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The Relation of Acculturation to Overweight, Obesity, Pre-Diabetes and Diabetes Among US Mexican-American Women and Men

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Abstract

Objective—To estimate and compare the prevalences of overweight, obesity, pre-diabetes and diabetes among a nationally representative sample of Mexican-American, non-Latino White and Black adults, and by acculturation for Mexican-Americans.

Design, settings and participants—The NHANES 1999–2008 data sets were used. Binomial regression models were used to compute prevalence ratios and their respective 95% confidence intervals to assess the relationships of race/ethnicity and acculturation with obesity, overweight, pre-diabetes and diabetes.

Main outcome measures—overweight, obesity, pre-diabetes, and diabetes.

Results—Mexican Americans had a higher prevalence of overweight than White non-Latinos and Black non-Latinos. **Obesity** was significantly more prevalent among the most acculturated Mexican Americans but not the least acculturated. In contrast, the least acculturated Mexican Americans had the highest prevalence of **overweight**. The prevalence of pre-diabetes was higher among Mexican Americans than White non-Latinos and Black non-Latinos. The most acculturated Mexican Americans had a higher prevalence of **diabetes** and the prevalence of **pre-diabetes** was elevated in less acculturated Mexican Americans. In both unadjusted and adjusted models, the less acculturated were significantly more likely to be overweight and significantly less likely to be obese, compared to more acculturated Mexican Americans, and acculturation was not associated with diabetes or pre-diabetes in adjusted models.

Conclusion—Our results suggest that **obesity** was less prevalent among the least acculturated Mexican-Americans but, **overweight** was more prevalent.

Keywords

acculturation; Mexican Americans; diabetes status; body mass index status

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INTRODUCTION

Obesity and diabetes, major risk factors for cardiovascular disease, are more prevalent in Mexican Americans than non-Latino Whites.[1–8] The prevalence of **overweight** is also higher for Mexican Americans than for non-Latino Whites.[1, 3, 4] While in the study by Flegal and colleagues[1] the prevalence of **overweight** differed for Mexican American (74.4%) and non-Latino White (67.4%) men, the largest differences observed were between Mexican American women (71.9%) and non-Latino White women (57.3%). Similarly, several studies have shown that the prevalence of **pre-diabetes** is higher for Mexican Americans than for non-Latino Whites[2, 5, 7, 9] and significantly higher in Mexican American men (42.2%) than Mexican American women (21.2%).[1] In contrast, using the more recent 2005–2006 NHANES data, no statistically significant differences were found in the prevalence of **pre-diabetes** by race/ethnicity or gender.[7]

In the US, the estimated prevalence for **obesity and overweight** among Mexican American women (39.7% and 32.2% respectively) and men (28.9% and 45.5% respectively) is high.[1] The prevalence of **diabetes** for Mexican American women over the age of 20 years was 11%; for Mexican American men it was 9.9%.[2] Obesity and diabetes are precursors to serious health related-complications, such as heart disease, stroke, high blood pressure, osteoarthritis, cancer, kidney disease, blindness, nervous system disease, and dental disease.[10, 11] In 2007, heart disease, cancer, stroke and diabetes were among the top five leading causes of mortality for Latino men and women.[12]

The degree of **acculturation** differs markedly within the Mexican-American community, and these differences may influence the risk of obesity and diabetes. Among Latinos in the US, Mainous and colleagues[13] found that increased acculturation was associated with higher prevalence of obesity but with lower prevalence of diabetes. However, Latinos in the US are a heterogeneous population, and results have not been consistent regarding the relationship between **acculturation** and **obesity** or **diabetes** for Mexican-Americans.[6, 9, 14–21] In the San Antonio Heart Study, Hazuda et al[20] found an inverse relation between acculturation and diabetes, with increasing acculturation accompanied by statistically significant declines in the prevalence of diabetes and obesity among Mexican Americans. In contrast, Ahluwalia et al[14] found a positive association between weight and acculturation such that Mexican Americans with low levels of acculturation were less likely to be obese (24%) than Mexican Americans with high levels of acculturation (32%). Further, using the 1982–1984 Hispanic Health and Nutrition Examination Survey (HHANES), Harris et al[9] found no association between acculturation and diabetes among Mexican Americans. In addition, the relation between acculturation and impaired fasting glucose (pre-diabetes) is not known but has important preventive implications for diabetes and cardiovascular disease in the Mexican American population.

The objectives of the present study, therefore, were: 1) to estimate and compare the prevalences of obesity, overweight, pre-diabetes and diabetes among a nationally representative sample of Mexican-American, White (non-Latina) and Black (non-Latina) adults using the National Health and Nutrition Examination Survey (NHANES) 1999–2008 data sets; and 2) to assess whether different levels of acculturation among Mexican

Americans were associated with differing prevalences of overweight, obesity, pre-diabetes and diabetes. We hypothesized that increasing acculturation shifts a predisposition from overweight to obesity and pre-diabetes to diabetes.

METHODS

Survey Design and Sample

Data from the National Health and Nutrition Examination Survey (NHANES) were used to examine the prevalences of and the relation of acculturation to obesity, overweight, pre-diabetes, and diabetes among adults aged 20–89 years.[22] The NHANES has extensive information on health and nutrition obtained through interviews (demographic, socioeconomic, dietary, and health-related questions), examinations (physical and dental) and laboratory tests. In 1999, the NHANES became a continuously repeated cross-sectional survey with approximately 5000 new participants examined each year. In the past, the NHANES were conducted as a series of two-year surveys. Data used for the present analyses included the combined 1999–2000, 2001–2002, 2003–2004, 2005–2006 and 2007–2008 public use data files.[22] The NHANES used a complex probability survey design and sample weighting methodology. The primary sampling units were counties throughout the US. Sample weights were based on the Year 2000 Decennial Census, providing unbiased national estimates.[23]

Primary outcome variables

Obesity was defined as measured body mass index (BMI) (in kg/m^2) greater than or equal to 30; overweight was defined as a BMI of 25 to 29.9; normal weight was defined as a BMI less than or equal to 24.9.[24] Pre-diabetes was defined as fasting plasma glucose of 100 to 125 mg/dl.[25] Diabetes was defined and ascertained in three ways: 1) fasting plasma glucose of 126 mg/dl or greater or 2) participants self-report of physician diagnosis of diabetes, or 3) positive response to the question "…are you now taking diabetes medicine". This information was combined to create one variable for diabetes status with three categories (i.e. no diabetes, pre-diabetes and diabetes). Preliminary analysis to determine whether the use of a single measure for diabetes status (i.e. fasting glucose) versus the combined measure for diabetes status (i.e. fasting glucose or physician reported diabetes or use of diabetes medicine) differed with regard to acculturation and sociodemographic variables indicated that no significant differences existed between the two methods of assessing diabetes status.

Primary independent variables

Ethnicity was determined by self-identification as White non-Latino, Black non-Latino or Mexican American. The NHANES race/ ethnicity variable was only provided as a re-coded variable that combined the race and ethnicity variables into White non-Latino, Black non-Latino, Mexican American, Other Race-including Multiracial and Other Latino. Only White non-Latinos, Black non-Latinos and Mexican Americans were included for these analyses. Approximately 22,621 (unweighted sample size) participants interviewed for NHANES during the 1999–2008 time period were included in these analyses. Of those, about 5,069 (unweighted sample size) were Mexican-American. The NHANES included predominate

language, which we used to assess acculturation and has been used previously as highly correlated with acculturation in investigations of health outcomes in Latino populations.[26] For Mexican American participants, we combined predominate language with birthplace and developed four acculturation categories: US-born (predominately English-speaking or predominately Spanish-speaking) and Mexico-born (predominately English-speaking or predominately Spanish-speaking).

Covariates

Based on the existing health literature, the following factors were assessed for potential confounding: age at interview, socioeconomic status, family history of diabetes, marital status, gender, and health insurance. Age was categorized into three groups (20–39, 40–59 and 60–85 years). Socioeconomic status of the participants was assessed by the participants' self-reported educational level. As described in the Statistical Analyses section below, gender, marital status, education, age and health insurance were retained in the overweight and obesity binomial regression models; whereas gender, education, age, family history of diabetes and health insurance were retained in the pre-diabetes and diabetes binomial regression models.

Exclusions

Pregnant women and participants under the age of 20 years were excluded.

Statistical Analyses

The NHANES study adopted a complex, multistage, probability cluster sampling design.[23] We used SAS version 9.2[27] and R version 2.10.1[28] to account for the complex sample design, the use of sample weights, and the estimation of sampling error. We used SAS SURVEY for our descriptive analysis and R SURVEY for our complex analysis. The SAS SURVEY and R SURVEY packages use the Taylor linearization or replicate weights to estimate sampling errors.[23, 27, 28] The R SURVEY package provides a computational tool for analyzing survey data with complex sample design, with equivalent performance to other tools such as SAS SURVEY procedures and SUDAAN RLOGIST procedure.[29, 30] The NHANES data set contains oversampled population groups such as African Americans, Mexican Americans, adolescents, low income White Americans and individuals over the age of 60.[23] Therefore, analysis of subsamples (e.g. laboratory and examination data) required appropriate subsample weights to account for that stage of selection and additional non-response. The appropriate use of sample weights, stratification and clustering of the design were incorporated into our analyses of the NHANES data to obtain the correct estimates and the respective standard errors of these estimates.[23]

The combined 1999–2000, 2001–2002, 2003–2004, 2005–2006 and 2007–2008 data files were used for our analyses. Exploratory analyses included Chi-square analyses (using PROC SURVEYFREQ) and log-binomial regression (using function SVYGLM in R package SURVEY). Chi-square tests were conducted to examine the relations of race/ethnicity and acculturation (measured by location of birth and language), as well as other potentially confounding variables to overweight, obesity, pre-diabetes and diabetes. We used the "change-in-estimate" criterion to identify which of our covariates might be potential

confounders (p.256)[31]. The "change-in-estimate" criterion compares the unadjusted estimate with the adjusted estimates. For this study, a change of 10% from the unadjusted prevalence ratio by inclusion of the potential covariate in the adjusted prevalence ratios was used as the criterion for retention of the covariate in the final model. Unadjusted prevalence ratios (PRs) and 95% confidence intervals (CIs) were computed using R to estimate the individual associations using log-binomial regression. Adjusted prevalence ratios (PRs) and 95% confidence intervals (CIs) were computed to study the independent relations of race/ethnicity and acculturation to overweight, obesity, pre-diabetes and diabetes status, while adjusting for the confounding variables that met the retention criterion mentioned above. We examined the interaction between acculturation and socioeconomic status, no significant differences were found.

RESULTS

Bivariate results for obesity and overweight by race/ethnicity and acculturation

Over half of the population in all three racial/ethnic groups was **overweight or obese** (Table 1). Among White non-Latinos, the prevalence of **overweight and obesity** was 65.1%, and among Black non-Latinos and Mexican Americans was higher at 73.1% and 73%, respectively. The prevalence of **overweight** was highest among Mexico-born (predominately Spanish speaking: 42.7%; predominately English speaking: 38.1%), and prevalence of **obesity** was highest among the more acculturated US-born Mexican Americans (predominately English speaking: 41.4%; predominately Spanish speaking: 39.3%). Gender, marital status, education, age, family history of diabetes and health insurance were all associated with **overweight** and **obesity**. Men were more likely to be **overweight** than women. Black non-Latinos were more likely than White non-Latinos to be **obese** but less likely to be overweight. Whereas Mexican Americans were more likely to be **overweight** at all acculturation levels compared to White non-Latinos, Mexican Americans that were the most acculturated (US-born, predominately English-speaking) were more likely to be **obese** compared to White non-Latinos.

Adjusted PRs for obesity and overweight by race/ethnicity and acculturation

In models comparing those with obesity and those with normal weight, the Mexico-born in both the unadjusted and adjusted analyses were significantly less likely to be **obese** compared to the most acculturated group (US-born predominately English-speaking), after adjusting for gender, marital status, education, age, and health insurance (Table 2). In comparison, Mexican Americans who were less acculturated (i.e. Mexico-born, predominately Spanish speaking) were significantly more likely to be **overweight** than Mexican Americans who were more acculturated (i.e. US-born predominately English speaking) for both the unadjusted (PR=1.26, 95% CI=1.17, 1.35) and adjusted (PR=1.23, 95% CI=1.12, 1.36) models comparing overweight with normal weight.

Bivariate results for the relation of pre-diabetes and diabetes to race/ethnicity and acculturation

The prevalence of **pre-diabetes** was high among all three racial/ethnic groups (Table 3). Among White non-Latinos the prevalence of pre-diabetes was 31.8%, among Black non-

Latinos 23% and was 33.4% among Mexican Americans. The least acculturated Mexican Americans (Mexico-born, predominately Spanish Speaking) had the highest prevalence of pre-diabetes (37.4%). Among Black non-Latinos the prevalence of **diabetes** was higher (14.5%) compared to White non-Latinos (9.6%). For Mexican Americans the prevalence of **diabetes** was also high, particularly among the US-born (predominately English speaking, 12.7% and predominately Spanish speaking, 18.7%) compared to the less acculturated (Mexico-born predominately English speaking, 7.8%; Mexico-born, predominately Spanish speaking, 10.2%). Gender, education, age, family history of diabetes, and health insurance were all associated with **pre-diabetes** and **diabetes**.

Adjusted PRs for pre-diabetes and diabetes by race/ethnicity and acculturation

In unadjusted models comparing pre-diabetes with no diabetes, the least acculturated group of Mexican Americans (i.e. Mexico-born, predominately Spanish speaking) was significantly more likely than the most acculturated group (i.e. US-born, predominately English speaking) to have **pre-diabetes** (PR=1.27, 95% CI= 1.13, 1.44). After adjusting for gender, education, age, family history of diabetes, and health insurance, this association was reduced and was not significant (PR=1.17, 95% CI = 0.99, 1.40). No other statistically significant associations were observed for the relation of acculturation to **pre-diabetes** and **diabetes** among Mexican Americans (Table 4).

DISCUSSION

Among Mexican Americans, acculturation was related to both increased BMI and diabetes status. In particular, Mexican Americans who were less acculturated were more likely to be **overweight** but less likely to be **obese** compared to Mexican Americans who were the most acculturated. Although not statistically significant in our adjusted model, the least acculturated Mexican Americans were also somewhat more likely to have **pre-diabetes**. Mainous et al[13] and Ahluwalia et al[14] similarly reported a higher prevalence of overweight and lower prevalence of **obesity** among US Latinos who were less acculturated. In addition to our novel finding regarding **pre-diabetes**, we identified a pattern similar to that found by Mainous et al[13] for **acculturation, obesity** and **overweight** and **diabetes** in analyses confined to U.S. Mexican Americans, while including more recent data than those of Mainous et al. In contrast to Hazuda et al[20], we found that the lower prevalence of **obesity** in Mexico-born Mexican Americans was reflected in providing protection from **diabetes** compared to those with higher levels of **acculturation** (i.e. US born), possibly due to the higher prevalence of **overweight** in the former group. Consistent with other research, we found no statistically significant association between **acculturation** and **diabetes**.[9]

We were able to contribute information on health disparities to the body of literature pertaining to Mexican American men and women, the relation of **acculturation** to **obesity, overweight,** and particularly **pre-diabetes** and **diabetes**. In addition, including fasting blood glucose, use of diabetic medications and physician-diagnosed diabetes as part of our definitions for **pre-diabetes** and **diabetes** gave a more complete profile of the differences in prevalence of these outcomes among White non-Latinos, Black non-Latinos and Mexican Americans. Including additional study years of NHANES data also allowed us to make

additional comparisons and include other factors that are important in describing health disparities among the major racial and ethnic groups in the United States. Specifically, we also included marital status and family history of diabetes in our adjusted analyses. These are important factors for Mexican Americans because a large proportion of this ethnic group is married.[32] We were also able to focus on one distinct Latino subgroup (i.e. Mexican Americans) and describe a risk profile that included acculturation for this group for **overweight, obesity, pre-diabetes** and **diabetes**.

Previous studies have also reported an increased prevalence of impaired fasting glucose (pre-diabetes) in Mexican Americans compared with non-Latino whites or non-Latino Blacks.[2] Our study is the first to our knowledge however, to report on the relationship between **acculturation** and **pre-diabetes** in Mexican Americans. The high prevalence of **pre-diabetes** in our study population of Mexican Americans (and, in particular less acculturated Mexican Americans) is of public health concern. Pre-diabetes is also garnering attention as a risk factor for diabetes, cardiovascular disease and increased mortality risk.[33, 34] For example, a longitudinal study by Wen and colleagues[35] assessed the effects of varying levels of fasting blood glucose on mortality risks and observed that impaired fasting glucose (pre-diabetes) of 110–125 mg/d was associated with increased mortality risks for diabetes and cardiovascular disease.

Our results thus have important implications for prevention efforts aimed at decreasing the incidence of diabetes and obesity in the Mexican American population and also pose issues for further research. First, the higher prevalence of obesity and diabetes in the US-born Mexican Americans suggests that this section of the population needs to be most strongly targeted for prevention efforts. Second, these outreach efforts must be aimed at those who are predominately Spanish-speaking as well as English speakers because high prevalence rates of overweight, obesity, pre-diabetes and diabetes are seen in both sectors of the US-born population. Third, further research is needed to understand the factors that contribute to the increase in obesity and diabetes prevalences in US-born generations, and to the increase in overweight and pre-diabetes in Mexico-born generations, so that these can be addressed in prevention efforts.

CONCLUSION

Our results confirm that health disparities exist between Mexican Americans and non-Latino Whites for obesity and diabetes. First, the prevalence of **overweight and obesity** was higher for Mexican Americans than for White non-Latinos. Similarly, the prevalence of **pre-diabetes** and **diabetes** was higher for Mexican Americans than for White non-Latino adults. In addition, differences were found by different levels of **acculturation** for Mexican Americans. Lastly, our results suggest that **diabetes and obesity** are less prevalent among the least acculturated Mexican-Americans but, surprisingly, **overweight and pre-diabetes** were more prevalent in this group.

The reasons for differences in overweight, obesity, pre-diabetes and diabetes for Mexican-Americans are not clear but suggest that some aspects of greater acculturation increase the risk of obesity and diabetes among Mexican-Americans.[36] It may be that the least

acculturated Mexican Americans (i.e. those who immigrate to the US) bring with them health behaviors that are protective for their overall health (such as nutritious diets and increased physical activity) but over time these healthy behaviors are replaced with unhealthy behaviors, such as consuming excess calories from unhealthful foods (that are readily and cheaply available) and decreasing physical activity. These are areas that require further investigation so as to target prevention efforts appropriately.

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Table 1

Sociodemographic Characteristics Of Adult White non-Latino, Black non-Latino and Mexican American Men and Women (weighted n=177,457,300) by Normal, Overweight and Obese: National Health and Nutrition Examination Survey 1999–2008.

Characteristic*	Normal† (BMI ≤24.9) %	Overweight† (BMI 25–29.9) %	Obese† (BMI ≥30) %
Race/Ethnicity			
White non-Latino	34.9	34.0	31.1
Black non-Latino	27.0	30.7	42.4
Mexican American	27.0	38.9	34.1
Born in US			
Predominately English	24.6	34.0	41.4
Predominately Spanish	24.5	36.3	39.3
Born in Mexico			
Predominately English	30.5	38.1	31.4
Predominately Spanish	28.2	42.7	29.1
Gender			
Male	29.6	40.4	30.0
Female	37.8	28.1	34.0
Marital Status			
Married	31.5	35.7	32.8
Not Married	37.7	31.1	31.2
Education			
Less than High School	30.9	34.9	34.2
High School Diploma	31.5	33.7	34.8
College/AA Degree	35.9	34.0	30
Age			
20–39 Years	41.5	30.8	27.7
40–59 Years	29.1	35.0	35.9
60–85 Years	29.0	38.3	32.7
Health Insurance			
Yes	32.8	34.6	32.6
No	38.0	32.4	29.6

* For each characteristic, an individual chi-square test was carried out to test the association between weight status and the characteristic.

† Normal weight was defined as a body mass index (BMI) less than or equal to 24; overweight was defined as a BMI of 25 to 29.9; Obesity was defined as a BMI greater than or equal to 30.

Table 2

Unadjusted and Adjusted Prevalence Ratios (PRs) and 95% Confidence Intervals (CIs) for Overweight and Obesity of Mexican Americans by Place Of Birth And Primary Language.

Place Of Birth And Primary Language	Overweight* PR (95% CI)	Obesity* PR (95% CI)
Unadjusted		
Born in US		
Predominately English†	1 ref	1 ref
Predominately Spanish	1.07 (0.83, 1.38)	0.95 (0.75, 1.19)
Born in Mexico		
Predominately English	1.12 (0.95, 1.32)	0.76 (0.65, 0.89)
Predominately Spanish	1.26 (1.17, 1.35)	0.70 (0.65, 0.76)
Adjusted‡		
Born in US		
Predominately English†	1 ref	1 ref
Predominately Spanish	1.05 (0.83, 1.34)	0.93 (0.75, 1.16)
Born in Mexico		
Predominately English	1.11 (0.94, 1.30)	0.76 (0.65, 0.89)
Predominately Spanish	1.23 (1.12, 1.36)	0.70 (0.64, 0.76)

*Normal weight was defined as a body mass index (BMI) less than or equal to 24; overweight was defined as a BMI of 25 to 29.9; Obesity was defined as a BMI greater than or equal to 30.

†Reference group is born in US – predominately English speaking Mexican Americans and normal weight.

‡Adjusted for gender, marital status, education, age and health insurance.

Table 3

Sociodemographic Characteristics Of Adult White non-Latino, Black non-Latino and Mexican American Men and Women (weighted n=181,642,387) by No Diabetes, Pre-Diabetes and Diabetes: National Health and Examination Survey 1999–2008.

Characteristic*	No Diabetes† %	Pre-diabetes† %	Diabetes† %
Race/Ethnicity			
White non-Latino	58.6	31.8	9.6
Black non-Latino	62.5	23.0	14.5
Mexican American	55.2	33.4	11.4
Born in US			
Predominately English	58.0	29.4	12.7
Predominately Spanish	51.4	29.9	18.7
Born in Mexico			
Predominately English	63.4	28.8	7.8
Predominately Spanish	52.4	37.4	10.2
Gender			
Male	51.4	37.4	11.2
Female	65.3	24.7	10.0
Education			
Less than High School	49.1	34.7	16.2
High School Diploma	56.4	31.9	11.7
College/AA Degree	62.9	29.1	8.1
Age			
20–39 Years	76.0	21.1	2.9
40–59 Years	54.1	35.0	10.9
60–85 Years	37.3	40.0	22.8
Family History of Diabetes			
Yes	54.3	29.9	15.7
No	62.3	31.7	5.9
Health Insurance			
Yes	57.5	31.0	11.4
No	62.8	30.5	6.6

*For each factor, an individual chi-square test was carried out to test the association between the diabetes status and the factor.

†Pre-diabetes was defined as fasting plasma glucose of 100 to 125 mg/dl and diabetes as fasting plasma glucose of 126 mg/dl or greater; diabetes was also identified by self-report of physician diagnosis of diabetes and responses to the question "… taking diabetes medicine"

Table 4

Unadjusted and Adjusted Prevalence Ratios (PRs) and 95% Confidence Intervals (CIs) for Pre-Diabetes And Diabetes among Mexican Americans by Place Of Birth And Primary Language.

Place Of Birth And Primary Language	Pre-Diabetes* PR (95% CI)	Diabetes* PR (95% CI)
Unadjusted		
Born in US		
Predominately English†	1 ref	1 ref
Predominately Spanish	1.02 (0.75, 1.38)	1.48 (0.95, 2.31)
Born in Mexico		
Predominately English	0.98 (0.78, 1.23)	0.62 (0.31, 1.24)
Predominately Spanish	1.27 (1.13, 1.44)	0.81 (0.62, 1.06)
Adjusted‡		
Born in US		
Predominately English†	1 ref	1 ref
Predominately Spanish	1.00 (0.74, 1.34)	0.85 (0.58, 1.25)
Born in Mexico		
Predominately English	0.96 (0.78, 1.18)	0.71 (0.39, 1.32)
Predominately Spanish	1.17 (0.99, 1.40)	0.96 (0.78, 1.19)

*Pre-diabetes was defined as fasting plasma glucose of 100 to 125 mg/dl and diabetes as fasting plasma glucose of 126 mg/dl or greater; diabetes was also identified by self-report of physician diagnosis of diabetes and responses to the question "… taking diabetes medicine".

†Reference group is born in US – predominately English speaking Mexican Americans and no diabetes.

‡Adjusted for gender, education, age, family history of diabetes and health insurance.