Title

Relation of Diabetes to Cognitive Function in Hispanics/Latinos of Diverse Backgrounds in the United States.

Journal

Journal of aging and health, 31(7)

ISSN

0898-2643

Authors

Elfassy, Tali
Aiello, Allison E
Schneiderman, Neil
et al.

Publication Date

2019-08-01

DOI

10.1177/0898264318759379

Peer reviewed

HHS Public Access

Author manuscript

J Aging Health. Author manuscript; available in PMC 2020 August 01.

Published in final edited form as:

J Aging Health. 2019 August ; 31(7): 1155–1171. doi:10.1177/0898264318759379.

Relation of Diabetes to Cognitive Function In Hispanics/Latinos of Diverse Backgrounds in the U.S.

Tali Elfassy, PhD[1], **Allison E. Aiello, PhD**[2], **Neil Schneiderman, PhD**[3], **Mary N. Haan, PhD**[4], **Wassim Tarraf, PhD**[5], **Hector M. González, PhD**[6], **Marc Gellman, PhD**[3], **Hermes J. Florez, MD, PhD**[1], **Jose A. Luchsinger, MD**[7,8], **Clinton B. Wright, MD**[9], **Ellen Grober, PhD**[10], **Adina Zeki Al Hazzouri, PhD.**[8]

[1]Department of Public Health Sciences, Division of Epidemiology, University of Miami.

[2]Department of Epidemiology, UNC Gillings School of Global Public Health, University of North Carolina at Chapel Hill.

[3]Department of Psychology, University of Miami.

[4]Department of Epidemiology & Biostatistics, University of California San Francisco.

[5]Institute of Gerontology and Department of Healthcare Sciences, Wayne State University.

[6]Department of Epidemiology and Biostatistics, Michigan State University.

[7]Department of Medicine, Columbia University Medical Center, New York

[8]Department of Epidemiology, Columbia University Mailman School of Public Health, New York

[9]Director of Division of Clinical Research, National Institute of Neurological Disorders and Stroke, Bethesda, MD (CW).

[10]Department of Neurology, Albert Einstein College of Medicine, NY (E.G.).

Abstract

Objectives: To examine the association between diabetes and cognitive function within US Hispanics/Latinos of Central American, Cuban, Dominican, Mexican, Puerto Rican and South American background.

Methods: This cross-sectional study included 9,609 men and women (mean age 56.5 years) who are members of the Hispanic Community Health Study/Study of Latinos. We classified participants as having diabetes, pre-diabetes, or normal glucose regulation. Participants underwent a neurocognitive battery consisting of tests of verbal fluency, delayed recall, and processing speed. Analyses were stratified by Hispanic/Latino subgroup.

Results: From fully-adjusted linear regression models, compared with having normal glucose regulation, having diabetes was associated with worse processing speed among Cubans (β=−1.99; 95%CI:−3.8;−0.19) and Mexicans (β=−2.26; 95%CI:−4.02;−0.51). Compared with having normal

Corresponding Author: Adina Zeki Al Hazzouri, PhD, Department of Epidemiology, Mailman School of Public Health, Columbia University, 722 West 168th Street, Room 513, New York, NY 10032, Phone: +01 (212)-304-7620, az2567@cumc.columbia.edu.

CONFLICT OF INTEREST:
None

glucose regulation, having pre-diabetes or diabetes was associated with worse delayed recall only among Mexicans (pre-diabetes:β=−0.34; 95%CI:−0.63;−0.05 and diabetes:β=−0.41; 95%CI: −0.79;−0.04). No associations with verbal fluency.

Discussion: The relationship between diabetes and cognitive function varied across Hispanic/Latino subgroup.

Keywords

Cognitive aging; Diabetes; Epidemiology; Minority Aging; Hispanics/Latinos

INTRODUCTION

Mounting evidence suggests that type-2 diabetes is associated with increased risk, in some instances double the risk, of cognitive decline and dementia.[1–3] While the exact underlying mechanisms remain relatively unclear, possible mechanisms linking type-2 diabetes to cognitive function include chronic hyperglycemia or hypoglycemia, insulin resistance, stroke and other cerebrovascular disease.[4,5] US Hispanics/Latinos are disproportionately affected by diabetes compared to non-Latino whites,[6,7] and previous work has shown that the prevalence of diabetes-related cognitive deterioration is higher in Hispanic/Latinos than in non-Latino whites.[8] Prior work on the relationship between diabetes and cognitive function in Hispanics/Latinos has focused primarily on Latinos of Mexican descent, including findings from the Hispanic Established Populations for the Epidemiologic Study of the Elderly[9] and the Sacramento Area Latino study on Aging.[10,11]

Yet, the US Hispanic and Latino population is heterogeneous, and prior evidence suggests that CVD risk factors and other older age health outcomes vary among Hispanic/Latino subgroups.[12–16] For example, earlier findings from the Hispanic Health and Nutrition Examination Survey have shown higher prevalence of diabetes for Mexican Americans and Puerto Ricans compared to Cubans[6]. More recent findings from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) have shown that the prevalence of major CVD risk factors,[17–19] including hypertension, obesity, diabetes, diet, and physical activity varied markedly across subgroups of Hispanics/Latinos. Despite such differences in common CVD risk factors by Hispanic/Latino subgroup, and numerous potential pathways underlying the association between diabetes and cognitive, it is currently unknown whether the association between diabetes and cognitive function differs across Hispanic/Latino subgroups.

In this study, we use data from a large population-based cohort of Hispanic/Latino adults in the US (ages 44–74 years) to investigate the associations between diabetes and cognitive function among Hispanics/Latinos of Central American, Cuban, Dominican, Mexican, Puerto Rican and South American background. We hypothesized that the association between diabetes and cognitive function would be stronger among Hispanics/Latinos with a greater CVD burden—particularly Puerto Ricans and Cubans.

METHODS

Study Population

The Hispanic Community Health Study/Study of Latinos (HCHS/SOL) is a population based study of 16,415 community dwelling self-identified Hispanic/Latinos of varying heritage. In brief, participants aged 18–74 were recruited in areas surrounding 4 field sites: Bronx, NY; Chicago, IL, Miami-Dade, FL; and San Diego, CA. A two-stage area probability sample of households was selected; stratification and over-sampling at each stage was used to attain appropriate representation of Hispanic/Latinos in the target population.[20] Detailed descriptions of the HCHS/SOL study and sample design have been published elsewhere.[20,21]

Participants underwent a comprehensive examination at baseline between years 2008–2011 during which they underwent a clinical examination, had fasting blood samples collected, answered a questionnaire pertaining to their medical history and health behaviors, and underwent a neurocognitive testing.[21] All participants provided informed consent and the study was approved by each study site Institutional Review Board. The present analysis was also approved by the Publications & Presentations committee of the HCHS/SOL study.

Assessment of diabetes

Fasting blood glucose (FPG) adjusted for fasting time was assessed using a hexokinase enzymatic method (Roche Diagnostics Corporation, Indianapolis, IN). A 2-hour OGTT (oral glucose tolerance test) was used to measure glucose tolerance among participants with a fasting plasma glucose < 150 mg/dL. And glycosylated hemoglobin (A1c) was measured in EDTA whole blood using a Tosoh G7 automated high-performance liquid chromatography analyzer (Tosoh Bioscience Inc., San Francisco, CA).

Diabetes status/impaired glucose classification was defined based on the American Diabetes Association criteria,[22] and thus participants were classified as having “diabetes” if one of the following criterion were met: FPG ≥ 126 mg/dL, 2-hour post load OGTT level ≥ 200 mg/dL, A1C ≥ 6.5%, or use of diabetes medication (documented through scanned medications). Otherwise, individuals were classified as having “impaired glucose tolerance or prediabetes” if one of the following criterion were met: FPG in the range of 100–125 mg/dL, or 2-hour post load OGTT level in the range of 140 – 199 mg/dL, or A1C in the range of 5.7% - 6.5%. Participants were classified as having “normal glucose regulation” if one of the following criterion were met: FPG < 100mg/dL, 2-hour post load OGTT level < 140 mg/dL, or A1C < 5.7%.

Assessment of cognitive function

Study participants aged 44 years or older were administered a neurocognitive battery that included three tests. All tests were administered in the participant’s preferred language. The Brief-Spanish-English Verbal Learning Test (B-SEVLT) assesses the ability to memorize and retrieve words.[23] For this task, participants were asked to recall a list of 15 common words over three trials. Recall of the words were requested again after a short delay, during which a distractor list was read. The number of words retrieved in the delayed recall test was then analyzed. The Word Fluency (WF) Tests of the Multilingual Aphasia Examination

measures verbal functioning.[24] During this task, participants were asked to produce as many words as possible that begin with the letters F and A within 60 seconds. The Digit Symbol Substitution Test (DSST) is a subtest of the Wechsler Adult Intelligence Scale-Revised and it measures processing speed and sustained attention.[25] For this task, participants were asked to translate digits (1–9) into symbols, using a key, with a maximum of 90 seconds. Cognitive test scores were analyzed in their raw form. Higher scores on all tests indicated better performance. Details of the neurocognitive battery have been published elsewhere.[26]

Heritage and other covariates

Questionnaires administered as part of the baseline visit were used to obtain information on heritage/ancestry. Heritage was characterized as the following categories: Dominicans, Central Americans, Cubans, Mexicans, Puerto Ricans and South Americans. HCHS/SOL participants reported their age, sex, educational attainment, language of preference (Spanish vs. English), nativity (born in the 50 US States vs. foreign-born), smoking status (never, current, or former), and history of stroke or transient ischemic attack. Physical activity was assessed with the modified version of the World Health Organization Global Physical Activity Questionnaire, and participants were coded as either meeting or not the 2008 guidelines (at least the equivalent of 150 mins/week of moderate intensity or 75mins/week of vigorous intensity physical activity). Measured height and weight were used to calculate body mass index (BMI in kg/m^2), and obesity was defined as having a BMI ≥ 30 kg/m^2. Waist circumference (WC in cm) was measured at the iliac crest using Gulick II 150 and 250 cm anthropometric tape and rounded to the nearest cm. Abdominal obesity or having a large waist was defined as a WC ≥ 102 cm in men and WC > 88 cm in women. Three seated blood pressure measurements were taken using an automatic sphygmomanometer (OMRON HEM-907 L) and then averaged. Hypertension was defined as having systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg, or documented use of anti-hypertension medication through scanned medications.

Statistical Analysis

Of the 9,618 participants age 44 or older who were administered the neurocognitive battery, 143 (or 1.5% of the sample) had missing data for one or more covariates (Hispanic/Latino subgroup, education, language preference, nativity, BMI, waist circumference, cigarette use, physical activity, history of stroke, or diabetes) and were excluded from the analysis. The final analytical sample included 9,475 individuals.

Sample characteristics, including diabetes characteristics were assessed across Hispanic/Latino subgroup, and differences across subgroups were assessed using chi-square tests for proportions and ANOVAs for means. Given the study population sampling scheme (described earlier), these estimates were age standardized to the US Standard 2010 population.[27] The relationship between diabetes and cognitive function (especially B-SEVLT cognitive test) significantly varied by Hispanic/Latino subgroup (p-value of interaction <0.05); and thus all models were stratified by Hispanic/Latino subgroup. We then used multivariable linear regression models to examine the association between diabetes status and cognitive function, within Hispanic/Latino subgroup, and adjusted for potential confounders based on a priori literature and their association with diabetes and cognition.

We first adjusted for socio-demographic variables, including age, sex, education, nativity, and language of prefrence, and then added adjustment for behavioral and cardiovascular disease risk factors, including smoking status, BMI, large waist circumference, physical activity, hypertension, and stroke/TIA. All analyses were conducted in SUDAAN version 11.0.1 (Research Triangle Park, NC), to account for the complex survey design of the HCHS/SOL study. Significance testing was 2-sided with 5% significance level.

RESULTS

Mean age in the sample differed by Hispanic/Latino subgroup ($p<0.01$) (Table 1). South Americans were most likely to have had more than a high school education (50.1%), compared with other groups ($p<0.01$). Spanish language was overwhelmingly preferred by most subgroups, except in Puerto-Ricans (only 56.5% of whom preferred Spanish). Likewise, the majority of participants were foreign-born, with Puerto-Ricans and Mexicans being more likely to be US born, compared to others ($p<0.01$). South Americans had significantly the lowest prevalence of diabetes (19.6%), obesity (37.4%), and hypertension (35.8%), compared with other subgroups.

The distribution of key risk factors of cognitive function among participants with diabetes differed across Hispanic/Latino subgroups (Figure 1). For example, participants of Cuban heritage who have diabetes were more likely to be smokers and less physically active than other Hispanic/Latino subgroups with diabetes.

From fully-adjusted linear regression models stratified by Hispanic/Latino subgroup (Table 2), compared with having normal glucose regulation, having diabetes was associated with lower DSST score (processing speed) among Cubans ($\beta=-1{\cdot}99$; 95%CI: $-3{\cdot}8;-0{\cdot}19$) and Mexicans ($\beta=-2{\cdot}26$; 95%CI: $-4{\cdot}02;-0{\cdot}51$). Compared with having normal glucose regulation, having pre-diabetes or diabetes was associated with lower B-SEVLT score (delayed recall) only among Mexicans (pre-diabetes: $\beta=-0{\cdot}34$; 95%CI: $-0{\cdot}63;-0{\cdot}05$; diabetes: $\beta=-0{\cdot}41$; 95%CI: $-0{\cdot}79;-0{\cdot}04$), from fully-adjusted models. We found no association between diabetes status and word fluency, among all Hispanic/Latino subgroups.

DISCUSSION

This is the first study, to our knowledge, to examine the relationship between diabetes and cognitive function within diverse Hispanics/Latinos. An added advantage is that each subgroup has a large enough sample size to permit subsample analysis. The diabetes-cognition relationship varied by heritage and was mostly significant among Mexicans and Cubans. Among Mexicans, having diabetes or even pre-diabetes was significantly associated with worse cognitive performance on domains of processing speed and attention (DSST) and verbal memory (B-SEVLT) but not on language. All significant associations were independent of key risk factors of cognitive function, including education and vascular factors, thus suggesting that they do not fully account for these associations. Pathways resulting in diabetes-related cognitive deficit may not be necessarily the same across Hispanics/Latinos who are heterogeneous with regard to heritage, nativity, language, and other behavioral and social determinants of diabetes and cognition.

Our findings are consistent with evidence from previous studies among older adult Latinos, particularly among Mexican Americans, showing that diabetes is associated with worse cognitive performance.[9,11,28] Recent findings from the Washington Heights-Inwood Columbia Aging Project, a multi-ethnic cohort, found significant associations between diabetes and worse cognitive performance and mild cognitive impairment.[20,29] The risk of cognitive impairment attributable to diabetes in this population from Northern Manhattan has been reported to be particularly high among Hispanics and Blacks compared to whites, with disparities in diabetes partially explaining disparities in cognitive impairment.[8] In a sample of middle-aged Hispanics, majority Dominicans, diabetes and pre-diabetes were associated with worse cognitive function in multiple domains, including memory and executive function.[30] The latter finding is not consistent with our study in which we did not find a diabetes-cognition association in Dominicans. In an analysis of the Northern Manhattan Study (NOMAS), diabetes was not associated with cognitive function after adjusting for potential confounders.[31] While NOMAS is a multi-ethnic study, the association of diabetes with cognitive function was not explored within racial/ethnic subgroups.

The mechanisms underlying the association of diabetes with worse cognitive performance and with higher risk of dementia remain relatively unclear. Studies have shown that persons with diabetes have a greater risk of stroke[4,5] and cerebral infarcts.[32,33] Diabetes has also been linked to accumulation or impaired clearance of brain amyloid.[34] In addition, whether diabetes is a cerebrovascular risk factor or a risk factor for Alzheimer pathology or both remains debatable. However, our findings, showing significant diabetes-related cognitive deficit on processing speed and attention among Mexican and Cuban Americans, suggest an underlying cerebrovascular mechanism. In other Hispanic/Latino sub-groups, for example among Hispanic/Latinos of Dominican, Central American, Puerto Rican, and South American heritage, diabetes was not associated with cognition but rather the association was fully explained by socio-demographic factors.

In this study, there are a few limitations worth noting. This is a cross-sectional analysis and we did not have repeated measures of cognitive function and thus could not examine cognitive change which is important for understanding how diabetes plays a role in the etiology of cognitive decline and development of dementia. Our study did not provide a comprehensive assessment of all cognitive domains and we did not have neuroimaging data or biomarkers for Alzheimer's disease, and as such we could not directly address mechanisms. However, the cognitive tests covered several domains that enabled us to indirectly examine mechanisms. In our cohort, similar to what is observed in the literature, persons with diabetes have lower educational attainment than those with normal glucose regulation (data not shown), which may reflect decreased cognitive reserve and resilience to cognitive deterioration, vascular and AD pathology.[35,36] And it is those individuals that showed the worst diabetes-related cognitive function. In addition to less cognitive reserve, it is possible that those individuals had limited experience with strategies of test taking which in turn may compromise their performance. However, we acknowledge that while we adjusted for education in the current analyses, our measure does not reflect the quality of education. Furthermore, we did not have data regarding country of primary educational attainment which may ultimately influence cognitive performance.

All significant associations were independent of key risk factors, including education and vascular factors. However, pathways resulting in diabetes-related cognitive deficit, including experiences of diabetes, may not be necessarily the same across Latinos who are heterogeneous with regard to background, nativity, language, and other social determinants of diabetes and cognition. While we adjusted for key risk factors, it is possible that they resulted in a cascade of risk through other unmeasured pathways, thus resulting in the different diabetes-cognition relationship across subgroups. Finally, there could be residual confounding due to unmeasured shared determinants of both diabetes and cognition, including early life confounders that could have influenced peak cognitive performance earlier in life. While language preference and nativity could be potential modifiers of the diabetes-cognitive function relationship, the majority of the participants were spanish-speaker and foreign-born which limited our power to conduct those analyses.

Despite these limitations, the present study has several strengths that contribute to existing literature on the relationship between diabetes and cognition. This is the first study to report such associations among six large Hispanic/Latino subgroups, known to be heterogeneous with regard to key risk factors of diabetes and cognition. The latter is particularly important given the evidence that the prevalence of cognitive deficit attributable to diabetes is disproportionately distributed across ethnic groups. Our measure of diabetes followed the guideline by the American Diabetes Association and was based on fasting glucose, HbA1c and OGTT as well as medication use. A major strength of this study is the large sample size which accommodates within Hispanic/Latino subgroup analyses, unlike any other previous study. Finally, our cohort included a wide age range capturing not only older age but also middle-age, a period during which the prevalence of diabetes and prediabetes increases, thus facilitating the study of diabetes-related cognitive deficit.

In summary, we found that the diabetes-cognition relationship varied across Hispcanic/Latino subgroups and was mostly significant among Mexicans and Cubans. Among Mexicans, having diabetes or even pre-diabetes was significantly associated with worse cognitive performance on domains of processing speed and attention (DSST test) and verbal memory (B-SEVLT), suggesting an underlying cerebrovascular mechanism. Our findings suggest that the association between diabetes and cognitive function is at least partially independent of vascular pathways, and that less cognitive reserve along with other unmeasured pathways and residual confounding could account for the observed associations. To our knowledge, this is the first study of Hispanics/Latinos with large enough sample size to accommodate within subgroup investigation of the relationship between diabetes and cognition. This study lays foundation for future research to investigate those associations within subgroups of Hispanics/Latinos whenever possible, and to explore potential underlying mechanisms by which diabetes may differentially influence cognition within Hispanics/Latinos.

REFERENCES

1. Cukierman T, Gerstein HC, Williamson JD. Cognitive decline and dementia in diabetes--systematic overview of prospective observational studies. Diabetologia. 2005;48(12):2460–2469. [PubMed: 16283246]

2. Biessels GJ, Strachan MW, Visseren FL, Kappelle LJ, Whitmer RA. Dementia and cognitive decline in type 2 diabetes and prediabetic stages: towards targeted interventions. The lancet Diabetes & endocrinology. 2014;2(3):246–255. [PubMed: 24622755]

3. Chen L, Magliano DJ, Zimmet PZ. The worldwide epidemiology of type 2 diabetes mellitus--present and future perspectives. Nature reviews Endocrinology. 2012;8(4):228–236.

4. Boden-Albala B, Cammack S, Chong J, et al. Diabetes, fasting glucose levels, and risk of ischemic stroke and vascular events: findings from the Northern Manhattan Study (NOMAS). Diabetes Care. 2008;31(6):1132–1137. [PubMed: 18339972]

5. Manschot SM, Brands AM, van der Grond J, et al. Brain magnetic resonance imaging correlates of impaired cognition in patients with type 2 diabetes. Diabetes. 2006;55(4):1106–1113. [PubMed: 16567535]

6. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999–2010. Jama. 2012;307(5):491–497. [PubMed: 22253363]

7. Knowlden AP, Sharma M. Systematic review of school-based obesity interventions targeting African American and Hispanic children. Journal of health care for the poor and underserved. 2013;24(3):1194–1214. [PubMed: 23974391]

8. Noble JM, Manly JJ, Schupf N, Tang MX, Luchsinger JA. Type 2 diabetes and ethnic disparities in cognitive impairment. Ethnicity & disease. 2012;22(1):38–44. [PubMed: 22774307]

9. Nguyen HT, Black SA, Ray LA, Espino DV, Markides KS. Predictors of decline in MMSE scores among older Mexican Americans. The journals of gerontology Series A, Biological sciences and medical sciences. 2002;57(3):M181–185.

10. Mayeda ER, Haan MN, Kanaya AM, Yaffe K, Neuhaus J. Type 2 diabetes and 10-year risk of dementia and cognitive impairment among older Mexican Americans. Diabetes Care. 2013;36(9):2600–2606. [PubMed: 23514732]

11. Mayeda ER, Haan MN, Yaffe K, Kanaya AM, Neuhaus J. Does type 2 diabetes increase rate of cognitive decline in older Mexican Americans? Alzheimer disease and associated disorders. 2015;29(3):206–212. [PubMed: 25650694]

12. Diez Roux AV, Detrano R, Jackson S, et al. Acculturation and socioeconomic position as predictors of coronary calcification in a multiethnic sample. Circulation. 2005;112(11):1557–1565. [PubMed: 16144996]

13. 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(8):1621–1628. [PubMed: 18458142]

14. Mainous AG 3rd, Majeed A, Koopman RJ, et al. Acculturation and diabetes among Hispanics: evidence from the 1999–2002 National Health and Nutrition Examination Survey. Public Health Reports. 2006;121(1):60–66. [PubMed: 16416699]

15. Morales LS, Leng M, Escarce JJ. Risk of cardiovascular disease in first and second generation Mexican-Americans. J Immigr Minor Health. 2011;13(1):61–68. [PubMed: 19466546]

16. Bethel JW, Schenker MB. Acculturation and smoking patterns among Hispanics: a review. Am J Prev Med. 2005;29(2):143–148. [PubMed: 16005811]

17. Arredondo EM, Sotres-Alvarez D, Stoutenberg M, et al. Physical Activity Levels in U.S. Latino/Hispanic Adults: Results From the Hispanic Community Health Study/Study of Latinos. Am J Prev Med. 2016;50(4):500–508. [PubMed: 26597505]

18. Daviglus ML, Talavera GA, Aviles-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(17):1775–1784. [PubMed: 23117778]

19. Siega-Riz AM, Sotres-Alvarez D, Ayala GX, et al. Food-group and nutrient-density intakes by Hispanic and Latino backgrounds in the Hispanic Community Health Study/Study of Latinos. The American journal of clinical nutrition. 2014;99(6):1487–1498. [PubMed: 24760972]

20. Lavange LM, Kalsbeek WD, Sorlie PD, et al. Sample design and cohort selection in the Hispanic Community Health Study/Study of Latinos. Ann Epidemiol. 2010;20(8):642–649. [PubMed: 20609344]

21. Sorlie PD, Aviles-Santa LM, Wassertheil-Smoller S, et al. Design and implementation of the Hispanic Community Health Study/Study of Latinos. Ann Epidemiol. 2010;20(8):629–641. [PubMed: 20609343]
22. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2010;33 Suppl 1:S62–69. [PubMed: 20042775]
23. Gonzalez HM, Mungas D, Reed BR, Marshall S, Haan MN. A new verbal learning and memory test for English- and Spanish-speaking older people. Journal of the International Neuropsychological Society: JINS. 2001;7(5):544–555. [PubMed: 11459106]
24. Spreen OSE. A compendium of neuropsychological tests: Administration, normas, and commentary. 2nd edition New York: Oxford University Press; 1998.
25. Wechsler D Wechsler Adult Intelligence Scale-III (WAIS-III). San Antonio, TX: Psychological Corporation; 1997.
26. Gonzalez HM, Tarraf W, Gouskova N, et al. Neurocognitive function among middle-aged and older Hispanic/Latinos: results from the Hispanic Community Health Study/Study of Latinos. Archives of clinical neuropsychology: the official journal of the National Academy of Neuropsychologists. 2015;30(1):68–77. [PubMed: 25451561]
27. US Department of Commerce. Age and Sex Composition: 2010. Economics and Statistics Administration. US Census Bureau 2011 http://www.census.gov/prod/cen2010/briefs/c2010br-03.pdf
28. Wu JH, Haan MN, Liang J, Ghosh D, Gonzalez HM, Herman WH. Impact of diabetes on cognitive function among older Latinos: a population-based cohort study. J Clin Epidemiol. 2003;56(7):686–693. [PubMed: 12921938]
29. Luchsinger JA, Reitz C, Patel B, Tang MX, Manly JJ, Mayeux R. Relation of diabetes to mild cognitive impairment. Arch Neurol. 2007;64(4):570–575. [PubMed: 17420320]
30. Luchsinger JA, Cabral R, Eimicke JP, Manly JJ, Teresi J. Glycemia, Diabetes Status, and Cognition in Hispanic Adults Aged 55–64 Years. Psychosom Med. 2015;77(6):653–663. [PubMed: 26163818]
31. Vieira JR, Elkind MS, Moon YP, et al. The metabolic syndrome and cognitive performance: the Northern Manhattan Study. Neuroepidemiology. 2011;37(3–4):153–159. [PubMed: 22005335]
32. Arvanitakis Z, Schneider JA, Wilson RS, et al. Diabetes is related to cerebral infarction but not to AD pathology in older persons. Neurology. 2006;67(11):1960–1965. [PubMed: 17159101]
33. Peila R, Rodriguez BL, Launer LJ, Honolulu-Asia Aging S. Type 2 diabetes, APOE gene, and the risk for dementia and related pathologies: The Honolulu-Asia Aging Study. Diabetes. 2002;51(4):1256–1262. [PubMed: 11916953]
34. Selkoe DJ. The origins of Alzheimer disease: a is for amyloid. JAMA. 2000;283(12):1615–1617. [PubMed: 10735401]
35. Stern Y What is cognitive reserve? Theory and research application of the reserve concept. Journal of the International Neuropsychological Society: JINS. 2002;8(3):448–460. [PubMed: 11939702]
36. Bangen KJ, Gu Y, Gross AL, et al. Relationship Between Type 2 Diabetes Mellitus and Cognitive Change in a Multiethnic Elderly Cohort. J Am Geriatr Soc. 2015;63(6):1075–1083. [PubMed: 26096383]

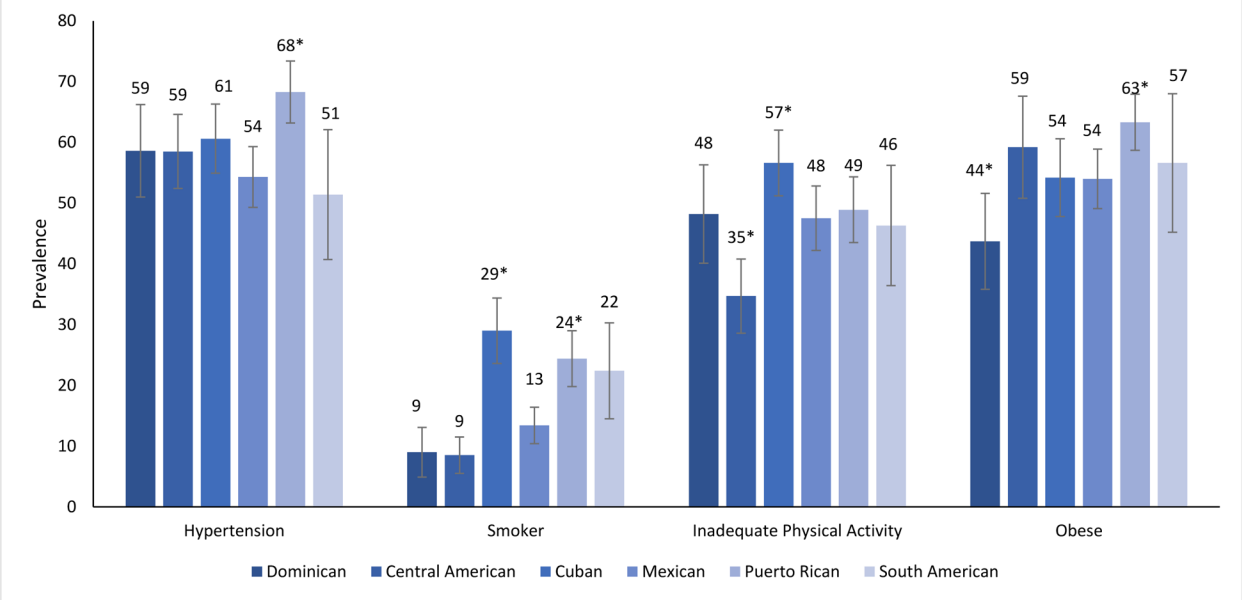

Figure 1.

Age adjusted prevalence of risk factors among HCHS/SOL participants with diabetes, across Hispanic/Latino subgroup.

*Indicates the age-adjusted estimate is significantly different from Mexican, $p < 0.05$.

J Aging Health. Author manuscript; available in PMC 2020 August 01.

Table 1:

Age-standardized baseline characteristics of the study population, by Hispanic/Latino subgroup.

	Dominican n=852 (9.4%)	Central American n= 941 (6.6%)	Cuban n=1,557 (27.3%)	Mexican n=3,545 (30.8%)	Puerto Rican n=1,743 (18.1%)	South American n=646 (5.6%)	*P-Value*
	Mean (SE) or % (SE)						
Sociodemographic characteristics							
Age (years)	55.4 (0.4)	55.7 (0.4)	58.2 (0.3)	55.3 (0.2)	56.9 (0.3)	55.8 (0.5)	**<0.01**
Female	60.1 (2.1)	61.2 (2.1)	48.4 (1.3)	56.5 (1.4)	54.4 (1.4)	60.6 (2.3)	**<0.01**
Education							
Less than High School	50.1 (2.2)	45.9 (2.3)	27.2 (1.3)	49.9 (2.0)	43.3 (2.0)	25.8 (2.3)	**<0.01**
High School Graduate	17.3 (1.4)	17.8 (1.7)	25.97 (1.4)	16.7 (1.1)	23.2 (1.4)	23.9 (2.3)	
More than High School	32.7 (2.2)	36.3 (2.2)	47.1 (1.4)	33.4 (1.9)	33.4 (2.0)	50.3 (2.6)	
Spanish language preferred	96.1 (0.8)	96.0 (1.1)	97.4 (0.5)	87.2 (1.1)	56.5 (2.3)	95.4 (1.0)	**<0.01**
Foreign-born	99.4 (0.2)	99.6 (0.2)	98.6 (0.4)	89.2 (0.9)	73.5 (1.5)	99.0 (0.4)	**<0.01**
Diabetes characteristics							
Diabetes (ADA definition)	31.5 (1.9)	31.8 (2.3)	24.8 (1.3)	30.1 (1.4)	31.2 (1.7)	19.6 (1.9)	**<0.01**
Fasting glucose							
< 100 mg/dL	52.7 (2.1)	50.9 (2.4)	53.6 (1.4)	54.0 (1.4)	50.3 (1.9)	58.7 (2.6)	**<0.01**
≥100 and <126 mg/dL	34.7 (2.1)	33.3 (2.2)	35.1 (1.3)	31.4 (1.4)	33.21 (1.7)	32.9 (2.5)	
≥126 mg/dL	12.6 (1.5)	15.8 (1.8)	11.3 (1.0)	14.6 (1.0)	16.4 (1.2)	8.4 (1.5)	
A1C[a]							
<5·7%	32.9 (1.8)	38.3 (2.1)	48.4 (1.5)	36.7 (1.2)	38.3 (1.9)	48.0 (2.3)	**<0.01**
≥5·7% and <6·5%	45.1 (2.4)	40.7 (2.2)	36.5 (1.3)	42.6 (1.4)	39.0 (1.7)	40.8 (2.4)	
≥6·5%	22.0 (1.9)	20.9 (2.1)	15.0 (1.1)	20.6 (1.2)	22.8 (1.4)	11.1 (1.7)	
A1C control[a] (<7%)	84.5 (2.0)	84.0 (2.0)	90.7 (0.9)	85.8 (1.0)	83.1 (1.2)	92.0 (1.5)	**<0.01**
Other health characteristics							
Obese	41.7 (2.4)	42.7 (2.4)	40.8 (1.4)	40.3 (1.3)	49.5 (1.9)	37.4 (2.5)	**<0.01**
Large waist circumference	59.6 (2.5)	61.7 (2.3)	61.9 (1.4)	64.7 (1.3)	64.8 (1.7)	56.4 (2.5)	**0.02**
Current smoker	10.4 (1.6)	13.1 (1.5)	30.3 (1.7)	13.6 (1.0)	28.9 (1.7)	14.2 (1.7)	**<0.01**
Physical activity	601.5 (53.0)	574.3 (35.0)	420.7 (23.4)	550.8 (26.1)	463.2 (26.0)	487.8 (40.9)	**<0.01**
Hypertension	48.2 (2.6)	44.2 (1.8)	49.3 (1.3)	37.6 (1.7)	49.3 (1.6)	35.8 (2.3)	**<0.01**

	Dominican n=852 (9.4%)	Central American n= 941 (6.6%)	Cuban n=1,557 (27.3%)	Mexican n=3,545 (30.8%)	Puerto Rican n=1,743 (18.1%)	South American n=646 (5.6%)	*P-Value*
			Mean (SE) or % (SE)				
Stroke/TIA	6.0 (1.1)	4.8 (1.1)	4.1 (0.5)	2.3 (0.4)	6.4 (0.8)	2.5 (0.9)	**<0.01**

Note. Except for age, all variables are age-standardized to US 2010 Census population, using the following age groups and proportions: 45–49: 0.220038; 50–54: 0.216061; 55–59: 0.190545; 60–64: 0.210396; 65+: 0.210396.

[a]A1C of 5·7% corresponds to 39 mmol/mol; 6·5% corresponds to 48 mmol/mol; 7% corresponds to 53 mmol/mol

Table 2.

Multivariable associations between diabetes status and cognitive function, by Hispanic/Latino subgroup.

	Overall N=9,475	Dominican n=852	Central American n=941	Cuban n=1,557	Mexican n=3,545	Puerto Rican n=1,743	South American n=646
				β (95%CI)			
Word Fluency (range: 0–49)							
Sociodemographic-adjusted *							
Normal	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Prediabetes	−0.06 (−0.55, 0.43)	0.35 (−1.00, 1.70)	−1.05 (−2.33, 0.24	0.49 (−0.36, 1.34)	−0.73 (−1.65, 0.18)	0.48 (−1.12, 2.08)	0.37 (−1.08, 1.82)
Diabetes	**−0.88 (−1.44, −0.33)**	0.12 (−1.56, 1.80)	−0.95 (−2.70, 0.80)	−0.65 (−1.69, 0.39)	**−1.62 (−2.67, −0.57)**	−0.27 (−1.52, 0.97)	−0.84 (−2.58, 0.90)
Fully-Adjusted †							
Normal	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Prediabetes	0.08 (−0.39, 0.56)	0.45 (−0.85, 1.75)	−0.89 (−2.17, 0.39)	0.54 (−0.35, 1.43)	−0.45 (−1.38, 0.48)	0.55 (−0.94, 2.03)	0.84 (−0.59, 2.26)
Diabetes	−0.49 (−1.08, 0.11)	0.25 (−1.51, 2.02)	−0.62 (−2.45, 1.22)	−0.46 (−1.54, 0.62)	−1.04 (−2.17, 0.08)	0.18 (−1.19, 1.55)	0.26 (−1.48, 2.00)
B-SEVLT (range: 0–15)							
Sociodemographic-adjusted *							
Normal	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Prediabetes	0.08 (−0.10, 0.26)	−0.29 (−0.90, 0.32)	0.16 (−0.35, 0.67)	**0.40 (0.06, 0.74)**	**−0.30 (−0.58, −0.02)**	0.21 (−0.32, 0.75)	0.37 (−0.13, 0.87)
Diabetes	−0.06 (−0.26, 0.15)	−0.44 (−1.21, 0.32)	0.18 (−0.42, 0.77)	0.11 (−0.31, 0.53)	−0.35 (−0.71, 0.00)	0.31 (−0.19, 0.81)	0.00 (−0.68, 0.67)
Fully-Adjusted †							
Normal	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Prediabetes	0.07 (−0.12, 0.25)	−0.21 (−0.85, 0.42)	0.19 (−0.34, 0.73)	**0.36 (0.02, 0.71)**	**−0.34 (−0.63, −0.05)**	0.20 (−0.33, 0.72)	0.49 (−0.02, 1.01)
Diabetes	−0.06 (−0.28, 0.17)	−0.31 (−1.08, 0.46)	0.26 (−0.42, 0.93)	0.04 (−0.41, 0.49)	**−0.41 (−0.79, −0.04)**	0.31 (−0.21, 0.82)	0.26 (−0.49, 1.01)
DSST (range: 0–83)							
Sociodemographic-adjusted *							
Normal	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Prediabetes	−0.42 (−1.14, 0.29)	−0.37 (−2.18, 1.43)	1.02 (−1.12, 3.17)	−1.05 (−2.71, 0.62)	−0.95 (−2.21, 0.31)	0.45 (−1.22, 2.13)	0.63 (−1.65, 2.91)
Diabetes	**−1.77 (−2.60, −0.93)**	−1.65 (−3.91, 0.60)	−0.50 (−2.75, 1.76)	**−2.05 (−3.80, −0.30)**	**−2.56 (−4.15, −0.98)**	−1.36 (−3.07, 0.36)	1.43 (−1.54, 4.40)
Fully-Adjusted †							
Normal	Ref	Ref	Ref	Ref	Ref	Ref	Ref

	Overall N=9,475	Dominican n=852	Central American n=941	Cuban n=1,557	Mexican n=3,545	Puerto Rican n=1,743	South American n=646
				β (95%CI)			
Prediabetes	−0.39 (−1.13, 0.36)	−0.39 (−2.14, 1.35)	0.91 (−1.21, 3.03)	−1.03 (−2.75, 0.70)	−0.80 (−2.11, 0.52)	0.34 (−1.39, 2.07)	0.81 (−1.47, 3.09)
Diabetes	**−1.56 (−2.45, −0.68)**	−1.54 (−3.65, 0.58)	−0.54 (−3.01, 1.93)	**−1.99 (−3.80, −0.19)**	**−2.26 (−4.02, −0.51)**	−1.27 (−3.17, −0.63)	2.16 (−0.85, 5.16)

*Adjusts for age, sex, education, language, nativity, overall model additionally adjusts for Hispanic/Latino subgroup..

†Additionally adjusts for BMI, large waist circumference, smoking, physical activity, hypertension, stroke/TIA.

DSST: Digit Symbol Substitution Test. B-SEVLT: Brief Spanish English Verbal Learning Test.

P-values for interaction between diabetes and Hispanic/Latino subgroup for models 1 and 2 respectively were: 0.25 and 0.30 for Word fluency, 0.01 and 0.03 for B-SEVLT, and 0.68 and 0.39 for DSST.