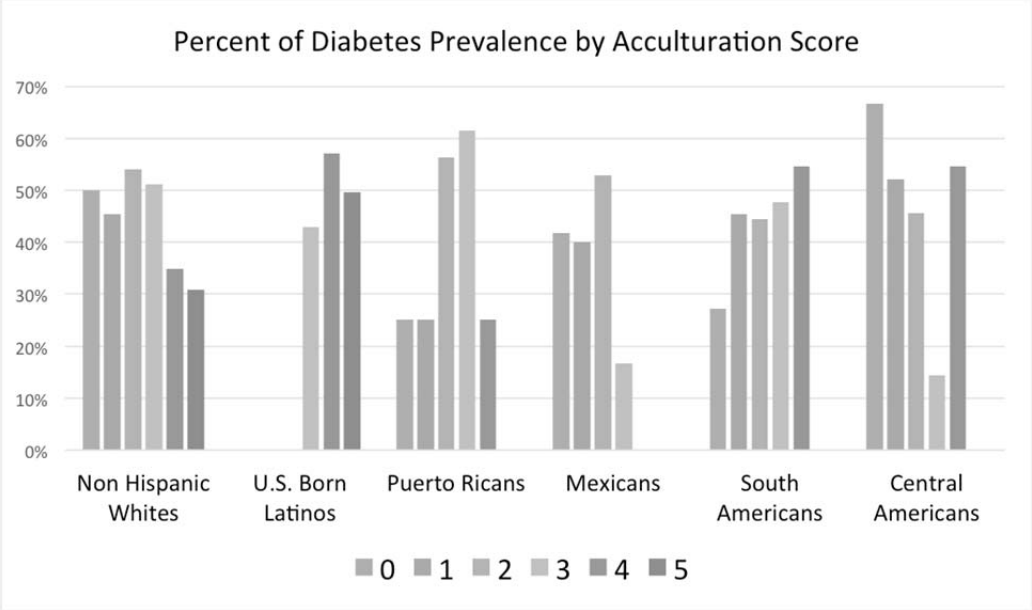

FIGURE 3: This graph shows the prevalence of type II diabetes and acculturation score.

Throughout the logistic regression models (Table 3), South Americans did not report statistically significant evidence in all models. The unadjusted model reported odds ratios in U.S. born Latinos of 2.01 (95% CI (1.64-2.45) and p <0.01) of developing T2D compared to Non-Hispanic whites. Additionally, all Latino subgroups except for South Americans reported statistically significant odds ratio higher than one. After adjusting for sociodemographic factors that could serve as cofounders, Model 1 adjusted for sex, gender, BMI, current smoking status, AHEI 2010 score, education, and income. After adjustment, only U.S. Born Latinos, Puerto Ricans, and Central Americans reported statistically significant odds ratios higher than 1.0. After adjustment of Model 3, statistically significant evidence of an odds ratio of 1.57 was observed for U.S. Born Latinos. Statically significant evidence started to disappear after adjustment for all subgroups with lower odds ratios and p values greater than 0.05 after adjustments.

DISCUSSION

The findings from this study confirm the hypothesis by providing evidence of the variability of T2D pathogenesis in Latino subgroups. Similarly, the results demonstrate variability in associations of diabetes between education, community nutritional resources, acculturation, and diet among Latino subgroups. Also, Latino subgroups reported higher odds of having T2D and a higher prevalence compared to Non-Hispanic Whites that provides evidence for the disproportionate burden on Latinos other studies have previously reported. The associations between Latino heritage and T2D persisted only for U.S. Born Latinos after adjustment for diet, education, acculturation, neighborhood resources for healthy food, BMI, smoking status, age, sex, and income. This study contributes to the knowledge and understanding of health status of Latinos in the U.S. for interventions to tackle this critical issue in the Latino community.

This study provided results that align with results from studies performed by the HCHS/SLO where South Americans, just like in this study, reported lowest prevalence values compared to all subgroups (Schneiderman et al., 2014). Puerto Ricans also reported the second highest prevalence of T2D among all subgroups (National Diabetes Statistics Report, 2014). Additionally, the results concur with previous findings where participants of Latino origin (all subgroups) have a higher prevalence of T2D (48%) compared to Non-Hispanic Whites (33.85%) where age could have played a factor for the higher prevalence values for participants of this study compared to those of the CDC where Non-Hispanic whites reported prevalence values of 7.6% and 13% for Latinos (National Diabetes Statistics Report, 2014). Results also coincide with

those from the National Institutes of Health titled *The Health Status and Behaviors of Hispanics*, which claims that foreign-born Latinos have a better health status than Latinos born in the United States (Escarce et al., 2006). Researchers found different T2D prevalence rates among foreign-born Latinos (47%) and U.S. born Latinos (50.65%) (Escarce et al., 2006), which supports the claim that foreign-born Latinos have a better health status compared those born in the U.S. on the development of T2D where age, sex, culture, country of origin, and years of residence in the U.S. could play pivotal roles. Although the composite score for this study provided evidence of higher prevalence of diabetes in higher scores, this measure lacked measurements of specific behaviors related to acculturation and health status such as smoking, physical activity, and diet (Pérez-Escamilla and Putnik, 2007). Thus there is a need to continue investigating post-migration effects and correlations between resource accessibility and acculturation in Latinos from different backgrounds.

As expected, participants with lower educational achievement reported higher prevalence of diabetes ($p < 0.05$) which aligns with findings from the HCHS/SOL (Schneiderman et al., 2014). Although the prevalence of diabetes remains higher for all subgroups compared to Non-Hispanic Whites across all levels of educational achievement, Latinos born in the U.S. report the highest prevalence of diabetes compared to all subgroups provides evidence to speculate longitudinal effects of education and nativity status on chronic disease. These findings suggest the necessity for more programs to address education gap and possibly incorporating nutrition and physical education programs to prevent T2D at early ages. Similarly, South and Central Americans reported data ($p < 0.05$) that aligns results from Neelakantan et al. where higher

prevalence of chronic disease was associated with the lowest quartile of AHEI 2010 scores on Chinese participants (Neelakantan et al., 2016). For neighborhood resources, the results align with two studies that also analyzed data from the MESA study where longer exposures to adverse neighborhood conditions such as physical activity and healthy foods were associated to lower incidence of T2D (Christine et al., 2015). Despite findings from this study, data on Latino subgroups remains limited.

Limitations on this study include sample size for power, representation of Dominicans and Cubans, and inability to observe parental national origin for U.S. born Latinos to categorize subgroups based on national heritage. The small size of participants for some subgroups could also account for inaccurate results. Other limitations include not being able to measure risk and incidence given that temporality could not be measured. Although this study faced some limitations, these findings still valuably contribute to the literature on health disparities and diabetes in a number of ways. First, This study features statistically significant evidence for the effect of various risk factors on Latino subgroups that affect the presence of T2D. Moreover, this study provides evidence of greater health disparities for Latinos born in the United States by observing highlighting the MESA dataset in a fashion that focused solely on Latinos and specific person and area-level measurements that allow for the analysis of how social stratification, structural violence, and allocation of resources are keystones in the type of choices people make where a healthy choice is not the default choice.

While public health interventions seek to expand access to health care, inclusion of the understanding of undocumented Latino immigrants as well as those who identify as indigenous

is necessary to continue expanding the understanding and evidence of the health status of this heterogeneous population. Further interventions that are culturally sensitive and community based will produce best outcomes to understand the effects of multi-level exposures and impacts of chronic disease. Future research using the MESA dataset could include multi-level analysis for more evidence that supports the Latino Health Paradox by looking at factors associated to other epidemics and preventable mortality. Additionally future research directions could include using similar methodology or multivariable analysis for other critical non-communicable disease such as heart disease and atherosclerosis in Latinos or other subpopulations. These future findings could help organize and evaluate adequate initiatives to address the impacts of chronic disease in this population.

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APPENDIX

Table 1: Distribution of Diabetes by Socioeconomic Factors

	Non-Diabetic **2341** (62%)	Diabetic **1417** (38%)	N = 3758
Age (Years)			
44-54	**800** (72.99%)	**296** (27.01%)	1096
55-64	**661** (62.77%)	**392** (37.32%)	1053
65-74	**609** (55.72%)	**484** (44.28%)	1093
74-84	**271** (52.52%)	**245** (47.48%)	516
			$p < 0.05$
Sex			
Female	**1352** (69.69%)	**588** (30.31%)	1940
Male	**989** (54.40%)	**829** (45.60%)	1818
			$p < 0.05$
Race/Ethnicity			

Non-Hispanic White	**1802** (66.15%)	**922** (33.85%)	2724
US Born Latino	**229** (49.35%)	**235** (50.65%)	464
Puerto Rican	**73** (52.52%)	**66** (47.48%)	139
Mexican	**116** (54.98%)	**95** (45.02%)	211
South American	**67** (58.77%)	**47** (41.23%)	113
Central American	**54** (50.94%)	**52** (49.06%)	106
			$p < 0.05$
Body Mass Index, kg/m2			
<25	**812** (79.7%)	**206** (20.3%)	1018
25-29.9	**968** (62%)	**591** (38%)	1559
≥30	**561** (47%)	**620** (53%)	1181
			$p < 0.05$
Current Smoking Status			
No	**2063** (62%)	**1257** (38%)	3320
Yes	**278** (63.4%)	**160** (36.6%)	438
			$p = 0.589$
Education			
Less than High School	**319** (47%)	**362** (53%)	681
Completed High School /GED	**378** (53%)	**295** (43%)	682
Some College/Technical School	**648** (64%)	**366** (36%)	1014
Bachelor's/Graduate Degree	**985** (72%)	**389** (28%)	1374
			$p < 0.05$
Income			
< $5,000	**28** (45%)	**30** (55%)	58
$5,000-$19,999	**340** (51%)	**336** (49%)	676
$20,000-$39,999	**545** (57%)	**405** (43%)	950
≥ $40,000	**1383** (70%)	**605** (30%)	1988
			$p < 0.05$
Alternative Healthy Eating Index, score*			
19.9-34	**140** (59%)	**97** (41%)	237
35-50	**767** (59%)	**530** (41%)	1297
50-64	**881** (62%)	**529** (38%)	1410
65-80	**282** (70%)	**119** (30%)	401
80-94	**21** (68%)	**11** (32%)	32
			$p < 0.05$
Healthy Food Environment Resources, score (1-5)**			
1	**0** (0%)	**0** (0%)	0

2	**377** (63%)	**212** (36%)	589
3	**1502** (60%)	**1015** (40%)	2517
4	**437** (71%)	**180** (29%)	617
			$p < 0.05$
Acculturation* **			
0	**39** (54%)	**33** (46%)	72
1	**59** (56%)	**47** (44%)	106
2	**208** (48%)	**227** (52%)	435
3	**75** (52%)	**64** (46%)	139
4	**144** (57%)	**108** (43%)	252
			$p < 0.05$

*Score out of 3,377 respondents from sample

**Score out of 3,723 respondents from sample

***Score out of 3,559 respondents from sample

Table 2: Prevalence Percent of Type II Diabetes in Latino Subgroups

N= 3758	**Non-Hispanic Whites**	**U.S. Born Latinos**	**Puerto Rican**	**Mexican**	**South American**	**Central American**
	n= 2717	n= 464	n= 139	n= 211	n=114	n= 106
	Diabetic Participants n= 922	Diabetic Participants n= 235	Diabetic Participants n= 66	Diabetic Participants n= 95	Diabetic Participants n= 47	Diabetic Participants n= 52
	Diabetes Prevalence	Diabetes Prevalence	Diabetes Prevalence	Diabetes Prevalence	Diabetes Prevalence	Diabetes Prevalence

Education						
Less than High School	51%	60%	56%	54%	42%	55%
Completed High School/GED	40%	54%	45%	43%	43%	47%
Some College/Technical School	32%	48%	44%	32%	47%	41%
Bachelor's/Graduate Degree	27%	42%	29%	36%	32%	25%
						$p < 0.05$
Alternative Healthy Eating Index, Score						
19.9-34	35%	66%	45%	33%	50%	100%
35-49	37%	50%	48%	49%	41%	53%
51-64	34%	49%	45%	46%	43%	50%
65-79	27%	52%	75%	24%	40%	13%
80-94	31%	-*	0%	33%	-*	0%
						$p < 0.05$
Neighborhood Healthy Food, Score						
2	34%	52%	0%	46%	50%	0%
3	36%	32%	46%	60%	45%	52%
4	27%	73%	60%	47%	38%	0%
						$p < 0.05$
Acculturation, Score						
0 (Least Acculturated)	50%	-*	25%	42%	27%	67%
1	45%	-*	25%	40%	45%	52%
2	54%	-*	56%	53%	44%	46%
3	51%	43%	62%	17%	48%	14%
4	35%	57%	25%	0%	55%	55%
5 (Most Acculturated)	31%	50%	-*	-*	-*	-*
						$p < 0.05$

*N/A

Table 3: Logistic Regression Models

Odds Ratios of Developing Type II Diabetes Mellitus in Latino Subgroups Compared to Non-Hispanic Whites after Multivariable Adjustment

	Non-Hispanic White n= 2724 OR (95% CI)	**U.S. Born Latinos** n= 464 OR (95% CI)	**Puerto Ricans** n= 139 OR (95% CI)	**Mexicans** n= 211 OR (95% CI)	**South Americans** n=114 OR (95% CI)	**Central Americans** n= 104 OR (95% CI)
Unadjusted Model	**1.0**	**2.01** (1.64-2.45)**	**1.77** (1.26-2.49)*	**1.6** (1.2-2.49)*	1.37 (0.94-2.01)	**1.88** (1.28-2.78)*
MODEL 1 Adjusted for Age, Sex, BMI, Current Smoking Status, Income, Education, AHEI Score	**1.0**	**1.5** (1.2-1.87)**	**1.49** (1.02-2.16)*	1.36 (0.99-1.88)	1.18 (0.78-1.79)	**1.63** (1.1-2.49)*
MODEL 2 MODEL 1 + Community Resources	**1.0**	**1.42** (1.12-1.8)*	1.23 (0.81-1.9)	1.09 (0.76-1.58)	1.32 (0.85-2.13)	1.34 (0.85-2.13)
MODEL 3 MODEL 2 + Acculturation	**1.0**	**1.57** (1.23- 1.99)*	1.11 (0.69- 1.79)	0.86 (0.559- 1.32)	0.995 (0.59- 1.68)	1.06 (0.636-1.77)

** P Value < 0.01 *P Value < 0.05