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Association of Acculturation and Health Literacy with Prevalent Dysglycemia and Diabetes Control Among Latinos in the Boston Area Community Health (BACH) Survey

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Abstract

This study assessed the effect of acculturation on type 2 diabetes and whether health literacy may mediate this association. The Boston Area Community Health cohort is a multi-stage stratified random sample of adults from Boston including 744 Latinos. We defined dysglycemia as a HbA1c 5.7 %. Multivariable analyses examined the associations between acculturation and health literacy adjusting for demographic and clinical variables. Similar analyses were performed among participants with HbA1c 7.0 % to assess the association between acculturation and diabetes control. Among an insured primarily foreign born Spanish speaking Latino population, with a long residence period in the US and good healthcare utilization, higher levels of acculturation were not associated with dysglycemia. Lower levels of acculturation were associated with worse diabetes control. Health literacy level did not modify these associations. Elucidating the components of heterogeneity among Latinos will be essential for understanding the influence of acculturation on diabetes.

Keywords

Acculturation; Health literacy; Latinos; Type 2 diabetes

Introduction

Dysglycemia, defined as prediabetic or diabetic glycemic levels, is associated with increased cardiovascular disease morbidity and mortality [1, 2]. Latinos are at increased risk for obesity, higher rates of dysglycemia and type 2 diabetes (T2D) and develop T2D at younger

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Compliance with Ethical Standards

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ages and with lower BMI compared with non-Latino whites (NHW) [3–6]. Understanding the socio-cultural factors that affect T2D prevalence is important for developing successful culturally tailored interventions in high risk groups [7]. High acculturation and low health literacy may be two factors associated with this higher risk among Latinos.

Acculturation is an important socio-cultural influence that may explain the disproportionate health burden of T2D among Latinos. Acculturation is defined as the process whereby an immigrant culture adopts the beliefs and practices of a host culture [8–10]. It is a complex multidimensional process with both positive and negative effects that may differentially influence the development of T2D risk factors. Higher acculturation has been associated with higher prevalence of unhealthy diet and less exercise leading to increased BMI and thus a higher risk for T2D [11, 12]. However, greater acculturation may also bring positive effects through increased insurance coverage with greater access to health care and use of preventive health services, improved socioeconomic status, and increased English language ability.

Health literacy's role in T2D self-management is potentially modifiable. It is defined as the "degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions" [13]. Low health literacy is more common among racial/ethnic minority groups and has been associated with increased hospitalizations and emergency care, poorer ability to demonstrate taking medications properly and interpret medication labels and health messages [14]. It is also associated with poorer diabetes knowledge and worse self-management activities [15, 16]. No study to date has explored whether health literacy, measured with a scale validated in both English and Spanish, may mediate the effect of acculturation on T2D.

The association between acculturation and T2D is inconsistent among Latinos in the published literature possibly for several reasons. The observed conflicting findings of prior studies may be due to the heterogeneity of the Latino population and within-Latino group variability based on country of origin. The landmark Hispanic Community Health Study/ Study of Latinos (HCHS/SOL), a population-based cohort study of 16,415 Latino women and men aged 18–74 years, demonstrates significant T2D variation in prevalence, awareness and control by country of origin [11]. In addition, acculturation typically has not been measured directly with the use of multidimensional validated scales but instead with the use of multiple limited acculturation proxy measures such as country of origin, age at migration, and language preference [8–10]. Also, most scales utilized did not fully capture the bicultural aspect of acculturation since acculturation is a continuum in the life process. Finally, acculturation is a complex process with both positive and negative effects on lifestyle behaviors across the lifespan that may differentially impact the development and self-management of T2D [8].

To address these shortcomings, this study investigates the association of dysglycemia prevalence with acculturation, using a validated multidimensional scale, in an urban Latino population of primarily Puerto Ricans and Dominicans followed in the Boston Area Community Health (BACH) Survey. This is a unique community-based random sample of inner-city Boston residents with universal health insurance and good health care access and

utilization. We hypothesized that higher acculturation is associated with higher prevalence of hyperglycemia among those participants with low health literacy. Among those with diabetes, we hypothesized that higher acculturation and higher literacy were associated with better control of T2D.

Methods

Participants

This paper used data from the BACH Survey III cohort. The BACH Survey is a longitudinal cohort study of residents of three Boston inner city areas, aged 30–79 years at baseline (March 2002–June 2005) [17, 18]. Briefly, BACH is a multistage 1:1:1 stratified random sample of participants by gender and self-identified race/ethnicity (Black, Latino, White), and age. A total of 5502 adults participated in baseline BACH I (1767 black, 1876 Latino, 1859 white; 2301 men, 3201 women). The second follow-up survey data collection period was in 2008 and BACH III was January 2010 to March 2012. Completed interviews for BACH III were obtained for 3155 individuals (1184 men; 1971 women). The majority of Latino participants were Puerto Rican or Dominican. In all surveys, data were collected during a 2-h interview in English or Spanish, after written informed consent. All participants provided written informed consent and the study was approved by New England Research Institutes' Institutional Review Board.

Measures

Acculturation was measured using the validated Bidimensional Acculturation Scale (BAS) for Latinos [19]. The BAS is based on Likert scale ranging from 1 to 4 with mean scoring of each of the 12-items in each domain for each respondent. Each respondent has 2 scores: the Hispanic domain and the Anglo domain. Scores range from 1 to 4 for each cultural domain. Cutoff of 2.5 indicate low or high level in each domain. Scores of 2.5 or higher in both domains indicates the individual is bicultural. In the BACH cohort, there were very few bicultural acculturation participants ($n = 56$) so these were combined with the high acculturation participants ($n = 239$).

A fasting blood draw was conducted by a trained phlebotomist during the home visit. Fasting glucose was measured with a HemoCue 201 (Brea, CA) point-of-care analyzer. HbA1c was measured by Quest Diagnostics (Generation 2 TinaQuant assay; analytic measurement range 3.4–18 % HbA_{1c}). Following the American Diabetes Association guidelines, dysglycemia was defined as HbA1c ≥ 5.7 % (39 mmol/mol) [1]. For analyses of diabetes control, we dichotomized HbA1c at ≥ 7.0 versus <7.0 % (53 mmol/mol) based on the underlying distribution and the results of the ACCORD trial demonstrating increased adverse events with strict control and for easier clinical interpretation [20].

Participants were administered a version of the Test of Functional Health Literacy in Adult-short form (sTOFHLA), a validated instrument, which assesses health literacy in both English and Spanish [21]. This is a 36 item in person survey [22]. Following established convention, we categorized participants as having inadequate (0–16), marginal [17–22], or adequate [23–36] health literacy.

The home visit consisted of an in-person interview, conducted in English or Spanish, and a clinical component. The interview provided the following information: nativity (foreign born vs. US born), years of residence in the US (categorized in 5 year intervals), first language (English, Spanish, other), having insurance (yes/no) and a usual place of care (yes/no), number of visits to a healthcare provider in the prior year, past medical history, current smoking status (yes/no), and medications. Socioeconomic status (SES) was measured by self-reported household income and educational attainment. Household income, originally grouped into 12 ordinal categories, was collapsed into the following three categories of US dollars: <20,000, 20–49,999, and ≥50,000. Educational attainment was categorized as less than high school, high school graduate or equivalent, some college, and college or advanced degree were combined due to smaller numbers. Measured clinical variables included anthropometric measurements (height and weight) and blood pressure. Anthropometric measures were obtained using a validated field protocol developed for use in large, community-based epidemiologic studies [23]; measurements are identical to those employed in BACH. Height was measured with a square and ruler, weight with a portable battery scale, and waist circumference with a 200 cm fabric measuring tape. Blood pressure (BP) was measured using the Microlife Digital Fully Automatic Blood Pressure Monitor (Microlife USA, Dunedin, FL), recommended by the British Hypertension Society for both clinical and home usage. This instrument obtains three BP measurements and averages them, with date and time of measurement recorded automatically. Basal pulse rate was also measured. Blood examination included lipid profile measurement measured by Quest Diagnostics (Cambridge, MA) on an Enzymatic/Olympus 5400.

Data Analysis

Two-tailed Chi-square tests for categorical variables and one-way analysis of variance for continuous variables were used to test for differences between the high and low acculturation groups. A series of multivariable linear or binary logistic regression models were utilized to assess the association between acculturation and dysglycemia. Model 1 presents the association of acculturation and the outcome. Model 2 adjusts for literacy. Model 3 adjusts model 2 for age and sex. Model 4 adjusts for the following: age, gender, education, health literacy, BMI, cholesterol level, presence of coronary disease and the use of antihyperglycemic medications. Model 4 was repeated twice to separately include an interaction term between acculturation and health literacy and acculturation with education to assess their association with diabetes. These four models were repeated in a subgroup of 148 diabetic Latinos to assess the association between acculturation and control of diabetes. All statistical analyses were performed using SUDAAN 11 (Research Triangle Park, North Carolina). To account for the survey design, data observations were weighted inversely to their probability of selection at baseline, adjusted for non-response bias at follow-up, and post-stratified to the Boston census population in 2010. To minimize reductions in precision due to missing data [24–26], multiple imputation was implemented only for demographic covariates using the Multivariate Imputation by Chained Equations (MICE) algorithm in R [27]. Imputations were conducted separately for each racial/ethnic by gender combination to preserve interaction effects, and the complex survey sample design was taken into account. Fifteen multiple imputation datasets were created stratified by race/ethnicity by gender. A *p* value of 0.05 was considered significant in all analyses.

Results

Table 1 displays the descriptive statistics for self-identified Latinos (N = 744) stratified by the main predictor acculturation, categorized as low versus high. Most participants had a low level of acculturation (60 %) with most being older, female, foreign born, Spanish speakers, who also reported residing in the US 20 years. They also had a high school education or less, inadequate levels of health literacy and a low household income. Although overall rates were high, more highly acculturated Latinos were more likely to be insured and have a usual place of care. Across both acculturation groups, the median number of clinical visits from the prior year was four visits.

Compared to those with high acculturation, low acculturated participants were more likely to have a HbA1c 5.7 % (39 mmol/mol). There were no significant differences between both acculturation groups by BMI, total cholesterol, presence of CAD, current smoking status and use of insulin and non-insulin diabetes medications. There was a significant inverse health literacy gradient and a HbA1c 5.7 % (39 mmol/mol) with inadequate health literacy having the highest [Inadequate (65 %) vs. Marginal (47 %) vs. Adequate (32 %), $p < 0.0001$]/[Mean HbA1c: Inadequate (6.1 %) vs. Marginal (6.0 %) vs. Adequate (5.7 %)].

Table 2 shows logistic regression models examining the association of dysglycemia measured by HbA1c (5.7 vs. <5.7 %) (39 mmol/mol) with acculturation and health literacy. Model 1 demonstrates that the low acculturation group is more likely to have diabetes compared to those with high acculturation. The addition in model 2 of health literacy attenuates to nonsignificance the effect of acculturation while low health literacy (inadequate and marginal categories) is strongly associated with diabetes compared to those with adequate health literacy. The effects of both literacy and acculturation are attenuated to nonsignificance but increasing age and increasing BMI and lower education achievement compared to college education achievement are associated with diabetes. The addition of an acculturation and literacy interaction term to Model 4 was nonsignificant ($p = 0.82$) as well as a separate full model 4 with the interaction of acculturation and education ($p = 0.22$).

Table 3 shows the results of multivariable results of 148 diabetic Latinos on treatment for diabetes. Models 1–3 demonstrates no significant association between acculturation and a HbA1c 7 % (53 mmol/mol) but, the fully adjusted Model 4 shows that low acculturated participants were more likely to not be well controlled. The addition of an acculturation and literacy interaction term to Model 4 was nonsignificant ($p = 0.25$) as well as a separate full model 4 with the interaction of acculturation and education ($p = 0.53$).

Discussion

Among a primarily foreign born, Spanish speaking, mainly Caribbean Latino population with a long residence period in the US, universal health insurance and good health care access and utilization, we found that higher levels of acculturation were not associated with dysglycemia. Health literacy level did not modify this association. Importantly, in fully adjusted models, low education attainment remained significantly associated with

dysglycemia compared to college educated Latinos as has been found in prior studies [28]. Low acculturation was associated with worse diabetes control.

There are several possible explanations for these findings. First, Latinos are a heterogeneous racial and ethnic group representing multiple countries of origin with varying levels of education, socioeconomic status, and cultural traditions whose effects vary by the different regions of the US where they live. These factors influence the prevalence of dysglycemia and T2D across Latino subgroups. This within-Latino group heterogeneity has not been fully accounted for with most prior research primarily involving Mexican and Mexican Americans [4, 29]. The Hispanic Community Health Study/Study of Latinos (HCHS/SOL) has demonstrated important variation in diabetes and risk factor prevalence with Puerto Ricans and Dominicans having the highest prevalence of obesity and T2D [11]. Thus, our findings are probably more representative of Caribbean Latino subgroups in the Northeast of the US with insurance and good medical access and utilization.

Second, the association between acculturation and T2D is inconsistent among Latinos because of important moderating factors. NHANES based studies of Mexicans and Mexican Americans had high rates of uninsurance which may have confounded the acculturation associations. Mexican and Mexican Americans have a strong association between increasing T2D prevalence and higher acculturation due to increased rates of obesity from deleterious diets and low physical activity [29–32]. But these acculturation findings were partially moderated by SES status with low SES and low acculturated Mexican women having a higher prevalence of T2D and obesity compared to more acculturated and higher SES counterparts [31]. In addition, the prevalence of T2D is significantly increased in relation to length of residence in the US [33] and age and health at migration [34].

Our cohort is relatively homogeneous on many of these factors (e.g., country of origin, SES level, length of residence in the US and preferred language) allowing us to see the effects of acculturation in a distinct subgroup. However, this does not allow extrapolation to other Latino subgroups with differing characteristics. Historic and socioeconomic differences in migration patterns across Latino subgroups combined with differences in receiving communities likely impacts how acculturation operates in different subgroups [10]. As US citizens, the experience of Puerto Ricans in the Northeast with generations of migration will differ significantly from noncitizen Mexicans in the Southwest.

Third, acculturation is a complex multidimensional phenomenon and it has typically not been measured directly with the use of validated scales. The Bidimensional Acculturation Scale (BAS) for Hispanics used in our study is comprised of 12 items for two cultural dimensions—Hispanic and non-Hispanic domains—that measure language use, proficiency and electronic media use in those languages (i.e., television, radio). However, a language based scale may not fully capture health related attitudes, values and behaviors that are part of the causal pathway for T2D development. Language ability does not include the dynamic personal and communal networks that can be acquired over time in Latino dense areas that mitigate the barriers of low language proficiency. Increasing time in the US may also be associated with a mixture of beliefs and behaviors that could be “the best of both worlds [35].” Thus, higher acculturation has been associated with increased insurance coverage

with greater access to health care and use of preventive health services, and improved socioeconomic status [8]. Although 60 % of our sample had low acculturation, our participants were insured, had good access to healthcare and reported a median of four physician visits in the prior year. Access and intensity of medical care use may mitigate any acculturative differences reported in other studies. In addition, 93 % of those with low acculturation have been in the US 10 years or longer thus our cohort may also be reaping the benefits of US residence.

Our sample of low acculturated participants had high rates of inadequate literacy. Health literacy is a complex construct that operates through both system factors (i.e., access and use of healthcare, patient-provider interactions) and patient sociocognitive motivational (i.e., beliefs and attitudes) and volitional determinants (i.e., self-efficacy) [36, 37]. Beliefs and attitudes are associated with access to health information and knowledge and this is associated with action around task-specific skills such as T2D self-management activities. As a complex chain of interrelated factors, it is not surprising that health literacy and acculturation are not interrelated for dysglycemia in our analyses. Although low health literacy is consistently associated with poorer diabetes knowledge, recent systematic reviews document inconsistent evidence between health literacy and diabetes self-efficacy care and clinical outcomes in diabetes [38]. The association of low health literacy and poor diabetes knowledge might explain our finding of worse diabetes control among those with low acculturation who in our sample are more likely to have inadequate health literacy.

Our study has several possible limitations. First, BACH participants are primarily limited to Puerto Ricans and Dominicans. Prior research has demonstrated varying CVD risk factor distribution among Latinos by country of origin [39, 40]. However, this analysis is a unique scientific contribution given that there are few studies of T2D and acculturation effects among this Latino heritage group. Second, perhaps because of healthcare reform in Massachusetts (2006), our cohort had higher rates of insurance and health care access compared to other national (NHANES) and California based cohorts such as the California Health Interview Survey. However, disparities in CVD risk factor identification and management are well known and these disparities are only partially explained by insurance status and healthcare access. Thus, our study highlights the possible true effects of acculturation among Puerto Ricans and Dominicans without the confounder of uninsurance. Finally, this is a cross-sectional analysis limiting causal inference.

Our study has several important strengths to highlight. BACH uses a validated multidimensional acculturation instrument instead of proxy measures. Thus, our main exposure variable has a more precise and complete measurement. Similarly, our measure of health literacy is a validated and widely used scale. Second, our paper may be the only paper studying the effect of health literacy with acculturation on dysglycemia in Latinos.

New Contribution to the Literature

Our findings that higher levels of acculturation were not associated with dysglycemia in a primarily Caribbean foreign born cohort is important given the setting of universal health insurance and good health care access and utilization. The effect of acculturation is complex including both negative and positive influences. Our findings highlight that there is no

simple unified acculturative process that leads to one general negative health outcome. Universal access to high quality health care is an important factor for eliminating T2D disparities. Importantly, this effect was seen among a highly vulnerable subsection of Latinos in the US—foreign born, low income and primarily Spanish speaking Latinos [8]. Future research needs to investigate many other important socioeconomic and sociocultural factors that impact T2D prevalence and management. This paper focused on health literacy which did not mediate the association between dysglycemia and acculturation nor diabetes control. However, we found that low education attainment remained significantly associated with dysglycemia compared to college educated Latinos. Future studies will need to further decompose the effects of education and income beyond health literacy to include other factors such as social networks, social capital and resilience [7]. It will be important to continue to understand the relationship of acculturation with other interrelated socioeconomic and sociocultural factors that affect dysglycemia and its complications in order to develop successful culturally tailored interventions.

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References

1. American Diabetes Association. Standards of medical care in diabetes–2014. *Diabetes Care*. 2014; 37(Suppl. 1):S14–80. [PubMed: 24357209]
2. Levitzky YS, Pencina MJ, D'Agostino RB, et al. Impact of impaired fasting glucose on cardiovascular disease: the Framingham Heart Study. *J Am Coll Cardiol*. 2008; 51:254–70.
3. Gregg EW, Cadwell BL, Cheng YJ, et al. Trends in the prevalence and ratio of diagnosed to undiagnosed diabetes according to obesity levels in the US. *Diabetes Care*. 2004; 27:2806–12. [PubMed: 15562189]
4. Cowie CC, Rust KF, Ford ES, et al. Full accounting of diabetes and pre-diabetes in the U.S. population in 1988–1994 and 2005–2006. *Diabetes Care*. 2009; 32:287–94. [PubMed: 19017771]
5. Cowie CC, Rust KF, Byrd-Holt DD, et al. Prevalence of diabetes and high risk for diabetes using hemoglobin A1C criteria in the U.S. population in 1988–2006. *Diabetes Care*. 2010; 22:562–8. [PubMed: 20067953]
6. Boltri JM, Okosun IS, Davis-Smith M, Vogel RL. Hemoglobin A1c levels in diagnosed and undiagnosed black, Hispanic, and white persons with diabetes: results from NHANES 1999–2000. *Ethn Dis*. 2005; 15:562–7. [PubMed: 16259477]
7. Gonzalez LS, Berry DC, Davison JA. Diabetes self-management education interventions and glycemic control among hispanics: a literature review. *Hisp Health Care Int*. 2013; 11(4):157–66. DOI: 10.1891/1540-4153.11.4.157 [PubMed: 24831069]
8. Lara M, Gamboa C, Kahramanian MI, Morales LS, Bautista DE. Acculturation and Latino health in the United States: a review of the literature and its sociopolitical context. *Annu Rev Public Health*. 2005; 26:367–97. [PubMed: 15760294]
9. Zambrana RE, Carter-Pokras O. Role of acculturation research in advancing science and practice in reducing health care disparities among Latinos. *Am J Public Health*. 2010; 100:18–23. [PubMed: 19910358]
10. Thomson MD, Hoffman-Goetz L. Defining and measuring acculturation: a systematic review of public health studies with Hispanic populations in the United States. *Soc Sci Med*. 2009; 69:983–91. [PubMed: 19525050]

11. Daviglus ML, Talavera GA, Avilés-Santa ML, et al. Prevalence of major cardiovascular risk factors and cardiovascular diseases among Hispanic/Latino individuals of diverse backgrounds in the United States. *JAMA*. 2012; 308:1775–84. [PubMed: 23117778]
12. Ayala GX, Baquero B, Klinger S. A systematic review of the relationship between acculturation and diet among Latinos in the United States: implications for future research. *J Am Diet Assoc*. 2008; 108:1330–44. [PubMed: 18656573]
13. Nielsen-Bohlman, L.; Panzer, AM.; Kindig, DA. Health literacy: a prescription to end confusion. The National Academies Press; Washington, DC: 2004.
14. Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K. Low health literacy and health outcomes: an updated systematic review. *Ann Intern Med*. 2011; 155:97–107. [PubMed: 21768583]
15. Getaneh A, Light LS, Brillon DJ. Diabetes control among Hispanics in the action to control cardiovascular risk in diabetes trial. *J Gen Intern Med*. 2012; 27:1499–505. [PubMed: 22744725]
16. Fransen MP, Beune EJ, Baim-Lance AM, Bruessing RC, Essink-Bot ML. Diabetes self-management support for patients with low health literacy: perceptions of patients and providers. *J Diabetes*. 2014; doi: 10.1111/1753-0407.12191
17. McKinlay JB, Link CL. Measuring the urologic iceberg: Design and implementation of the Boston area community health (BACH) survey. *Eur Urol*. 2007; 52:389–96. [PubMed: 17383808]
18. Piccolo RS, Araujo AB, Pearce N, McKinlay JB. Cohort profile: the Boston area community health (BACH) survey. *Int J Epidemiol*. 2012; 43:42–51. [PubMed: 23220718]
19. Marin G, Gamba RJ. A new measurement of acculturation for Hispanics: the bidimensional acculturation scale for Hispanics (BAS). *Hisp J Behav Sci*. 1996; 18:297–316.
20. The Action to Control Cardiovascular Risk in Diabetes (ACCORD) Study Group. Long-term effects of intensive glucose lowering on cardiovascular outcomes. *N Engl J Med*. 2011; 364:818–28. [PubMed: 21366473]
21. Baker DW, Williams MV, Parker RM, Gazmararian JA, Nurss J. Development of a brief test to measure functional health literacy. *Patient Educ Couns*. 1999; 38:33–42. [PubMed: 14528569]
22. Nurss, JR.; Parker, RM.; Williams, MV.; Baker, DW. Test of functional health literacy in adults. 2nd ed. Peppercom Books & Press; Snow Camp, NC: 2001.
23. McKinlay, S.; Kipp, D.; Johnson, P.; Downey, K.; Carelton, R. A field approach for obtaining physiological measures in surveys of general populations: response rates, reliability and costs. *Health Survey Research Methods: proceedings of the fourth conference on Health Survey Research Methods*, Washington DC, 1982; Washington, DC. 1984. p. 195-204. DHHS Pub. No. (PHS) 84-3346
24. Rubin, DB. Multiple imputation for nonresponse in surveys. Wiley; New York: 1987.
25. Little, R.; Rubin, DB. Statistical analysis with missing data. Wiley; New York: 2002.
26. Schafer, J. Analysis of incomplete multivariate data. Chapman and Hall; New York: 1997.
27. van Buuren S, Groothuis-Oudshoorn K. mice: Multivariate imputation by chained equations in R. *J Stat Softw*. 2011; 45:1–67.
28. Golden SH, Brown A, Cauley JA, et al. Health disparities in endocrine disorders: biological, clinical, and nonclinical factors—an Endocrine Society scientific statement. *J Clin Endocrinol Metab*. 2012; 97:E1579–639. [PubMed: 22730516]
29. Meigs JB, Wilson PW, Nathan DM, D'Agostino RB Sr, Williams K, Haffner SM. Prevalence and characteristics of the metabolic syndrome in the San Antonio Heart and Framingham Offspring Studies. *Diabetes*. 2003; 52(8):2160–7. [PubMed: 12882936]
30. Kandula NR, Diez-Roux AV, Chan C, et al. Association of acculturation levels and prevalence of diabetes in the multi-ethnic study of atherosclerosis (MESA). *Diabetes Care*. 2008; 31:1621–8. [PubMed: 18458142]
31. Hazuda HP, Haffner SM, Stern MP, Eifler CW. Effects of acculturation and socioeconomic status on obesity and diabetes in Mexican Americans. The San Antonio Heart Study. *Am J Epidemiol*. 1988; 128:1289–301. [PubMed: 3195568]
32. Sundquist J, Winkleby MA. Cardiovascular risk factors in Mexican American adults: a transcultural analysis of NHANES III, 1988–1994. *Am J Public Health*. 1999; 89:723–30. [PubMed: 10224985]

33. Oza-Frank R, Stephenson R, Narayan KM. Diabetes prevalence by length of residence among US immigrants. *J Immigr Minor Health*. 2011; 13:1–8. [PubMed: 19688263]
34. Colón-López V, Haan MN, Aiello AE, Ghosh D. The effect of age at migration on cardiovascular mortality among elderly Mexican immigrants. *Ann Epidemiol*. 2009; 19:8–14. [PubMed: 18922703]
35. Schwartz SJ, Pantin H, Sullivan S, Prado G, Szapocznik J. Nativity and years in the receiving culture as markers of acculturation in ethnic enclaves. *J Cross Cult Psychol*. 2006; 37:345–53. [PubMed: 16799700]
36. Paasche-Orlow MK, Wolf MS. The causal pathways linking health literacy to health outcomes. *Am J Health Behav*. 2007; 31(Suppl. 1):S19–26. [PubMed: 17931132]
37. Fransen MP, von Wagner C, Essink-Bot ML. Diabetes self-management in patients with low health literacy: ordering findings from literature in a health literacy framework. *Patient Educ Couns*. 2012; 88:44–53. [PubMed: 22196986]
38. Al Sayah F, Majumdar SR, Williams B, Robertson S, Johnson JA. Health literacy and health outcomes in diabetes: a systematic review. *J Gen Intern Med*. 2013; 28:444–52. [PubMed: 23065575]
39. Borrell LN, Crawford ND, Dallo FJ, Baquero MC. Self-reported diabetes in Hispanic subgroup, non-Hispanic black, and non-Hispanic white populations: National Health Interview Survey, 1997–2005. *Public Health Rep*. 2009; 124:702–10. [PubMed: 19753948]
40. Pabon-Nau LP, Cohen A, Meigs JB, Grant RW. Hypertension and diabetes prevalence among US Hispanics by country of origin: the National Health Interview Survey 2000–2005. *J Gen Intern Med*. 2010; 25:847–52. [PubMed: 20490949]

Table 1

Characteristics of Latino participants by acculturation status

Characteristic [mean (SE) or percentage]	Low acculturation (N = 449)	High acculturation (N = 295)	<i>p</i>
Age, years (continuous)	52.2 (1.1)	48.2 (0.7)	0.001
Gender			
Male	42.6 %	50.0 %	0.26
Female	57.4 %	50.0 %	
BMI (continuous)	30.7 (0.4)	29.1 (0.7)	0.11
SBP, mmHg (continuous)	129.9 (1.0)	124.5 (1.5)	0.001
Total cholesterol (continuous)	190.3 (3.2)	188.4 (3.1)	0.66
Medications			
Insulin	4.3 %	5.0 %	0.66
Non-insulin diabetes medication	12.7 %	8.1 %	0.07
Presence of CAD ^d	15.8 %	11.9 %	0.25
Foreign born	97.1 %	73.4 %	<0.0001
Years in US			
5–10	6.7 %	2.8 %	0.001
10–15	17.0 %	7.6 %	
15–20	19.2 %	7.2 %	
>20	57.2 %	82.4 %	
First language			
English	0.0 %	18.9 %	<0.0001
Spanish	99.8 %	68.7 %	
Other	0.2 %	10.0 %	
Health literacy			
Inadequate	44.2 %	19.4 %	<0.0001
Marginal	13.5 %	10.2 %	
Adequate	42.2 %	70.4 %	
Education			
<High school	40.8 %	14.5 %	<0.0001
High school	43.3 %	29.3 %	
Technical or associates degree	10.5 %	25.2 %	
Bachelors or advanced degree	5.4 %	30.9 %	
Household income			
<\$30,000	79.3 %	40.1 %	<0.0001
\$30,000–\$59,999	17.8 %	30.5 %	
\$60,000	2.9 %	29.4 %	
Current smoker? (% yes)	17.7 %	18.2 %	0.93
Has usual place of care	93.8 %	96.1 %	0.52
Has any insurance	92.2 %	97.8 %	0.01
HbA1c 5.7 % (39 mmol/mol)	51.6 %	36.6 %	0.01

Characteristic [mean (SE) or percentage]	Low acculturation (N = 449)	High acculturation (N = 295)	<i>p</i>
<5.7 %	48.4 %	63.4 %	
HbA1c (continuous)	5.88 (0.05)	5.80 (0.06)	0.33

^a CAD includes MI, CHF, Stroke, TIA, Angina and PVD

Table 2
Multivariable models of the association between acculturation and () 5.7 vs.<5.7 %) (39 mmol/mol) among Latino participants

Characteristic	Model 1			Model 2			Model 3			Model 4		
	OR	95 % CI	p	OR	95 % CI	p	OR	95 % CI	p	OR	95 % CI	p
Acculturation												
Low	1.84	1.17, 2.91	0.009	1.35	0.84, 2.16	0.21	1.49	0.93, 2.39	0.09	0.93	0.56, 1.55	0.78
High	-	-	-	-	-	-	-	-	-	-	-	-
Health literacy												
Inadequate				3.64	2.14, 6.19	<0.001				1.62	0.88, 2.97	0.28
Marginal				1.81	0.98, 3.33					1.07	0.57, 1.99	
Adequate				-	-	-						
Age, year (continuous)							1.08	1.05, 1.10	<0.001	1.06	1.04, 1.09	<0.001
Male							1.04	0.66, 1.66	0.85	1.31	0.78, 2.21	0.31
Education												0.02
<High school										3.89	1.50, 10.11	
High school										2.03	0.84, 4.88	
Technical/associates										1.68	0.59, 4.81	
Bachelors+										-	-	-
BMI (continuous)										1.06	1.01, 1.12	0.02

Table 3

Multivariable models of the association between acculturation and HbA1c (7 vs. <7 %) (53 mmol/mol) among diabetics on treatment

Characteristic	Model 1			Model 2			Model 3			Model 4		
	OR	95 % CI	p	OR	95 % CI	p	OR	95 % CI	p	OR	95 % CI	p
Acculturation												
Low	0.40	0.15, 1.05	0.06	0.40	0.14, 1.12	0.08	0.41	0.14, 1.15	0.09	0.27	0.09, 0.80	0.018
High	-	-	-	-	-	-	-	-	-	-	-	-
Health literacy												0.92
Inadequate				1.14	0.38, 3.36	0.88				1.03	0.30, 3.55	
Marginal				1.42	0.37, 5.46					1.29	0.34, 4.96	
Adequate				-	-	-	-	-	-	-	-	-
Age, year (continuous)							0.99	0.94, 1.03	0.51	0.99	0.94, 1.03	0.49
Male							0.65	0.28, 1.49	0.31	0.76	0.32, 1.82	0.54
Education												0.30
<High school										11.65	0.76, 17.82	
High school										6.32	0.44, 9.72	
Technical/associates										5.02	0.29, 8.51	
Bachelors+										-	-	-
BMI (continuous)										0.99	0.92, 1.07	0.84